COURSE CATALOGUE

Undergraduate and Postgraduate Courses

DR. KHEM SINGH GILL AKAL COLLEGE OF AGRICULTURE

Eternal University, Baru Sahib, Sirmour (H.P.) 173101

DECEMBER, 2022

FOREWARD

Sponsored by The *Kalgidhar Trust* and established by *Himachal Pradesh Government Act No. 3 of 2009,* **Eternal University** is one of the first private and residential universities in northern India exclusively for girl students providing the secure educational environment for academic and spiritual development of the students. The University with its seven constituent colleges is duly recognized by UGC, AICTE, ICAR, INC, NCTE, DSIR, DBT and accredited by NAAC. Keeping in view the importance of Agriculture sector in India, the University started the first private College of Agriculture. Akal College of Agriculture now known as Dr. Khem Singh Gill Akal College of Agriculture began its journey in 2014 with 33 students in B.Sc. (Hons.) Agriculture and has now over 350 students registered under different undergraduate and post graduate programmes. The college was started with the aim of not only teaching students the various aspects of agriculture, but also to serve the issues related to various crops to the local population of this backward district (Sirmaur) of Himachal Pradesh. All the agricultural students are given extensive exposure to awareness of the latest agricultural development, training, hands-on experience and skill development through field training, Rural Agricultural Work Experience, SAUs KVK training, Experiential Learning, industrial and agricultural institution visits.

The University has established a Plant and Soil Health Clinic at the campus to provide instant diagnostic service to the local farmers on pest and diseases and package and practices of the important fields, fruit and vegetables crops of the region. Clusters of villages of five Gram Panchyats have also been adopted by the University for providing awareness, consultancy, extension and skill development services to the farmers at their doorsteps for exploring the high potential of this region with new Start up and entrepreneurial opportunities in the emerging and allied disciplines of agriculture for inclusive development of the region.

I am optimistic that the dedicated girl students would prove to be a major force to improve the plight of surrounding farmers to new height. I am pleased to appreciate the efforts of Faculty and students of this college.

I am pleased to learn that the college has come out with a useful and informative document entitled ‘Course Catalogue’. I am sure that this compilation will go a long way in helping the students and faculty as also other interested students seeking admission to this college/university. I congratulate the Dean of the college and the faculty for preparing this important document.

Place: Baru Sahib

Dr. A. S. Ahluwalia
Pro Vice Chancellor
Eternal University, Baru Sahib
District Sirmour, Himachal Pradesh

Preface

Dr. Khem Singh Gill Akal College of Agriculture (erstwhile Akal College of Agriculture) was established during the year 2014 as a constituent college of Eternal University Baru Sahib and started functioning w.e.f. 01/07/2014. Initially B.Sc. (Hons.) Agriculture programme was started for girl students with an intake capacity of 60 students with course curriculum of Fourth Dean's Committee recommendations of ICAR, New Delhi. This programme was approved vide Academic Council Meeting item no. 04 dated 28/04/2014 with the revision of course curriculum as per Fifth Dean's Committee recommendations and approval vide item no. 58/10/2018 in the Academic Council Meeting held on 13/08/2018, the revised course curriculum was implemented from the Academic Session 2018-19 for B.Sc. (Hons.) Agriculture degree programme. B.Tech. Food Technology degree programme was started from the Academic Session 2015-16 with course curriculum of Fourth Dean's Committee recommendations of ICAR, New Delhi. Course curriculum for this programme was revised as per Fifth Dean's Committee recommendations of ICAR and duly approved in the Academic Council meeting held during September 2017 and was implemented from the Academic Session 2017-18.

M.Sc. Agronomy degree programme was started from the Academic Session 2017-18. Its nomenclature was revised as M.Sc. Ag. Agronomy from the Academic Session 2021-22 and the revised course curriculum as per BSMA guidelines of ICAR and duly approved in the 72nd Academic Council meeting held on 12/12/2020 vide item no. 72/08/2020 and was implemented from the Academic Session 2021-22.

M.Sc. Horticulture (Vegetable Science) and M.Sc. Horticulture (Fruit Science) degree programmes were started from the Academic Session 2018-19. M.Sc. Horticulture (Floriculture and Landscape Architecture) degree programme has been started from the Academic Session 2021-22. The course curriculum for all these programmes were revised as per BSMA guidelines of ICAR and duly approved in the 72nd Academic Council meeting held on 12/12/2020 vide item no. 72/08/2020 and were implemented from the Academic Session 2021-22.

M.Sc. Plant Pathology degree programme was started from the Academic Session 2018-19. Its nomenclature was revised as M.Sc. Ag. Plant Pathology from the Academic Session 2021-22 and the revised course curriculum as per BSMA guidelines of ICAR and duly approved in the 72nd Academic Council meeting held on 12/12/2020 vide item no. 72/08/2020 and was implemented from the Academic Session 2021-22.

M.Sc. Genetics and Plant Breeding degree programme was started from the Academic Session 2018-19. Its nomenclature was revised as M.Sc. Ag. Genetics and Plant Breeding from the Academic Session 2021-22 and the revised course curriculum as per BSMA guidelines of ICAR and duly approved in the 72nd Academic Council meeting held on 12/12/2020 vide item no. 72/08/2020 and was implemented from the Academic Session 2021-22.

M.Sc. Entomology degree programme was started from the Academic Session 2018-19. Its nomenclature was revised as M.Sc. Ag. Entomology from the Academic Session 2021-22 and the revised course curriculum as per BSMA guidelines of ICAR and duly approved in the 72nd Academic Council meeting held on 12/12/2020 vide item no. 72/08/2020 and was implemented from the Academic Session 2021-22.

M.Sc. Ag. Agricultural Economics degree programme was started from the Academic Session 2019-2022 and the course curriculum as per BSMA guidelines of ICAR and duly approved in the 64th Academic Council meeting held on 06/08/2019 vide item no. 64/02/2019 and was implemented from the Academic Session 2019-20.

M.Sc. Biotechnology degree programme was started from the Academic Session 2011-12. The course curriculum was approved vide item no. 02 Academic Council Meeting held on 08/08/2011.

M.Tech. Food Technology degree programme was started from the Academic Session 2021-22. The revised course curriculum as per BSMA guidelines of ICAR and duly approved in the 74th Academic Council meeting held on 15/06/2021 vide item no. 74/13(i)/2021 and was implemented from the Academic Session 2021-22.

M.Sc. Food Science and Technology degree programme was started from the Academic Session 2021-22. The revised course curriculum as per BSMA guidelines of ICAR and duly approved in the 72nd Academic Council meeting held on 12/12/2020 vide item no. 72/08/2020 and was implemented from the Academic Session 2021-22.

M.Sc. Ag. Soil Science and Agriculture Chemistry degree programme course curriculum as per BSMA guidelines of ICAR and duly approved in the 74th Academic Council meeting held on 15/06/2021 vide item no. 74/13(ii)/2021 and was implemented from the Academic Session 2021-22.

M.Sc. Ag. Agricultural Extension degree programme course curriculum as per BSMA guidelines of ICAR and duly approved in the 78th Academic Council meeting held on 30/06/2022 vide item no. 06(ii) and was implemented from the Academic Session 2022-23.

Ph.D. Horticulture (Vegetable Science) degree programme was started from the Academic Session 2021-22. The course curriculum as per BSMA guidelines of ICAR and duly approved in the 74th Academic Council meeting held on 15/06/2021 vide item no. 74/13(iii)/2021 and was implemented from the Academic Session 2021-22.

Ph.D. Agronomy degree programme was started from the Academic Session 2021-22. The course curriculum as per BSMA guidelines of ICAR and duly approved in the 74th Academic Council meeting held on 15/06/2021 vide item no. 74/13(iv)/2021 and was implemented from the Academic Session 2021-22.

The revised course curriculum Ph.D. Entomology degree programme as per BSMA guidelines of ICAR and duly approved in the 74th Academic Council meeting held on 15/06/2021 vide item no. 74/13(v)/2021 and was implemented from the Academic Session 2021-22.

Ph.D. Biotechnology degree programme was started from the Academic Session 2012-13. The course curriculum was approved vide item no. 02 Academic Council Meeting held on 08/08/2011.

Ph.D. Food Technology degree programme was started from the Academic Session 2017-18. The course curriculum was approved vide item no. 07 in the Academic Council Meeting held on 10/11/2017.

Ph.D. Genetics and Plant Breeding programme was started from the Academic Session 2022-23. The course curriculum as per BSMA guidelines of ICAR and duly approved in the 78th Academic Council meeting held on 30/06/2022 vide item no. 06(i)and was implemented from the Academic Session 2022-23.

The course catalogue comprising 713 pages pertaining to two UG programmes i.e. B.Sc. (Hons.) Agriculture and B.Tech. Food Technology degree programmes, thirteen M.Sc. programmes i.e. M.Sc. Ag. Agronomy, M.Sc. Horticulture (Vegetable Science), M.Sc. Horticulture (Fruit Science), M.Sc. Horticulture (Floriculture and Landscape Architecture), M.Sc. Ag. Plant Pathology, M.Sc. Ag. Genetics and Plant Breeding, M.Sc. Ag. Entomology, M.Sc. Ag. Agricultural Economics, M.Sc. Biotechnology, M.Tech. Food Technology, M.Sc. Food Science and Technology, M.Sc. Ag. Soil Science and Agriculture Chemistry and M.Sc. Ag. Agricultural Extension and six Ph.D. programmes i.e. Ph.D. Horticulture (Vegetable Science), Ph.D. Agronomy, Ph.D. Entomology, Ph.D. Biotechnology, Ph.D. Food Technology and Ph.D. Genetics and Plant Breeding have been compiled and updated with necessary corrections and is now ready for the use by students and faculty members.

The editing and compilation of this document was a herculean task but has been completed with the active support of all faculty members which deserves my appreciations. The secretarial assistance rendered by Mr. Sandeep Parmar, PA to Dean is gratefully acknowledged.

Dr. S.K. Sharma
Dean
Dr. Khem Singh Gill Akal College of Agriculture
Eternal University, Baru Sahib
District Sirmour (H.P.) 173101

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Course Catalogue

(As per Fifth Deans Committee Report 2016, ICAR)

For

B.Sc. (Hons.) Agriculture

Dr. Khem Singh Gill Akal College of Agriculture

Eternal University, Baru Sahib

Discipline-wise Courses

Discipline/Course title	Credit Hours
Agronomy	
Fundamentals of Agronomy	4(3+1)
Introductory Agro-Meteorology & Climate Change	2(1+1)
Crop Production Technology – I (Kharif Crops)	2(1+1)
Crop Production Technology – II (Rabi Crops)	2(1+1)
Farming System & Sustainable Agriculture	1(1+0)
Practical Crop Production - I (Kharif Crops)	2(0+2)
Practical Crop Production - II (Rabi Crops)	2(0+2)
Principles of Organic Farming	2(1+1)
Geoinformatics and Nanotechnology and Precision Farming	2(1+1)
Rainfed Agriculture & Watershed Management	2(1+1)
Total Credit Hours	**21(10+11)**
Genetics & Plant Breeding	
Fundamentals of Genetics	3(2+1)
Principles of Seed Technology	3(1+2)
Fundamentals of Plant Breeding	3(2+1)
Crop Improvement-I (Kharif Crops)	2(1+1)
Crop Improvement-II (Rabi Crops)	2(1+1)
Total Credit Hours	**13(07+06)**
Soil Science & Agricultural Chemistry	
Fundamentals of Soil Science	3(2+1)
Manures, Fertilizers and Soil Fertility Management	3(2+1)
Problematic Soils and their Management	2(2+0)
Total Credit Hours	**08(06+02)**
Entomology	
Fundamentals of Entomology	4(3+1)
Pests of Crops and Stored Grain and their Management	3(2+1)
Management of Beneficial Insects	2(1+1)
Total Credit Hours	**09(06+03)**
Agricultural Economics	
Fundamentals of Agricultural Economics	2(2+0)
Agricultural Finance and Co-operation	3(2+1)
Agricultural Marketing Trade & Prices	3(2+1)
Farm Management, Production & Resource Economics	2(1+1)
Total Credit Hours	**10(07+03)**
Agricultural Engineering	
Introductory Soil and Water Conservation Engineering	2(1+1)
Farm Machinery and Power	2(1+1)
Renewable Energy and Green Technology	2(1+1)
Protected Cultivation and Secondary Agriculture	2(1+1)
Total Credit Hours	**08(04+04)**
Plant Pathology	
Fundamentals of Plant Pathology	4(3+1)
Diseases of Field and Horticultural Crops and their Management-I	3(2+1)
Diseases of Field and Horticultural Crops and their Management-II	3(2+1)
Principles of Integrated Pest and Disease Management	3(2+1)
Total Credit Hours	**13(09+04)**

Horticulture	
Fundamentals of Horticulture	2(1+1)
Production Technology for Fruit and Plantation Crops	2(1+1)
Production Technology for Vegetables and Spices	2(1+1)
Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
Post-harvest Management and Value Addition of Fruits and Vegetables	2(1+1)
Total Credit Hours	**10 (05+05)**
Food Science & Technology	
Principles of Food Science & Nutrition	**2(2+0)**
Agricultural Extension and Communication	
Fundamentals of Agricultural Extension Education	3(2+1)
Rural Sociology & Educational Psychology	2(2+0)
Entrepreneurship Development and Business Communication	2(1+1)
Communication Skills and Personality Development	2(1+1)
Total Credit Hours	**09(06+03)**
Biochemistry / Physiology / Microbiology/ Environmental Sciences	
Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
Fundamentals of Crop Physiology	2(1+1)
Agricultural Microbiology	2(1+1)
Environmental Studies & Disaster Management	3(2+1)
Introduction to Forestry	2(1+1)
Total Credit Hours	**12(07+05)**
Statistics, Computer Application and I.P.R.	
Statistical Methods	2(1+1)
Agri- Informatics	2(1+1)
Intellectual Property Rights	1(1+0)
Total Credit Hours	**05(03+02)**
Animal Production	
Livestock and Poultry Management	**4(3+1)**
Language	
Comprehension & Communication Skills in English (Gradial course)	**2(1+1)**
Remedial Courses	
Agricultural Heritage	1(1+0)
Introductory Biology	2(1+1)
Elementary Mathematics	2(2+0)
Total Credit Hours	**05(04+01)**
Non-Gradial Courses	
NSS/NCC/Physical Education & Yoga Practices	2(0+2)
Human Values & Ethics	1(1+0)
Educational Tour	2(0+2)
Total Credit Hours	**05(01+04)**

Discipline-wise summary of credit hours

Group	Credit
Agronomy	21(10+11)
Genetics & Plant Breeding	13(7+6)
Soil Science & Agricultural Chemistry	8(6+2)
Entomology	9(6+3)
Agricultural Economics	10(7+3)
Agricultural Engineering	8(4+4)
Plant Pathology	13(9+4)
Horticulture	10(5+5)
Food Science	2(2+0)
Agricultural Extension	9(6+3)
Biochemistry / Physiology / Microbiology/ Environmental Sciences	12(7+5)
Statistics, Computer Application and I.P.R.	5(3+2)
Animal Production	4(3+1)
English	2 (1+1)
Remedial Courses	03 (Biol/ Math); 01 (Agriculture)
NSS/NCC/Physical Education & Yoga Practices	2(0+2)
Human Values and Ethics	1(1+0)
Educational Tour	2(0+2)
Total	126 + 3 (for Bio / Math)/ 01(Agri) + 5 NC 126+3+1+5+ 9 credits elective
Rural Agricultural Work Experience Experiential Learning Programme	20 20
Grand Total	**144+20+20=184**
New Courses	**24+4 (remedial)+1 (NC)**

B.Sc. (Hons.) Agriculture
Semester-wise distribution of courses

		Semester I	
S. No.		**Subject**	**Credits**
1	Hort-101	Fundamentals of Horticulture	2 (1+1)
2	BT-101	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
3	Soil-101	Fundamentals of Soil Science	3(2+1)
4	Forst-101	Introduction to Forestry	2 (1+1)
5	Eng-101	Comprehension & Communication Skills in English	2 (1+1)
6	Agron-102	Fundamentals of Agronomy	4(3+1)
7	Bot-101	Introductory Biology*/Elementary Mathematics*	2 (1+1)/ 2(2+0)*
8	Agron-101	Agricultural Heritage*	1(1+0)*
9	Ext-101	Rural Sociology & Educational Psychology	2 (2+0)
10	Edu-101	Human Values & Ethics (non gradial)	1(1+0)**
11		NSS/NCC/Physical Education & Yoga Practices**	2 (0+2)**
		TOTAL *R: Remedial course; **NC: Non-gradial courses	**18+03*+03****

		Semester II	
S. No.		**Subject**	**Credits**
1	PBG-102	Fundamentals of Genetics	3(2+1)
2	Micro-102	Agricultural Microbiology	2(1+1)
3	Soil-102	Introductory Soil and Water Conservation Engineering	2(1+1)
4	Bot-102	Fundamentals of Crop Physiology	2 (1+1)
5	Econ-102	Fundamentals of Agricultural Economics	2 (2+0)
6	Pl. Path-102	Fundamentals of Plant Pathology	4(3+1)
7	Ent-102	Fundamentals of Entomology	4(3+1)
8	Ext-102	Fundamentals of Agricultural Extension Education	3(2+1)
9	ENG-102	Communication Skills and Personality Development	2(1+1)
		Total	**24(16+8)**

		Semester III	
S. No.	**Corse Code**	**Subject**	**Credits**
1	Agron-201	Crop Production Technology – I (Kharif Crops)	2 (1+1)
2	PBG-201	Fundamentals of Plant Breeding	3 (2+1)
3	Econ-201	Agricultural Finance and Cooperation	3 (2+1)
4	AGI-201	Agri- Informatics	2 (1+1)
5	FMP-201	Farm Machinery and Power	2 (1+1)
6	Hort-201	Production Technology for Vegetables and Spices	2 (1+1)
7	Env-201	Environmental Studies and Disaster Management	3(2+1)
8	Stat-201	Statistical Methods	2(1+1)
9	LPM-201	Livestock and Poultry Management	4 (3+1)
		Total	**23(14+9)**

		Semester IV	
S. n.	**Course Code**	**Subject**	**Credits**
1	Agron-202	Crop Production Technology –II (Rabi Crops)	2 (1+1)
2	Hort-202	Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
3	RE-202	Renewable Energy and Green Technology	2(1+1)
4	Soil-202	Problematic Soils and their Management	2(2+0)
5	Hort-203	Production Technology for Fruit and Plantation Crops	2(1+1)
6	PBG-202	Principles of Seed Technology	3(1+2)
7	Agron-203	Farming System & Sustainable Agriculture	1(1+0)
8	Econ-202	Agricultural Marketing Trade & Prices	3(2+1)
9	Agron-204	Introductory Agro-Meteorology & Climate Change	2(1+1)
10	EC-202	Elective Course	3 credit
		Total	**19(11+8) + 3**

		Semester V	
Sr. No.	**Course Code**	**Subject**	**Credits**
1	Pl. Path-301	Principles of Integrated Pest and Disease Management	3(2+1)
2	Soil-301	Manures, Fertilizers and Soil Fertility Management	3 (2+1)
3	Ent-301	Pests of Crops and Stored Grain and their Management	3 (2+1)
4	Pl. Path-302	Diseases of Field and Horticultural Crops and their Management -I	3 (2+1)
5	PBG-301	Crop Improvement-I (Kharif Crops)	2 (1+1)
6	Ext-301	Entrepreneurship Development and Business Communication	2 (1+1)
7	Agron-301	Geoinformatics and Nano-Technology and Precision Farming	2 (1+1)
8	Agron-302	Practical Crop Production – I (Kharif crops)	2 (0+2)
9	IPR-301	Intellectual Property Rights	1(1+0)
10	EC-301	Elective course	3 credit
		Total	**21(12+09) + 3**

		Semester VI	
S.No.	**Course Code**	**Subject**	**Credits**
1	Agron-303	Rainfed Agriculture & Watershed Management	2 (1+1)
2	PCS-302	Protected Cultivation and Secondary Agriculture	2 (1+1)
3	Pl. Path-303	Diseases of Field and Horticultural Crops and their Management-II	3 (2+1)
4	Hort-302	Post-harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)
5	Ent-302	Management of Beneficial Insects	2 (1+1)
6	PBG-302	Crop Improvement-II (Rabi crops)	2 (1+1)
7	Agron-304	Practical Crop Production –II (Rabi crops)	2 (0+2)
8	Agron-305	Principles of Organic Farming	2 (1+1)
9	Econ-302	Farm Management, Production & Resource Economics	2 (1+1)
10	FSN-302	Principles of Food Science and Nutrition	2(2+0)
11	EC-302	Elective course	3 credit
		Total	**21 (11 + 10)+ 3**

Elective Courses

Course no.	Courses	Credit Hours
Agricultural Economics		
ELCT-321	Agribusiness Management	3(2+1)
Plant Pathology		
ELCT-312	Agrochemicals	3(2+1)
ELCT-221	Food Safety and Standards	3(2+1)
ELCT-311	Biopesticides & Biofertilizers	3(2+1)
Plant Breeding		
ELCT-323	Commercial Plant Breeding	3(1+2)
Horticulture		
ELCT-322	Landscaping	3(2+1)
ELCT-313	Protected Cultivation	3(2+1)
ELCT-222	Hi-tech. Horticulture	3(2+1)
Agronomy		
ELCT-314	Micro Propagation Technologies	3(1+2)
ELCT-223	Weed Management	3(2+1)
ELCT-324	System Simulation and Agro-advisory	3(2+1)
Extension Education		
ELCT-224	Agricultural Journalism	3(2+1)

Semester VII

RAWE Component

Rural Agricultural Work Experience and Agro-industrial Attachment (RAWE & AIA)			
S. no.	**Activities**	**No. of weeks**	**Credit Hours**
1	General orientation & On campus training by different faculties	1	14
2	Village attachment	8	
	Unit attachment in Univ./ College. KVK/ Research Station Attachment	5	
3	Plant clinic	2	2
	Agro-Industrial Attachment	3	3
4	Project Report Preparation, Presentation and Evaluation	1	1
	Total weeks for RAWE & AIA	20	20

- **Agro- Industrial Attachment:** The students would be attached with the agro-industries for a period of 3 weeks to get an experience of the industrial environment and working**.**
- Educational tour will be conducted in break between IV & V Semester or VI & VII Semester

RAWE Component-I

Village Attachment Training Programme

Sl. No.	**Activity**	**Duration**
1	Orientation and Survey of Village	week
2	Agronomical Interventions	week
3	Plant Protection Interventions	week
4	Soil Improvement Interventions (Soil Sampling and Testing)	week
5	Fruit and Vegetable Production Interventions	week
6	Food Processing and Storage Interventions	week
7	Animal Production Interventions	week
8	Extension and Transfer of Technology Activities	week

RAWE Component –II

Agro Industrial Attachment

- Students shall be placed in Agro and Cottage Industries and Commodities Boards for 03 weeks.
- Industries include Seed/Sapling production, Pesticides-insecticides, Post harvest-processing-value addition, Agri-finance institutions, etc.

Activities and Tasks during Agro-Industrial Attachment Programme

- Acquaintance with industry and staff
- Study of structure, functioning, objective and mandates of the industry
- Study of various processing units and hands-on trainings under supervision of industry staff
- Ethics of industry
- Employment generated by the industry
- Contribution of the industry promoting environment
- Learning business network including outlets of the industry
- Skill development in all crucial tasks of the industry
- Documentation of the activities and task performed by the students
- Performance evaluation, appraisal and ranking of students

VIII semester

Modules for Skill Development and Entrepreneurship: A student has to register 20 credits opting for two modules of (0+10) credits each (total 20 credits) from the package of modules in the VIII semester Experiential Learning Programme (ELP).

S. no.	Subject Code	Title of the module	Credits
1	***READY-401**	Production Technology for Bioagents and Biofertilizer	0+10
2	**READY -402**	Seed Production and Technology	0+10
3	**READY -403**	Mushroom Cultivation Technology	0+10
4	**READY -404**	Soil, Plant, Water and Seed Testing	0+10
5	**READY -405**	Commercial Beekeeping	0+10
6	**READY -406**	Poultry Production Technology	0+10
7	**READY -407**	Commercial Horticulture	0+10
8	**READY -408**	Floriculture and Landscaping	0+10
9	**READY -409**	Food Processing	0+10
10	**READY -410**	Agriculture Waste Management	0+10
11	**READY -411**	Organic Production Technology	0+10
12	**READY -412**	Commercial Sericulture	0+10

***READY**= Rural Entrepreneurship Awareness Development Yojana

NOTE: In addition to above ELP modules other important modules may be given to the students by SAUs

Evaluation of Experiential Learning Programme

S. No.	Parameters	Max. Marks
1.	Project Planning and Writing	10
2.	Presentation	10
3.	Regularity	10
4.	Monthly Assessment	10
5.	Output delivery	10
6.	Technical Skill Development	10
7.	Entrepreneurship Skills	10
8.	Business networking skills	10
9.	Report Writing Skills	10
10.	Final Presentation	10
	Total	**100**

Semester-wise distribution of courses

		Semester I	
S. No.		**Subject**	**Credits**
1	Hort-101	Fundamentals of Horticulture	2 (1+1)
2	BT-101	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
3	Soil-101	Fundamentals of Soil Science	3(2+1)
4	Forst-101	Introduction to Forestry	2 (1+1)
5	Eng-101	Comprehension & Communication Skills in English	2 (1+1)
6	Agron-102	Fundamentals of Agronomy	4(3+1)
7	Bot-101	Introductory Biology*/Elementary Mathematics*	2 (1+1)/ 2(2+0)*
8	Agron-101	Agricultural Heritage*	1(1+0)*
9	Ext-101	Rural Sociology & Educational Psychology	2 (2+0)
10	Edu-101	Human Values & Ethics (non gradial)	1(1+0)**
11		NSS/NCC/Physical Education & Yoga Practices**	2 (0+2)**
		TOTAL *R: Remedial course; **NC: Non-gradial courses	18+03*+03**

B.Sc. (Hons.) Agriculture

Course Contents

Hort-101
Fundamentals of Horticulture

Credits: 1 + 1 | Mid-Session Exam: 20 (15+5#)
Contact Hours: 14 + 28 | Practical Exam: 50
End-Semester Exam: 30

Objective: To provide learning and education on different aspects of horticulture and imparting practical knowledge.

Learning Outcome: Students will gain knowledge on different aspects of horticulture and will attain working knowledge on different horticulture practices in field.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Horticulture - definition and branches, importance and scope	2
2.	Horticultural and botanical classification; climate and soil for horticultural crops	2
3.	Plant propagation-methods and propagating structures. Seed dormancy and seed germination	2
4.	Principles of orchard establishment. Principles and methods of training and pruning, juvenility and flower bud differentiation	2
5.	Unfruitfulness. Pollination, pollinizers and pollinators. Fertilization and parthenocarpy	2
6.	Medicinal and aromatic plants	2
7.	Importance of plant bio-regulators in horticulture	1
8.	Irrigation methods. Fertilizers application in horticultural crops	1

Practical

S. No.	Particulars	No. of practical
1.	Identification of garden tools	2
2.	Identification of horticultural crops	2
3.	Preparation of seed bed or nursery bed	1
4.	Practice of sexual and asexual methods of propagation including micro-propagation	2
5.	Layout and planting of orchard	2
6.	Training and pruning of fruit trees	2
7.	Preparation of potting mixture	1
8.	Fertilizer application in different crops	1
9.	Visits to commercial nurseries or orchards	1

Suggested Books/Readings:

1. Chadha K. L. (2019) Handbook of Horticulture. ICAR, New Delhi.
2. Prasad S. and Kumar U. (2018) Principles of Horticulture 2nd edtn. Agribios, Jodhpur
3. Prasad S. and Kumar U. (2016) A Handbook of Fruit Production. Agribios, Jodhpur
4. Salunkhe D. K. and Kadam S. S. (2013) A Handbook of Fruit Science Technology. CRC Press (Taylor & Francis). New Delhi.
5. Singh J. (2016) Basic Horticulture. Kalyani Publisher, New Delhi
6. Rajamanickam C. and Vijai Selvaraj K. S. (2021) Principles and Practices of Plant Propagation and Nursery Management. Satish Serial Publishing House, New Delhi.
7. Rajan S. and Markose B. (2018) Propagation of Horticultural Crops. Kalyani Publisher, New Delhi
8. Sharma R. R (2018) Propagation of Horticultural Crops, Principles and Practices. Kalyani Publisher, New Delhi

BT-101

Fundamentals of Plant Biochemistry and Biotechnology

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objectives: To explore students about various types of biomolecules, their structure, functions and metabolism with basic concepts and techniques in plant biochemistry and biotechnology.

Learning outcome: Students will gain knowledge on different aspects of biochemistry and biotechnology and will attain working knowledge during practical session in laboratory.

Units	Contents	Lectures
I	Importance of Biochemistry. Properties of water, pH and buffer. Carbohydrate: Importance and classification, structures of monosaccharides, reducing and oxidizing properties of monosaccharides, mutarotation; structure of disaccharides and poly saccharides. Lipid: Importance and classification; structures and properties of fatty acids; storage lipids and membrane lipids.	7
II	Proteins: Importance of proteins and classification; structures, titration and zwitter ions nature of amino acids; structural organization of proteins. Enzymes: General properties; classification; mechanism of action; Michaelis & Menten and Line Weaver Burk equations; introduction to allosteric enzymes.	5
III	Nucleic acids: Importance and classification; structure of nucleotides, A, B & Z DNA; RNA: Types and secondary & tertiary structures.	3
IV	Metabolism of carbohydrates: Glycolysis, TCA cycle, glyoxylate cycle, electron transport chain. Metabolism of lipids: β-oxidation, biosynthesis of fatty acids.	3
V	Concepts and applications of plant biotechnology: Scope, organ culture, embryo culture, cell suspension culture, callus culture, anther culture, pollen culture and ovule culture and their applications; micro-propagation methods; organogenesis and embryogenesis, synthetic seeds and their significance; embryo rescue and its significance; somatic hybridization and cybrids; somaclonal variation and its use in crop improvement; cryo-preservation	5
VI	Introduction to recombinant DNA methods: physical (Gene gun method), chemical (PEG mediated) and *Agrobacterium* mediated gene transfer methods; transgenics and its importance in crop improvement	3
VII	The PCR techniques and its applications; RFLP, RAPD, SSR; marker assisted breeding in crop improvement; biotechnology regulations.	2
	Total	**28**

Practical

S. No.	Particulars	No. of practicals
1	Preparation of solutions, pH & buffers	1
2	Qualitative tests of carbohydrates	2
3	Quantitative estimation of glucose/proteins	1
4	Titration methods for estimation of amino acids/lipids	1
5	Effect of pH, temperature and substrate concentration on enzyme action	1
6	Paper chromatography/TLC demonstration for separation of amino acids/ monosaccharides	2
7	Sterilization techniques used in plant tissue culture	2
8	Composition of various tissue culture media and preparation of stock solutions for MS nutrient medium. Callus induction from various explants	1
9	Micro-propagation, hardening and acclimatization	1

10	Demonstration on isolation of genomic DNA	1
11	Demonstration of gel electrophoresis techniques and DNA finger printing	1

Suggested Readings

1. Nelson, D., and Cox, M., 2017. Lehninger Principles of Biochemistry, 7th Edition. WH Freeman and Company, New York.
2. Jain, J.L., Jain, S., and Jain, N., 2016. Fundamentals of Biochemistry. 7th Edition. S Chand & Company, New Delhi.
3. Voet, D., Voet, G.J., and Pratt, C.W., 2012. Principles of Biochemistry. 4th Edition. John Wiley & Sons, Inc. USA.
4. Chawla, H.S., 2009. Introduction to Plant Biotechnology. 3rd edition. CRC Press, New York.
5. Bhojwani, S.S., and Rajdan, M.K.,1996. Plant Tissue Culture: Theory and Practice. Elsevier Science, Netherlands.
6. Krebs, J.E., Goldstein, E.S., and Kilpatrick, S.T., 2017. Lewin's Genes XII. Jones & Bartlett Learning, USA.
7. Yadav, R. K., and Singh, L., 2021. Fundamentals of Plant Biochemistry and Biotechnology. Bhavya Books, New Delhi.
8. Singh B. D. 1998. Biotechnology Kalyani, Publication New Delhi.

Soil -101

Fundamentals of Soil Science

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To know about basic processes of soil formation it's physical, chemical and biological properties and factors affecting soil fertility and crop production.

Learning Outcome: Students will gain knowledge on different aspects of soil science and will attain working knowledge on different soil science practices in laboratory and field.

Details of Course:

Units	Particulars	No. of Lectures
I	Soil as a natural body: Pedological and edaphological concepts of soil; soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation. Soil profile, components of soil.	**4**
II	Soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity. Elementary knowledge of soil taxonomy classification and soils of India. Soil water retention, movement and availability. Soil air, composition, gaseous exchange, problem and plant growth. Soil temperature; source, amount and flow of heat in soil; effect on plant growth,	**12**
III	Soil reaction: pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability; soil colloids-inorganic and organic; silicate clays: constitution and properties; sources of charge; ion exchange, cation exchange capacity, base saturation;	**6**
IV	Soil organic matter: composition, properties and its influence on soil properties; humic substances - nature and properties;	**2**
V	Soil organisms: macro and microorganisms, their beneficial and harmful effects;	**2**
VI	Soil pollution: behavior of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.	**2**
	Total	**28**

Practical

S. No.	Practical Description	No. of practicals
1.	Study of soil profile in field.	1
2.	Study of soil sampling tools, collection of representative soil sample, its processing and storage.	2
3.	Study of soil forming rocks and minerals.	1
4.	Determination of soil density, moisture content and porosity.	1
5.	Determination of soil texture by feel and Bouyoucos Methods.	1
6.	Studies of capillary rise phenomenon of water in soil column and water movement in soil.	2
7.	Determination of soil pH and electrical conductivity.	1
8.	Determination of cation exchange capacity of soil.	1
9.	Study of soil map.	1
10.	Determination of soil colour.	1
11.	Demonstration of heat transfer in soil.	1
12.	Estimation of organic matter contents of soil.	1
	Total	14

Suggested Books/Readings:

S. No.	Suggested Readings
1	Biswas, T.D. and Mukherjee, S.K. 2001. Text Book of Soil Science. Tata McGraw Hill Publishing Co., New Delhi
2	Brady, N.C. 1990. Nature and Properties of Soils. 10th Edn, Macmillian Publishing Co. Inc., New York
3	Das.D.K, 1997. Introductory Soil Science. Kalyani Publishers, New Delhi.
4	Foth, H.D. and Turk, L. M. 1972. Fundamental of Soil Science. 5th Edn. Wiley Eastern Pvt. Ltd., New Delhi
5	Gupta, P.K. 2007. Soil, Plant, Water and Fertilizer Analysis. Published by AGROBIOS (India), Jodhpur
6	ISSS, 2002. Fundamentals of Soil Science. Published by Indian Society of Soil Science, IARI, New Delhi
7	Jaiswal, P.C. 2006. Soil, Plant and Water Analysis. 2nd Edn. Kalyani Publishers, Ludhiana
8	Samuel L. Tisdale, Werner.L. Nelson, James D. Beaton and John L. Havlin. 1995. Soil Fertility and Fertilizers. 5th Edn. Macmillan Publishing Company, USA.

Forst-101
Introduction to Forestry

Credits: 1 + 1 Mid-Session Exam: 20 (15+5#)
Contact Hours: 14 + 28 Practical Exam: 50
End-Semester Exam: 30

Objective: To provide knowledge regarding forestry including importance of forest, forest mensuration and agroforestry.

Learning outcome: The student will gain knowledge various forestry features, forest regeneration, forest mensuration and agroforestry.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Introduction- definitions of basic terms related to forestry.	1
2.	Objectives of silviculture and forest classification.	1
3.	Salient features of Indian Forest Policies.	1
4.	Forest regeneration; Natural regeneration- from seeds and vegetative parts, coppicing, pollarding, root suckers.	1
5.	Artificial regeneration- objectives; choice between natural regeneration, essential preliminary considerations.	1
6.	Crown classification.	1
7.	Tending operations- weeding, cleaning, thinning- mechanical, ordinary, crown and advance thinning.	1
8.	Forest mensuration- objectives, diameter measurement and instruments used in diameter measurement.	1
9.	Non-instrumental methods of height measurement- shadow and single pole method; Instrumental methods of height measurement- geometric and trigonometric principles, instruments used in height measurement.	1
10.	Tree stem form, form factor, form quotient, measurement of volume of felled and standing trees, age determination of trees.	1
11.	Agroforestry- definitions, importance, criteria of selection of trees in agroforestry, different agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens.	2
12.	Cultivation practices of two important fast growing tree species of the region.	2
	Total	14

Practical

S. No.	Particulars	No. of practicals
1.	Identification of tree species.	2
2.	Diameter measurements using callipers and tape, diameter measurements of forked, buttressed, fluted and leaning trees.	2
3.	Height measurement of standing tress by shadow method, single pole method and hypsometer.	2
4.	Volume measurement of logs using various formulae.	2
5.	Nursery lay out, seed sowing, vegetative propagation techniques.	2
6.	Forest plantations and their management.	2
7.	Visits to nearby forest-based industries.	2
	Total	14

Suggested Books/Readings:

	Authors/Name of Books/Publisher
1.	Manikandan and Prabhu S. (2012). India Forestry. Jain Brothers, New Delhi
2.	Prasad, S. (2017). Textbook of Environment Forestry Science. ICAR, New Delhi
3.	Chaturvedi A.N. and Khanna LS. (1982). Forest Mensuration. International Book Distributors, Dehradun
4.	Negi SS. (1997). Forest Policy and Law. International Book Distributors, Dehradun
5.	Prakash R. (2006). Forest Management. International Book Distributors, Dehradun
6.	Dwivedi, A.P. (2012). Agroforestry Principles and Practices. Oxford and IBH Publishing Company Pvt. Ltd, New Delhi
7.	Khanna, L.S. (2009). Principles and Practices of Silviculture. Khanna Bandhu Publishers, Dehradun
8.	Prakash R. (2006). Forest Management. International Book Distributors, Dehradun

Eng-101
Comprehension and Communication Skills in English

Credits: 1 + 1 | Mid-Session Exam: 20 (15+5[#])
Contact Hours: 14 + 28 | Practical Exam: 50
End-Semester Exam: 30

Objective: To make the student know about different aspects of English language speaking, reading and writing and to make them understand its significance in communication.

Learning Outcome: Students will gain knowledge on different aspects of English language and will attain practical knowledge on different speaking and vocabulary in language laboratory.

Details of Course:

S. No.	Particulars	No. of lectures
1	Importance of language and communication skills	1
2	Spoken and conversational English, debate and discussion	1
3	Basic sentence patterns in English, sentence structure, subject verb agreement, articles, prepositions, punctuation, parts of speech, narration, active and passive voice, antonym, synonym, prefix and suffix, homophones, homonyms, often confused words.	4
4	Reading comprehension	1
5	Basic rules of composition, précis writing, proposal, letter writing; preparation of CV and resume, covering letter and job applications, synopsis writing and report writing.	4
6	Concept of register, development of vocabulary, dictionary and thesaurus, indexing contents, glossary, reading of texts, dialogues, note taking and note making, development of paragraphs, cohesion, coherence and style.	3
	Total Lectures	**14**

Practical

S. No.	Particulars	No. of practicals
1.	Listening comprehension, listening short talks or lecture, speeches, reading dialogues, various levels of reading	3
2.	Communication: An introduction to Phonetics, stress, intonation, syllables, their types, clarity of voice, speaking and listening practice, improving reading skills	3
3.	Summary and report writing, Elementary knowledge of English sounds with word stress and intonation	3
4.	Interviews: mock interviews, group discussion, team spirit, extempore, debates and discussions, exercises to help the students in the enrichment of vocabulary based on IELTS, PTE, TOEFL and other competitive examinations.	5

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Balasubramanian T. 1989. A Text book of Phonetics for Indian Students, Orient Longman, New Delhi.
2.	Balasubrmanyam M. 1985. Business Communication, Vani Educational Books, New Delhi.
3.	Kulbhushan K., 2021. Effective Communication Skills, Khanna Publishing House, New Delhi.

4.	Sharma R C and Krishna Mohan 1978. Business Correspondence, Tata Mc Graw Hill Publishing Company, New Delhi.
5.	O'Connor, J. D. 1991. Better English Pronunciation, Cambridge University Press, Press Syndicate of the University of Cambridge, UK.

Agron-102
Fundamentals of Agronomy

Credits: 3 + 1
Contact hours: 42 + 28

Mid-session exam: 30 (25+5#)
Practical exam: 25
End-semester exam: 45

Objective: To know about basic processes of agronomy and its scope, different aspects significant for crop yield.

Learning Outcome: Students will gain knowledge on different aspects of agronomy and will attain working knowledge on different agronomical practices in the laboratory and field.

Details of Course:

S. No.	Particulars	No. of lectures
1	Agronomy and its scope, seeds and sowing, tillage and tilth, crop density and geometry, crop nutrition, manures and fertilizers, nutrient use efficiency	10
2	Water resources, soil-plant-water relationship, crop water requirement, water use efficiency, irrigation- scheduling criteria and methods, quality of irrigation water, logging.	10
3	Weeds- importance, classification, crop-weed competition, concepts of weed management principles and methods, herbicides- classification, selectivity and resistance, allelopathy.	10
4	Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops, crop management technologies in problematic areas, harvesting and threshing of crops.	12
	Total lectures	**42**

Practical

S. No.	Particulars	No. of practicals
1	Weeds- importance and classification.	1
2.	Pesticides and tillage implement.	1
3	Study of agroclimatic zones of India.	1
4	Identification of weeds in crops.	1
5	Methods of herbicide and fertilizer application.	1
6	Study of yield contributing characters and yield estimation.	1
7	Seed germination and viability test.	1
8	Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement.	1
9	Use of tillage implements-reversible plough, one-way plough, harrow, leveler and seed drill.	1
10	Study of soil moisture measuring devices.	1
11	Measurement of field capacity.	1
12	Measurement of bulk density.	1
13	Measurement of infiltration rate.	1
14	Measurement of irrigation water.	1

Suggested Books/Readings:

	Authors/Name of Books/Publisher
1.	Gopal Chandra De. (1980). Fundamentals of Agronomy. Oxford and IBH Publishing Co. Ltd., Bengaluru.
2.	Reddy. S.R. (1999). Principles of Agronomy. Kalyani Publishers, Ludhiana.
3.	Balasubramaniyan, P and Palaniappan, S.P. (2017). Principles and Practices of Agronomy. AgroBios (India) Ltd.,Jodhpur
4.	Prihar, S.S. (2017). Irrigation of Field crops. ICAR Publishers.
5.	Gupta, O.P. (2008). Modern Weed Management. Agribios (India), Jodhpur.
6.	Das, P.C. (2015). Manures and Fertilizers. Kalyani Publishers, New Delhi.
7.	Brady, N.C. and Well, R.R. 2002. The Nature and Properties of Soils (13th ed.). Pearson Education, Delhi.
8.	Havlin, J. L., Beaton, J. D., Tisdale, S.L., and Nelson, W.L. 2006. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7thed.). Pearson Education, Delhi.
9.	Hand Book of Agriculture, 2020, ICAR, New Delhi

Bot-101
Introductory Biology

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To know about basic knowledge of biology and different aspects of the living world.

Learning Outcome: Students will gain knowledge on different aspects of biology and will attain working knowledge on different aspects of life and its evolution.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Introduction to the living world, diversity and characteristics of life, origin of life, evolution and eugenics.	3
2.	Binomial nomenclature and classification. Cell and cell division.	3
3.	Morphology of flowering plants.	2
4.	Seed and seed germination.	2
5.	Plant systematics- viz; Brassicaceae, Fabaceae and Poaceae.	3
6.	Role of animals in agriculture.	1
	Total lectures	**14**

Practical

S. No.	Particulars	No. of practicals
1.	Morphology of flowering plants – root, stem and leaf and their modifications.	3
2.	Inflorescence, flower and fruits. Cell, tissues & cell division.	3
3.	Internal structure of root, stem and leaf.	2
4.	Study of specimens and slides.	3
5.	Description of plants - Brassicaceae, Fabaceae and Poaceae.	3
	Total lectures	**14**

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	M.P. Pendarvis and J. L. Crawley. 2018. Exploring Biology in the Laboratory. 3rd Edition. Morton Publishing Company. Eaglewood, USA
2.	S. Fowler, R. Roush and J. Wise. 2013. Concepts of Biology. Xan Edu Publishing Inc; 1st Edition. MI United States.
3.	S. J. Bidlack, S. Jansky, and K. Stern. 2013. Stern's Introductory Plant Biology. McGraw-Hill Education. New Delhi.
4.	L. C. Pearson . 1995. The Diversity and Evolution of Plants. CRC Press, New Delhi.

Math-101
Elementary Mathematics

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: Students will learn basic concepts and application of co-ordinate geometry, differentiation, integration and matrices etc.

Learning Outcome: Students will gain knowledge regarding different aspects of elementary mathematics.

Details of Course:

S. No.	Particulars	No. of lectures
1	Straight lines : Distance formula, section formula (internal and external division), change of axes (only origin changed), equation of co-ordinate axes, equation of lines parallel to axes, slope-intercept form of equation of line, slope-point form of equation of line, two point form of equation of line, intercept form of equation of line, normal form of equation of line, general form of equation of line, point of intersection of two straight lines, angles between two straight lines, parallel lines, perpendicular lines, angle of bisectors between two lines, area of triangle and quadrilateral.	6
2	Circle: Equation of circle whose center and radius is known, general equation of a circle, equation of circle passing through three given points, equation of circle whose diameters is line joining two points (x_1, y_1) & $(x_2, y2)$, tangent and normal to a given circle at given point (Simple problems), condition of tangency of a line $y = mx + c$ to the given circle $x^2 + y^2 = a^2$.	6
3	Differential Calculus : Definition of function, limit and continuity, simple problems on limit, simple problems on continuity, differentiation of x^n , e^x , sin x & cos x from first principle, derivatives of sum, difference, product and quotient of two functions, differentiation of functions of functions (Simple problem based on it), logarithmic differentiation (Simple problem based on it), differentiation by substitution method and simple problems based on it, differentiation of Inverse trigonometric functions. Maxima and minima of the functions of the form y = f (x) (Simple problems based on it).	6
4	Integral Calculus: Integration of simple functions, integration of product of two functions, integration by substitution method, definite integral (simple problems based on it), area under simple well-known curves (simple problems based on it).	5
5	Matrices and Determinants: Definition of matrices, addition, subtraction, multiplication, transpose and inverse up to 3rd order, properties of determinants up to 3rd order and their evaluation	5
	Total lectures	**28**

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	NCERT, (2007) Mathematics, Part 1 and 2.
2	N. Piskunov, 1977, Differential and Integral Calculus, Peace Publishers Moscow.
3	Gorakh Prasad, (1952) Differential Calculus, Pothishala Private Ltd., Allahabad.
4	Shanti Narayan and P K Mittal (2004) A textbook of matrices, S Chand Publications, New Delhi

Agron-101
Agricultural Heritage

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: To make the student aware regarding Indian agriculture system and its various aspects.

Learning Outcome: Students will gain knowledge on different aspects of agriculture heritage, their significance and future prospects.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Introduction of Indian agricultural heritage. Ancient agricultural practices. Relevance of heritage to present day agriculture.	3
2.	Past and present status of agriculture and farmers in society. Journey of Indian agriculture and its development from past to modern era.	3
3.	Plant production and protection through indigenous traditional knowledge.	2
4.	Crop voyage in India and world. Agriculture scope.	2
5.	Importance of agriculture and agricultural resources available in India. Crop significance and classifications.	3
6.	National agriculture setup in India. Current scenario of Indian agriculture. Indian agricultural concerns and future prospects.	1
	Total lectures	**14**

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	ICAR 1989 Handbook of Agriculture, Indian Council of Agricultural Research, New-Delhi
2.	Nene, Y.L. 2007. Glimpses of the Agricultural Heritage of India. Asian AgriHistroy Foundation, Secunderabad, Andhra Pradesh.
3.	Nene, Y.L., Saxena, R.C. and Choudhary, S.L. 2009. A Textbook on Ancient History of Indian Agriculture, Munshiram Manoharial Publishers Pvt. Ltd, New Delhi.
4.	D. Kumari, Manimuthu Veeral. 2014. Text Book on Agricultural Heritage of India. Agrotech Publishing Academy, Udaipur.

Ext-101
Rural Sociology & Educational Psychology

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To provide education on different aspects of sociology in rural areas and to give valuable information on different components of educational psychology.

Learning outcome: The student will learn different sociology aspects for rural development. They will also learn components of educational psychology and their application in agriculture extension.

Details of Course:

S. No.	Particulars	No. of lectures
1	Sociology and Rural sociology. Definition and scope, its significance in agriculture extension.	6
2	Social Ecology, rural society, social groups, social stratification, culture concept	5
3	Social Institution, social change & development.	5
4	Educational psychology: Meaning & its importance in agriculture extension.	6
5	Behavior: Cognitive, affective, psychomotor domain, personality, learning, motivation, theories of motivation, intelligence.	6
	Total lectures	**28**

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Desai A.R. (2011). Rural Sociology in India. Popular Prakashan Ltd.Mumbai.
2	Samanta. R.K. and Arora, S.K. (Editors) (1997). An Introduction to Sociology. Kitab Mahal S.D. Pvt. Ltd., Allahabad.
3	Samanta. R.K. and Arora, S.K. (Editors) (1997). Management of Agricultural Extension in Global Perspectives. B.R. Publishing Corporation. New Delhi.
4	Mondal, S. and Ray G.L (2007). A Text Book of Rural Development. Kalyani Publishers, Chennai
5	Pitale, R.L. (1982). Project Appraisal Technique. Oxford and IBH Pub. Co., New Delhi.
6	Ray G.L (2015). Extension Communication and Management. Kalyani Publishers, Chennai.
7	Dahama OP. and Bhatnagar, OP. 2019. Education and Communication for Development, Oxford & IBH Publishing Co Pvt. Ltd., New Delhi.
8	Sandhu, AS. 2019. Textbook on Agricultural Communication Process and Methods, CBS Publishers and Distributors Pvt. Ltd., Delhi
9	Chitambar, JB. 2020. Introductory Rural Sociology, New Age International Private Limited, New Delhi.

Edu-101
Human Values and Ethics

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: To provide education regarding ethics in human life, right and responsibilities of humans and sensitization against drug abuse and its management.

Learning outcome: The student will become aware regarding ethics in human life and will also come to know about his duties and responsibilities in society. The student will also gain information on drug abuse, its disadvantages and its management.

Details of Course:

S. No.	Particulars	No. of lectures
I	Universal human aspirations, happiness and prosperity. Human values and ethics - Concept, definition, significance and sources - Fundamental values - Right conduct, peace, truth, love and non-violence. Principles and philosophy – Self exploration, self-awareness, self-satisfaction, decision making, motivation, sensitivity, success, selfless service.	4
II	Case study of ethical lives. Positive spirit, body, mind and soul - Attachment and detachment. Spirituality and spirituality quotient. Examinations.	3
III	Ethics - Professional, environmental, ICT Sensitization towards others particularly senior citizens, developmentally challenged and gender. Positive attitude and scientific temper. Team work and volunteering.	2
IV	Rights and responsibilities. Road safety. Human relations and family harmony, modern challenges and value conflict.	2
V	Sensitization against drug abuse and other social evils. Developing personal code of conduct (SWOT/SWOC/SNAC Analysis). Management of anger and stress.	3

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Gaur RR, Sanga lR and Bagaria GP. 2011. A Foundation Course in Human Values and Professional Ethics. Excel Books, Darya Ganj, Delhi.
2	Sharma RA. 2011. Human Values and Education – Axiology, Inculcation and Research. R. Lall Book Depot, Meerut.
3	Srivastava S. 2011. Human Values and Professional Ethics. S K Kataria and Sons, New Delhi.
4	D.R. Kiran. 2013. Professional Ethics & Human Values. Tata McGraw-Hill Publishing Co. Ltd, NOIDA.
5	Tripathy, AN. 2003. Human Values, New Age International Publishers, New Delhi.
6	Bajpai, BL. 2008. Indian Ethos and Modern Management, New Royal Book Co., Lucknow.
7	Dhar, PL.; Gaur, RR. 1990, Science and Humanism, Commonwealth Publishers, New Delhi.

NSS/NCC/Physical education and Yoga practice

National Service Scheme Credit hours: 2(0+2)

Practical-Course aims at evoking social consciousness among students through various activities viz., working together, constructive and creative social work, to be skillful in executing democratic leadership, developing skill in programme development to be able for self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society. Following activities are to be taken up under the NSS course:

1. Introduction and basic components of NSS: Orientation
2. NSS programmes and activities
3. Understanding youth
4. Community mobilisation
5. Social harmony and national integration
6. Volunteerism and shramdan
7. Citizenship, constitution and human rights
8. Family and society
9. Importance and role of youth leadership
10. Life competencies
11. Youth development programmes
12. Health, hygiene and sanitation
13. Youth health, lifestyle, HIV AIDS and first aid
14. Youth and yoga
15. Vocational skill development
16. Issues related environment
17. Disaster management
18. Entrepreneurship development
19. Formulation of production-oriented project
20. Documentation and data reporting
21. Resource mobilization
22. Additional life skills
23. Activities directed by the Central and State Government

Physical Education and Yoga Practices

- Teaching of skills of Football – demonstration, practice of the skills, correction, involvement in game situation
- Teaching of different skills of Football – demonstration, practice of the skills, correction, involvement in game situation
- Teaching of advance skills of Football – involvement of all the skills in game situation with teaching of rules of the game
- Teaching of skills of Basketball – demonstration, practice of the skills, correction of skills, involvement in game situation
- Teaching of skills of Basketball – demonstration, practice of the skills, involvement in game situation
- Teaching of skills of Basketball – involvement of all the skills in game situation with teaching of rule of the game
- Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills, involvement in game situation
- Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills, involvement in game situation
- Teaching of advance skills of Kabaddi – involvement of all the skills in game situation with teaching of rule of the game
- Teaching of skills of Ball Badminton – demonstration, practice of the skills, correction of skills,

involvement in game situation

- Teaching of skills of Ball Badminton – involvement of all the skills in game situation with teaching of rule of the game
- Teaching of some of Asanas – demonstration, practice, correction and practice
- Teaching of some more of Asanas – demonstration, practice, correction and practice
- Teaching of skills of Table Tennis – demonstration, practice of skills, correction and practice and involvement in game situation
- Teaching of skills of Table Tennis – demonstration, practice of skills, correction and practice and involvement in game situation
- Teaching of skills of Table Tennis – involvement of all the skills in game situation with teaching of rule of the game
- Teaching – Meaning, Scope and importance of Physical Education
- Teaching – Definition, Type of Tournaments
- Teaching – Physical Fitness and Health Education
- Construction and laying out of the track and field (*The girls will have Tennikoit and Throw Ball).

Semester II			
S. No.		**Subject**	**Credits**
1	PBG-102	Fundamentals of Genetics	3(2+1)
2	Micro-102	Agricultural Microbiology	2(1+1)
3	Soil-102	Introductory Soil and Water Conservation Engineering	2(1+1)
4	Bot-102	Fundamentals of Crop Physiology	2 (1+1)
5	Econ-102	Fundamentals of Agricultural Economics	2 (2+0)
6	Pl. Path-102	Fundamentals of Plant Pathology	4(3+1)
7	Ent-102	Fundamentals of Entomology	4(3+1)
8	Ext-102	Fundamentals of Agricultural Extension Education	3(2+1)
9	ENG-102	Communication Skills and Personality Development	2(1+1)
		Total	**24(16+8)**

PBG -102

Fundamentals of Genetics

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To know about basic processes of genetics and molecular aspects associated with it and its scope significant for crop improvement.

Learning Outcome: Students will gain knowledge on different aspects of genetics and will attain working knowledge on different cytology and molecular genetics practises in lab.

Details of Course:

Sr. No.	Particulars	No. of Lectures
1.	Pre and Post Mendelian concepts of heredity, Mendelian principles of heredity. Architecture of chromosome; karyotype and ideograms; special types of chromosomes.	6
2	Chromosomal theory of inheritance- cell cycle and cell division- mitosis and meiosis. Probability and Chi-square test. Dominance relationships, Epistatic interactions with example.	6
3	Multiple alleles, pleiotropism and pseudoalleles, Sex determination and sex linkage, sex limited and sex influenced traits, Blood group genetics, Linkage and its estimation, crossing over mechanisms, chromosome mapping. Structural and numerical variations in chromosome and their implications, Use of haploids, dihaploids and doubled haploids in Genetics.	6
4	Mutation, classification, Methods of inducing mutations & CIB technique, mutagenic agents. Qualitative & Quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Cytoplasmic inheritance. Genetic disorders. Nature, structure & replication of genetic material.	6
5	Protein synthesis, Transcription and translational mechanism of genetic material, Gene concept: Gene structure, function and regulation, Lac and Trp operons.	4

Practical

Sr. No.	Particulars	No. of practicals
1	Study of microscope. Study of cell structure.	2
2	Mitosis and Meiosis cell division.	2
3	Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross, Practice on mitotic and meiotic cell division,	2
4	Probability and Chi-square test.	2
5	Determination of linkage and cross-over analysis (through two point test cross and three point test cross data).	2
6	Study on sex linked inheritance in Drosophila.	2
7	Study of models on DNA and RNA structures.	2

Suggested Books/Readings:

1. Gupta, P.K. 2007. Genetics, Rastogi Publications, Meerut
2. Singh, B.D. 2015. Genetics, Kalyani Publishers, New Delhi
3. Singh, B.D. 2015. Fundaments of Genetics, Kalyani Publishers, New Delhi
4. Miglani, G.S. 2008. Fundamentals of Genetics, Alpha Science International, Oxford, UK
5. Snusted, D.P. and Simmons, M.J. 2009. Principles of Genetics, V Edition. John Wiley and Sons Inc, NOIDA
6. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley, NOIDA

Micro-102
Agricultural Microbiology

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: The studies of beneficial microbes for agriculture application

Learning Outcome: Students will gain knowledge on different aspects of microbiology and will attain working knowledge on different microbiological practises in lab.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Introduction: Microbial world: Prokaryotic and eukaryotic microbes. Bacteria: cell structure, chemoautotrophy, photo autotrophy, growth	3
2.	Bacterial genetics: Genetic recombination transformation, conjugation and transduction, plasmids, transposon	2
3.	Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles	3
4.	Biological nitrogen fixation: symbiotic, associative and asymbiotic. *Azolla,* blue green algae and mycorrhiza.	2
5.	Rhizosphere and phyllosphere	1
6.	Microbes in human welfare: silage production, biofertilizers, biopesticides, biofuel production and biodegradation of agro-waste.	3

Practical

S. No.	Particulars	No. of practicals
1.	Introduction to microbiology laboratory and its equipments; Microscope- parts, principles of microscopy, resolving power and numerical aperture.	2
2.	Methods of sterilization.	2
3.	Nutritional media and their preparations.	2
4.	Enumeration of microbial population in soil- bacteria, fungi, actinomycetes.	2
5.	Methods of isolation and purification of microbial cultures.	1
6.	Isolation of *Rhizobium* from legume root nodule.	1
7.	Isolation of *Azotobacter* from soil. Isolation of *Azospirillum* from roots.	1
8.	Isolation of BGA	1
9.	Staining and microscopic examination of microbes.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Rangaswamy, G, 1992. Agricultural Microbiology, PHI Publication, New Delhi.
2.	Subbarao NS, 1999. Soil Microbiology - Oxford and IBH publishing Co Pvt Ltd, New Delhi.
3.	Singh T and Purohit SS, 2008. Biofertilizer Technology, Agrobios, Jodhpur
4.	Suri S, 2011. Biofertilizers and Biopesticides, APH Publishing Corporation, New Delhi.
5.	Sharma AK, 2012. Biofertilizers for Sustainable Agriculture, Agrobios, Jodhpur.
6.	Aggarwal RM, 2013. Soil Microbiology - Wisdom Press/Dominant Publishers, New Delhi.
7.	Rao N. S. S, 2019. Soil Microbiology. CBS Publisher, Delhi.
8.	Robert. L. 2013. Soil Microbiology. John Wiley, NOIDA.

Soil-102

Introductory Soil and Water Conservation Engineering

Credits: 1 + 1 Mid-Session Exam: 20 (15+5#)

Contact Hours: 14 + 28 Practical Exam: 50

End-Semester Exam: 30

Objective: To know about different agent which cause soil erosion and different methods of soil water conservation

Learning Outcome: Students will gain knowledge on different aspects of soil and water conservation and will attain working knowledge on different conservation practises.

Details of Course:

Units	Particulars	No. of Lectures
I	Introduction to Soil and Water Conservation causes of soil erosion. Definition and agents of soil erosion, water erosion: Forms of water erosion. Gully classification and control measures.	4
II	Soil loss estimation by universal Loss Soil Equation. Soil loss measurement techniques. Principles of erosion control:	3
III	Introduction to contouring, strip cropping. Contour bund. Graded bund and bench terracing. Grassed water ways and their design. Water harvesting and its techniques.	4
IV	Wind erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.	3

Practical

S. No.	Practical Description	No. of practicals
1.	General status of soil conservation in India	2
2.	Calculation of erosion index.	2
3.	Estimation of soil loss.	2
4.	Measurement of soil loss.	1
5.	Preparation of contour maps	1
6.	Design of grassed water ways	1
7.	Design of contour bunds.	1
8.	Design of graded bunds	1
9.	Estimation of DTPA extractable Zn in soils.	1
10.	Design of bench terracing system	1
11.	Problem on wind erosion.	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Ojha, T.P. and A.M.Michael. 2001, Principles of Agricultural Engineering, Vol.II. Jain Brothers New Delhi.3rd edition.
2	Singhal, O.P. 1998, Agricultural Engineering, Aman Publishing House, Meerut

Bot-102
Fundamentals of Crop Physiology

Credits: 1 + 1 | Mid-Session Exam: 20 (15+5#)
Contact Hours: 14 + 28 | Practical Exam: 50
End-Semester Exam: 30

Objective: To know about basic physiological processes in plants and its significance.

Learning outcome: Students will gain knowledge on different aspects of plant physiology and will attain working knowledge on different physiological experiments in lab and field.

Details of Course:

S. No.	Particulars	No. of lectures
1	Introduction to crop physiology and its importance in Agriculture.	2
2	Plant cell: an Overview; Diffusion and osmosis; Absorption of water, transpiration and Stomatal Physiology; Mineral nutrition of Plants: Functions and deficiency symptoms of nutrients, nutrient uptake mechanisms.	3
3	Photosynthesis: Light and Dark reactions, C3, C4 and CAM plants; Respiration: Glycolysis, TCA cycle and electron transport chain.	3
4	Fat Metabolism: Fatty acid synthesis and Breakdown; Plant growth regulators: Physiological roles and agricultural uses.	3
5	Physiological aspects of growth and development of major crops: Growth analysis, Role of Physiological growth parameters in crop productivity.	3

Practical

S. No.	Particulars	No. of practicals
1.	Study of plant cells.	2
2.	Structure and distribution of stomata.	2
3.	Photosynthesis, respiration and rate of transpiration.	2
4.	Imbibitions, osmosis and plasmolysis.	2
5.	Measurement of root pressure.	1
6.	Rate of transpiration.	1
7.	Separation of photosynthetic pigments through paper chromatography.	1
8.	Tissue test for mineral nutrients.	1
9.	Estimation of relative water content.	1
10.	Measurement of photosynthetic CO_2 assimilation by Infra-Red Gas Analyser (IRGA).	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Taiz, L., Zeiger, E. 2003. Plant physiology, 3rd Edition. Panima Publishing Corporation, New Delhi
2.	Noggle G.R. and Fritz G.J. 1992. Introductory Plant Physiology II Edition. Prentice Hill of India (P) Ltd., New Delhi
3.	Bidwil R.G.S. 1979. Plant Physiology II Edition. Macmillan, Publishing Co., Inc. New York
4.	Salisburry, F. B. and Ross. C.W. 2009 Plant Physiology, 4th Edition. CBS Publishers and Distributors, New Delhi
5.	Milthrope, F.L. and Marby, J. 1979. An Introduction to Crop Physiology, Cambridge University Press, London

6.	Devlin R. M. and Witham F. H. 1983. Plant Physiology 4th Edn. CBS Publishers and Distributors, New Delhi.
7.	Gupta .N.K and Sunita Gupta. 2002. Plant Physiology. Oxford and IBH Publishing Co.Pvt. Ltd. New Delhi.
8.	Malick, C. P and Srivastava, A.K. 2000. Text book of Plant Physiology.Kalyani publishers, New Delhi.

Econ-102
Fundamentals of Agricultural Economics

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To make student understand principles of economics and its applications in agriculture.

Learning outcome: The students will understand different aspects of economics such as demand, returns, cost, supply distribution and income and its applications in agriculture sector.

Details of Course:

S. No.	Particulars	No. of lectures
1	*Economics:* Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro and macroeconomics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium, economic laws as generalization of human behavior. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. Agricultural planning and development in the country.	4
2	*Demand:* meaning, law of demand, schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium and derivation of demand curve, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity.	4
3	Production: process, creation of utility, factors of production, input output relationship.	1
4	*Laws of returns*: Law of variable proportions and law of returns to scale.	1
5	*Cost:* concepts, short run and long run cost curves.	2
6	Supply: Stock v/s supply, law of supply, schedule, supply curve, determinants of supply, elasticity of supply	1
7	Market structure: meaning and types of market, basic features of perfectly competitive and imperfect markets. Price determination under perfect competition; short run and long run equilibrium of firm and industry, shut down and break-even points.	2
8	Distribution theory: meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit.	2
9	*National income:* Meaning and importance, circular flow, concepts of national income accounting and approaches to measurement, difficulties in measurement.	2
10	Population: Importance, Malthusian and Optimum population theories, natural and socioeconomic determinants, current policies and programmes on population control.	2
11	Money: Barter system of exchange and its problems, evolution, meaning and functions of money, classification of money, supply, general price index, inflation and deflation. Banking: Role in modern economy, types of banks, functions of commercial and central bank, credit creation policy.	2
12	Agricultural and public finance: meaning, micro v/s macro finance, need for agricultural finance, public revenue and public expenditure	2
13	*Tax:* meaning, direct and indirect taxes, agricultural taxation, VAT.	2
14	*Economic systems:* Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning	3

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Sundram K.P.M. and Vaish M.C. 1978. Principles of Economics. Vikas Publishing House Pvt. Ltd., NOIDA.
2	Dewett K.K. and Verma J.D., 1973. Elementary Economic Theory. S. Chand and Company, New Delhi.
3	Dewett K.K. and Navalur M.H., 2016. Modern Economic Theory. S. Chand and Company, New Delhi.
4	Talathi J. M., Naik V.G. and Jalgaonkar V.N. 2019. Introduction to Agricultural Economics and Agribusiness Management. Ane Books Pvt. Ltd., Chennai.

Pl. Path-102

Fundamentals of Plant Pathology

Credits: 3 + 1 Mid-session exam: 30 (25+5#)
Contact hours: 42 + 28 Practical exam: 25
End-semester exam: 45

Objective: Introduce student the basic principle and concept of Plant Pathology.

Learning Outcome: The fundamental of Plant Pathology course is helpful for understanding the differentiation between different microbes causing diseases in plants.

Details of Course:

Units	Contents	Lectures
I	Introduction, important plant pathogenic organisms, different groups, fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viriods, algae, protozoa and phanerogamic parasites with examples of diseases caused by them.	6
II	*Fungi*: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes.	8
III	*Bacteria and mollicutes*: general morphological characters. Basic methods of classification and reproduction. *Viruses*: nature, structure, replication and transmission. Study of phanerogamic plant parasites.	7
IV	*Nematodes:* General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (*Heterodera, Meloidogyne, Anguina, Radopholus* etc.) Growth and reproduction of plant pathogens. Liberation / dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens	7
V	Phenomenon of infection, pre-penetration, penetration and post penetration. Pathogenesis. Role of enzymes, toxins and growth regulators in disease development. Defense mechanism in plants**.** Epidemiology: Factors affecting disease development. Principles and methods of plant disease management. Nature,	7
VI	Role and mechanisms of biological control and PGPR. Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics. Integrated plant disease management (IDM), concept, advantages and importance.	7

Practical:

S. No.	Particulars	No. of practicals
1.	Acquaintance with various laboratory equipments and microscopy. Collection and preservation of disease specimen. Preparation of media, isolation and Koch's postulates. General study of different structures of fungi.	5
2.	Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plantviruses. Study of phanerogamic plant parasites.	4

3.	Study of morphological features and identification of plant parasitic nematodes. Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting. Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations**.**	5

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Aneja, K. R. and Mehrotra, R. S. 2021.Introduction of Mycology. DPH.PVT LTD. New Delhi
2.	Agrios, G.N. 2021. Plant Pathology. Elsevier. Academic Press. New York
3.	Nene, Y. L. and Thapliyal, P. N. 2018. Fungicides in Plant Disease Control. Meditech and IBH New Delhi
4.	Gopinath, H. 2017. A Textbook of Mycology. New Central Book Agency PVT LTD. New Delhi
5.	Singh, R.S 2002. Introduction to Principles of Plant Pathology. Oxford and IBH Publishing, New Delhi
6.	Dasgupta, M.K. 1998. Principles of Plant Pathology. Allied Publishers Pvt. Ltd. Bengaluru
7.	Prakasam,V. Reguchander,T. and Prabakar, K. 1998. Plant Diseases Management. A.E. Publication, Coimbatore.

Ent-102

Fundamentals of Entomology

Credits: 3 + 1 Mid-session exam: 30 (25+5#)
Contact hours: 42 + 28 Practical exam: 25
End-semester exam: 45

Objective: To make the student understand basic principles of entomology and various aspects associated with it.

Learning Outcome: The student will gain knowledge regarding insect morphology, systematics and IPM.

Details of Course:

Units	Contents	Lectures
I	History of Entomology in India. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and molting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, Wing venation, modifications and wing coupling apparatus. Structure of male and female genital organ. Metamorphosis and diapauses in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretary (Endocrine) and reproductive system, in insects. Types of reproduction in insects. Major sensory organs like simple and compound eyes, chemoreceptor.	6
II	Metamorphosis and diapauses in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretary (Endocrine) and reproductive system, in insects. Types of reproduction in insects. Major sensory organs like simple and compound eyes, chemoreceptor.	5
III	Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors– temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance.	6
III	Categories of pests. Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Chemical control importance, hazards and limitations.	6
IV	Recent methods of pest control, repellents, anti-feed ants, hormones, attractants, and gamma radiation. Insecticides Act 1968- Important provisions. Application techniques of spray fluids. Symptoms of poisoning, first aid and antidotes.	6
V	Systematics: Taxonomy –importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto Orders, basic groups of present-day insects with special emphasis to orders and families of Agricultural importance like Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae;	6
VI	Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papiloinidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthridinidae, Apidae. Trichogrammatidae, lchneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.	7

Practical:

S. No.	Particulars	No. of practicals
1.	Methods of collection and preservation of insects including immature stages.	2
2.	External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs.	2
3.	Wing venation, types of wings and wing coupling apparatus.	2
4.	Types of insect larvae and pupae.	1
5.	Dissection of digestive system in insects (Grasshopper).	1
6.	Dissection of male and female reproductive systems in insects (Grasshopper).	1
7.	Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance.	2
8.	Insecticides and their formulations.	1
9.	Pesticide appliances and their maintenance.	1
10.	Sampling techniques for estimation of insect population and damage.	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Chapman RF, Simpson SJ & Douglas AE. 2013. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.
2.	Johnson NF & Triplehorn. 2005. Borror and Delong's Introduction to the Study of Insects. 7th Edition, Cengage Learning, New Delhi.
3.	Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publishers, New Delhi
4.	Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. Vol 1 & 2. 10th Ed. Chapman & Hall, London.
5.	Snodgross RE. 1993. *Principles of Insect Morphology.* Cornell Univ. Press, Ithaca.
6.	Mayr E. 1991. *Principles of Systematic Zoology*. Tata McGraw-Hill, New Delhi.
7.	Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy*. Blackie, London.
8.	Dhaliwal GS & Arora R. 2006. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.
9.	Pedigo RL. 2002. *Entomology and Pest Management.* 4th Ed. Prentice Hall, New Delhi.
10.	Dhaliwal, G. S. 2009. An Outline of Entomology 2nd ed. Kalyani Publishers, New Delhi.
11.	Elzinga, R.T. 2003. Fundamentals of Entomology. Prentice-Hall, Delhi.

Ext-102

Fundamentals of Agricultural Extension Education

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To provide knowledge regarding extension system in India and new trends, monitoring, evaluation of extension system.

Learning outcome: The student will attain knowledge for extension education and will learn concepts of different aspects extension system.

Details of Course:

S. No.	Particulars	No. of lectures
I	Education: Meaning, definition & Types; Extension Education- meaning, definition, scope and process; objectives and principles of Extension Education; Extension Programme planning- Meaning, Process, Principles and Steps in Programme Development.	6
II	Extension systems in India: extension efforts in pre-independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, etc.) and post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.); various extension/ agriculture development programmes launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND, NATP, NAIP, etc.).	6
III	New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc. Rural Development: concept, meaning, definition; various rural development programmes launched by Govt. of India. Community Dev.-meaning, definition, concept & principles, Philosophy of C.D. Rural Leadership: concept and definition, types of leaders in rural context; extension administration: meaning and concept, principles and functions.	6
IV	Monitoring and evaluation: concept and definition, monitoring and evaluation of extension programmes; transfer of technology: concept and models, capacity building of extension personnel; extension teaching methods: meaning, classification, individual, group and mass contact methods, ICT Applications in TOT (New and Social Media), media mix strategies;	5
V	Communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication. Agriculture journalism; diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.	5

Practical

S. No.	Particulars	No. of practicals
1.	Audio-visual aids – Meaning, importance and classification - Selection, planning, preparation, evaluation, presentation and use of audio-visual aids – Charts.	1
2	Selection, planning, preparation, evaluation, presentation and use of audio-visual aids – Charts, posters, flip charts, flash cards, plannel graphs.	1
3	Selection, planning, preparation, evaluation, presentation and use of audio-visual aids – Power point slides.	1
4	Planning and preparation of extension literature – Leaflet, folder, pamphlet, booklet, news stories and success stories.	1
5	Handling and use of audio visual equipments such as public address equipment (PAE) system and still camera and digital camera and Liquid Crystal Display (LCD) Projector.	1
6	Group discussion – Simulated exercise.	1
7	Visit to a village to study on going rural development and agricultural developmental programmes.	1
8	To study and familiarize university extension system. 9. Visit to KVK. 10. Visit to Farmers' Training Centre (FTC).	1
9	Visit to District Agricultural Advisory and Transfer of Technology Centre (DAATTC).	1
10	Visit to study organization and functioning of DRDA, DWMA, ATMA, JDA Office and other development departments at district level.	1
11	Visit to a village to exercise PRA techniques.	1
12	Visit to community radio and television studio for understanding the process of programme production, Script writing.	1
13	Developing script for radio.	1
14	Developing script for television.	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Dahama, O.P. and Bhatnagar, O.P. 1999. Extension and Communication for Development. Oxford & IBH Private Limited, New Delhi/Mumbai.
2	Ganesh, R., Mohammad Iqbal and Ananda Raja. 2003. Reaching the Unreached – Basics of Extension Education. Associate Publishing Company, New Delhi.
3	Ray, G.L. 2006. Extension Communication and Management. Naya Prokash/Kalyani Publishers, Kalkatta/Ludhiana.
4	Vasantha R and Kiran. 2012 Extension Education - New Horizons – Kalyani Publishers, New Delhi.
5	Chandrakantan, K and Palaniswamy, (2000). Advances in Communication Technology, Indian Publishers, New Delhi.
6	Raydu, C.S., (1993). Media and Communication Management. Himalaya Publishing House, Mumbai.
7	Dahama, O.P. and Bhatnagar, O.P. (2003). Education and Communication for Development. Oxford and IBH, New Delhi.

Eng-102
Communication Skills and Personality Development

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To provide knowledge regarding communication skills and to develop the overall personality of the student.

Learning outcome: The student will be learning different kinds of communication skills which will lead them into an organized and pleasing personality.

Details of Course:

S. No.	Particulars	No. of lectures
I	Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication	3
II	listening and note taking, writing skills, oral presentation skills	2
III	Field diary and lab record; indexing, footnote and bibliographic procedures.	2
IV	Reading and comprehension of general and technical articles, precise writing, summarizing	3
V	Abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.	4

Practical

S. No.	Particulars	No. of practicals
1.	Listening and note taking, writing skills, oral presentation skills	2
2	Field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles	3
3	Precise writing, summarizing, abstracting; individual and group presentations.	2
4	Visit to community radio and television studio for understanding the process of programme production, Script writing.	3
5	Developing script for radio.	2
6	Developing script for television.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Sandhu, A. S. (1999). Textbook on Agricultural Communication; Process and Methods. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
2	Dahama, O. P. and Bhatnagar, O.P., 1998, Education and Communication for Development, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3	Ray, G. L., 2010 (7th Edition), Extension Communication and Management, Kalyani Publishers, Ludhiana.
4	Supe, S. V. 2013 (2nd Edition), A Text Book of Extension Education, Agrotech Publishing Academy, Udaipur.
5	Verma, K.C. 2013. The Art of Communication. Kalpaz Publications, New Delhi.
6	Sharma R C and Krishna Mohan. 1978. Business Correspondence. Tata Mc Graw Hill Publishing Co. Pvt. Ltd, New Delhi.
7	Adivi Reddy, A., 2001, Extension Education, Sree Lakshmi Press, Bapatla.

		Semester III	
S. No.	**Corse Code**	**Subject**	**Credits**
1	Agron-201	Crop Production Technology – I (Kharif Crops)	2 (1+1)
2	PBG-201	Fundamentals of Plant Breeding	3 (2+1)
3	Econ-201	Agricultural Finance and Cooperation	3 (2+1)
4	AGI-201	Agri- Informatics	2 (1+1)
5	FMP-201	Farm Machinery and Power	2 (1+1)
6	Hort-201	Production Technology for Vegetables and Spices	2 (1+1)
7	Env-201	Environmental Studies and Disaster Management	3(2+1)
8	Stat-201	Statistical Methods	2(1+1)
9	LPM-201	Livestock and Poultry Management	4 (3+1)
		Total	23(14+9)

Agron-201
Crop Production Technology-I (Kharif Crops)

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To make student understand about various aspects associated with production of different kharif crops.

Learning outcomes: The student will have a thorough knowledge regarding different kharif crops, their origin, distribution and various crop production technologies associated with them.

Details of Course:

S. No.	Particulars	No. of lectures
1	Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops. Cereals – rice, maize, sorghum, pearl millet and finger millet, pulses-pigeonpea, mungbean and urdbean;	4
2	Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of pulse crops -pigeonpea, mungbean and urdbean;	3
3	Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of oilseed crops - groundnut, and soybean;	2
4	Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of fibre crops- cotton & jute and forage crops-sorghum, cowpea, cluster bean and napier.	5

Practical

S. No.	Particulars	No. of practicals
1	Rice nursery preparation, transplanting of rice,	2
2.	Sowing of soybean, pigeonpea and mungbean	2
3	Sowing of maize, groundnut and cotton,	2
4	Effect of seed size on germination and seedling vigour of kharif season crops,	2
5	Effect of sowing depth on germination of kharif crops	1
6	Identification of weeds in kharif season crops	1
7	Top dressing and foliar feeding of nutrients,	1
8	study of yield contributing characters and yield calculation of kharif season crops	1
9	Study of crop varieties and important agronomic experiments at experimental farm.	1
10	Study of forage experiments morphological description of kharif season crops, visit to research centers of related crops.	1

Suggested Books/Readings:

	Authors/Name of Books/Publisher
1.	ICAR (Indian Council of Agricultural Research). (2020). Hand Book of Agriculture. ICAR, New Delhi.
2.	Pal, M., Deka, J., and Rai. (1996). Fundamentals of Cereal Crop Production. Tata McGraw Hill Pub., New Delhi
3.	Prasad, R. (ed.). (1999). A Text Book of Rice Agronomy. Jain Brothers, New Delhi.
4.	Yadav, D.S. (2002). Pulse Crops. Kalyani Publishers, New Delhi.
5.	Chakraverty, A. 1981. Post-Harvest Technology of Cereals, Pulses and Oil Seeds. Oxford and IBH Publishing Company, New Delhi.
6.	Prihar, S.S. (2017). Irrigation of Fields Crops. ICAR Publishers, New Delhi
7.	Gupta, O.P. (2008), Modern Weed Management. Agribios (India), Jodhpur.
8.	Prasad, R. (2017). Field Crops Production, Commercial Crops Volume II. ICAR, Krishi Anusandhan Bhavan, Pusa, New Delhi.
9.	Chhidda Singh, Prem Singh and Rajbir Singh. 2003. Modern Techniques of Raising Field Crops (2nd ed.). Oxford and IBH, New Delhi.
10.	Narayanan, T.R. and Dobadghao, P.M. 1972. Forage Crops of India, ICAR, New Delhi

PBG-201

Fundamentals of Plant Breeding

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To make student understand basic concept of conventional and molecular plant breeding technology.

Learning Outcomes: The student will attain knowledge regarding pant breeding techniques for various crops and to screen the crop material for desired traits.

Details of Course:

Sr. No.	Particulars	No. of Lectures
1.	Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, modes of reproduction and apomixes, self-incompatibility and male sterility-genetic consequences, cultivar options.	6
2	Domestication, Acclimatization and Introduction; Centers of origin/ diversity, components of Genetic variation; Heritability and genetic advance; Genetic basis and breeding methods in self- pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population; Multiline concept.	6
3	Concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross pollinated crops, modes of selection; Population improvement Schemes-Ear to row method, Modified Ear to Row, recurrent selection schemes;	5
4	Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; Breeding methods in asexually propagated crops, clonal selection and hybridization; Maintenance of breeding records and data collection;	5
5	Wide hybridization and pre-breeding; Polyploidy in relation to plant breeding, mutation breeding-methods and uses; Breeding for important biotic and abiotic stresses; Biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding; Intellectual Property Rights, Patenting, Plant Breeders and & Farmer's Rights.	6

Practical

Sr. No.	Particulars	No. of practicals
1	Plant Breeder's kit, Study of germplasm of various crops. Emasculation and hybridization techniques in self & cross-pollinated crops.	2
2	Study of floral structure of self-pollinated and cross-pollinated crops.	2
3	Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system.	2
4	Handling of segregation populations. Methods of calculating mean, range, variance, standard deviation, heritability.	2
5	Designs used in plant breeding experiments, analysis of Randomized Block Design.	2
6	To work out the mode of pollination in a given crop and extent of natural out-crossing.	2
7	Prediction of performance of double cross hybrids.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Singh, P. 2014. Plant Breeding At a Glance. Kalyani Publishers, New Delhi.
2.	Singh, B.D. 2014. Plant Breeding Principles and Methods. Kalyani Publications, New Delhi.
3.	Allard, R.W. 2010. Principle of Plant Breeding. 2nd edition, Wiley India Pvt. Ltd., New Delhi

Econ-201

Agricultural Finance and Co-Operation

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objectives: The objective of the course is to make student understand the concepts and theory of agriculture finance and credit, the tools and techniques in financial analysis.

Learning Outcomes: The student will come to know the role of national and international financial institutions being played for reconstruction and development. This course also provides an opportunity to the students to learn the principles of cooperation and the role being played by them in marketing of agricultural produce.

Details of Course:

S. No.	Particulars	No. of lectures
1	Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian Agriculture	2
2	Agricultural credit: meaning, definition, need, classification.	2
3	Credit analysis: 4 R's, and 3C's of credits.	2
4	Sources of agricultural finance: institutional and non-institutional sources, commercial banks, social control and nationalization of commercial banks, Micro financing including KCC. Lead bank scheme, RRBs, Scale of finance and unit cost.	3
5	An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, world bank, Insurance and Credit Guarantee Corporation of India.	3
6	Cost of credit. Recent development in agricultural credit.	2
7	Preparation and analysis of financial statements – Balance Sheet and Income Statement.	3
8	Basic guidelines for preparation of project reports- Bank norms – SWOT analysis.	3
9	Agricultural Cooperation – Meaning, brief history of cooperative development in India, objectives, principles of cooperation, significance of cooperatives in Indian agriculture.	3
10	Agricultural Cooperation in India- credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing;	3
11	Role of ICA, NCUI, NCDC, NAFED	2

Practical

S. No.	Particulars	No. of practicals
1	Determination of most profitable level of capital use.	2
2	Optimum allocation of limited amount of capital among different enterprise.	2
3	Analysis of progress and performance of cooperatives using published data.	2
4	Analysis of progress and performance of commercial banks and RRBs using published data.	1
5	Visit to a commercial bank, cooperative bank and cooperative society to acquire first-hand knowledge of their management, schemes and procedures.	1
6	Estimation of credit requirement of farm business – A case study	1
7	Preparation and analysis of balance sheet – A case study.	1

8	Preparation and analysis of income statement – A case study. Appraisal of a loan proposal– A case study.	1
9	Techno-economic parameters for preparation of projects.	1
10	Preparation of Bankable projects for various agricultural products and its value-added products.	1
11	Seminar on selected topics.	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Ghosal, SN., 1966. Agricultural Financing in India, Asia Publishing House, Bombay.
2	Johi, S.S. and C.V.Moore., 1970. Essentials of Farm Financial Management, Today and Tomorrow's Printers and Publishers, New Delhi.
3	John, J.Hamptron., 1983. Financial Decision Making: Concepts, Problems and Cases, Prentice-Hall of India, New Delhi.
4	Kenneth, Duft D., 1979. Principles of Management in Agribusiness, Reston Publishing Company, Reston.
5	Mamoria, C.B., 1979. Agricultural Problems in India, Kitab Mahal, Allahabad
6	Mukhi, H R. 1983. Cooperation in India and Abroad. New Heights Publishers, New Delhi.
7	Muniraj, R., 1987. Farm Finance for Development, Oxford & IBH Publishing Company Private Ltd., New Delhi.
8	Subba Reddy, S., P. Raghu Ram., P. Sastry, T.V.N. and Bhavani Devi I. 2010. Agricultural Economics., Oxford & IBH Publishing Company Private Ltd., New Delhi.
9	William, G. Murray and Nelson Aarson, G., 1960. Agricultural Finance, The Iowa State University Press, Ames, Iowa.

AGI-201
Agri-Informatics

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To provide knowledge on application of different computer systems in agriculture and the concept of e-agriculture.

Learning outcome: The student will be able to operate and utilize computer systems for its application in various aspects of agriculture system.

Details of Course:

S. No.	Particulars	No. of lectures
1.	**UNIT-1** Introduction to Computers, Operating Systems, definition and types, Applications of MS-Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, uses of DBMS in Agriculture	3
2.	**UNIT-2** World Wide Web (www): Concepts and components. Introduction to computer programming languages, concepts and standard input/output operations.	2
3.	**UNIT-3** e-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advisory, e-banking markets market price, post-harvest management etc; Geospatial technology for generating valuable agri-information	5
4.	**UNIT-4** Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning using IT tools.	4

Practical

S. No.	Particulars	No. of practicals
1.	Study of Computer Components	2
2.	Practice of important DOS Commands.	2
3.	MS-WORD and MS Power-point for creating, editing and presenting a scientific Document.	2
4.	MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data.	2
5.	MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system.	2
6.	Crop Simulation: Computation of water and nutrient requirements of crop using CSM and IT tools	2
7.	Decision Support System: Preparation of contingent crop planning. Forecasting and early warning.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Vanatha G. and Kalpana M. 2011. Agro- Informatics. New India Publishing Agency, New Delhi
2.	Sinha P.K. and Sinha P. 2007. Computer Fundamentals. BPB Publication, New Delhi

FMP-201
Farm Machinery and Power

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective:

I. To familiarize the agriculture with tractors and the various systems of the tractors.

II. To familiarize the agriculture students with agricultural machinery & implements for different agricultural production systems.

III. To familiarize the students with the operations of tillage, sowing & Planting, Plant protection and Harvesting implements.

IV. To inculcate the knowledge of calibration of the sowing equipments.

Learning Outcomes: The student will gain knowledge about various implements used in agriculture. The student will also be able to know about its practical implementation and working of different systems associated with these implements.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Status of Farm Power in India, Sources of Farm Power	01
2.	I.C. engines, working principles of I C engines, comparison of two stroke and four stroke cycle engines , Study of different components of I.C. engine, I.C. engine terminology and solved problems	02
3.	Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor, Familiarization with Power transmission system: clutch, gear box, differential and final drive of a tractor, Tractor types, Cost analysis of tractor power and attached implement	03
4.	Familiarization with Primary and Secondary Tillage implement, implement for hill agriculture, implement for intercultural operations	02
5.	Familiarization with sowing and planting equipment, calibration of a seed drill and solved examples	02
6.	Familiarization with harvesting and threshing equipment	02
7.	Familiarization with Plant Protection equipment	02

Practical

S. No.	Particulars	No. of practicals
1.	Study of different components of I.C. engine.	2
2.	To study air cleaning and cooling system of engine	2
3.	Familiarization with clutch, transmission, differential and final drive of a tractor	2
4.	Familiarization with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system of engine	2
5.	Learning of tractor driving	2
6.	Familiarization with operation of power tiller Implements for hill agriculture	1
7.	Familiarization with seed cum-fertilizer drills their seed metering mechanism and calibration, planters and trans planter	1

8.	Familiarization with different types of sprayers and dusters Familiarization with different inter cultivation equipment	1
9.	Familiarization with harvesting and threshing machinery	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Jagdishwar Sahay, 2009. Elements of Agricultural Engineering. Standard Publisher Distributers, Darya Ganj, Delhi
2.	ICAR/Handbook of Agricultural Engineering, 2020.Indian Council of Agriculture Research, New Delhi.
3.	T P. Ojha & A M Michael, 2018. Principal of Agricultural Engineering Vol. 1, Jain Brothers, New Delhi
4.	T P. Ojha & A M Michael, 2018. Principal of Agricultural Engineering Vol. 2, Jain Brothers, New Delhi
5.	Suresh R & Sanjay Kumar, 2004. Objectives and Solved Problems in Farm Power and Machinery Engineering. Standard Publisher Distributers, Darya Ganj, Delhi
6.	V Ganesan, 2017. Internal Combustion Engines. 4 Edition, McGraw Hill Education, NOIDA.

Hort-201
Production Technology for Vegetables and Spices crops

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To provide understanding about different production technology associated with various vegetable and spices crops.

Learning outcome: The student will learn about different vegetable and spices crops and the production technology associated with them.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Importance of vegetables and spices in human nutrition and national economy	1
2.	Kitchen gardening	1
3.	Brief about origin, area, climate, soil improved verities and cultivation practices such as time of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders of important vegetables and spices: Tomato, Brinjal, Chili and Capsicum	2
4.	Cucumber, Melons, Gourds, Pumpkin, French beans and Peas	2
5.	Cole crops: Cabbage, Cauliflower, Knol-Khol	1
6.	Bulb crops: Onion, Garlic	2
7.	Root crops: Carrot, Radish, Beetroot and Tuber crop: Potato	2
8.	Leafy vegetables: Amaranth and Palak	1
9.	Perennial vegetables	2

Practical

S. No.	Particulars	No. of practicals
1.	Identification of vegetables & spice crops and their seeds	2
2.	Nursery raising	2
3.	Direct seed sowing and transplanting	2
4.	Study of morphological characters of different vegetables & spices	2
5.	Fertilizer application	2
6.	Harvesting & preparation for market	2
7.	Economices of vegetables and spices cultivation	2

Suggested Books/Readings:

1. Bose TK and Som MG. 2007. **Vegetable Crops in India. Naya Prokash, Kolkata**
2. Chadda KL. 2004. **Handbook of Horticulture.** Indian Council of AgriculturalResearch, Pusa, New Delhi.
3. Choudhary BR. 2009. A Textbook on Production Technology of Vegetables. Kalyani Publishers, New Delhi.
4. Dhaliwal MS. 2017. **Handbook of Vegetable Crops.** Kalyani Publishers, New Delhi.
5. Fageria MS. 2003. **Vegetable crops (Production Technology) Vol-II.** Kalyani Publishers, New Delhi.
6. Gopalkrishna TR. 2021. **Vegetable Crops.** Nipa Paperbacks, New Delhi.
7. Hazra P and Som MG. 2014. **Technology for Vegetable Production and Improvement.** Naya Prokash, Kolkata.
8. Hazra P and Som MG. 2015. **Vegetable Science.** Kalyani Publishers, New Delhi.
9. Peter KV. 2007. **Vegetable Crops.** New India Publishing Agency, New Delhi.

10. Rana MK. 2008. **Olericulture in India.** Kalyani Publishers, New Delhi.
11. Rana MK. 2014. **Scientific Cultivation of Vegetables.** Kalyani Publishers, New Delhi.
12. Thamburaj S and Singh N. 2013. **Textbbook of Vegetables, Tuber Crops and Spices.** Indian Council of Agricultural Research, Pusa, New Delhi.

Env-201

Environmental Studies and Disaster Management

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact Hours: 28 + 28 Practical Exam: 35
End-Semester Exam: 40

Objective: To provide knowledge regarding environment resources, their safety along with natural disaster, their impact and management.

Learning outcome: The student will get knowledge so as to safeguard various natural resources and to conserve the ecosystem, biodiversity. They will gain knowledge on various natural disasters and their management.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Multidisciplinary nature of environmental studies Definition, scope and importance. Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems.	2
2.	a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.	2
3.	c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.	2
4.	e) Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.	3
5.	Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.	1
6.	Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids.	2
7.	Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	2
8.	Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation.	2
9.	Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards.	2
10	Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, and watershed management.	2

11	Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act.	2
12	Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.	2
13	Disaster Management Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.	2
14	Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.	2

Practical

S. No.	Particulars	No. of practicals
1.	Pollution case studies.	4
2.	Case Studies- Field work: Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site-Urban/Rural/Industrial/ Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.	10

Suggested Books/Readings:

1.P.D. Sharma, 2010, Ecology and Environment, Rastogi Publication, Meerut-New Delhi
2.Dahiya P, Ahlawat M, 2013, Environmental Science: A New Approach, Alpha Science, Kharagpur
3.Bamanayha BR, Verma LN, and Verma A, 2005, Fundamentals of Environmental Sciences, Yash Publishing House, Bikaner
4.Gupta AK, Nair SS, Chattergi S, (Editors) , 2013, Disaster Management and Risk Reduction: Role of Environmental Knowledge, Alpha Science, Kharagpur
5.Agarwal KC, 1999, Environmental Biology, Agro Botanica, Bikaner
6.Shivashamugham P, 2018, Textbook on Environmental Science, NIPA, Pitampura, New Delhi
7.Verma VP, 2019, Environmental Studies and Disaster Management, S.K. Kataria and Sons, Daryaganj, New Delhi-110002.

Stat-201
Statistical Methods

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To provide knowledge regarding various statistical methods and data analysis.

Learning outcome: The student will gain knowledge regarding different statistical approaches and methods to evaluate a data set and prove the given data set significant or else non-significant.

Details of Course:

S. No.	Particulars	No. of lectures
1	Definition of statistics, its use and limitations; Frequency distribution and frequency curve and cumulative frequency curve; Measures of central tendency; Measures of dispersion;	3
2	Probability: Definition, additive and multiplicative law for two events; Normal distribution and its properties;	2
3	Introduction to sampling; Sampling techniques. Tests of significance: Null hypothesis, alternate hypothesis, Type I & II Error, one and two tail tests, level of significance and confidence interval; SND test for means: Single sample and two samples Z-test;	3
4	Student's t-test for means, single sample, two samples and paired t-test; F-test; Chi-square test in 2x2 contingency table; Yate's correction for continuity; Analysis of variance and its assumptions.	3
5	Correlation: Scatter diagram and Karl Pearson's coefficient of correlation for ungrouped data and its testing; Linear regression and its properties; Analysis of CRD and RBD; Analysis of Latin Square Design.	3

Practical

S. No.	Particulars	No. of practicals
1	Construction of frequency distribution tables and frequency curves	2
2	Computation of Arithmetic: Mean	2
3	Computation of median, Mode	2
4	Standard deviation; Variance and coefficient of variation for ungrouped and grouped data	2
5	SND test for means	1
6	Student's t-test, F-test	1
7	Chi-square test	1
8	Correlation coefficient 'r' and its testing	1
9	Fitting of regression equations	1
10	Analysis of CRD, RBD and LSD.	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Freud JE & Perles BM. 2006. Modern Elementary Statistics. 12th Ed. Pearson India, NOIDA.
2	Kapoor VK. 2003. Problems and Solutions in Statistics. 7th Edition. Sultan Chand and Sons, New Delhi.
3	Snedecor GW. & Cochran WG. 1989. Statistical Methods. Iowa State University Press, Iowa.

LPM-201

Livestock and Poultry Management

Credits: 3 + 1 Mid-session exam: 30 (25+5#)
Contact hours: 42 + 28 Practical exam: 25
End-semester exam: 45

Objective: To provide knowledge regarding the livestock and poultry management, and their role in the economy.

Learning outcome: The students will get knowledge about livestock management and its role in economy which will assist them in setting up their own livestock as an entrepreneur.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Role of livestock in the national economy. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves, growing heifers and milch animals.	7
2.	Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers. Important Indian and exotic breeds of cattle, buffalo, sheep, goat, swine and poultry. Improvement of farm animals and poultry.	7
3.	Digestion in livestock and poultry.	7
4.	Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry.	7
5.	Feed supplements and feed additives. Feeding of livestock and poultry. Introduction of livestock and poultry diseases.	7
6.	Prevention (including vaccination schedule) and control of important diseases of livestock and poultry.	7

Practical

S. No.	Particulars	No. of practicals
1.	External body parts of cattle, buffalo, sheep, goat, swine and poultry. Handling and restraining of livestock. Identification methods of farm animals and poultry.	2
2.	Visit to IDF and IPF to study breeds of livestock and poultry and daily routine farm operations and farm records.	2
3.	Judging of cattle, buffalo and poultry. Culling of livestock and poultry. Planning and layout of housing for different types of livestock.	2
4.	Computation of rations for livestock. Formulation of concentrate mixtures. Clean milk production, milking methods.	2
5.	Hatchery operations, incubation and hatching equipments.	2
6.	Management of chicks, growers and layers. Debeaking, dusting and vaccination. Economics of cattle, buffalo, sheep, goat, swine and poultry production.	2
7.	Economics of vegetables and spices cultivation	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Banerjee, G. C. (2018). A Textbook of Animal Husbandry. Oxford and IBH Publishing Co. New Delhi
2.	Kumar, A. T. (2002). Handbook of Animal Husbandry. ICAR Research Publication, New Delhi.
3.	Ghosh, N. (2019). Livestock Production Management. PHI Learning Private Ltd. Delhi.
4.	Upadhyay, D., Sahu, S. and Archana. (2019). Objective book on Livestock Production Management. Jain Publisher, New Delhi

		Semester IV	
S. n.	**Course Code**	**Subject**	**Credits**
1	Agron-202	Crop Production Technology –II (Rabi Crops)	2 (1+1)
2	Hort-202	Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
3	RE-202	Renewable Energy and Green Technology	2(1+1)
4	Soil-202	Problematic Soils and their Management	2(2+0)
5	Hort-203	Production Technology for Fruit and Plantation Crops	2(1+1)
6	PBG-202	Principles of Seed Technology	3(1+2)
7	Agron-203	Farming System & Sustainable Agriculture	1(1+0)
8	Econ-202	Agricultural Marketing Trade & Prices	3(2+1)
9	Agron-204	Introductory Agro-meteorology & Climate Change	2(1+1)
10	EC-202	Elective Course	3 credit
		Total	**19(11+8) + 3**

Agron-202

Crop Production Technology-II (Rabi crops)

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To make student understand about various aspects associated with production of different rabi crops.

Learning outcomes: The student will have a thorough knowledge regarding different rabi crops, their origin, distribution and various crop production technologies associated with them.

Details of Course:

S. No.	Particulars	No. of lectures
1	Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; cereals – wheat and barley,	2
2	Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; pulses-chickpea, lentil, peas,	3
3	Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; oilseeds: -rapeseed, mustard and sunflower; and sugar crops: sugarcane	4
4	Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; medicinal and aromatic crops-mentha, lemon grass and citronella,	2
5	Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; Forage crops-berseem, lucerne and oat.	3

Practical

S. No.	Particulars	No. of practicals
1	Sowing methods of wheat and sugarcane	2
2.	Identification of weeds in *rabi* season crops	2
3	Study of morphological characteristics of *rabi* crops	2
4	Study of yield contributing characters of *rabi* season crops,	2
5	Yield and juice quality analysis of sugarcane,	2
6	study of important agronomic experiments of *rabi* crops at experimental farms	1
7	Study of *rabi* forage experiments,	1
8	Oil extraction of medicinal crops,	1
9	Visit to research stations of related crops.	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	ICAR [Indian Council of Agricultural Research].2006. Hand Book of Agriculture. ICAR, New Delhi
2	Pal, M., Deka, J., and Rai, R.K. 1996. Fundamentals of Cereal Crop Production. Tata McGraw Hill Pub., New Delhi
3	Chidda Singh, Prem Singh and Rajbir Singh. 2003. Modern Techniques of Raising Field Crops (2nd Edition). Oxford and IBH, New Delhi.

Hort-202
Production Technology of Ornamental Crops, MAPs and Landscaping

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5[#])
Practical Exam: 50
End-Semester Exam: 30

Objective: To provide understanding about different production technology associated with various ornamental and medicinal & aromatic crops along with their landscaping

Learning outcome: The student will learn about different ornamental and medicinal & aromatic crops and the production technology and landscaping associated with them.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Importance and scope of ornamental crops, medicinal and aromatic plants and landscaping	1
2.	Principles of landscaping	1
3.	Landscape uses of tree, shrubs and climbers	1
4.	Production technology of important cut flowers like rose, gerbera, carnation, lilium and orchids under protected conditions	2
5.	Production technology of gladiolus, chrysanthemum and tuberose under open conditions	2
6.	Package of practices for loose flowers like marigold and jasmine under open conditions	2
7.	Production technology of important medicinal plants like ashwagandha, asparagus, aloe, costus, cinnamomum, periwinkle & isabgol	2
8.	Production technology of important aromatic plants like mint, lemongrass, citronella, palmarosa, oscimum, rose, geranium and vetiver	1
9.	Processing and value addition in ornamental crops and MAPs produce	2

Practical

S. No.	Particulars	No. of practicals
1.	Identification of ornamental plants	2
2.	Identification of medicinal and aromatic plants	2
3.	Nursery bed preparation and seed sowing	2
4.	Training and pruning of ornamental plants	2
5.	Planning and layout of garden	1
6.	Bed preparation and planning of MAP	1
7.	Protected structure- care and maintenance	1
8.	Intercultural operations in flowers and MAP	1
9.	Harvesting & post-harvest handling of cut and loose flowers and processing of MAP	1
10.	Visit to commercial flower/MAP unit	1

Suggested Books/Readings:

S. No.	Authors/Name of Books/ Publisher
1.	Arora, J.S. (2006). Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana, Punjab.
2.	Bose, T.K., Malti, R.G., Dhua, R.S. and Das, P. (2014). Floriculture and Landscaping. Naya Prokash., Kolkata.
3.	Grewal, H.S. and Singh, P. (1999). Landscape designing and Ornamental plants. Kalyani Publishers. Ludhiana Punjab.
4.	Roy, R.K. (2013). Fundamentals of Garden Designing. New India Publishing Agency, New Delhi
5.	Tiwari, A.K. and Kumar, R. (2012). Fundamental of Ornamental Horticulture and Landscape gardening. New India Publishing Agency, New Delhi.
6.	Singh, A.K. and Sisodia, A. (2017). Textbook of Floriculture and Landscaping. New India Publishing Agency, New Delhi.

RE-202
Renewable Energy and Green Technology

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: The objective of study the course Renewable Energy and Green Technology is to gain a general knowledge about the various Renewable Energy Technologies. This course will make the student familiar with technologies associated with Bioenergy, Solar Energy, Wind energy and its applications or contributions in Agricultural Sector. Special emphasis has been given to harnessing of Bioenergy from various Agricultural feedstocks. Focus has been given to makes the student familiar with solar energy gadgets and its design and the utilization of solar energy in various sectors.

Learning Outcome: Students will gain awareness about various renewable energy resources and their importance in the field of agriculture.

Details of Course:

S. No.	Particulars	No. of lectures
1	Classification of energy sources, contribution of these of sources in agricultural sector Familiarization of biomass	2
2	Utilization of Biomass for biofuels production and their application, Biogas and Familiarization with types of biogas plants. Producer Gas and its utilization, Familiarization with types of Biomass gasifiers	2
3	Liquid Biofuels: Production of Bio alcohol, Biodiesel and Biooil from bioenergy resource and Utilization of it as Bioenergy	2
4	Introduction of solar energy, collection and their application, Familiarization with solar energy gadgets: solar cooker, solar water heater	2
5	Application of solar energy: solar drying, solar pond, solar distillation	2
6	Conversion of Solar energy into Electricity, Solar photovoltaic system and applications	2
7	Introduction of wind energy, Types of wind Mills and their application	2

Practical

S. No.	Particulars	No. of practicals
1	Familiarization with renewable energy gadgets	1
2	To study the production process of bio-fuels	1
3	To study the Constructional details of KVIC, Janata and Deen Bandhu Type Biogas plant	2
4	To study updraft and downdraft Biomass Gasifier	1
5	To study the processing of biodiesel production from Jatropha	1
6	To study the Biomass briquetting technology	1
7	Familiarization with different solar energy gadgets.	1
8	To study and performance evaluation of solar photovoltaic system	1
9	To study of solar pumping, solar fencing	1
10	To study and performance evaluation of Solar Water Heating System	1
11	To study and performance evaluation of Box type solar cooker	1
12	To study and performance evaluation of solar drying system	1
13	To study solar distillation and solar pond.	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	S.P. Sukhatme and J K Nayak, 2008. Solar Energy – Principles of Thermal Collection and Storage, McGraw Hill, New Delhi
2	Garg H P. and Prakash J., 1997. Solar Energy: Fundamentals & Applications, Tata McGraw Hill, New Delhi.
3	V.V.N. Kishore (Ed), 2014. Renewable Energy Engineering and Technology – Principles and Practice, TERI Press, New Delhi.
4	D Pimentel, 2008. Bio-fuels, Solar and Wind as Renewable Energy Systems: Benefits and Risks, Springer, New Delhi
5	Mousdale DM, 2008. Bio-fuels: Biotechnology, Chemistry, and Sustainable Development, CRC Press, New Delhi.
6	S P Sukhatme, 2008. Solar Energy, Tata McGraw Hill, New Delhi.

Soil-202
Problematic Soils and their Management

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To know about the kinds of problematic soils and how to make the utilization of land with appropriate management practices.

Learning Outcome: The student will learn various problematic soils and to make use of these soils for improved crop production using suitable management practices.

Details of Course:

Units	Particulars	No. of Lectures
I	Soil quality and health, Distribution of Waste land and problem soils in India. Their categorization based on properties.	**4**
II	Reclamation and management of Saline and sodic soils, Acid soils, Acid Sulphate soils, Eroded and Compacted soils, Flooded soils, Polluted soils.	**10**
III	Irrigation water-quality and standards, utilization of saline water in agriculture. Remote sensing and GIS in diagnosis and management of problem soils.	**6**
IV	Multipurpose tree species, bio remediation through MPTs of soils, land capability and classification, land suitability classification. Problematic soils under different Agro-ecosystems.	**8**

Suggested Books/Readings:

S. No.	Suggested Readings
1	Brady, N.C. 1990. Nature and Properties of Soils. 10th Edition, MacMillan Publishing Co. Inc., New York
2	Das. D.K, 1997. Introductory Soil Science. Kalyani Publishers, New Delhi.
3	Foth, H.D. and Turk, L. M. 1972. Fundamental of Soil Science. 5th Edition. Wiley Eastern Pvt. Ltd., New Delhi
4	Gupta, P.K. 2007. Soil, Plant, Water and Fertilizer Analysis. Published by AGROBIOS (India), Jodhpur
5	ISSS, 2002. Fundamentals of Soil Science. Published by Indian Society of Soil Science, IARI, New Delhi
6	Jaiswal, P.C. 2006. Soil, Plant and Water Analysis. 2nd Edition Kalyani Publishers, Ludhiana
7	Samuel L. Tisdale, Werner.L. Nelson, James D. Beaton and John L. Havlin. 1995. Soil Fertility and Fertilizers. 5th Edition. MacMillan Publishing Company, NOIDA.

Hort-203
Production Technology for Fruit and Plantation Crops

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To provide understanding about different production technology associated with various fruit and plantation crops.

Learning outcome: The student will learn about different fruits and plantation crops and the production technology associated with them.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Importance and scope of fruit and plantation crop industry in India	2
2.	Importance of rootstocks	1
3.	Production technologies for the cultivation of major fruits- mango, banana, citrus, grapes, guava, litchi, papaya	2
4.	Production technologies for sapota, apple, pear, peach, walnut, almond	2
5.	Minor fruits- date, ber, pineapple, pomegranate, jackfruit, strawberry	3
6.	Plantation crops- coconut, arecanut, cashew	2
7.	Others plantation crops- tea, coffee and rubber	2

Practical

S. No.	Particulars	No. of practicals
1.	Seed propagation	2
2.	Scarification and stratification of seeds	2
3.	Propagation methods for fruit and plantation crops	2
4.	Description and identification of fruit	2
5.	Preparation of plant bio-regulators and their uses	2
6.	Important pests, disease and physiological disorders of above fruits and plantation crops	2
7.	Visit to commercial orchards	2

Suggested Books/Readings:

1. Chadha K. L. (2019) Handbook of Horticulture. ICAR, New Delhi.
2. Prasad S. and Kumar U. (2016) A Handbook of Fruit Production. Agribios, Jodhpur.
3. Pradeep Kumar T. and Suma B. (2008) Management of Horticultural Crops. New India Publishing Agency, New Delhi.
4. Bal J. S. (2018) Fruit Growing. Kalyani Publisher, New Delhi
5. Banday FA and Sharma MK. Advances in Temperate Fruit Production (2010) Kalyani Publishers, New Delhi
5. Chadha K. L. (2019) Advances in Horticulture. Malhotra Publishing House, New Delhi.
6. Dhillon W. S. (2013) Fruit Production in India. Narendra Publishing House, New Delhi.
7. Radha T. and Mathew L. (2019) Fruit Crops. New India Publishing Agency, New Delhi.
8 Chattopadhyay T.K. (2019) A Text Book on Pomology Volume II, III and IV (Tropical Fruit Crops, Sub-tropical Fruit Crops and Temperate Crops) Kalyani Publisher, New Delhi.
9. Sharma R. R. and Krishna H. (2017) Text Book on Temperate Fruits. CBS Publishers New Delhi.

PBG-202
Principles of Seed Technology

Credits: 1 + 2
Contact Hours: 14 + 56

Mid-Session Exam: 15 (10+5#)
Practical Exam: 65
End-Semester Exam: 20

Objective: To make student familiar with production of seeds of different crops of commercial importance.

Learning Outcome: The students will learn different breeding methods for seed production of various crops.

Details of Course:

Sr. No.	Particulars	No. of Lectures
1.	Seed and seed technology: introduction, definition and importance. Causes of deterioration of crop varieties and their control; Maintenance of genetic purity during seed production, Seed quality; Definition, Characters of good quality seed, Different classes of seed.	3
2	Foundation and certified seed production of important crops. Seed certification, phases of certification, procedure for seed certification, field inspection. Seed Act and Seed Act enforcement.	2
3	Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983, Detection of genetically modified crops, Transgene contamination in non-GM crops, GM crops and organic seed production.	3
4	Seed drying and processing, Seed testing for quality assessment, seed treatment, its importance, method of application and seed packing. Seed storage; general principles, stages and factors affecting seed longevity during storage.	3
5	Measures for pest and disease control during storage. Seed marketing: structure and organization, sales generation activities, promotional media. Factors affecting seed marketing, Role of WTO and OECD in seed marketing. Private and public sectors and their production and marketing strategies.	3

Practical

Sr. No.	Particulars	No. of practicals
1	Seed production in major cereals: Wheat, Rice, Maize, Sorghum, Bajra and Ragi. Seed production in major pulses: Urd, Mung, Pigeonpea, Lentil, Gram, Field bean, pea.	5
2	Seed production in important vegetable crops.	4
3	Seed production in major oilseeds: Soybean, Sunflower, Rapeseed, Groundnut and Mustard.	5
4	Seed sampling and testing: Physical purity, germination, viability, etc. Seed and seedling vigour test. Genetic purity test: Grow out test, Molecular and biochemical test.	5
5	Seed certification: Procedure, Field inspection, Preparation of field inspection report.	5
6	Visit to seed production farms, seed testing laboratories and seed processing plant.	4

Suggested Books/Readings:

1. Aggarwal, P. K. 2010. Principles of Seed Technology. Indian Council of Agricultural Research, New Delhi
2. Aggarwal, R. L. 2009. Seed Technology. Oxford & I.B.H. Publishing Co. Pvt. Ltd., New Delhi
3. Copeland, L. O. and Miller, M. D. 2001. Principles of Seed Science and Technology. Springer Verlag US
4. Desai, B.B.; Kotecha, P.M. and Salunkhe, D.K. 1997. Seeds Handbook: Biology, Production, Processing, and Storage, New York: Marcel Dekker.
5. Neema, N.P. 1989. Principles of Seed Certification and Testing – Allied Publishers Pvt. Ltd., New Delhi.
6. Tunwar, N.S. and S.V. Singh. 1988. Indian Minimum Seed Certification Standards. Published by Central Seed Certification Board, New Delhi.

Agron-203
Farming System and Sustainable Agriculture

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: To know about farming system practices and resource management practices for sustained agricultural production.

Learning Outcomes: The student will have a thorough understanding of different cropping systems, integrated farming system and resource cycling for sustainable agriculture.

Details of Course:

Units	Particulars	No. of Lectures
I	Farming System-scope, importance, and concept, Types and systems of farming system and factors affecting types of farming, Farming system components and their maintenance, cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation, Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system;	6
II	Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture, HEIA, LEIA and LEISA and its techniques for sustainability,	3
III	Integrated farming system-historical background, objectives and characteristics, components of IFS and its advantages, Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques,	3
IV	Resource cycling and flow of energy in different farming system, farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field.	2

Suggested Books/Readings:

S. No.	Suggested Readings
1	Dahama, A.K. 2007. Organic Farming for Sustainable Agriculture. 2nd Edn. Published by AGROBIOS (India) Jodhpur
2	Gupta, P.K. 2006. Vermi-composting for Sustainable Agriculture. Published by AGROBIOS (India) Jodhpur
3	Sharma, A.K. 2006. A Hand Book of Organic Farming. Published by AGROBIOS (India) Jodhpur
4	Sharma, A.K. 2005. Bio-fertilizers for Sustainable Agriculture. Published by AGROBIOS (India) Jodhpur

Econ-202

Agricultural Marketing, Trade and Prices

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objectives: The objective of the course is to make student understand the kind of market structure, their classification and working of various markets and marketing trades

Learning Outcomes: The students will come to know the concept of demand and supply in agricultural products, their life cycle, their pricing, promotion strategies. The will also learn the role and functions of various marketing channels. They will also learn about the role of national and international organization in agricultural marketing.

Details of Course:

S. No.	Particulars	No. of lectures
1	Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets.	2
2	Demand, supply and producer's surplus of Agri-commodities: nature and determinants of demand and supply of farm products.	2
3	Producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of Agri-commodities.	2
4	Product life cycle (PLC) and competitive strategies: Meaning and stages in PLC; characteristics of PLC; strategies in different stages of PLC.	2
5	Pricing and promotion strategies: pricing considerations and approaches – cost based and competition-based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits & demerits.	3
6	Marketing process and functions: Marketing process-concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark).	3
7	Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency.	3
8	costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs.	3
9	Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions; cooperative marketing in India.	2
10	Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy.	3
11	Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in Agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR.	3

Practical

S. No.	Particulars	No. of practicals
1	Plotting and study of demand and supply curves and calculation of elasticities.	1
2	Study of relationship between market arrivals and prices of some selected commodities.	1
3	Computation of marketable and marketed surplus of important commodities.	2
4	Study of price behaviour over time for some selected commodities.	2
5	Construction of index numbers.	2
6	Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class.	2
7	Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning.	2
8	Application of principles of comparative advantage of international trade.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Acharya S.S and Agarwal NL, 2006, Agricultural Marketing in India. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
2	Kahlon A.S and Tyagi.D S, 1983 Agricultural Price Policy in India. Allied Publishers Pvt. Ltd., New Delhi
3	Kulkarni, K R.1964, Agricultural Marketing in India. The Co-operators Books Depot, Mumbai.
4	Mamoria, C.B. and Joshi. R L.1995, Principles and Practices of Marketing in India, Kitab Mahal, Allahabad.

Agron-204
Introductory Agro-Meteorology & Climate Change

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5[#])
Practical Exam: 50
End-Semester Exam: 30

Objective: To know about farming system practices and resource management practices for sustained agricultural production.

Learning Outcomes: The student will understand different farming systems and resource management under different conditions for sustained agriculture.

Details of Course:

Units	Particulars	No. of Lectures
1	Meaning and scope of agricultural meteorology; Earth atmosphere- its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze	3
2	Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Energy balance of earth	3
3	Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification	3
4	Artificial rainmaking. Monsoon- mechanism and importance in Indian agriculture, Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave. Agriculture and weather relations	3
5	Modifications of crop microclimate, climatic normal for crop and livestock production. Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.	2

Practical

S. No.	Particulars	No. of practicals
1	Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording.	1
2	Measurement of total, shortwave and longwave radiation, and its estimation using Planck's intensity law. Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS.	1
3	Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis.	2
4	Measurement of soil temperature and computation of soil heat flux. Determination of vapor pressure and relative humidity.	2
5	Determination of dew point temperature.	2
6	Measurement of atmospheric pressure and analysis of atmospheric conditions.	2
7	Measurement of wind speed and wind direction, preparation of wind rose. Measurement, tabulation and analysis of rain.	2

8	Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET.	2

Suggested Books/Readings:

S. No.	Suggested Readings
1	Khadekar, S.R. 2001. Meteorology. Agromet Publishers, Nagpur
2	Prasada Rao, G.S.L.H.V. 2005. Agricultural Meteorology. Second Edition. Kerala Agricultural University, Thrissur.
3	Varshneya, M.C. and Balakrishna Pillai, B. 2003. Textbook of Agricultural Meteorology. ICAR, New Delhi.
4	Reddy. T.Y and Reddy, G.H.S.1995. Principles of Agronomy, Kalyani Publishers, Ludhiana.

		Semester V	
S. n.	**Course Code**	**Subject**	**Credits**
1	Pl. Path-301	Principles of Integrated Pest and Disease Management	3(2+1)
2	Soil-301	Manures, Fertilizers and Soil Fertility Management	3 (2+1)
3	Ent-301	Pests of Crops and Stored Grains and their Management	3 (2+1)
4	Pl. Path-302	Diseases of Field and Horticultural Crops and their Management -I	3 (2+1)
5	PBG-301	Crop Improvement-I (Kharif Crops)	2 (1+1)
6	Ext-301	Entrepreneurship Development and Business Communication	2 (1+1)
7	Agron-301	Geoinformatics and Nano-technology and Precision Farming	2 (1+1)
8	Agron-302	Practical Crop Production – I (Kharif crops)	2 (0+2)
9	IPR-301	Intellectual Property Rights	1(1+0)
10	EC-301	Elective course	3 credit
		Total	21(12+09)+ 3

Pl. Path-301

Principles of Integrated Pest and Disease Management

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To acquaint the student about diversity of farming situations and the complexities of agroecosystems and that can improve the resilience of cropping systems and our capacity to adapt crop protection to local realities.

Learning Outcomes: Dependency on pesticides for the protection of crops is associated with undesirable effects on the environment, health, and the sustained efficacy of their use. Our aim is to encourage IPM practitioners to development of sustainable crop protection strategies

Details of Course:

Units	Contents	Lectures
I	Categories of insect pests and diseases, IPM: Introduction, history, importance, concepts, principles and tools of IPM. Economic importance of insect pests, diseases and pest risk analysis.	4
II	Methods of detection and diagnosis of insect pest and diseases. Calculation and dynamics of economic injury level and importance of Economic threshold level.	5
III	Methods of control: Host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Ecological management of crop environment. Introduction to conventional pesticides for the insect pests and disease management.	5
IV	Survey surveillance and forecasting of Insect pest and diseases.	5
V	Development and validation of IPM module Implementation and impact of IPM (IPM module for Insect pest and disease.	5
VI	Safety issues in pesticide uses. Political, social and legal implication of IPM. Case histories of important IPM programmes. Case histories of important IPM programmes.	4

Practical:

S. No.	Particulars	No. of practicals
1.	Methods of diagnosis and detection of various insect pests, and plant diseases, Methods of insect pests and plant disease measurement, Assessment of crop yield losses, calculations based on economics of IPM, Identification of biocontrol agents, different predators and natural enemies.	5
2.	Mass multiplication of *Trichoderma, Pseudomona*s, *Trichogramma*, NPV etc. Identification and nature of damage of important insect pests and diseases and their management. Crop (agroecosystem) dynamics of a selected insect pest and diseases.	5
3.	Plan & assess preventive strategies (IPM module) and decision making. Crop monitoring attacked by insect, pest and diseases. Awareness campaign at farmers' fields.	4

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Agrios, G. N. 2021. Plant Pathology. Elsevier. Academic Press. New York
2.	Dhaliwal G S, Singh R and Jindal V.2013. A Textbook of Integrated Pest Management. Kalyani Publisher, New Delhi.
3.	Nene, Y. L. and Thapliyal, P. N. 2018. Fungicides in Plant Disease Control. Meditech and IBH New Delhi
4.	Prakasam, V. Reguchander, T. and Prabakar, K. 2011. Plant Diseases Management. A.E. Publication, Coimbatore.
5.	Pedigo, R. L. 2002. Entomology and Pest Management 4th Edition. Prentice Hall, New Delhi.
6.	Maloy. O.C. 1993. Plant Disease control. Principles and Practice. John Wiley and Sons. Inc. New York.
7.	Gupta, V. K. and Sharma, R. C. 2012.Integrated Disease Management and Plant Health. Scientific Publishers, Jodhpur.

Soil-301

Manures, Fertilizers and Soil Fertility Management

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To know about different organic and inorganic nutrients sources, their application methods and precautions for effective utilization and improved crop production.

Learning Outcome: The student will learn about different nutritional sources and their role in soil fertility for improved crop production.

Details of Course:

Units	Particulars	No. of Lectures
I	Introduction and importance of organic manures, properties and methods of preparation of bulky and concentrated manures. Green/leaf manuring. Fertilizer recommendation approaches. Integrated nutrient management.	4
II	Chemical fertilizers: classification, composition and properties of major nitrogenous, phosphatic, potassic fertilizers, secondary & micronutrient fertilizers, Complex fertilizers, Nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order.	8
III	History of soil fertility and plant nutrition. criteria of essentiality. role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants.	6
IV	Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients. Soil fertility evaluation, Soil testing. Critical levels of different nutrients in soil.	5
V	Forms of nutrients in soil, plant analysis, rapid plant tissue tests. Indicator plants. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE), methods of application under rainfed and irrigated conditions.	5

Practical

S. No.	Practical Description	No. of practicals
1.	Introduction of analytical instruments and their principles, calibration and applications of colorimetry	2
2.	Principles, calibration and applications of flame photometry**.**	1
3.	Estimation of soil organic carbon	1
4.	Estimation of alkaline hydrolysable N in soils.	1
5.	Estimation of soil extractable P in soils.	1
6.	Estimation of exchangeable K in soils	1
7.	Estimation of exchangeable Ca and Mg in soils	1
8.	Estimation of soil extractable S in soils	1
9.	Estimation of DTPA extractable Zn in soils.	1
10.	Estimation of N in plants	1
11.	Estimation of P in plants	1
12.	Estimation of K in plants.	1
13	Estimation of Sulphur in plants.	1

Suggested Books/Readings:

S. No.	Suggested Readings
1	Brady, N.C. 1990. Nature and Properties of Soils. 10th Edition, MacMillan Publishing Co. Inc., New York
2	Das.D.K, 1997. Introductory Soil Science. Kalyani Publishers, New Delhi.
3	Foth, H.D. and Turk, L. M. 1972. Fundamental of Soil Science. 5th Edition. Wiley Eastern Pvt. Ltd., New Delhi
4	Gupta, P.K. 2007. Soil, Plant, Water and Fertilizer Analysis. Published by AGROBIOS (India), Jodhpur
5	ISSS, 2002. Fundamentals of Soil Science. Published by Indian Society of Soil Science, IARI, New Delhi
6	Jaiswal, P.C. 2006. Soil, Plant and Water Analysis. 2nd Edition. Kalyani Publishers, Ludhiana
7	Samuel L. Tisdale, Werner. L. Nelson, James D. Beaton and John L. Havlin. 1995. Soil Fertility and Fertilizers. 5th Edition. Macmillan Publishing Company, NOIDA.

Ent-301

Pests of Crops and Stored Grains and their Management

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To make the student understand important insect pests of agriculture and horticulture crops.

Learning Outcomes: the student will be able to identify as well as the management of different insect pests of agriculture and horticulture crops.

Details of Course:

Units	Contents	Lectures
I	General account on nature and type of damage by different arthropods pests.	2
II	Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage, and management of major pests and scientific name, order, family, host range, distribution, nature of damage and control practice of important arthropod pests of various field crops.	4
III	Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage, and management of major pests and scientific name, order, family, host range, distribution, nature of damage and control practice of arthropod pests of various vegetable crops.	5
IV	Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage, and management of major pests and scientific name, order, family, host range, distribution, nature of damage and control practice of important arthropod pests of various fruit crop.	5
V	Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage, and management of major pests and scientific name, order, family, host range, distribution, nature of damage and control practice of important arthropod pests of various plantation crops.	5
VI	Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage, and management of major pests and scientific name, order, family, host range, distribution, nature of damage and control practice of important arthropod pests of spices and condiments.	5
VII	Factors affecting losses of stored grain and role of physical, biological, mechanical and chemical factors in deterioration of grain. Insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management. Storage structure and methods of grain storage and fundamental principles of grain store management.	2

Practical:

S. No.	Particulars	No. of practicals
1.	Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking crops and their produce: (a) Field Crops; (b) Vegetable Crops; (c) Fruit Crops; (d) Plantation, gardens, Narcotics, spices & condiments.	3
2.	Identification of insect pests and Mites associated with stored grain. Determination of insect infestation by different methods.	3
3.	Assessment of losses due to insects. Calculations on the doses of insecticides application technique.	2
4.	Fumigation of grain store / godown. Identification of rodents and rodent control operations in godowns.	2

5.	Identification of birds and bird control operations in godowns. Determination of moisture content of grain. Methods of grain sampling under storage condition.	2
6.	Visit to Indian Storage Management and Research Institute, Hapur and Quality Laboratory, Department of Food., Delhi. Visit to nearest FCI godowns.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Atwal AS, Dhaliwal GS & David BV. 2001. *Elements of Economic Entomology*. Popular Book Depot, Chennai.
2.	Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology*. Kalyani Publ., New Delhi.
3.	Dunston AP. 2007. *The Insects: Beneficial and Harmful Aspects*. Kalyani Publ., New Delhi.
4.	Nair MRGK. 1986. *Insect and Mites of Crops in India.* ICAR, New Delhi.
5.	Saxena RC & Srivastava RC. 2007. *Entomology at a Glance*. Agrotech Publ. Academy, Jodhpur.
6.	Prakash I & Mathur RP. 1987. *Management of Rodent Pests.* ICAR, New Delhi.
7.	Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South Asia and their Management.* Kalyani Publ., New Delhi.
8.	Butani DK & Jotwani MG. 1984. *Insects and Vegetables.* Periodical Expert Book Agency, New Delhi.
9.	Verma LR, Verma AK & Goutham DC. 2004. *Pest Management in Horticulture Crops: Principles and Practices*. Asiatech Publ., New Delhi.
10.	Bhargava, M. C., Kumawat, K. C. (2019). Pests of Stored Grains & Their Management: 2nd Fully Revised and Enlarged Edition: New India Publishing Agency, New Delhi.

Pl. Path-302

Diseases of Field and Horticultural Crops and their Management- I

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To study and identification of important diseases related to Agricultural and Horticultural crop and their management practices.

Learning Outcome: Diseases of Field and Horticultural Crops and their management- I course is helpful for students for understanding Kharif crop diseases.

Details of Course:

S. No.	Particulars	No. of lectures
1	Symptoms, etiology, disease cycle and management of Rice: blast, brown spot, bacterial blight, sheath blight, false smut, khaira and tungro	2
2	Symptoms, etiology, disease cycle and management of Maize: stalk rots, downy mildew, leaf spots; Sorghum: smuts, grain mold and anthracnose, Bajra: downy mildew and ergot; Groundnut: Collar rot, Bud necrosis virus, early and late leaf spots, wilt, Sesame Cercospora leaf spot, Phyllody, Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot and mosaic;	8
3	Symptoms, etiology, disease cycle and management of Pigeonpea: Phytophthora blight, wilt and sterility mosaic; Finger millet: Blast and leaf spot; black & green gram: Cercospora leaf spot and anthracnose, web blight and yellow mosaic; Castor: Phytophthora blight; Tobacco: black shank, black root rot and mosaic.	4
4	Symptoms, etiology, disease cycle and management of Guava: wilt and anthracnose; Banana: Panama wilt, bacterial wilt, Sigatoka and bunchy top; Papaya: foot rot, leaf curl and mosaic, Pomegranate: bacterial blight; Cruciferous vegetables: Alternaria leaf spot and black rot; Brinjal: Phomopsis blight and fruit rot and Sclerotinia blight;	7
5	Symptoms, etiology, disease cycle and management of Tomato: damping off, wilt, early and late blight, buck eye rot and leaf curl and mosaic; Okra: Yellow Vein Mosaic; Beans: anthracnose and bacterial blight; Ginger: soft rot; Colocasia: Phytophthora blight; Coconut: wilt and bud rot; Tea: blister blight; Coffee: rust	7

Practical

S. No.	Particulars	No. of practicals
1	Diseases of Rice, Maize, Sorghum, Bajra, Groundnut and Soybean	2
2	Diseases of Pigeonpea, Finger millet, black & green gram, Castor and Tobacco	2
3	Diseases of Guava, Banana, Papaya and Pomegranate	2
4	Diseases of Tomato, Okra and Beans,	2
5	Diseases of Ginger, Colocasia, Coconut, Tea and Coffee	2
6	Diseases of Cruciferous vegetables and Brinjal.	2
7	Field visits at appropriate time during the semester.	2
Note:	**Students should submit 50 pressed, well mounted diseased specimens in three installments during the semester**	

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Santhakumari, P (ed) 2004. Advances in the diseases of plantation crops and spices, IDB Co., Lucknow.
2	Singh, R. S. 1995. Diseases of Vegetables Crops. Oxford and IBH Publishing Co. New Delhi
3	Singh, R.S 2001. Plant Disease Management, Oxford and IBH N. Delhi.
4	Mehrotra, R. S. 2003, Plant Pathology. TATA McGraw Hill Pub. Co. New Delhi.
5	Gupta, V. K. and Paul, Y. S. 2002. Diseases of Field Crops. Indus Publishing Agency, New Delhi.
6	Saha, L. R. 2008. Handbook of Plant Diseases. Kalyani Publishers, New Delhi.
7	Gupta, S. K. and Thind, T. S. 2018. Disease Problems in Vegetable Production. Scientific Publishers, New Delhi.

PBG-301
Crop Improvement – I (*Kharif*)

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5[#])
Practical Exam: 50
End-Semester Exam: 30

Objective: To make student learn about different kharif crops and various techniques associated with them for their improvement.

Learning Outcomes: It will student able to identify different kharif crops and perform experiments on them for their improvement.

Details of Course:

Sr. No.	Particulars	No. of Lectures
1.	Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibers; fodders and cash crops; vegetable and horticultural crops	4
2	Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative characters	2
3	Important concepts of breeding self-pollinated, cross pollinated and vegetative propagated crops	2
4	Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional);	4
5	Hybrid seed production technology in Maize, Rice, Sorghum, Pearl millet and Pigeon pea, etc. Ideotype concept and climate resilient crop varieties for future.	2

Practical

Sr. No.	Particulars	No. of practicals
1	Floral biology, emasculation and hybridization techniques in different crop species; viz., Rice, Jute, Maize, Sorghum, Pearl millet, Ragi, Pigeonpea, Urdbean, Mungbean, Soybean, Groundnut, Seasame, Caster, Cotton, Cowpea, Tobacco, Brinjal, Okra and Cucurbitaceous crops.	3
2	Maintenance breeding of different *kharif* crops.	2
3	Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Kharif* crops	3
4	Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, donor parents for different characters;	2
5	Visit to seed production plots.	2
6	Visit to AICRP plots of different field crops.	2

Suggested Books/Readings:

1. Ashraf, M. 2012. Crop Production for Agricultural Improvement. Springer Science & Business Media, Germany.
2. Briggs, F.N. and P.F. Knowles, 1970. Introduction to Plant Breeding. Reinhold, New York.
3. Chopra, V.L. 1994. Plant Breeding. Theory and Practice. Oxford and IBH Publishing Co., New Delhi.
4. Harihar Ram and Hari Govind Singh, 1994. Crop Breeding and Genetics. Kalyani Publishers, New Delhi.
5. Sharma, J.R. 1994. Principles and Practices of Plant Breeding. Tata McGraw - Hill Publishing Co. Ltd., New Delhi.
6. Richards, A.J. 1986. Plant Breeding Systems. George Allen & Unwin, London.

Ext-301
Entrepreneurship Development and Business Communication

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To provide knowledge regarding entrepreneurship, developing organizational skills, troubleshooting and Agri- entrepreneurship.

Learning outcome: The student will have a knowledge regarding entrepreneurship skills, to develop a Agri-enterprise and to develop organizational as well as troubleshooting skills to be a successful Agri-businessman.

Details of Course:

Sr. No.	Particulars	No. of Lectures
1.	Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation, Government policy and programs and institutions for entrepreneurship development,	3
2	Impact of economic reforms on Agribusiness/ Agri enterprises, Entrepreneurial Development Process; Business Leadership Skills	2
3	Developing organizational skill (controlling, supervising, problem solving, monitoring & evaluation), Developing Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills),	2
4	Problem solving skill, Supply chain management and Total quality management, Project Planning Formulation and report preparation	3
5	Financing of enterprise, Opportunities for Agri entrepreneurship and rural enterprise.	4

Practical

Sr. No.	Particulars	No. of practicals
1	Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement motivation	4
2	Exercise in creativity, time audit through planning	4
3	Monitoring and supervision, identification and selection of business idea	3
4	Preparation of business plan and proposal writing, visit to entrepreneurship development institute and entrepreneurs.	3

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Harold Koontz & Heinz Weihrich. 2004. Essentials of Management: An International Perspective, 2nd Ed. Tata Mc-Graw Hill Publishing Pvt Ltd., New Delhi.
2	Bhaskaran, S. 2014. Entrepreneurship Development and Management. Aman Publishing House, Meerut.
3	Natrajan,K. and Ganeshan, K.P. 2012.Principles of Management. Himalaya Publishing House, New Delhi.
4	Khanka, SS. 1999. Entrepreneurship Development, S. Chand and Co., New Delhi.
5	Mondal, S and Ray, GL. 2003. Text Book of Entrepreneurship and Rural Development. Kalyani Publishers, New Delhi.
6	Anil Kumar, S.; Poornima, S.C.; Abraham Mini K. and Jayashree, K. 2003. Entrepreneurship Development, New Age International Publishers, New Delhi.
7	Desai, V. 1997. Small Scale Industries and Entrepreneurship. Himalaya Publishing

	House, New Delhi.
8	Desai, V. 2000. Dynamics of Entrepreneurial Development and Management. Himalaya Publishing House, New Delhi.
9	Mohanty, SK. 2009. Fundamentals of Entrepreneurship. Prentice Hall of India Pvt. Ltd., New Delhi.
10	Grover, Indu. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy, Udaipur.

Agron-301
Geoinformatics, Nano-technology and Precision Farming

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To make student understand about precision farming and the role of Geo informatics, remote sensing in agriculture.

Learning outcome: The student will learn different aspects of precision farming, Image processing, remote sensing, Nanotechnology, and its application in agriculture.

Details of Course:

S. No.	Particulars	No. of lectures
1	Precision agriculture: concepts and techniques; their issues and concerns for Indian agriculture; Geo-informatics- definition, concepts, tool and techniques; their use in Precision Agriculture.	2
2	Crop discrimination and Yield monitoring, soil mapping; fertilizer recommendation using geospatial technologies; Spatial data and their management in GIS; Remote sensing concepts and application in agriculture	3
3	Image processing and interpretation; Global positioning system (GPS), components and its functions; Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs	3
4	STCR approach for precision agriculture; Nanotechnology, definition, concepts and techniques,	2
5	brief introduction about nanoscale effects, Nano-particles, Nano-pesticides, Nano-fertilizers, Nano-sensors,	2
6	Use of nanotechnology in seed, water, fertilizer, plant protection for scaling-up farm productivity.	2

Practical

S. No.	Particulars	No. of practicals
1	Introduction to GIS software, spatial data creation and editing. Introduction to image processing software. Visual and digital interpretation of remote sensing images.	3
2	Generation of spectral profiles of different objects. Supervised and unsupervised classification and acreage estimation. Multispectral remote sensing for soil mapping. Creation of thematic layers of soil fertility based on GIS.	3
3	Creation of productivity and management zones. Fertilizers recommendations based of VRT and STCR techniques.	3
4	Crop stress (biotic/abiotic) monitoring using geospatial technology. Use of GPS for agricultural survey.	2
5	Formulation, characterization and applications of nanoparticles in agriculture. Projects formulation and execution related to precision farming.	3

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Krishna, K.K. 2013. Precision Farming: Soil Fertility and Productivity Aspects. Apple Academic Press, Darya Ganj, New Delhi.
2	Srivastava, G.S. 2014. An Introduction to Geoinformatics. McGrew Hill Education (India) Pvt. Ltd., New Delhi
3	Gupta, R.K. and Subhash Chander. 2008. Principles of Geoinformatics. Jain Brothers, New Delhi.

Agron-302
Practical Crop Production-I (Kharif Crops)

Credits: 0 + 2 Mid Session Exam: 50
Contact Hours: 0 + 56 End Semester Exam: 50

Objective: To make student learn about different techniques associated with production of Kharif crops.

Learning outcomes: It will provide student a thorough practical knowledge and ability to do crop planning, field preparation and other significant aspects required for performing different agricultural practices for kharif crops.

Practical

S. No.	Particulars	No. of practicals
1	Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pest diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce.	10
2	The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies.	9
3	Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students	9

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Chhidda Singh, Prem Singh and Rajbir Singh. 2003. Modern Techniques of Raising Field Crops (2nd ed.). Oxford and IBH, New Delhi.
2	ICAR [Indian Council of Agricultural Research].2006. Hand Book of Agriculture. ICAR, New Delhi
3	Prasad, R. (ed.). 2001. Field Crop Production. ICAR, New Delhi
4	Pal, M., Deka, J., and Rai, R.K. 1996. Fundamentals of Cereal Crop Production. Tata McGraw Hill Pub., New Delhi

IPR-301
Intellectual Property Rights

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: To provide education regarding the intellectual property rights and also various national and international measures taken to safeguard the intellectual studies and their outcomes. This will also educate regarding farmers and breeder's rights against the illegitimate use of the outcome of their studies.

Learning outcome: The student will get awareness regarding the rights of an intellectual and farmer and the outcome of their work. This will assist the student to prevent his future research from any illegitimate use.

Details of Course:

S. No.	Particulars	No. of lectures
I	Introduction and meaning of intellectual property. Brief introduction to GATT, WTO, TRIPs and WIPO. Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc.	3
II	Types of Intellectual Property and legislations covering IPR in India: Patents and Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets. Patents Act 1970.	3
III	Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database.	2
IV	Origin and history including a brief introduction to UPOV for protection of plant varieties. Protection of plant varieties under UPOV and PPV&FR Act of India, Plant breeders' rights. Registration of plant varieties under PPV&FR Act, 2001. Breeders, researcher and farmers rights.	3
V	Traditional knowledge meaning and rights of TK holders. Convention on Biological Diversity. International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.	3

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Acharya, N.K. 2014. Text book of Intellectual Property Rights. Asia Law House, Hyderabad.
2	Loganathan, E.T. 2012. Intellectual Property Rights. New Century Publications, New Delhi.
3	Rosedar, S.R.A. 2016. Intellectual Property Rights. Lexis Nexis (2nd Ed.), Nagpur.

		Semester VI	
S.No.	**Course Code**	**Subject**	**Credits**
1	Agron-303	Rainfed Agriculture & Watershed Management	2 (1+1)
2	PCS-302	Protected Cultivation and Secondary Agriculture	2 (1+1)
3	Pl. Path-303	Diseases of Field and Horticultural Crops and their Management-II	3 (2+1)
4	Hort-302	Post-harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)
5	Ent-302	Management of Beneficial Insects	2 (1+1)
6	PBG-302	Crop Improvement-II (Rabi crops)	2 (1+1)
7	Agron-304	Practical Crop Production –II (Rabi crops)	2 (0+2)
8	Agron-305	Principles of Organic Farming	2 (1+1)
9	Econ-302	Farm Management, Production & Resource Economics	2 (1+1)
10	FSN-302	Principles of Food Science and Nutrition	2(2+0)
11	EC-302	Elective course	3 credit
		Total	21 (11 + 10)+ 3

Agron-303
Rainfed Agriculture and Watershed Management

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To make student learn about rainfed agriculture and its various aspects.

Learning Outcomes: The student will learn and understand problems associated with rainfed culture, different soil and water conservation techniques, crop adaptation and management of crops in rainfed areas.

Details of Course:

S. No.	Particulars	No. of lectures
1	Rainfed agriculture: Introduction, types, History of rainfed agriculture and watershed in India	2
2	Problems and prospects of rainfed agriculture in India; Soil and climatic conditions prevalent in rainfed areas	2
3	Soil and water conservation techniques, Drought: types, effect of water deficit on physio-morphological characteristics of the plants,	3
4	Crop adaptation and mitigation to drought; Water harvesting: importance, its techniques, Efficient utilization of water through soil and crop management practices,	3
5	Management of crops in rainfed areas, Contingent crop planning for aberrant weather conditions, Concept, objective, principles and components of watershed management, factors affecting watershed management.	4

Practical

S. No.	Particulars	No. of practicals
1	Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons.	3
2	Studies on cropping pattern of different rainfed areas in the country and demarcation of rainfed area on map of India.	3
3	Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops.	2
4	Critical analysis of rainfall and possible drought period in the country, effective rainfall and its calculation. Studies on cultural practices for mitigating moisture stress.	2
5	Characterization and delineation of model watershed. Field demonstration on soil & moisture conservation measures.	2
6	Field demonstration on construction of water harvesting structures. Visit to rainfed research station/watershed.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Jayanthi, C. and Kalpana, R. 2016. Dryland Agriculture, Kalyani Publishers, Ludhiana
2	Reddy, S.R. and Reddy, G. Prabhakara. 2015. Dryland Agriculture, Kalyani Publishers, Ludhiana.
3	Murthy, J. V. S. 1994. Watershed Management, Wiley Eastern Limited. New Age International Limited, New Delhi.
4	Singh, P.K. 2000. Watershed Management (Design & Practices), e-media Publication, Udaipur, India.

PCS-302
Protected Cultivation and Secondary Agriculture

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To understand the practices in protected cultivation and secondary agriculture.

Learning Outcomes: After reading this course the students are expected to be perfect in various techniques of cultivation of crops under poly houses and the value of secondary agriculture in improving the economy of farming community.

Details of Course:

S. No.	Particulars	No. of lectures
1	Green house technology: Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses	2
2	Design criteria of green house for cooling and heating purposes. Green house equipments, materials of construction for traditional and low-cost green houses.	2
3	Irrigation systems used in greenhouses, typical applications, passive solar green house, hot air greenhouse heating systems, green house drying.	3
4	Cost estimation and economic analysis. Important Engineering properties such as physical, thermal and aero & hydrodynamic properties of cereals, pulses and oilseed, their application in PHT equipment design and operation.	3
5	Drying and dehydration; moisture measurement, EMC, drying theory, various drying method, commercial grain dryer (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, recirculatory dryer and solar dryer). Material handling equipment; conveyer and elevators, their principle, working and selection.	4

Practical

S. No.	Particulars	No. of practicals
1	Study of different type of greenhouses based on shape. Determine the rate of air exchange in an active summer winter cooling system.	3
2	Determination of drying rate of agricultural products inside green house. Study of greenhouse equipment.	3
3	Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops.	3
4	Determination of engineering properties (shape and size, bulk density and porosity of biomaterials). Determination of Moisture content of various grains by moisture meter.	3
5	Field visit to seed processing plant.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Kothari S, S.C. Kaushic and A.N. Mathur. 2016, Green House: Science and Technology. Himanshu Publication, Udaipur.
2	Michael, A.M. and T. P. Ojha, 2021, Principles of Agricultural Engineering, Vol. I. Jain Brothers, New Delhi.
3	Henderson, S.M. and R.L. Perry, 1955, Agricultural Process Engineering. John Willy and Sons, New York.
4	Shay K.M. and Singh, K.K, 2004, Unit Operation of Agriculture Processing. Vikas Publication House, New Delhi.

Pl. Path-303

Diseases of Field and Horticultural Crops and their Management- II

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To study and identification of important diseases related to Agricultural and Horticultural crop and their management practices.

Learning Outcome: Diseases of Field and Horticultural Crops and their management- I course is helpful for students for understanding Rabi crop diseases.

Details of Course:

S. No.	Particulars	No. of lectures
1	Symptoms, etiology, disease cycle and management of Sunflower; Alternaria leaf spot, Head rot, Root rot and stem rot; Wheat: rusts, loose smut, karnal bunt, Flag smut, powdery mildew, alternaria blight, and ear cockle	3
2	Symptoms, etiology, disease cycle and management of; Rapeseed mustard; Alternaria blight, white rust, downy mildew, stem rot, Bacterial spot. Sugarcane: red rot, smut, wilt, grassy shoot, ratoon stunting and Pokkah Boeng;	4
3	Symptoms, etiology, disease cycle and management of Gram: wilt, grey mould and Ascochyta blight; Lentil: rust and wilt; Cotton: anthracnose, vascular wilt, and black arm; Pea: downy mildew, powdery mildew and rust.	4
4	Symptoms, etiology, disease cycle and management of Mango: anthracnose, malformation, bacterial blight and powdery mildew; Citrus: canker and gummosis;	4
5	Symptoms, etiology, disease cycle and management of Grape vine: downy mildew, Powdery mildew and anthracnose; Apple: scab, powdery mildew, fire blight and crown gall; Peach: leaf curl.	4
6	Symptoms, etiology, disease cycle and management of Strawberry: leaf spot Potato: early and late blight, black scurf, leaf roll, and mosaic	4
7	Symptoms, etiology, disease cycle and management of Cucurbits: downy mildew, powdery mildew, wilt; Onion and garlic: purple blotch, and Stemphylium blight; Chilies: anthracnose and fruit rot, wilt and leaf curl; Turmeric: leaf spot Coriander: stem gall Marigold: Botrytis blight; Rose: dieback, powdery mildew and black leaf spot.	5

Practical

S. No.	Particulars	No. of practicals
1	Diseases of Wheat and Sugarcane	2
2	Diseases of Gram, Lentil, Cotton and Pea	2
3	Diseases of Mango, Citrus, Grape vine, Apple and Peach	2
4	Diseases of Strawberry and Potato	2
5	Diseases of Cucurbits, Onion and garlic	2
6	Diseases of Chilies, Turmeric, Marigold and Rose	2
7	Field visits at appropriate time during the semester.	2
Note:	**Students should submit 50 pressed, well mounted diseased specimens in three installments during the semester**	

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Santhakumari, P (ed) 2004. Advances in the Diseases of Plantation Crops and Spices, IDB Co., Lucknow.
2	Singh, R. S. 1995. Diseases of Vegetables Crops. Oxford and IBH Publishing Co. New Delhi
3	Singh. R.S. 2001. Plant Disease management, Oxford and IBH New Delhi.
4	Mehrotra, R. S. 2003, Plant Pathology. TATA McGraw Hill Pub. Co. New Delhi.
5	Gupta, V. K. and Paul, Y. S. 2002. Diseases of Field Crops. Indus Publishing Agency New Delhi
6	Saha, L. R. 2008. Handbook of Plant diseases. Kalyani Publishers, New Delhi
7	Gupta, S. K. and Thind, S. 2018. Disease Problems in Vegetable Production. Scientific Publishers, New Delhi.

Hort-302
Post-harvest Management and Value Addition of Fruits and Vegetables

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To provide knowledge regarding post-harvest processes, value addition concept.

Learning outcome: The student will learn different post-harvest processes, value addition methods and canning process of vegetables and fruits.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Importance of post-harvest processing of fruits and vegetables, extent and possible causes of post-harvest losses	1
2.	Pre-harvest factors affecting post-harvest quality, maturity, ripening and changes occurring during ripening	2
3.	Respiration factors affecting respiration rate	1
4.	Harvesting and field handling	1
5.	Storage (ZECC, cold storage, CA, MA and hydro baric storage)	1
6.	Value addition concept; Principles and methods of preservation	2
7.	Intermediate moisture food- jam, jelly, marmalade, preserve, candy- Concepts and Standards	2
8.	Fermented and non-fermented beverages	1
9.	Tomato products- Concepts and Standards	1
10.	Drying/ dehydration of fruits and vegetables- Concepts and methods; Osmotic drying	1
11.	Canning- Concepts and Standards, packaging of products	1

Practical

S. No.	Particulars	No. of practicals
1.	Applications of different types of packaging, containers for shelf life extension	2
2.	Effect of temperature on shelf life and quality of produce	2
3.	Demonstration of chilling and freezing injury in vegetables and fruits	2
4.	Extraction and preservation of pulps and juices	2
5.	Preparation of jam, jelly, RTS, nectar, squash, osmotically dried products, fruit bar candy and tomato products, canned products	2
6.	Quality evaluation of products- physio-chemical and sensory	2
7.	Visit to processing unit/industry	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Jacob JP. 2008. A Handbook on Post Harvest Management of Fruits and Vegetables. Daya Publishing House, New Delhi.
2.	Morris TN. 2006. Principles of Fruit Preservation. Biotech Books, Delhi
3.	Saraswathy S., Preethi T.L., Balasubramanyan S., Suresh J., Revathy N. and. Natarajan S. 2008, Post Harvest Management of Horticultural Crops. Agribios, Jodhpur.
4.	Srivastava RP and Kumar S. 2002. Fruits and Vegetable Preservation- Principles and Practices. International Book Distributing Co., Lucknow
5.	Verma LR and Josgi VK. 2000. Post-Harvest Technology of Fruits and Vegetables Vol. I & II. Indus Publishing Co. New Delhi

Ent-302
Management of Beneficial Insects

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To make the student aware about beneficial insects and the benefits associated with them.
Learning Outcomes: The students will learn and understand the advantages associated with different insects, their life cycle and their mass multiplication techniques.

Details of Course:

Units	Contents	Lectures
I	Importance of beneficial Insects, Beekeeping and pollinators, biology, commercial methods of rearing, equipment used, seasonal management of honey bee, bee enemies and diseases. Bee pasturage, bee foraging and communication. Insect pests and diseases of honey bee. Hive productivity, role of pollinators in cross pollinated plants.	3
II	Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Rearing, mounting and harvesting of cocoons. Pest and diseases of silkworm, management, rearing appliances of mulberry silkworm and methods of disinfection.	4
III	Species of lac insect, morphology, biology, host plant, lac production – seed lac, button lac, shellac, lac products.	3
IV	Insect orders bearing predators and parasitoids used in pest control and their mass multiplication techniques. Important species of pollinators, weed killers and scavengers with their importance.	4

Practical:

S. No.	Particulars	No. of practicals
1.	Honey bee species, castes of bees. Beehive appliances, examination of honey bee and seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication.	4
2.	Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves.	4
3.	Species of lac insect, host plant identification. Identification of other important pollinators, weed killers and scavengers.	3
4.	Visit to research and training institutions devoted to beekeeping, sericulture, lac culture and natural enemies. Identification and techniques for mass multiplication of natural enemies.	3

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Aruga H. 1994. *Principles of Sericulture*. Oxford & IBH, New Delhi.
2.	Atwal AS. 2000. Essentials of Beekeeping and Pollination. Kalyani Publishers, New Delhi.
3.	Atwal AS. 2006. *The World of the Honey Bee*. Kalyani Publ., New Delhi.
4.	Ganga G. 2003. *Comprehensive Sericulture.* Vol. II. *Silkworm Rearing and Silk Reeling*. Oxford & IBH, New Delhi.
5.	Partiban S & David BV. 2007. *Management of Household Pests and Public Health Pests*. Namratha Publications, Chennai.
6.	Singh S. 1975. *Beekeeping in India*. ICAR, New Delhi.

PBG-302
Crop Improvement – II (*Rabi*)

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To make student learn about different rabi crops and various techniques associated with them for their improvement.

Learning Outcomes: It will student able to identify different rabi crops and perform experiments on them for their improvement.

Details of Course:

Sr. No.	Particulars	No. of Lectures
1.	Centers of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fodder crops and cash crops; vegetable and horticultural crops;	4
2	Plant genetic resources, its utilization and conservation; study of genetics of qualitative and quantitative characters;	3
3	Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional);	4
4	Hybrid seed production technology of *rabi* crops.	2
5	Ideotype concept and climate resilient crop varieties for future.	1

Practical

Sr. No.	Particulars	No. of practicals
1	Floral biology, emasculation and hybridization techniques in different crop species namely Wheat, Oat, Barley, Chickpea, Lentil, Field pea, Rajma, Horse gram, Rapeseed Mustard, Sunflower, Safflower, Potato, Berseem.	2
2	Sugarcane, Tomato, Chili, Onion; Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods	2
3	Study of field techniques for seed production and hybrid seeds production in *Rabi* crops	2
4	Estimation of heterosis, inbreeding depression and heritability	2
5	Layout of field experiments; Study of quality characters, study of donor parents for different characters;	2
6	Visit to seed production plots	2
7	Visit to AICRP plots of different field crops	2

Suggested Books/Readings:

1. Ashraf, M. 2012. Crop Production for Agricultural Improvement. Springer Science & Business Media, Germany.
2. Briggs, F.N. and P.F. Knowles, 1970. Introduction to Plant Breeding. Reinhold, New York.
3. Chopra, V.L. 1994. Plant Breeding. Theory and Practice. Oxford and IBH Publishing Co., New Delhi.
4. Harihar Ram and Hari Govind Singh, 1994. Crop Breeding and Genetics. Kalyani Publishers, New Delhi.
5. Sharma, J.R. 1994. Principles and Practices of Plant Breeding. Tata McGraw - Hill Publishing Co. Ltd., New Delhi.
6. Richards, A.J. 1986. Plant Breeding Systems. George Allen & Unwin, London.

Agron-304
Practical Crop Production-II

Credits: 0 + 2 Mid-Session Exam: 50
Contact Hours: 0 + 56 End-Semester Exam: 50

Objective: To make students learn about different techniques associated with production of rabi crops.

Learning outcomes: It will provide student a thorough practical knowledge and ability to do crop planning, field preparation and other significant aspects required for performing different agricultural practices for rabi crops.

Practical

S. No.	Particulars	No. of practicals
1	Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce.	10
2	The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies.	9
3	Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students	9

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Chhidda Singh, Prem Singh and Rajbir Singh. 2003. Modern Techniques of Raising Field Crops (2nd ed.). Oxford and IBH, New Delhi.
2	ICAR [Indian Council of Agricultural Research].2006. Hand Book of Agriculture. ICAR, New Delhi
3	Prasad, R. (ed.). 2001. Field Crop Production. ICAR, New Delhi
4	Pal, M., Deka, J., and Rai, R.K. 1996. Fundamentals of Cereal Crop Production. Tata McGraw Hill Pub., New Delhi

Agron-305
Principles of Organic Farming

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To make students understand the various aspects associated with organic farming and its implementation.

Learning Outcomes: The student will learn about organic farming, its promotion, advantages, restrictions and other aspects for its implementation in agriculture.

Details of Course:

S. No.	Particulars	No. of lectures
1	Organic farming, principles and its scope in India; Initiatives taken by Government (central/ state),	2
2	NGOs and other organizations for promotion of organic agriculture	2
3	Organic ecosystem and their concepts; Organic nutrient resources and its fortification;	3
4	Restrictions to nutrient use in organic farming; Choice of crops and varieties in organic farming;	3
5	Fundamentals of insect, pest, disease and weed management under organic mode of production;	2
6	Operational structure of NPOP; Certification process and standards of organic farming; Processing, leveling, economic considerations and viability, marketing and export potential of organic products.	2

Practical

S. No.	Particulars	No. of practicals
1	Visit of organic farms to study the various components and their utilization;	4
2	Preparation of enrich compost, vermicompost, bio-fertilizers/bio-inoculants and their quality analysis; Indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management;	6
3	Cost of organic production system; Post harvest management; Quality aspect, grading, packaging and handling.	4

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Dahama,A.K. 2007. Organic Farming for Sustainable Agriculture. 2nd Edn. Published by AGROBIOS (India) Jodhpur
2	Sharma, A.K. 2006. A Hand Book of Organic Farming. Published by AGROBIOS (India) Jodhpur
3	Palaniappan, S.P and Anandurai, K. 1999. Organic Farming- Theory and Practice, Scientific Pub., Jodhpur.
4	Gehlot, D. 2005. Organic Farming: Standards, Accreditation, Certification and Inspection. Published by AGROBIOS (India) Jodhpur Published by AGROBIOS (India) Jodhpur

Econ-302
Farm Management, Production and Resource Economics

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: The objective of this course is to make students aware regarding farm management, production and resource economics.

Learning Outcomes: Students will learn the management of farm, production and resource economics aspects.

Details of Course:

S. No.	Particulars	No. of lectures
1	Meaning and concept of farm management, objectives and relationship with other sciences.	2
2	Meaning and definition of farms, its types and characteristics, factor determining types and size of farms.	2
3	Principles of farm management: concept of production function and its type, use of production function in decision-making on a farm, factor-product, factor-factor and product-product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage.	2
4	Meaning and concept of cost, types of costs and their interrelationship, importance of cost in managing farm business and estimation of gross farm income, net farm income, family labour income and farm business income.	1
5	Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises.	1
6	Importance of farm records and accounts in managing a farm, various types of farm records needed to maintain on farm, farm inventory, balance sheet, profit and loss accounts.	1
7	Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting-linear programming, appraisal of farm resources, selection of crops and livestock's enterprises.	1
8	Concept of risk and uncertainty occurs in agriculture production, nature and sources of risks and its management strategies**,** Crop/livestock/machinery insurance– weather-based crop insurance, features, determinants of compensation.	1
9	Concepts of resource economics, differences between NRE and agricultural economics, unique properties of natural resources.	1
10	Positive and negative externalities in agriculture, Inefficiency and welfare loss, solutions.	1
11	Important issues in economics and management of common property resources of land, water, pasture and forest resources etc.	1

Practical

S. No.	Particulars	No. of practicals
1	Preparation of farm layout.	2
2	Determination of cost of fencing of a farm.	2
3	Computation of depreciation cost of farm assets.	2
4	Application of equi-marginal returns/opportunity cost principle in allocation of farm resources.	2
5	Determination of most profitable level of inputs use in a farm production process.	1

6	Determination of least cost combination of inputs.	1
7	Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises.	1
8	Selection of most profitable enterprise combination.	1
9	Preparation of farm plan and budget, farm records and accounts and profit & loss accounts.	1
10	Collection and analysis of data on various resources in India	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Johl, S.S. and Kapoor, T.R. (1973), Fundamentals of Farm Business Management, Kalyani Publishers, Ludhiana.
2	Sankhayan, P.L. (1988), Introduction to the Economics of Agricultural Production, Prentice Hall of India Private Limited, New Delhi-110 001
3	Raju, V.T. and Rao, D.V.S. (1990), Economics of Farm Production and Management, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi-110 001.
4	Dhondyal, S.P. (1985), Farm Management, Friends Publication Meerut (India).
5	Kahlon, A.S. and Karam Singh (1992), Economics of Farm Management, Allied Publishers, New Delhi
6	Doll, John P. and Orazem. F. (1984), Production Economics: Theory with Application, John Wiley and Sons, New York.

FSN-302
Principles of Food Science and Nutrition

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objectives: The objective of this course is to make student aware concept and basic features of food science.

Learning Outcomes: The students will learn about the various aspects regarding food science such as food composition, microbiology, food processing, nutrition and balanced diet.

Details of Course:

S. No.	Particulars	No. of lectures
1	Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.);	5
2	Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bio actives, important reactions)	5
3	Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods)	5
4	Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.)	5
5	Food and nutrition, Malnutrition (over and under nutrition), nutritional disorders; Energy metabolism (carbohydrate, fat, proteins)	4
6	Balanced/ modified diets, Menu planning, New trends in food science and nutrition.	4

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Bamji M.S, Rao N.A & Reddy V. (2003). Textbook of Human Nutrition. Oxford & IBH, New Delhi.
2	Srilakshmi B. (2013) Food Science, 4th Ed, New Age International Publisher, New Delhi
3	Manay S. and Shadaksharaswamy M. (2018). Foods Facts and Principles, 4th Ed, New Age International Publisher, New Delhi
4	Srivastava R.P. & Kumar S. (2003). Fruit and Vegetable Preservation - Principles and Practices. International Book Distributors. New Delhi.
5	Frazier J & Westhoff D.C. (1988). Food Microbiology. 4th Ed. McGraw Hill. New Delhi.
6	Belitz H.D. (1999). *Food Chemistry*. Springer. New York, United States.

Elective Courses: A student can select three elective courses out of the following and offer during 4th, 5th and 6th semesters.

Course no.	Courses	Credit Hours
Agricultural Economics		
ELCT-321	Agribusiness Management	3(2+1)
Plant Pathology		
ELCT-312	Agrochemicals	3(2+1)
ELCT-221	Food Safety and Standards	3(2+1)
ELCT-311	Biopesticides & Biofertilizers	3(2+1)
Plant Breeding		
ELCT-323	Commercial Plant Breeding	3(1+2)
Horticulture		
ELCT-322	Landscaping	3(2+1)
ELCT-313	Protected Cultivation	3(2+1)
ELCT-222	Hi-tech. Horticulture	3(2+1)
Agronomy		
ELCT-314	Micro propagation Technologies	3(1+2)
ELCT-223	Weed Management	3(2+1)
ELCT-324	System Simulation and Agro-advisory	3(2+1)
Extension Education		
ELCT-224	Agricultural Journalism	3(2+1)

ELCT-321

Agribusiness Management

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: The objective of this course is to develop analytical skills relevant to agribusiness management and to develop an understanding of ethical, socially responsible, sustainable behaviour, understanding and appreciation of broader issues relevant to agribusiness

Learning Outcomes: The student will develop and demonstrate an ability to apply economic principles to problems of farms, ranches, and other institutions in the food and fibre industries, technological skills used in quantitative analysis, such as ability to perform statistical analysis using spreadsheet. The student will be able to demonstrate an awareness of global issues relevant to agribusiness and agricultural development, appreciation for diversity in agribusiness employees, customers, and producers. The student will also be able to propose and assess economic policy solutions to agricultural and food issues

Details of Course:

S. No.	Particulars	No. of lectures
1	Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems.	2
2	Importance of agribusiness in the Indian economy and New Agricultural Policy.	2
3	Distinctive features of Agribusiness Management: Importance and needs of agro-based industries, Classification of industries and types of agro based industries.	3
4	Institutional arrangement, procedures to set up agro based industries. Constraints in establishing agro-based industries.	2
5	Agri-value chain: Understanding primary and support activities and their linkages.	2
6	Business environment: PEST & SWOT analysis. Management functions: Roles & activities, Organization culture.	2
7	Planning, meaning, definition, types of plans. Purpose or mission, goals or objectives, Strategies, polices procedures, rules, programs and budget. Components of a business plan, Steps in planning and implementation.	3
8	Organization staffing, directing and motivation.	2
9	Ordering, leading, supervision, communications, control. Capital Management and Financial management of Agribusiness. Financial statements and their importance.	2
10	Marketing Management: Segmentation, targeting & positioning. Marketing mix and marketing strategies. Consumer behaviour analysis,Product Life Cycle (PLC).	2
11	Sales & Distribution Management. Pricing policy, various pricing methods.	2
12	Project Management definition, project cycle, identification, formulation, appraisal, implementation, monitoring and evaluation.	2
13	Project Appraisal and evaluation techniques.	2

Practical

S. No.	Particulars	No. of practicals
1	Study of Agri-input markets: Seed, fertilizers, pesticides.	1
2	Study of output markets: grains, fruits, vegetables, flowers.	1
3	Study of product markets, retails trade commodity trading, and value-added products.	2
4	Study of financing institutions- Cooperative, Commercial banks, RRBs, Agribusiness Finance Limited, NABARD	2
5	Preparations of projects and Feasibility reports for agribusiness entrepreneur.	2
6	Appraisal/evaluation techniques of identifying viable project- Non-discounting techniques.	2
7	Case study of agro-based industries. Trend and growth rate of prices of agricultural commodities.	2
8	Net present worth technique for selection of viable project. Internal rate of return.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Cramer. G.L. and Jenson. C.W.1979. Agricultural Economics and Agribusiness. John Wiley & Sons, New York.
2	Gitteger Price, J. 1989 Economics Analysis of Agricultural Projects, John Hopkins University Press, London
3	Harsh, S.B. Conner, U.J. and Schwab G.D. 1981 Management of the Farm Business. Prentice Hall Inc., New Jersey
4	Joseph, L. Massie.1995. Essentials of Management. Prentice Hall of India Pvt. Ltd., New Delhi
5	Omri Rawlins, N, 1980. Introduction to Agribusiness. Prentice Hall of India Pvt. Ltd., New Delhi
6	Vaish, M. C. 1993. International Economics. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

ELCT-312
Agrochemicals

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To provide knowledge regarding agrochemicals and their various classes along with their application in agriculture.

Learning outcome: The student will gain knowledge regarding the use of agrochemicals in sustainable agriculture.

Details of Course:

S. No.	Particulars	No. of lectures
1	An introduction to agrochemicals, their type and role in agriculture, effect on environment, soil, human and animal health, merits and demerits of their uses in agriculture, management of agrochemicals for sustainable agriculture.	3
2	Herbicides-Major classes, properties and important herbicides. Fate of herbicides. Fungicides - Classification – Inorganic fungicides - characteristics, preparation and use of sulphur and copper, Mode of action-Bordeaux mixture and copper oxychloride.	4
3	Organic fungicides- Mode of action- Dithiocarbonates-characteristics, preparation and use of Zineb and maneb. Systemic fungicides- Benomyl, carboxin, oxycarboxin, Metalaxyl, Carbendazim, characteristics and use.	4
4	Introduction and classification of insecticides: inorganic and organic insecticides Organochlorine, Organophosphates, Carbamates, Synthetic pyrethroids Neonicotinoids, Biorationals, Insecticide Act and rules, Insecticides banned, withdrawn and restricted use, Fate of insecticides in soil & plant.	4
5	IGRs Biopesticides, Reduced risk insecticides, Botanicals, plant and animal systemic insecticides their characteristics and uses. Fertilizers and their importance.	3
6	Nitrogenous fertilizers: Feedstocks and Manufacturing of ammonium sulphate, ammonium nitrate, ammonium chloride, urea. Slow release N-fertilizers.	2
7	Phosphatic fertilizers: feedstock and manufacturing of single superphosphate. Preparation of bone meal and basic slag.	2
8	Potassic fertilizers: Natural sources of potash, manufacturing of potassium chloride, potassium sulphate and potassium nitrate. Mixed and complex fertilizers:	2
9	Sources and compatibility–preparation of major, secondary and micronutrient mixtures.	2
10	Complex fertilizers: Manufacturing of ammonium phosphates, nitro phosphates and NPK complexes. Fertilizer control order. Fertilizer logistics and marketing. Plant bio-pesticides for ecological agriculture, Bio-insect repellent.	2

Practical

S. No.	Particulars	No. of practicals
1	Sampling of fertilizers and pesticides.	2
2	Pesticides application technology to study about various pesticides appliances.	2
3	Quick tests for identification of common fertilizers.	1
4	Identification of anion and cation in fertilizer.	1
5	Calculation of doses of insecticides to be used.	1
6	To study and identify various formulations of insecticide available kin market.	1
7	Estimation of nitrogen in Urea.	1
8	Estimation of water soluble P_2O_5 and citrate soluble P_2O_5 in single super phosphate.	1
9	Estimation of potassium in Muriate of Potash/ Sulphate of Potash by flame photometer.	1
10	Determination of copper content in copper oxychloride.	1
11	Determination of sulphur content in sulphur fungicide.	1
12	Determination of thiram. Determination of ziram content.	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Das, P.C. 1993. Manures and Fertilizers. Kalyani Publishers, New Delhi.
2	Gupta,P.K, 1999. Hand book of Soil, Fertilizer and Manure. Agro Botanica, Bikaner.
3	Gupta, A.K. 2007. Methods in Environmental Analysis Water, Soil and Air. 2nd Edn. Published by AGROBIOS(India) Jodhpur
4	Purohit,S.S. 2006. Environmental Pollution Causes, Effects and Control. Published by AGROBIOS(India) Jodhpur
5	Shilpa, S, Varma, H.N and Bhargava, S.K. 2006. Air Pollution and its Impacts on Plant Growth. New India Publishing Agency, New Delhi
6	Singh, S.S, 1999. Soil Fertility and Nutrient Management. Kalyani Publishers, New Delhi
7	Sreeramalu, U.S. (1979). Chemistry of Insecticides and Fungicides. Oxford and IBH Publishing Co., New Delhi.
8	Stevens, R.W. (1977). Pesticides in the Environment Vol. Part 1. Marcel Dekker, Inc. New York
9	Tandon, H.L.S.1992. Fertilizers, Organic Manures, Recyclable Wastes and Biofertilizers. FDCO, New Delhi
10	Tisdale, S.L., W.L. Nelson Beaton J.D and Havlin J.L (1997). Soil Fertility and Fertilisers. 5th Edn Printice Hall of India New Delhi.
11	Ulysses, R. and Johnes, S. 1987. Fertilizers and Soil Fertility. Prentice Hall of India Pvt. Ltd., New Delhi
12	Yawalkar, K.S., Agarwal, J.P. and Bokdi, S. 1984. Manures and Fertilizers. Agrl. Horti. Publishing House, Nagpur

ELCT-221

Food Safety and Standards

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objectives: The course Food Safety and Standards has been designed to make the students aware about the Scope and factors affecting Food Safety, Hazards and Risks and their management, Sources of contamination and their control, Waste Disposal, Food Safety Management Tools, Genetically modified foods, Organic foods and Indian and International Standards for food products.

Learning outcome: By the end of this course, learners should be able to explain different Types of hazards i.e. Biological, Chemical and Physical hazards and also different methods for their management, different Sources of contamination in food and their control, maintenance of personal hygiene, food safety management tools such as ISO, HACCP and TQM, Food safety and standard authority of India (FSSAI), organic foods, GM foods and Indian and International Standards for quality control of processed products.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Food Safety – Definition, Importance, Scope and Factors affecting Food Safety. Hazards and Risks, Types of hazards - Biological, Chemical, Physical hazards. Management of hazards - Need. Control of parameters. Temperature control. Food storage. Product design.	6
2.	Hygiene and Sanitation in Food Service Establishments- Introduction. Sources of contamination and their control. Waste Disposal. Pest and Rodent Control. Personnel Hygiene. Food Safety Measures.	5
3.	Food Safety Management Tools- Basic concepts. PRPs, GHPs, GMPs, SSOPs etc. HACCP. ISO series. TQM - concept and need for quality, components of TQM, Kaizen Risk Analysis. Accreditation and Auditing.	5
4.	Water Analysis, Surface Sanitation and Personal Hygiene. Food laws and Standards. Indian Food Regulatory Regime, FSSAI Global Scenario CAC (Codex Alimentarius Commission). Other laws and standards related to food.	6
5.	Recent concerns- New and Emerging Pathogens. Packaging, Product labelling and Nutritional labelling. Genetically modified foods\ transgenics. Organic foods. Newer approaches to food safety. Recent Outbreaks. Indian and International Standards for food products.	6

Practical

S. No.	Particulars	No. of practicals
1.	Water quality analysis physico-chemical and microbiological.	2
2.	Preparation of different types of media.	2
3.	Microbiological Examination of different food samples.	2
4.	Assessment of surface sanitation by swab/rinse method.	2
5.	Assessment of personal hygiene.	2
6.	Biochemical tests for identification of bacteria and Scheme for the detection of food borne pathogens.	2
7.	Preparation of plans for Implementation of FSMS - HACCP, ISO: 22000.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Ed Aston G & Tiffney J. 1982. Guide to Improving Food Hygiene. Northwood Books, London.
2.	Harry H. Weiser, J. Mountney and W.W. Gord. 1988. Practical Food Microbiology and Technology (2nd edition), John Wiley and Sons, New York.
3.	Betty C.Hobbs. 1974. Food Poisoning and Food Hygiene (3rd Edition), Edward Arnold, London.
4.	Marriott. Norman G. 2006. Principles of Food Sanitation (5^{th} Edition), Springer, New Delhi.
5.	Barry Graham- Rack. 1964. Hygiene in food manufacturing and Handling. Food Trade Press Ltd., London.
6.	Cynthia A. Roberts (2001). The Food Safety Information Handbook. CRC. New, Delhi.
7.	Clive de W. Blackburn and Peter J. McClure (2002). Food Pathogens: Hazards, Risk Analysis and Control, CRC. New, Delhi.
8.	Shapton DA (1994). Principles and Practices of Safe Processing of Foods. Butterworth Publication, London.

ELCT-311

Biopesticides & Biofertilizers

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To provide knowledge about the various aspects of biopesticides and biofertilizers and specifications about their utilization.

Learning outcome: The students will gain knowledge regarding the various components of biopesticide and biofertilizers and their suitable utilization in sustainable agriculture.

Details of Course:

S. No.	Particulars	No. of lectures
1.	History and concept of biopesticides. Importance, scope and potential of biopesticide. Definitions, concepts and classification of biopesticides viz. pathogen, botanical pesticides, and biorationals.	5
2.	Botanicals and their uses. Mass production technology of bio-pesticides.	2
3.	Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes.	2
4.	Methods of application of biopesticides. Methods of quality control and Techniques of biopesticides. Impediments and limitation in production and use of biopesticide.	3
5.	Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- *Azospirillum, Azotobacter*, *Bacillus*, *Pseudomonas, Rhizobium* and *Frankia*; Cyanobacterial biofertilizers- *Anabaena, Nostoc, Hapalosiphon* and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza	5
6.	Nitrogen fixation -Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, K solubilization.	3
7.	Production technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertilizers	3
8.	FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers -Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.	5

Practical

S. No.	Particulars	No. of practicals
1.	Isolation and purification of important biopesticides: *Trichoderma*, *Pseudomonas*, *Bacillus, Metarhyzium* etc. and its production	1
2.	Identification of important botanicals	1
3.	Visit to biopesticide laboratory in nearby area. Field visit to explore naturally infected cadavers	2
4.	Identification of entomopathogenic entities in field condition. Quality control of Biopesticides	2
5.	Isolation and purification of *Azospirillum, Azotobacter, Rhizobium*, P-solubilizers and cyanobacteria	2
6.	Mass multiplication and inoculums production of biofertilizers.	2
7.	Isolation of AM fungi -Wet sieving method and sucrose gradient method.	2
8.	Mass production of AM inoculants.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Subbarao N.S. 1999. Soil Microbiology. Oxford and IBH Publishing Co Pvt Ltd, New Delhi.
2.	Singh T and Purohit SS, 2008. Biofertilizer Technology, Agrobios, New Delhi.
3.	Suri S, 2019. Biofertilizers and Biopesticides, APH Publishing Corporation, New Delhi.
4.	Sharma AK, 2012. Biofertilizers for Sustainable Agriculture, Agrobios, New Delhi.

ELCT-323
Commercial Plant Breeding

Credits: 1 + 2
Contact Hours: 14 + 56

Mid-Session Exam: 15 (10+5#)
Practical Exam: 65
End-Semester Exam: 20

Objective: To make student familiar with different breeding techniques of commercially important crops.

Learning Outcome: The student will gain knowledge regarding different plant breeding methods, IPR issues in commercial breeding and various aspects of seed production.

Details of Course:

Sr. No.	Particulars	No. of Lectures
1.	Types of crops and modes of plant reproduction. Line development and maintenance breeding in self and cross-pollinated crops (A/B/R and two-line system) for development of hybrids and seed production.	4
2	Genetic purity test of commercial hybrids. Advances in hybrid seed production of maize, rice, sorghum, pearl millet, castor, sunflower, cotton pigeon pea, Brassica etc.	3
3	Quality seed production of vegetable crops under open and protected environment. Alternative strategies for the development of the line and cultivars: haploid inducer, tissue culture techniques and biotechnological tools.	3
4	IPR issues in commercial plant breeding: DUS testing and registration of varieties under PPV & FR Act. Variety testing, release and notification systems in India.	2
5	Principles and techniques of seed production, types of seeds, quality testing in self and cross-pollinated crops.	2

Practical

Sr. No.	Particulars	No. of practicals
1	Floral biology in self and cross-pollinated species, selfing and crossing techniques. Techniques of seed production in self and cross-pollinated crops using A/B/R and two-line system.	4
2	Learning techniques in hybrid seed production using male-sterility in field crops.	4
3	Understanding the difficulties in hybrid seed production, Tools and techniques for optimizing hybrid seed production. Concept of line its multiplication and purification in hybrid seed production.	4
4	Role of pollinators in hybrid seed production. Hybrid seed production techniques in sorghum, pearl millet, maize, rice, rapeseed-mustard, sunflower, castor, pigeon pea, cotton and vegetable crops.	4
5	Concept of rouging in seed production plot. Sampling and analytical procedures for purity testing and detection of spurious seed.	4
6	Seed drying and storage structure in quality seed management. Screening techniques during seed processing viz., grading and packaging.	4
7	Visit to public private seed production and processing plants.	4

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Singh, P. 2014. Plant Breeding at a Glance. Kalyani Publishers, New Delhi.
2.	Singh, B.D. 2014. Plant Breeding Principles and Methods. Kalyani Publications, New Delhi.
3.	Allard, R.W. 2010. Principle of Plant Breeding. 2nd edition, Wiley India Pvt. Ltd.-New Delhi.

ELCT-322

Landscaping

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To provide knowledge regarding landscaping and its various aspects.

Learning outcome: The student will gain knowledge on landscaping, its components and its importance.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Importance and scope of landscaping	1
2.	Principles of landscaping, garden styles and types	1
3.	Terrace gardening and vertical gardening,	1
4.	Garden components, adornments, rockery, water garden, walk-paths, bridges, other constructed features etc. gardens for special purposes	2
5.	Trees: selection, propagation, planting schemes and canopy management	2
6.	Shrubs: selection, propagation and planting schemes	2
7.	Herbaceous perennials: selection, propagation, planting schemes, architecture	2
8.	Climber and creepers: importance, selection, propagation, planting	2
9.	Annuals: selection, propagation, planting scheme	2
10.	Other garden plants: palms, ferns, grasses and cacti succulents and shade loving plants	2
11.	Pot plants: selection, arrangement, management.	2
12.	Bio-aesthetic planning: definition, need and planning	2
13.	Landscaping of urban and rural areas & Peri-urban landscaping	2
14.	Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, playgrounds, airports, industries, institutions	2
15.	Bonsai: principles and management	1
16.	Lawn: establishment and maintenance	1
17.	CAD application	1

Practical

S. No.	Particulars	No. of practicals
1.	Identification of trees, shrubs, annuals, pot plants	2
2.	Propagation of trees, shrubs and annuals	2
3.	Care and maintenance of plants, shrubs and trees	2
4.	Potting and repotting	1
5.	Tools and implements used in landscape design	1
6.	Training and pruning of plants for special effects	1
7.	Lawn establishment and maintenance	1

8.	Layout of formal gardens and informal gardens	1
9.	Special type of gardens (sunken garden, terrace garden, rock garden) and designing of conservatory and lath house	1
10.	Use of computer software	1
11.	Visit to important gardens/ parks/ institutes	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Arora JS. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, New Delhi.
2.	Bose TK, Malti RG, Dhua RS and Das P. 2014. Floriculture and Landscaping. Naya Prokash, Koltata.
3.	Grewal HS and Singh Parminder. 2014 Landscape Designing and Ornamental Plants. Pointer Publishers, Jaipur
4.	Roy RK. 2013. Fundamentals of Garden Designing. New India Publishing Agency, New Delhi.
5.	Tiwari AK and Kumar R. 2012. Fundamentals of Ornamental Horticulture and Landscape Gardening. New India Publishing Agency, New Delhi.

ELCT-313
Protected Cultivation

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To study and identification of important diseases related to Agricultural and Horticultural crop and their management practices.

Learning outcome: The student will attain knowledge regarding different diseases and their eradication using different management practices.

Details of Course:

S. No.	Particulars	No. of lectures
1	Protected cultivation- importance and scope, Status of protected cultivation in India and World types of protected structure based on site and climate.	2
2	Cladding material involved in greenhouse/ poly house. Greenhouse design, environment control, artificial lights, Automation.	2
3	Soil preparation and management, Substrate management. Types of benches and containers. Irrigation and fertigation management.	4
4	Propagation and production of quality planting material of horticultural crops.	2
5	Greenhouse cultivation of important horticultural crops – rose, carnation, chrysanthemum, gerbera, orchid, anthurium, lilium, tulip, tomato, bell pepper, cucumber, strawberry, pot plants, etc.	9
6	Cultivation of economically important medicinal and aromatic plants. Off-season production of flowers and vegetables.	6
7	Insect pest and disease management.	3

Practical

S. No.	Particulars	No. of practicals
1	Raising of seedlings and saplings under protected conditions,	3
2	use of portrays in quality planting material production,	3
3	Bed preparation and planting of crop for production,	2
4	Inter cultural operations,	2
5	Soil EC and pH measurement,	2
6	Regulation of irrigation and fertilizers through drip, fogging ad misting.	2
Note:	**Students should submit 50 pressed, well mounted diseased specimens in three installments during the semester**	

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. 2014.Advances in Protected Cultivation. New India Publishing Agency, New Delhi.
2	Balraj Singh. 2006. Protected Cultivation of Vegetable Crops. Kalyani Publishers, Ludhiana.
3	Reddy P. Parvatha, 2003. Protected Cultivation. Springer Publications. USA.
4	Pant V Nelson. 1991.Green House Operation and Management. Bali Publications, New Delhi.

ELCT-222

Hi-tech. Horticulture

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact Hours: 28 + 28 Practical Exam: 35
End-Semester Exams: 40

Objective: To provide knowledge on different aspects of advanced horticulture approaches for high production.

Learning outcome: The student will attain knowledge on the different aspects of advanced horticulture and will be able to utilize them for high production of horticulture crops.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Introduction & importance	1
2.	Nursery management and mechanization	2
3.	Micro propagation of horticultural crops	2
4.	Modern field preparation and planting methods	2
5.	Protected cultivation: advantages, controlled conditions, method and techniques	2
6.	Micro irrigation systems and its components	2
7.	EC, pH-based fertilizer scheduling	2
8.	Canopy management	2
9.	High density orcharding	2
10.	Components of precision farming	2
11.	Remote sensing	1
12.	Geographical Information System (GIS), Differential Geo-positioning System (DGPS), Variable Rate Applicator (VRA)	3
13.	Application of precision farming in horticultural crops (fruits, vegetables and ornamental crops)	3
14.	Mechanized harvesting of produce	2

Practical

S. No.	Particulars	No. of practicals
1.	Types of poly houses and shade net houses	2
2.	Intercultural operations	2
3.	Tools and equipments identification and application	2
4.	Micro propagation	2
5.	Micro-irrigation	2
6.	EC, pH-based fertilizer scheduling	2
7.	Canopy management	1
8.	Visit to hi-tech orchard/nursery	1

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Chadha K.L. 2009. Advances in Horticulture. Malhotra Publishing House, New Delhi
2.	Chadha K.L. 2002. Handbook of Horticulture. ICAR, New Delhi
3.	Hartman, HT and Kester, DE. 1986. Plant Propagation Principles and Practices. Prentice Hall of India Pvt. Ltd., Bombay
4.	Prasad S & Kumar U. 2005. Greenhouse Management for Horticultural Crops. 2nd ed. (2005) Agrobios, Jodhpur.
5.	Tiwari GN. 2003. Green House Technology for Controlled Environment. Narosa Publ. House, New Delhi.

ELCT-314
Micropropagation Technologies

Credits: 1 + 2
Contact Hours: 14 + 56

Mid-Session Exam: 15 (10+5[#])
Practical Exam: 65
End-Semester Exam: 20

Objective: To provide knowledge regarding different micropropagation techniques and to harvest secondary metabolites from in vitro cultures for commercial production.

Learning outcome: The student will learn different techniques of *in vitro* culture and will be able to perform it in laboratory for the mass multiplication of the given plant sample.

Details of Course:

S. No.	Particulars	No. of lectures
1	Introduction, History, Advantages and limitations; Types of cultures (seed, embryo, organ, callus, cell),	5
2	Stages of micropropagation, Axillary bud proliferation (Shoot tip and meristem culture, bud culture),	3
3	Organogenesis (callus and direct organ formation), Somatic embryogenesis, cell suspension cultures,	3
4	Production of secondary metabolites, Soma clonal variation, Cryopreservation, Protoplast isolation, culture and fusion	3
	Total	**14**

Practical

S. No.	Particulars	No. of practicals
1	Identification and use of different equipments in tissue culture Laboratory	4
2	Nutrition media composition, sterilization techniques for media, containers and small instruments,	4
3	Sterilization techniques for explants, Preparation of stocks and working solution,	4
4	Preparation of working medium, Culturing of explants	4
5	Seeds, shoot tip and single node, Callus induction	4
6	Induction of somatic embryos regeneration of whole plants from different explants	4
7	Hardening procedures	4

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Chawla H.S. 2018. Introduction to Plant Biotechnology; CRC Press, New York.
2	Bhojwani S.S. & Razdan M.K. 1996. Plant Tissue Culture: Theory & Practice. Elsevier, New York.
3	Singh B.D. 2015. Plant Biotechnology; Kalyani Publishers, New Delhi.
4	Kalyan Kumar De. 2008. Plant Tissue Culture. New Central Book Agency, New Delhi.

ELCT-223
Weed Management

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact Hours: 28 + 28 Practical Exam: 35
End-Semester Exams: 40

Objective: To provide knowledge regarding weeds and their management for sustainable agriculture.

Learning outcome: The student will gain knowledge on different weeds, their disadvantages and the management to eradicate them for rapid and high agriculture production.

Details of Course:

S. No.	Particulars	No. of lectures
1	Introduction to weeds, characteristics of weeds their harmful and beneficial effects on ecosystem.	3
2	Classification, reproduction and dissemination of weeds.	4
3	Herbicide classification, concept of adjuvant, surfactant, herbicide formulation and their use.	5
4	Introduction to mode of action of herbicides and selectivity. Allelopathy and its application for weed management.	4
5	Bio-herbicides and their application in agriculture. Concept of herbicide mixture and utility in agriculture.	4
6	Herbicide compatibility with agro-chemicals and their application.	4
7	Integration of herbicides with non-chemical methods of weed management. Herbicide Resistance and its management.	4

Practical

S. No.	Particulars	No. of practicals
1	Techniques of weed preservation.	1
2	Weed identification and their losses study.	1
3	Biology of important weeds.	2
4	Study of herbicide formulations and mixture of herbicide.	2
5	Herbicide and agrochemicals study.	2
6	Shift of weed flora study in long term experiments.	2
7	Study of methods of herbicide application, spraying equipment's.	2
8	Calculations of herbicide doses and weed control efficiency and weed index.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Saraswat, V.N., Bhan, V.M. and Yaduraju, N.T. 2003. Weed Management, ICAR, New Delhi.
2	Gupta, O.P. 2015. Weed Management: Principles and Practices (2nd Ed.), Agribios, Jodhpur.
3	Gupta, O.P. 2016. Modern Weed Management, Agribios, Jodhpur.
4	Das, T.K. 2008. Weed Science: Basics and Applications, Jain Brothers, New-Delhi.
5	Rao, V.S. 2000. Principals of Weed Science (2nd Edition), Oxford and IBH Publishing Co., New Delhi.

ELCT-324

System Simulation and Agroadvisory

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To provide education regarding the impact of weather elements on crop production.

Learning outcome: The student will learn various weather components and their impact on crop production. This will make them aware about cropping seasons and related advantages and disadvantages.

Details of Course:

S. No.	Particulars	No. of lectures
1	System Approach for representing soil-plant-atmospheric continuum, system boundaries, Crop models, concepts & techniques, types of crop models, data requirements, and relational diagrams.	5
2	Evaluation of crop responses to weather elements; Elementary crop growth models; calibration, validation, verification and sensitivity analysis.	5
3	Potential and achievable crop production- concept and modelling techniques for their estimation. Crop production in moisture and nutrients limited conditions; components of soil water and nutrients balance.	6
4	Weather forecasting, types, methods, tools & techniques, forecast verification; Value added weather forecast, ITK for weather forecast and its validity;	4
5	Crop-Weather Calendars; Preparation of agro-advisory bulletin based on weather forecast.	4
6	Use of crop simulation model for preparation of Agro-advisory and its effective dissemination.	4

Practical

S. No.	Particulars	No. of practicals
1	Preparation of crop weather calendars.	1
2	Preparation of agro-advisories based on weather forecast using various approaches and synoptic charts.	1
3	Working with statistical and simulation models for crop growth.	2
4	Potential & achievable production; yield forecasting, insect & disease forecasting models.	2
5	Simulation with limitations of water and nutrient management options.	2
6	Sensitivity analysis of varying weather and crop management practices.	2
7	Use of statistical approaches in data analysis and preparation of historical, past and present meteorological data for medium range weather forecast.	2
8	Feedback from farmers about the agroadvisory.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Radha Krishna Murthy, V.2016. Principles and Practices of Agricultural Disaster Management. B.S Publications, Koti, Hyderabad.
2	Reddy, S.R.2014. Introduction to Agriculture and Agrometeorology. Kalyani Publishers, Ludhiana, Punjab.
3	Radha Krishna Murthy, V. 2002. Basic Principles of Agricultural Meteorology. B.S Publications, Koti, Hyderabad.

ELCT-224

Agricultural Journalism

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exams: 40

Objective: To provide knowledge on various aspects of journalism in agriculture.

Learning outcome: The student will gain knowledge on different components of journalism in agriculture and will be able to attain information from various readable sources. The student will also learn to contribute to these sources.

Details of Course:

S. No.	Particulars	No. of lectures
1	Agricultural Journalism: The nature and scope of agricultural journalism characteristics and training of the agricultural journalist, how agricultural journalism is similar to and different from other types of journalism.	4
2	Newspapers and magazines as communication media: Characteristics; kinds and functions of newspapers and magazines, characteristics of newspaper and magazine readers.	4
3	Form and content of newspapers and magazines: Style and language of newspapers and magazines, parts of newspapers and magazines.	4
4	The agricultural story: Types of agricultural stories, subject matter of the agricultural story, structure of the agricultural story.	4
5	Gathering agricultural information: Sources of agricultural information, interviews, coverage of events, abstracting from research and scientific materials, wire services, other agricultural news sources.	3
6	Writing the story: Organizing the material, treatment of the story, writing the news lead and the body, readability measures.	3
7	Illustrating agricultural stories: Use of photographs, use of artwork (graphs, charts, maps, etc.), writing the captions.	3
8	Editorial mechanics: Copy reading, headline and title writing, proofreading, lay outing.	3

Practical

S. No.	Particulars	No. of practicals
1	Practice in interviewing.	2
2	Covering agricultural events.	2
3	Abstracting stories from research and scientific materials and from wire services.	2
4	Writing different types of agricultural stories.	2
5	Selecting pictures and artwork for the agricultural story.	2
6	Practice in editing, copy reading, headline and title writing, proofreading, lay outing.	2
7	Testing copy with a readability formula. Visit to a publishing office.	2

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1	Ray, G. L. and Mondal, S. 2005. Journalism Including Communication, Farm and Rural Journalism, Public Relations, Kalyani Publication, Ludhiana.
2	Bhaskaran, C., Prakash, R. and Kishor Kumar, N. 2008. Farm Journalism and Media Management Agrotech Publishing Company, Udaipur.
3	Narayanaswamy V R. 1979. Strengthen Your Writing. Orient Longman, New Delhi.
4	Kamat,M.G. 1969. Writing for Farm Families. Allied Publishers, New Delhi.
5	Indu Grover, Nishi Sethi and Deepak Grover. 2008. Mass Handbook of Media and Communication. Agrotech Publishing Academy, Udaipur.
6	Arvind Kumar (1999). The Electronic Media. Anmol Publications, New Delhi.
7	Bhatt, S.C. (1993) Broadcast Journalism. Basic Principles. Har Anand Publications, Delhi
8	Bhatnagar, R. (2001). Print Media and Broadcast Journalism. Indian Publisher Distributors, Delhi
9	Katyal, V.P (2007). Fundamentals of Media Ethics. Cyber Tech Publishers, New Delhi.
10	*Subin* K *Mohan*, G Prasad Babu, Talata C Ratnayake and Ram (2010) Handbook on Farm Journalism. Pulari Publishers, Karnal.
11	A.K. Singh, 2014, Agricultural Extension and Farm Journalism. Agrobios, Jodhpur

Semester VII

RAWE Component-I

Rural Agricultural Work Experience and Agro-industrial Attachment (RAWE & AIA)			
S. no.	**Activities**	**No. of weeks**	**Credit Hours**
1	General orientation & On campus training by different faculties	1	14
2	Village attachment	8	
3	Unit attachment in Univ. / College. KVK/ Research Station Attachment	5	
4	Plant clinic	2	2
5	Agro-Industrial Attachment	3	3
6	Project Report Preparation, Presentation and Evaluation	1	1
	Total weeks for RAWE & AIA	20	20

Village Attachment

Sl. No.	Activity	Duration
1	Orientation and Survey of Village	1 week
2	Agronomical Interventions	1 week
3	Plant Protection Interventions	1 week
4	Soil Improvement Interventions (Soil sampling and testing)	1 week
5	Fruit and Vegetable production interventions	1 week
6	Food Processing and Storage interventions	1 week
7	Animal Production Interventions	1 week
8	Extension and Transfer of Technology activities	1 week

RAWE Component-II

Agro Industrial Attachment

Students shall be placed in Agro-and Cottage industries and Commodities Boards for 03 weeks. Industries include Seed/Sapling production, Pesticides-insecticides, Post-harvest-processing-value addition, Agri-finance institutions, etc.

S. No.	Activities and Tasks during Agro-Industrial Attachment Programme
1	Acquaintance with industry and staff
2	Study of structure, functioning, objective and mandates of the industry
3	Study of various processing units and hands-on trainings under supervision of industry staff
4	Ethics of industry
5	Employment generated by the industry
6	Contribution of the industry promoting environment
7	Learning business network including outlets of the industry Skill development in all crucial tasks of the industry
8	Documentation of the activities and task performed by the students
9	Performance evaluation, appraisal and ranking of students

VIII semester

Modules for Skill Development and Entrepreneurship: A student has to register 20 credits opting for two modules of (0+10) credits each (total 20 credits) from the package of modules in the VIII semester Experiential Learning Programme (ELP).

S. no.	Subject Code	Title of the module	Credits
1	***READY-401**	Production Technology for Bioagents and Biofertilizer	0+10
2	**READY -402**	Seed Production and Technology	0+10
3	**READY -403**	Mushroom Cultivation Technology	0+10
4	**READY -404**	Soil, Plant, Water and Seed Testing	0+10
5	**READY -405**	Commercial Beekeeping	0+10
6	**READY -406**	Poultry Production Technology	0+10
7	**READY -407**	Commercial Horticulture	0+10
8	**READY -408**	Floriculture and Landscaping	0+10
9	**READY -409**	Food Processing	0+10
10	**READY -410**	Agriculture Waste Management	0+10
11	**READY -411**	Organic Production Technology	0+10
12	**READY -412**	Commercial Sericulture	0+10

***READY**= Rural Entrepreneurship Awareness Development Yojana

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

M.Sc. Ag. (Agricultural Economics)

(First to Fourth Semester)

Syllabi Applicable for Admissions in 2019 onwards

MASTER OF SCIENCE IN AGRICULTURE (AGRICULTURAL ECONOMICS)

Objective:

The objective of this course is to train post graduate students in a challenging economic environment and empower them through the study and analysis of advanced quantitative methods and processes. To develop independent logical thinking and facilitate personality development. To equip the students for seeking suitable career in economics and related fields. To train in data analysis for better comprehensive and policy formulation. To develop among student's communication, study and analytical skills.

Duration:

The M.Sc. course will be a two-year (minimum & maximum three years) full-time programme. Each year consist of two semesters. Thus the M.Sc. course is of four semesters. In each semester there will be number of courses as per detail given under curricula.

Eligibility:

Bachelor degree in B. Sc (Agriculture)/(Horticulture)/(Agricultural Marketing & Cooperation)/(Forestry)
Or B. Sc (Hons.) Agriculture/Horticulture/)/(Agricultural Marketing & Cooperation)/(Forestry)

Medium of Instructions & Examination:

English shall be the medium of instruction and examination

Minimum Credit Requirements as per BSMA (ICAR):

The minimum credit requirement for the degree will be as under:

Subject	Credit hours as per BSMA ICAR for Master's programme	Credit hours approved for Master's programme
Major	20	25 (Agricultural Economics)
Minor	09	08
Supporting	05	09
Seminar	01	02
Research	20	20
Total credits	**55**	**64**
Compulsory non-credit courses	**06**	**03**

Minor subject: The subject closely related to student's major subject. Master in Business Administration (MBA) will be the minor subject.

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work. Courses in quantitative methods, operations research and computer science will comprise supporting subjects.

Non-credit courses: Library & information services, technical writing and communication skills and intellectual property management will be the non-credit courses. In these courses the student has to earn satisfactory grade.

Scheme of Examination:

Examinations shall be conducted at the middle and end of each semester as per the Academic calendar notified by the Eternal University. The system of evaluation shall be as follow:

Credits	THEORY			PRACTICAL		
	Total	Mid-session	End Term	Total	Mid-session	End Term
1+0/ 2+0/ 3+0/ 4+0	100	40 (30+10*)	60	-	-	-
0+1	-	-	-	100	50	50
1+1	50	20 (15+5*)	30	50	-	50
2+1	65	25 (20+5*)	40	35	-	35
3+1	75	30 (25+5*)	45	25	-	25

*Assignments marks

Attendance requirement:

The students are required to attend tutorials, seminars etc, arranged by the department from time to time. The minimum percentage of attendance required shall be as per the Eternal University rules.

Research Project Report cum Thesis:

The student admitted for the degree programme shall be allotted to a major guide after the last date of admission in the programme. An advisory committee shall be constituted for the student under the chairmanship of major guide and shall be got approved from the Dean Postgraduate Studies. The student will finalise the topic for her/his research project in consultation with the advisory committee in the beginning of second semester. Under the guidance of advisory committee, detailed synopsis of thesis will be prepared by the student as per laid down guidelines and procedures of the university. After the satisfaction of advisory committee, the student shall deliver a synopsis seminar in the department before the faculty and students. The suggestions made in the seminar will be incorporated and five copies of the final version of synopsis duly signed by the advisory committee, the HOD concerned and Dean of the college shall be submitted to the Dean Postgraduate Studies (PGS) for further approval of the competent authority. The research project completed and submitted in the form of thesis in partial fulfilment of the requirements for the degree will be of 100 marks; 70 marks for written research project cum thesis and 30 for viva-voce. The thesis will be got evaluated from external examiner appointed by Dean PGS. However, the viva-voce will be conducted after incorporating the suggestions made by external examiner by internal committee constituted by the Dean Postgraduate Studies.

Outcome of course programme:

By learning the field of agricultural economics, it is assumed that agricultural economists will achieve and may reliably demonstrate independently the application of theory in decision-making process, an aptitude in mathematics, statistics, the computer programs and an interest in farm management for food production and its distribution. Other specific skills and abilities would be to choose the right career. For example, farm managers and production economists would be able to work with modern technology and know safety regulations. Besides, they will get more opportunities to focus on specific areas, such as public policy, the environment and agri business. From farm manager to private economic consultant, crop manager and financial consultant there will be many career choices available in agricultural economics.

Curricula (Effective from the session 2019-20 onwards)

Semester-I

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours
1.	AG ECON 501	Micro Economic Theory	3	0	0	3	3
2.	AG ECON 502	Macro-Economic Theory	3	0	0	3	3
3.	AG ECON 504	Agricultural Production Economics	1	0	1	2	3
4.	AG ECON 505	Agricultural Marketing	2	0	1	3	4
5.	STAT 501 (Supporting)	Mathematical and Statistical Techniques	2	0	1	3	4
6.	LIB 501 (NC)	Library and Information Services	0	0	1	1	2
7.	ENG 502 (NC)	Technical Writing and Communication Skills	0	0	1	1	2
8.	IPM 503 (NC)	Intellectual Property Management in Agriculture	1	0	0	1	1
	-	Total	12	0	5	17	22

Semester-II

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours
1.	AG ECON 503	Research Methodology for Social Sciences	1	0	1	2	3
2.	AG ECON 506	Natural Resource and Environmental Economics	1	0	1	2	3
3.	AG ECON 507	Econometrics	2	0	1	3	4
4.	MATH 501 (Supporting)	Operations Research	2	0	1	3	4
5.	MBA 565 (Minor)	Project Management and Entrepreneurship Development	3	0	1	4	5
6.	CSE 551 (Supporting)	Computer Applications for Agricultural Economics	2	0	1	3	4
7.	AG ECON 591	Master's Seminar-I	1	0	0	1	1
8.	AG ECON 600	Master Research (Synopsis of thesis writing)	0	0	2	2	4
	-	Total	12	0	8	20	28

Semester - III

Sr.No.	Course Code	Course Title	L	T	P	Credits	Contact Hours
1.	AG ECON 508	Economics of Growth and Development	2	0	0	2	2
2.	AG ECON 509	International Economics	2	0	0	2	2
3.	AG ECON 510	Any **One** of the following options for Paper AG ECON-510: Rural Marketing Commodity Futures Trading (iii) History of Economic Thought (iv) Public Finance (v) Health Economics-I	3	0	0	3	3
4.	MBA 567 (Minor)	Financial Management	3	0	1	4	5
5.	AG ECON 591	Master's Seminar-II	1	0	0	1	1
6.	AG ECON 600	Master Research (Preparation of questionnaire)	0	0	2	2	4
	-	Total	11	0	03	14	17

Semester-IV

Sr.No.	Course Code	Course Title	L	T	P	Credits	Contact Hours
1.	AG ECON 600	Research ollection, analysis & thesis writing)	0	0	16	16	32
	-	Total	0	0	16	16	32

Total Credits including non-credits = SEM I + SEM II + SEM III + SEM IV
17 + 20 + 14 + 16 = 67

M. Sc. Ag. (Agricultural Economics)
Course Content

AG ECON-501
MICRO ECONOMIC THEORY

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42 + 0 End-Semester Exam: 60

Objective: This course is intended to provide an overview of microeconomic theory and its applications. The course starts with the theory of consumer behaviour consisting of consumer's utility maximization problem and demand theory. It intends to provide fundamental concepts and models in the theory of production and costs and sets out to provide a basic understanding of price and / or output determination under different types of market structures including factor markets. This course will also expose the students to the theory of general equilibrium and welfare economics.

Details of course:

Units	Contents	Lectures
I	Theory of Consumer Behaviour - Cardinal Utility Approach - Ordinal Utility Approach – Income effect and substitution effect – Applications of Indifference curve approach - revealed Preference Hypothesis – Consumer surplus -Derivation of Demand curve – Elasticity of demand.	12
II	Theory of Production – Laws of diminishing returns, – Returns to scale and economies of scale – Technical progress – Theory of Costs – Cost curves and their relationships – Law of Supply – Producers' surplus.	9
III	Market Equilibrium - Behavior of Firms in Competitive Markets – effect Competition- Effect of Taxation and Subsidies on market equilibrium - onopoly- Monopolistic - Oligopoly- Theory of Factor Markets.	12
IV	General Equilibrium Theory - Welfare Economics - Pareto Optimality – Social welfare criteria - Social Welfare functions.	9

Suggested Readings

David M Kreps 1990. *A Course in Microeconomic Theory*. Princeton University Press.
Dewitt KK. 2002. *Modern Economic Theory*. Sultan Chand & Co.
Henderson JM & Quandt RE. 2000. *Microeconomic Theory: A Mathematical Approach*. McGraw-Hill.
Koutsoyiannis A. 2003. Modern Microeconomics. The Macmillan Press.
Silberberg E & Suen W. 2001. *The Structure of Economics – A Mathematical Analysis*. McGraw-Hill.
Varian Hal R. 1999. *Intermediate Microeconomics*. Affiliated East-West Press.

AG ECON-502
MACRO ECONOMIC THEORY

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42 + 0 End-Semester Exam: 60

Objective: Macroeconomic theory course is intended to expose the students to macroeconomic concepts and theory, the application of the macro economic theory and implication of the macroeconomic policies.

Details of course:

Units	Contents	Lectures
I	Nature and Scope of Macro Economics - Methodology and Keynesian Concepts National Income - Concepts and measurement- Classical theory of Employment and Say's Law-Modern theory of Employment and Effective Demand.	9
II	Consumption function- Investment and savings - Concept of Multiplier and Accelerator - Output and Employment - Rate of interest - Classical, Neo classical and Keynesian version- Classical theory Vs Keynesian theory – Unemployment and Full employment.	12
III	Money and classical theories of Money and Price - Keynesian theory of money and Friedman Restatement theory of money - Supply of Money - Demand for Money -Inflation: Nature, Effects and control.	9
IV	IS & LM frame work - General Equilibrium of product and money markets - Monetary policy - Fiscal policy- Effectiveness of Monetary and Fiscal policy -Central banking. Business cycles - Balance of Payment - Foreign Exchange Rate determination.	12

Suggested Readings

Ahuja HL. 2007. *Macroeconomics: Theory and Policy*. S. Chand & Co.
Eugene A Diulio 2006. *Macroeconomics*. 4th Ed. Schaums' Outlines.
Gardner Ackely 1987. *Macro Economics: Theory and Policy*. Collier Macmillan.
Dornbusch. 2006. *Macroeconomics*. McGraw Hill Publication

AG ECON-503

RESEARCH METHODOLOGY FOR SOCIAL SCIENCES

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To expose the students to research methodology used in social sciences. The focus will be on providing knowledge related to research process, data collection and data analysis etc.

Details of course:

Units	Contents	Lectures
I	Importance and scope of research in agricultural economics. Types of research - Fundamental vs. Applied. Concept of researchable problem – research prioritization – Objectives of research, selection of research problem, the process of research.	3
II	Hypothesis – meaning - characteristics - types of hypothesis – review of literature– setting of objective and hypotheses of research problem-.	2
III	Project proposals – contents and scope – different types of projects to meet different needs – trade-off between scope and cost of the study. Research design and techniques –Types of research design.	3
IV	Preparation of schedule – problems in measurement of variables in agriculture. Interviewing techniques and field problems - methods of conducting survey – Reconnaissance survey and Pre testing. Data collection – assessment of data needs – sources of data collection – discussion of different situations. Mailed questionnaire and interview schedule –structured, unstructured, open ended and closed-ended questions. Scaling Techniques.	3
V	Coding editing – tabulation – validation of data. Tools of analysis – data processing. Diagrams and graphs, measures of central tendency, measures of variation, skewness and kurtosis; correlation and regression, testing of hypothesis, ANOVA. Interpretation of results – Preparing research report / thesis – Universal procedures for preparation of bibliography – writing of research articles.	3

Practical

Practical	Practical Description	No. of practicals
1.	Exercises in problem identification.	1
2.	Project proposals – contents and scope.	1
3.	Formulation of Objective and hypotheses.	1
4.	Assessment of data needs – sources of data – methods of collection of data.	1
5.	Methods of sampling – criteria to choose – discussion on sampling under different situations.	2
6.	Scaling Techniques –measurement of scales.	1
7.	Preparation of interview schedule - Field testing.	1
8.	Method of conducting survey.	1
9.	Exercise on coding, editing, tabulation and validation of data.	1
10.	Preparing for data entry into computer.	1
11.	Hypothesis testing – Parametric and Non-Parametric Tests.	1
12.	Exercises on format for Thesis / Report writing. Presentation of the results.	2

Suggested Readings

Black TR. 1993. *Evaluating Social Science Research - An Introduction***.** SAGE Publ.

Creswell JW. 1999. *Research Design - Qualitative and Quantitative Approaches.* SAGE Publ.

Dhondyal SP. 1997. *Research Methodology in Social Sciences and Essentials of Thesis Writing*. Amman Publ. House, New Delhi.

Kothari CR. 2004. *Research Methodology - Methods and Techniques***.** Wishwa Prakashan, Chennai.

Rangaswamy R.2018.A Text Book of Agricultural Statistics. New Age International Publishers, New Delhi.

Venkatasubramanian V. 1999. *Introduction to Research Methodology in Agricultural and Biological Sciences*. SAGE Publ.

AG ECON-504
AGRICULTURAL PRODUCTION ECONOMICS

Credits: 1 + 1 Mid-Session Exam: 20 (15+5#)
Contact Hours: 14 + 28 Practical Exam: 50
End-Semester Exam: 30

Objective: To expose the students to the concept, significance and uses of production economics techniques.

Details of course:

Units	Contents	Lectures
I	Nature, scope and significance of agricultural production economics- Methodology of Production function - Centrality of production functions, assumptions of production functions, commonly used forms - Properties, limitations, specification, estimation and interpretation of commonly used production functions.	4
II	Factors of production, classification, interdependence, and factor substitution - Determination of optimal levels of production and factor application -Optimal factor combination and least cost combination of production - Theory of product choice; selection of optimal product combination.	4
III	Cost functions and cost curves, components, and cost minimization -Duality theory – cost and production functions and its applications -Derivation of firm's input demand and output supply functions -Economies and diseconomies of scale.	3
IV	Technology in agricultural production, nature and effects and measurement - Measuring efficiency in agricultural production; technical, allocative and economic efficiencies - Yield gap analysis-concepts-types and measurement - Nature and sources of risk, modeling and coping strategies.	3

Practical

Practical	Practical Description	No. of practicals
1.	Different forms of production functions.	2
2.	Specification, estimation and interpretation of production functions.	1
3.	Returns to scale, factor shares, elasticity of production.	1
4.	Physical optima-economic optima-least cost combination.	1
5.	Optimal product choice.	1
6.	Cost function estimation, interpretation-estimation of yield gap.	2
7.	Incorporation of technology in production functions.	2
8.	Measurement of efficiencies.	2
9.	Measuring returns to scale and risk analysis.	2

Suggested Readings

Beattie BR & Taylor CR. 1985. *The Economics of Production*. John Wiley & Sons.
Doll JP & Frank O. 1978. *Production Economics - Theory and Applications*. John Wiley & Sons.
Gardner BL & Rausser GC. 2001. *Handbook of Agricultural Economics*. Vol. I. *Agricultural Production*. Elsevier.
Heady EO. *Economics of Agricultural Production and Resource Use*. Prentice-Hall.
Sankhyan PL. 1983. *Introduction to Farm Management*. Tata Mc Graw Hill.

AG ECON-505
AGRICULTURAL MARKETING

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (15+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart adequate knowledge and analytical skills in the field of agricultural marketing issues, and enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities.

Details of course:

Units	Contents	Lectures
I	Review of Concepts in Agricultural Marketing - Characteristic of Agricultural product and Production – Problems in Agricultural Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role - Need for regulation in the present context - Marketable & Marketed surplus estimation. Marketing Efficiency - Structure Conduct and Performance analysis - Vertical and Horizontal integration - Integration over space, time and form-Vertical coordination.	6
II	Marketing Co-operatives – APMC Regulated Markets - Direct marketing, Contract farming and Retailing - Supply Chain Management - State trading, Warehousing and other Government agencies -Performance and Strategies – Market infrastructure needs, performance and Government role - Value Chain Finance.	6
III	Role of Information Technology and telecommunication in marketing of agricultural commodities - Market Research-Market information service - electronic auctions (e-bay), e-Chaupals, Agmarket and Domestic and Export market Intelligence Cell (DEMIC) – Market extension.	5
IV	Spatial and temporal price relationship – price forecasting – time series analysis – time series models – spectral analysis. Price policy and economic development – non-price instruments.	5
V	Theory of storage - Introduction to Commodities markets and future trading - Basics of commodity futures - Operation Mechanism of Commodity markets – Price discovery - Hedging and Basis - Fundamental analysis - Technical Analysis -Role of Government in promoting commodity trading and regulatory measures.	6

Practical

Practical	Practical Description	No. of practicals
1.	Supply and demand elasticities in relation to problems in agricultural marketing.	1
2.	Price spread and marketing efficiency analysis.	1
3.	Marketing structure analysis through concentration ratios.	1
4.	Performance analysis of Regulated market and marketing societies.	1
5.	Analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products.	1
6.	Chain Analysis - quantitative estimation of supply chain efficiency.	1
7.	Market Intelligence – Characters, Accessibility, and Availability Price forecasting.	1
8.	Online searches for market information sources and interpretation of market intelligence reports – commodity outlook.	2
9.	Technical Analysis for important agricultural commodities.	2
10.	Fundamental Analysis for important agricultural commodities.	1
11.	Presentation of the survey results and wrap-up discussion, operational mechanism of future markets.	2

Suggested Readings

Purecell WD & Koontz SR. 1999. *Agricultural Futures and Options: Principles and Strategies*. 2nd Ed. Prentice-Hall.

Rhodes VJ. 1978. *The Agricultural Marketing System*. Grid Publ., Ohio.

Shepherd SG & Gene AF. 1982. *Marketing Farm Products*. Iowa State Univ. Press.

Singhal AK. 1986. *Agricultural Marketing in India*. Annual Publ., New Delhi.

STAT 501
MATHEMATICAL AND STATISTICAL TECHNIQUES

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (15+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart adequate knowledge and analytical skills in the field of mathematics and statistical tools and techniques for the development of models and enhance expertise in using such techniques in deriving estimates for the parameters of economic relationship. Use of techniques/methods in reducing fluctuations in the time series data and working out various indices.

Details of course:

Units	Contents	Lectures
I	Differentiation and Optimisation: Partial and total derivatives, Homogenous functions, Euler's rule, Finding the maximum and minimum of a function with two variables: With and without a single equality constraint. Simple economic applications such as elasticity and nature of commodity, consumer's and producer's optimisation problems.	5
II	Integration, Differential Equations, Linear Programming: Indefinite and definite integration of a function with a single variable, method of substitution. Economic applications. *Differential Equations:* Variable separable case, homogenous case, standard linear differential equations, Bernoulli's form, exact equations, linear differential equations with constant coefficients. *Linear Programming:* Setting up of the problem, various definitions, solution by graphical method.	6
III	Statistical methods: Measures of central tendency, dispersion, skewness and kurtosis. Index number analysis, Time Series, Correlation and Regression, Probability: Methods of Trend Measurement: Quadratic, exponential, modified exponential, Gompertz and logistic forms. Measurement of seasonal indices: Simple average, ratio to moving average, ratio to trend. Multiple and partial correlation involving three variables, multiple regression with two explanatory variables, regression coefficients, definitions of r, r^2, R^2. Probability: Classical and axiomatic definitions, additive and multiplicative rules, random variable and expected values, probability distributions: Cases of binomial, Poisson, normal.	10
IV	Sampling and census method: Types of sampling and sampling errors, Statistical Inference and Hypothesis Testing: Parameters and estimates, sampling distribution of a statistic, standard error, and distribution of sample mean properties of an ideal estimator, interval estimation, and confidence interval. Basic terminology of hypothesis testing, large and small sample tests, tests of significance of means, single proportion, difference between two proportions, simple correlation coefficient, regression coefficient, tests Involving F and X^2 distributions.	7

Practical

Practical	Practical Description	No. of practicals
1.	Application of difference and differential equations in the formulation and solving economic problems.	3
2.	Computation of trends and index numbers.	3
3.	Use of correlation and regression techniques both for time series and cross-sectional data.	3
4.	Interpretation of results.	2
5.	Meaning and use of parametric tests.	3

Suggested Readings

- Chiang, A.C. (Latest): *Fundamental Methods of Mathematical Economics*, McGraw Hill
- Yamane, Taro (1972), *Mathematics for Economists*, Prentice Hall, N Delhi.
- Allen, R.G.D. (Latest) : *Mathematical Analysis for Economists*, Macmillan.
- S.P Gupta: *Statistical Methods*, Sultan Chand Publication
- Freund, J. E. (Latest) : *Mathematical Statistics*, Prentice Hall India, 5th Edition.
- Arora, P. N., Sumeet Arora and S. Arora (Latest) : *Comprehensive Statistical Methods*, S. Chand & Company Ltd.
- David Anderson J. Dennis Sweeney: *Statistics for Business and Economics* CenGage Learning.

LIB- 501
LIBRARY AND INFORMATION SERVICES

Credits: 0+ 1 Mid-Session Exam: 50
Contact Hours: 28 End-Semester Exam: 50

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies and to use modern tools (Internet, OPAC, search engines etc) of information search.

Practical

Practical	Practical Description	No. of practicals
1.	Introduction to library and its services.	1
2.	Role of libraries in education, research and technology transfer.	1
3.	Classification systems and organization of library.	2
4.	Sources of information-primary sources, secondary sources and tertiary sources.	2
5.	Intricacies of abstracting and indexing services (science citation index, biological abstracts, chemical abstracts, CABI abstracts, etc.).	2
6.	Tracing information from reference sources.	1
7.	Literature survey; citation techniques/preparation of bibliography.	1
8.	Use of CD-ROM Databases.	1
9.	Online public access catalogue and other computerised library services.	1
10.	Use of internet including search engines and its resources.	1
11.	E-resources access methods.	1

ENG- 502
TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 0+ 1 Mid-Session Exam: 50
Contact Hours: 28 End-Semester Exam: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc.
To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Practical	Practical Description	No. of practicals
1.	Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.	1
2.	Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion).	1
3.	Writing of abstracts, summaries, précis, citations etc.	1
4.	Commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations.	1
5.	Writing of numbers and dates in scientific write-ups.	1
6.	Editing and proof-reading.	1
7.	Writing of a review article.	1
8.	Grammar (Tenses, parts of speech, clauses, punctuation marks).	1
9.	Error analysis (Common errors).	1
10.	Concord; Collocation; Phonetic symbols and transcription.	1
11.	Accentual pattern.	1
12.	Weak forms in connected speech.	1
13.	Participation in group discussion.	1
14.	Facing an interview; presentation of scientific papers.	1

Suggested Readings

Chicago *Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild *English Dictionary*. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
Richard WS. 1969. *Technical Writing*. Barnes & Noble.
Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek.
Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

IPM-503

INTELLECTUAL PROPERTY MANAGEMENT IN AGRICULTURE

Credits: 1+ 0 Mid-Session Exam: 40
Contact Hours: 14+0 End-Semester Exam: 60

Objective: The Course Objective of the course is to create awareness about intellectual property rights in agriculture. The course deals with management of patents, trademark, geographical indications, copy rights, designs, plant variety protection and biodiversity protection. The students will be taught on the marketing and commercialization of intellectual properties.

Details of course:

Units	Contents	Lectures
I	World Trade Organization- Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR) - Importance of Intellectual Property Management - IPR and Economic growth- IPR and Bio diversity -Major areas of concern in Intellectual Property Management -Technology Transfer and commercialization-Forms of different Intellectual Properties generated by agricultural research.	3
II	Discovery *versus* Invention - Patentability of Biological Inventions - Method of Agriculture and Horticulture- procedure for patent protection: Preparatory work. Record keeping, writing a patent document, filing the patent document -Types of patent application-patent application under the Patent cooperation treaty (PCT).	3
III	Plant genetic resources -Importance and conservation - Sui Generic System -Plant Varieties Protection and Farmers Rights Act- Registration of Extant varieties - Registration and protection of New Varieties / Hybrids / Essentially Derived Varieties - Dispute prevention and settlement -Farmers' Rights.	3
IV	Trademark- Geographical Indications of Goods and Commodities – Copy rights- Designs – Biodiversity Protection.	2
V	Procedures for commercialization of technology - Valuation, Costs and Pricing of Technology- Licensing and implementation of Intellectual Properties- Procedures for commercialization – Exclusive and non-exclusive marketing rights-Research Exemption and benefit sharing.	3

Suggested Readings

Ganguli P. 2001. *Intellectual Property Rights –Unleashing the Knowledge Economy*. Tata McGraw Hill.

Gupta AK. 2003. *Rewarding Conservation of Biological and Genetic Resources and Associated Traditional Knowledge and Contemporary Grass Roots Creativity*. Indian Institute of Management, Ahmedabad.

Khan SA & Mashelkar R. 2004. *Intellectual Property and Competitive Strategies in the 21st Century*. Kluwer Law International, The Hague.

AG ECON-506

NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To introduce economics principles related to natural resource and environmental Economics. To explore the concept of efficiency and the efficient allocation of natural Resources. To understand the economics of why environmental problems, occur. To explore the concept of efficiency and the efficient allocation of pollution control and pollution prevention decisions. To understand the environmental policy issues and alternative instruments of environmental policies.

Details of course:

Units	Contents	Lectures
I	Concepts, classification and problems of natural resource economics – Economy-Environment interaction – The material balance principle, Entropy law-Resources scarcity - Limits to growth - Measuring and mitigating natural resource scarcity – Malthusian and Ricardian scarcity – scarcity indices - Resource scarcity and technical Change.	3
II	Theory of optimal extraction renewable resources –economic models of oil extraction- efficiency - time path of prices and extraction - Hotelling's rule, Solow-Harwick's Rule. Theory of optimal extraction exhaustible resources – economic models of forestry and fishery.	2
III	Efficiency and markets – market failures - externalities – types - property rights – transaction costs – Coase's theorem and its critique - public goods – common property and open access resource management - Collective action.	2
IV	Environmental perspectives - biocentrism, sustainability, anthropocentrism - Environmental problems and quality of environment - Sources and types of pollution -air, water, solid waste, land degradation – environmental and economic impacts - Economics of pollution control - efficient reduction in environmental pollution.	2
V	Environmental regulation – economic instruments - pollution charges – Pigovian tax - tradable permits – indirect instruments - environmental legislations in India.	2
VI	Concept of sustainable development - Economic Perspective - Indicators of sustainability Relation between development and environment stress-Environmental Kuznet's curve Environmental Accounting – resource accounting methods - International Environmental Issues – climate change – likely impacts - mitigation efforts and international treaties.	3

Practical

Practical	Practical Description	No. of practicals
1.	Exhaustible resource management –optimum rate of oil extraction.	2
2.	Renewable resource management – optimum harvest of Forestry/fishery.	2
3.	Exercise on pollution abatement –I.	1
4.	Exercise on pollution abatement –II.	1
5.	Concepts in valuing the environment.	1
6.	Taxonomy of valuation techniques.	1
7.	Productivity change method – substitute cost method - Hedonic price method - Travel cost method -Contingent valuation methods.	2

8.	Discount rate in natural resource management.	1
9.	Environment impact assessment	1
10.	Visit to Pollution Control Board.	2

Suggested Readings

Ahmad Y, El Serafy S & Lutz E. (Eds.). 1989. *Environmental Accounting for Sustainable Development*. World Bank.

Freeman AM. 1993. *The Measurement of Environmental and Resource Values*. Resources for the Future Press, Baltimore.

Hackett SC. 2001. *Environmental and Natural Resource Economics: Theory, Policy, and the Sustainable Society*. M. E. Sharpe, Armonk, NY.

Hartwick JM & Olewiler ND. 1998. *The Economics of Natural Resource Use*. 2nd Ed. Addison-Wesley Educational Publ.

Kerr JM, Marothia DK, Katar Singh, Ramasamy C & Bentley WR. 1997. *Natural Resource Economics: Theory and Applications in India.* Oxford & IBH.

Kolstad CD. 2000. Environmental Economics. Oxford Univ. Press.

Pearce DW & Turner K. 1990. *Economics of Natural Resources and the Environment*. John Hopkins Univ. Press.

Prato T. 1998. *Natural Resource and Environmental Economics*. Iowa State Univ. Press.

Sankar U. 2001. Environmental Economics. Oxford Univ. Press.

Sengupta R. 2000. *Ecology and Economy, an Indian Perspective*. Oxford Univ. Press.

Tietenberg T. 2003. *Environmental and Natural Resource Economics*. 6th Ed. Addison Wesley.

AG ECON-507
ECONOMETRICS

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact Hours: 28 + 28 Practical Exam: 35
End-Semester Exam: 40

Objective: The objective of the course is to impart knowledge on econometric tools to the students of agricultural economics. Training in econometrics will help the student to analyze the economic problem by applying quantitative techniques.

Details of course:

Units	Contents	Lectures
I	Introduction – relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics-regression analysis.	6
II	Basic two variable regression - assumptions estimation and interpretation approach to estimation - OLS, MLE and their properties - extensions to multi variable models-multiple regression estimation and interpretation.	6
III	Violation of assumptions – identification, consequences and remedies for Multicollinearity, heteroscedasticity, autocorrelation – data problems and remedial approaches - model misspecification.	6
IV	Use of dummy variables-limited dependent variables – specification, estimation and interpretation.	5
V	Simultaneous equation models – structural equations - reduced form equations - identification and approaches to estimation.	5

Practical

Practical	Practical Description	No. of practicals
1.	Single equation two variable model specification and estimation	2
2.	Hypothesis testing- transformations of functional forms and OLS application	2
3.	Estimation of multiple regression model	1
4.	Hypothesis testing - testing and correcting specification errors	2
5.	Testing and managing Multicollinearity	1
6.	Testing and managing heteroscedasticity	1
7.	Testing and managing autocorrelation	1
8.	Estimation of regressions with dummy variables	1
9.	Estimation of regression with limited dependent variable	1
10.	Identification of equations in simultaneous equation systems.	2

Suggested Readings

Gujarati DN. 2003. *Basic Econometrics*. McGraw Hill.
Johnson AG Jr., Johnson MB & Buse RC. 1990. *Econometrics - Basic and Applied.* MacMillan.
Kelejan HH & Oates WE. 1994. *Introduction to Econometrics Principles and Applications*. Harper and Row Publ.
Koutsoyianis A. 1997. *Theory of Econometrics*. Barner & Noble.
Maddala GS. 1992. *Introduction to Econometrics*. MacMillan.
Maddala GS. 1997. *Econometrics.* McGraw Hill.
Pindyck RS & Rubinfeld DL. 1990. *Econometrics Models and Econometric Forecasts*. McGraw Hill.

MATH 501
OPERATIONS RESEARCH

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact Hours: 28 + 28 Practical Exam: 35
End-Semester Exam: 40

Objective: The objective of the course is to impart knowledge of linear programming techniques and to impart skill for their use in preparation of optimum plans for agriculture development.

Details of course:

Units	Contents	Lectures
I	Decision Making- Concepts of decision making, introduction to quantitative tools, introduction to linear programming, objectives, assumptions and uses of LP in different fields, formulation of linear programming problem, graphic solution to problems, formulation of problems.	6
II	Simplex Method: Concept of simplex Method, solving profit maximization and cost minimizations problems. Formulation of problems in agriculture sector as linear programming models and solutions.	6
III	Extension of Linear Programming models: Variable resource and price programming, transportation problems, recursive programming, dynamic programming.	6
IV	Game Theory- Concepts of game theory, two-person constant sum, zero sum game, saddle point, solution to mixed strategies, the rectangular game as Linear Programme.	5
V	Basic concepts in assignment model, inventory model.	5

Practical

Practical	Practical Description	No. of practicals
1.	Graphical and algebraic formulation of linear programming models.	4
2.	Solving of maximization and minimization problems by simplex method.	5
3.	Formulation of the simplex matrices for typical farm situations, problems related to transportation, game theory and inventory management.	5

Suggested Readings

Dorfman R. 1996. *Linear Programming & Economic Analysis*. McGraw Hill.
Loomba NP.2006. *Linear Programming*. Tata McGraw Hill.
Shenoy G. 1989. *Linear Programming-Principles & Applications*. Wiley Eastern Publ.
Vaserstein. 2006. *Introduction to Linear Programming*. Pearson Education Publication

MBA 565
PROJECT MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT

Credits: 3 + 1 | Mid-Session Exam: 30 (25+5#)
Contact Hours: 42 + 28 | Practical Exam: 25
End-Semester Exam: 45

Objective: The objective of this course is to expose the learner to the fields of project management and entrepreneurship development. Focus will be to train the students to develop new projects and encouraging them to start their own ventures.

Details of course:

Units	Contents	Lectures
I	Concept, characteristics of projects, types of projects, project identification, and Project's life cycle.	8
II	Project feasibility- market feasibility, technical feasibility, financial feasibility, and economic feasibility, social cost-benefit analysis, project risk analysis.	8
III	Network Methods: Meaning, Network Analysis, Requirements for Network Analysis, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT), Project scheduling and resource allocation.	8
IV	Financial appraisal/evaluation techniques- discounted/non-discounted cash flows; Net present values, profitability index, Internal rate of returns; Cost benefits ratio; Accounting rate of return, Payback period, Project implementation; Cost overrun, Project control and information system.	9
V	Entrepreneurship, significance of entrepreneurship in economic development qualities of entrepreneur, entrepreneurship development programs and role of various institutions in developing entrepreneurship, life cycles of new business, environmental factors affecting success of a new business, reasons for the failure and visible problems for business, developing effective business plans, Procedural steps in setting up of an industry.	9

Practical

Practical	Practical Description	No. of practicals
1.	Field visit to successful enterprises-	1
2.	Study of characteristics of successful entrepreneurs.	1
3.	Development of project proposal	1
4.	Case studies of success / failure enterprises	1
5.	Exercise on market survey	1
6.	Field visit to financial institutions	1
7.	Simulated exercise to understand management process	1
8.	Field visit to extension organizations to understand the functions of management	1
9.	Group exercise on development of short term and long-term plan	1
10.	Simulated exercise on techniques of decision making	1
11.	Designing organizational structure	2
12.	Group activity on leadership development skills	2

Suggested Readings

Chandra P. 2005. *Project Management*. Tata McGraw Hill.
Gopal Krishan P & Nagarajan K. 2005. *Project Management*. New Age.
Hisrich RD & Peters MP. 2002. *Entrepreneurship*. Tata McGraw Hill.
Kaplan JM. 2003. *Patterns of Entrepreneurship*. John Wiley & Sons.
Nandan H. 2007. *Fundamentals of Entrepreneurship Management*. Prentice Hall.
Ramamoorthy VE. 2005. *Textbook of Project Management*. MacMillan.

MBA 567
FINANCIAL MANAGEMENT

Credits: 3 + 1
Contact Hours: 42 + 28

Mid-Session Exam: 30 (25+5#)
Practical Exam: 25
End-Semester Exam: 45

Objective: The course aims to make students proficient in concepts and techniques of financial management. Focus will be on developing understanding of the application of Financial and investment decisions. Contents

Details of course:

Units	Contents	Lectures
I	Introduction to Financial Management, Its meaning and functions, Interface of financial management with other functional areas of a business. Financial Statements and Analysis - Proforma Balance Sheet and Income Statements, ratio, time series, common size and Du-Pont analysis.	7
II	Capital Structure, Determinants of size and composition of Capital Structure, Capital Structure Theories; Long term financing and Cost of Capital.	7
III	Working Capital Management, Determinants of Size and Composition of Working Capital, Cash and receivables management, Working Capital Management Theories, Financing of Working Capital.	7
IV	Financial planning and Forecasting, Financial planning for mergers & acquisition, Capital Budgeting, Undiscounted and Discounted cash flow methods of Investment Appraisal; Hybrid finance and lease finance.	7
V	Business Financing System in India, Money and Capital Markets, Regional and All - India Financial Institutions; venture capital financing and its stages, micro finance and International financial management.	7
VI	Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Network Techniques – PERT and CPM.	7

Practical

Practical	Practical Description	No. of practicals
1.	Demand and supply of institutional credit and Over dues-: An overview	1
2.	Rural Lending Programmes of Commercial Banks	1
3.	Preparation of District Credit Plan	1
4.	Co-operative credit	1
5.	Preparation of financial statements using farm level data	1
6.	Farm credit appraisal techniques and farm financial analysis	1
7.	Performance of Micro Financing Institutions	1
8.	Identification and formulation of investment projects	1
9.	Project appraisal techniques	2
10.	Financial Risk and risk management strategies	2
11.	Crop insurance schemes	2

Suggested Readings

Chandra P. 2000. *Financial Management*. Tata McGraw Hill.

Khan MY & Jain PK. 2004. *Financial Management*: Text, Problems and Cases. Tata McGraw Hill.

Pandey IM. 1997. *Financial Management*. Vikas Publ.

Ramachandran N & Kakani RK. 2005. *Financial Accounting for Management*. Tata McGraw Hill.

Van Horne JC. 1997. *Financial Management and Policy*. Prentice Hall.

CSE 551
COMPUTER APPLICATIONS FOR AGRICULTURAL ECONOMICS

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact Hours: 28 + 28 Practical Exam: 35
End-Semester Exam: 40

Objective: The basic objective of this subject is to provide knowledge about computer application in agricultural economics.

Details of course:

Units	Contents	Lectures
I	Information: Information concepts and processing; Evaluation of information processing techniques; Data; Information language and Communication Computer Organization: Central Processing Unit; Storage Devices: Primary and secondary storage devices; Input–Output devices; Generations of computer systems and growth of personal computers. Memory buffers: input /output buffers; Graphic interfacing; I/O Processors and multi-user environment	6
II	Overview: Languages; Compilers; Interpreters; Assemblers; OOPS; SQL; Java (an introduction) Use of MS-Office: Basics of MS-Word, MS-Excel and MS-PowerPoint; SPSS, Application of these software's for documentation and making reports; preparation of questionnaires, presentations, tables and reports (Practical)	6
III	Introduction to Operating Systems: Concept of an operating system; Operating system as resource manager and coordinator of devices and jobs; Elements of Window operating systems; Use of menus, tools and commands of window 2010/2015 operating systems Computer Networking: Single and multi-user; Multi-task computer systems; File maintenance; Concept of computer network: functions and scope of LAN, WAN Network; Internet; E-mail	6
IV	Internet and its uses: Architecture and functioning of Internet; World-wide web and its structure; Role of internet service providers; Website development related to different specialisations of economics; Searching and downloading from internet and uploading of websites in some cases; Updating of some simple websites	5
V	Microsoft Access & Spreadsheet: Concept of database creation and modification of database files; Expressions and functions Application: Information Technology (IT) applied to various functional areas of agricultural economics, such as Production / Operations, Marketing, Human Resource, Finance and Material inputs Management	5

Practical

Practical	Practical Description	No. of practicals
1.	Conversion of different number types	1
2.	creation of flow chart	1
3.	conversion of algorithm/flow chart to program	1
4.	mathematical operators	1
5.	operator precedence; sequence, control and iteration	1
6.	arrays and string processing; pointers and file processing	1
7.	Network and mail configuration; using network services	2
8.	browsing of internet	2
9.	creation of web pages	1
10.	creation of websites using HTML and creation of websites using DHTML	3

Suggested Readings

Awad, Elias M.; *Electronic Commerce: From Vision to Fulfilment.* (2007). Electronic Commerce, (New Delhi: Pearson Education).
Basandra S K- .2003. *Computers Today* (Gal gotia).
Cyganski- *Information Technology: Inside and Outside* (Pearson)
Kolkata, Ravi and Marcia Robinson . 2001. *Business 2.0: Roadmap for Success*.
Leaon, Alexis & Mathews: *Information Technology* (Vikas)
Leon A and Leon M-.1999. *Introduction to Computers* (Leon Tech world..
Loudon, Kenneth C. and Carol Guercio Traver: *E-commerce: business, technology, society*. ., (New Delhi : Pearson Education).
Lucas Jr H C- *Information technology for management* (Tata McGraw- Hill), 6th ed,
P.R. and Dave Chaffey. 2005. E -*Marketing E-Excellence; The Heart of e- Business*, Smith, (UK: Elsevier Ltd.)
S.Saxena 2003. *A first course in computers.* Vikas, publications.

AG ECON 591 MASTER'S SEMINAR-I 1+0+0

This course covers contemporary issues with respect to related field of research undertaken by the student. The students are asked to prepare PPTs on the contemporary issues which they have to present in front of the faculty and students. The presentation of the students will be evaluated by the three faculty members.

AG ECON 600 MASTER RESEARCH (Synopsis of thesis) 0+0+2

Here the student has to follow the steps in choosing her research problem under the guidance of advisory committee. The research project proposal is prepared in view of the literature available and the research gaps. The synopsis is designed as per the research methodology techniques in the subject and guidelines of the university. PPTs are made and synopsis seminar will be delivered by the student.

AG ECON-508

Economics of Growth and Development

Credits: 2+ 0 Mid-Session Exam: 40
Contact Hours: 28+0 End-Semester Exam: 60

Objective: To provide orientation to the students regarding the concepts and measures of economic development. To provide orientation on theories of economic growth and relevance of theories in developing countries. To make them to understand the agricultural policies and its effect on sustainable agricultural development. To make them to understand the globalization and its impact on agricultural development.

Details of course:

Units	Contents	Lectures
I	Development Economics – Scope and Importance - Economic development and economic growth - divergence in concept and approach - Indicators and Measurement of Economic Development – GNP as a measure of economic growth – New Measures of Welfare – NEW and MEW – PQLI – HDI – Green GNP - Criteria for under development – Obstacles to economic development – Economic and Non-Economic factors of economic growth.	7
II	Economic development – meaning, stages of economic development, determinants of economic growth. Theories of economic growth – Ricardian growth model –The Harrod – Domar Model – The Neo- classical Model of Growth – The Kaldor Model – Optimal Economic Growth – Recent experiences of developing country economies in transition – Role of state in economic development – Government measures to promote economic development. Introduction to development planning.	7
III	Role of agriculture in economic / rural development – theories of agricultural development –Population and food supply - need for sound agricultural policies – resource policies – credit policies – input and product marketing policies – price policies.	7
IV	Development issues, poverty, inequality, unemployment and environmental degradation – Models of Agricultural Development – Induced Innovation Model - policy options for sustainable agricultural development.	7

Suggested Readings

Chakaravathi RM. 1986. *Under Development and Choices in Agriculture*. Heritage Publ., New Delhi.

Diwett KK. 2002. *Modern Economic Theory***.** S. Chand & Co.

Eicher KC & Staatz JM. 1998. *International Agricultural Development*. Johns Hopkins Univ. Press.

Frank E. 1992. *Agricultural Polices in Developing Countries*. Cambridge Univ.Press.

Ghatak S & Ingersent K. 1984. *Agriculture and Economic Development*. Select Book Service Syndicate, New Delhi.

Jhingan ML. 1998. *The Economics of Development and Planning*. Vrinda Publ.

Jules PN. 1995. *Regenerating Agriculture – Polices and Practice for Sustainability and Self Reliance*. Vikas Publ. House.

Naqvi SNH. 2002. *Development Economics – Nature and Significance*. Sage Publ.

AG ECON-509

INTERNATIONAL ECONOMICS

Credits: 2+ 0 Mid-Session Exam: 40
Contact Hours: 28+0 End-Semester Exam: 60

Objective: The expected outcome of this course will be creating awareness among the students about the role of International Economics on National welfare.

Details of course:

Units	Contents	Lectures
I	Scope and Significance of International Economics - The role of trade- General Equilibrium in a Closed Economy (Autarky Equilibrium) – Equilibrium in a Simple Open Economy - Possibility of World Trade - Trade gains and Trade Equilibrium.	7
II	Tariff, Producer Subsidy, Export Subsidy, Import Quota and Export Voluntary Restraints- The Case of Small Country and Large Country Case.	7
III	Ricardian Model of Trade- Specific Factors Model- Heckscher - Ohlin Model - Trade Creation and Trade Diversion – Offer Curve - Export Supply Elasticity and Import Demand Elasticity – comparative Advantage and Absolute Advantage.	7
IV	Official Exchange Rate and Shadow Exchange Rate - Walras Law and Terms of Trade – Trade Blocks. IMF, World Bank, IDA, IFC, ADB – International Trade agreements – Uruguay Round – GATT – WTO.	7

Suggested Readings

Apple Yard DR & Field AJ Jr. 1995. *International Economics - Trade, Theory and Policy*. Irwin, Chicago.

Cherunilam F. 1998. *International Economics*. Tata McGraw Hill.

Krugman PR & Obstfeld M. 2000. *International Economics – Theory and Policy*. Addison-Wesley.

AG ECON-510
RURAL MARKETING (Option i)

Credits: 3+ 0 Mid-Session Exam: 40
Contact Hours: 42+0 End-Semester Exam: 60

Objective: To provide understanding regarding issues in rural markets like marketing environment, consumer behaviour, distribution channels, marketing strategies, etc.

Details of course:

Units	Contents	Lectures
I	Concept and scope of rural marketing, nature, type and characteristics of rural markets, potential of rural markets in India.	8
II	Scio-cultural, economic and institutional factors affecting rural marketing, factors affecting producers' surplus.	8
III	Rural consumer's behaviour - behaviour of rural consumers and farmers; buyer characteristics and buying behaviour; Rural v/s urban markets.	8
IV	Rural marketing strategy - Marketing of consumer durable and non-durable goods and services in the rural markets with special reference to product planning; product mix, pricing Course Objective, pricing policy and pricing strategy.	10
V	Product promotion - Media planning, planning of distribution channels, and organizing personal selling in rural market in India.	8

Suggested Readings

Krishnamacharyulu CSG & Ramakrishan L. 2002. *Rural Marketing.* Pearson Edu. Ramaswamy VS & Nanakumari S. 2006. *Marketing Management.* 3rd Ed. MacMillan.
Singh AK & Pandey S. 2005. *Rural Marketing*. New Age.
Singh Sukhpal. 2004. *Rural Marketing*. Vikas Publ. House.

AG ECON-510
COMMODITY FUTURES TRADING (Option ii)

Credits: 3+ 0 Mid-Session Exam: 40
Contact Hours: 42+0 End-Semester Exam: 60

Objective: This course is aimed at providing the basic understanding and the mechanics and value of futures markets for speculators and hedgers who in turn will serve as price risk management activities of agribusiness firms.

Details of course:

Units	Contents	Lectures
I	History and Evolution of commodity markets – Terms and concepts: spot, forward and futures Markets – factors influencing spot and future markets. Speculatory mechanism in commodity futures.	8
II	Transaction and settlement – delivery mechanism - role of different agents - trading strategies - potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets.	8
III	Risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features.	8
IV	Important Indian commodity exchanges - contracts traded – special features - Regulation of Indian commodity exchanges - FMC and its role.	8
V	Fundamental V/S Technical analysis – construction and interpretation of charts and chart patterns for analyzing the market trend – Market indicators – back testing. Introduction to technical analysis software – analyzing trading pattern of different commodity groups.	10

Suggested Readings

Kaufman PJ. 1986. *The Concise Handbook of Futures Markets*. John Wiley & Sons.
Leuthold RM, Junkus JC & Cordier JE. 1989. *The Theory and Practice of Futures Markets***.** Lexington Books.
Lofton T. 1993. *Getting Started in Futures*. 3rd Ed. John Wiley & Sons.
Purcell WD. 1991. *Agricultural Futures and Options: Principles and Strategies*. Macmillan Publ.
Wasendorf RR & McCafferty 1993. *All about Commodities from the Inside Out*. McGraw-Hill.

AG ECON-510
HISTORY OF ECONOMIC THOUGHT (Option iii)

Credits: 3+ 0 Mid-Session Exam: 40
Contact Hours: 42+0 End-Semester Exam: 60

Objective: The study of economic thought helps the students to understand the origin of economics and how the economic ideas have been instrumental in shaping the economic and political policies of different countries. The study of the subject helps to avoid the mistakes committed by earlier economic thinkers.

Details of course:

Units	Contents	Lectures
I	Mercantilism: Main Principles. Theory of economic development; Views of Keynes, Petty, Hume and Cantillon on Mercantilism: physiocracy: Natural Order, Agriculture and Product net, Social classes. Tableau Economique.	8
II	The Classical Period: Economic Thought of Adam Smith, David Ricardo, and J. S. Mill with special reference to their views on value, distribution international trade and economic development; Malthus theory of population; Says law of market. Ricardo Malthus controversy on Say's law of market.	10
III	Socialistic Economic Thought: Socialist critique of classical economic thought with special references to the views of Saint Simon, Sismondi and Proudhan. The Historical critics of Classicism, Karl Marx method of Economic analysis. Marx of economic crises. Transformation Problem.	8
IV	The Neo-Classical Period: Similarity and differences between classical and neo-classical thought; The Marginal Revolution with special reference to the contribution of the Austrian School, Leon Walras, Jevons.	8
V	Post Marshalling Development in Economic Theory: Contribution of Joan Robinson, E. H. Chamberlin; J. M. Keynes and Post Keynesian developments in economic theory	8

Suggested Readings

- Dasgupta, A.K. (Latest): *Epochs of Economic Theory*, Oxford University Press, New Delhi.
- Brien, D.P.O: *The Classical Economists*, London, Oxford University Press, Latest.
- Eric Roll (Latest): *History of Economic Thought*, Faber and Faber (Rupa).
- Gide, C. and Rist C. (Latest): *A History of Economic Doctrines*, George G. Harp & Co.
- Blaug, M. (Latest): *Economic Theory in Retrospect*, Vikas Publishing House.
- Schumpter, J.A. (Latest): *History of Economic Thought*, Oxford University Press.
- Tom Bottomore. 1985. *Dictionary of Marxist Thought*, Basic Black Well.

AG ECON-510

PUBLIC FINANCE (Option iv)

Credits: 3+ 0 Mid-Session Exam: 40
Contact Hours: 42+0 End-Semester Exam: 60

Objective: To introduce students to the public sector reform agenda with a focus on public finance issues; - to demonstrate administrative, political, and economic constraints to public finance reforms; - to develop analytical skills of the students in three major areas of public finance reforms (performance-based budgeting, mid-term financial planning, budget decentralization); - to train students how to develop budgeting and performance evaluation systems for public sector institutions; - to develop students' skills on how to write a public policy paper and make a presentation on public policy issues.

Details of course:

Units	Contents	Lectures
I	Scope of Public Finance: Meaning & scope of public finance. Private and Public Goods: Role of Government in economic activity; allocation, distribution& stabilisation functions. Efficient Provision of Public Goods in a Partial and General Equilibrium Approach. Role of Budget with Special Reference to the Goal of Distribution. Performance and programming budgeting. Classification of budgets.	10
II	Meaning and Type of Taxes: Requirements of a good tax structure. Approaches to taxation: micro analysis of direct and indirect taxes; individual income tax, corporation income tax, sales tax including value-added tax and expenditure tax. Incidence analysis in a partial and general equilibrium setting. Excess burden, Effects of taxation on work efforts, Savings and investment.	8
III	Growth and Structure of Public Expenditure: Effects on savings, investment & growth. Wagner's law and Peacock-Wiseman Hypothesis. Pattern of public expenditure in India and recent reforms in India.	8
IV	Fiscal Policy- Neutral & compensatory & functional finance; balanced budget multiplier Deficit Finance; Issues Relating to Public Debt: Debt Burden Analysis and Management of Public Debt; Recent Policy in India.	8
V	Union- state financial relations: Horizontal & vertical imbalances; the finance commission. Fiscal federalism- theory & problem; problem of centre state financial relations in India.	8

Suggested Readings

- Brown, C. V. and Jackson, P. M. 1990. *Public Sector Economics*, 4th edition, Basil Blackwell, Oxford.
- Musgrave, R. A. & Musgrave, P. B. 1973. *Public Finance in Theory and Practice*, International Edi., McGraw Hill.
- Houghton, R. W. (ed.) 1970. *Public Finance*, Harmondsworth Penguin Books.
- Peacock, and Straw, G. K. 1970. *The Economic Theory of Fiscal Policy*, George Allen & Unwin, London.
- S.K Singh: *Public Finance Theory & Practices*. S. Chand Publication
- Raghabendra Jha.1999. *Modern Public Economics*, Routledge.
- Misra & Puri (Latest Edi.) *Indian Economy*, Himalaya Publication
- Dutt.& Sundram: (Latest Edi.) *Indian Economy*, S. Chand Publication

AG ECON-510

HEALTH ECONOMICS - I (Option v)

Credits: 3+ 0 Mid-Session Exam: 40
Contact Hours: 42+0 End-Semester Exam: 60

Objective: To make understandable issues related to efficiency, effectiveness, value and behaviour in the production and consumption of *health* and *healthcare*. In broad terms, here the students are taught about the functioning of *healthcare* systems and *health*-affecting behaviours. The tools and techniques through which health related issues can be studied are also make understood through empirical data.

Details of course:

Units	Contents	Lectures
I	Relevance of Economics in Health and Medical care. Overview of health economics; concepts, definition and scope of health economics. Difference between health, health care and medical care, Basic concepts used in health economics, Measures of health status, economic development, health services and health.	12
II	Micro - economic tools for health economics: The law of demand, Price elasticity of demand, the law of supply, equilibrium, the theory of firm behaviour, imperfect competition, specification and measurement of economic variables and their relationship, health status indicators.	9
III	Health care: India's Potential. Stakeholders of healthcare industry, Measurement of medical care, changes in health status, demand for medical care, and India's share of world's health problems. Determinants of demand for health care, progress of health care supply in India.	12
IV	Public policy on health and health care. Challenges in rural health care, public and private expenditure in health care, policy reforms in health care sector, steps in building a high-class health care facility.	9

Selected Readings

- James W. Henderson. 2005. *Health Economics and Policy*; Thomson-South-Western, (Indian edition by Akash Press, New Delhi).
- Banerjee, D. 1975. *Social and Cultural Foundations of Health Service Systems of India*, Inquiry, Supplement to Vol. XII, June.
- Banerjee, D. 1982. *Poverty, class and Health Culture in India*, Vol. I Parachi Prakashan, New Delhi.
- Gandhian Institute for rural and Family Planning 1972. *Studies on Mortality in India*, Monograph Series No. 5.
- Madan, T. N.1980. *Doctors and Society –Three Asian Case Studies*, Vikas Publishing House, Delhi.
- Naik, J. P. 1977. *An alternative System of Health Care services in India – Some Proposals*, ICSSR, Delhi
- Feldstein, M. S. 1977. *Economic analysis of Health Service Efficiency*, North Holland, Amsterdam. Jimenez E. 1987. *Pricing Policy in the Social Sectors*, The Johns Hopkins University.
- Philip Jacobs. 1997. *The Economics of Health & Medical Care*, Anas pen publication

AG ECON 591 MASTER'S SEMINAR- II **1+0+0**

This course covers contemporary issues in Economics. The students are asked to prepare PPTs on the contemporary issues of Economics which they have to present in front of the faculty and students. The presentation of the students will be evaluated by the three faculty members.

AG ECON 600 MASTER RESEARCH (Preparation of questionnaire) **0+0+2**

Here, the major advisor shall sign the registration cards for registering the work to be accomplished (Preparation of questionnaire) under this course.

AG ECON 600 MASTER RESEARCH (Data collection, analysis & thesis writing) **0+0+16**

Here, the major advisor shall sign the registration cards for registering the work to be accomplished (Analysis of data & thesis writing) under this course.

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

M.Sc. Ag. (Agricultural Extension)

(First to Fourth Semester)

Syllabi Applicable for Admissions in 2022 onwards

Dr. Khem Singh Gill Akal College of Agriculture

PROGRAMME STRUCTURE

M. Sc. Ag. (Agricultural Extension)

Minor Field : Agri. Business Management and Agricultural Economics

Minimum Credit Requirements

Subject	**Minimum Credit Requirements as per BSMA, ICAR Guidelines**	**Proposed Credit Requirements to be Followed**
Major	20	20
Minor	09	11
Supporting	05	06
Seminar	01	01
Masters' Research	20	20
Compulsory non credit course	06	06
Total Credits	**61**	**64**

M.Sc. Ag. (Agricultural Extension)

- Major Courses (Total Credit: 20)
- Minor Courses (Total Credit : 11)
- Supporting Courses (Total Credit : 6)
- Research (Total Credit: 20)
- Seminar (Total Credit: 1)
- Compulsory non-credit course: 6

S. No.	Course name	Course title	Credit hours	Semester
Semester I				
Major				
1	EXT 501	Development Perspectives of Extension Education	1+1	I
2	EXT 502	Development Communication and Information Management	2+1	I
3	EXT 503	Diffusion and Adoption of Innovations	2+1	I
Minor				
1	AG ECON 505	Agricultural Marketing	2+1	I
Compulsory Non Creditable Courses				
1	PGS 501	Library Information Services	0+1	I
2	PGS 502	Technical Writing and Communication Skills	0+1	I
Total		**8+3+2**	**13**	
SEMESTER II				
Major				
1	EXT 504	Research Methods in Behavioral Sciences	2+1	II
2	EXT 505	E-Extension	2+1	II
3	EXT 599	Master's Research	0+2	II
Minor				
1	MBA 565	Project Management and Entrepreneurship Development	3+1	II
Supporting course				
1	STAT 501	Mathematical and Statistical Techniques	2+1	II
Compulsory Non Creditable Courses				
1	PGS 503	Intellectual Property and Its Management in Agriculture	1+0	II
2	PGS 504	Basic Concept in Laboratory Techniques	0+1	II
Total		**8+4+3+2**	**17**	
SEMESTER III				
Major				
1	EXT 506	Entrepreneurship Development and Management in Extension	2+1	III
2	EXT 507	Human Resource Development	2+1	III
3	EXT 591	Master's Seminar	1+0	III
4	EXT 599	Master's Research	0+3	III
Minor				
1	MBA 567	Financial Management	3+1	III
Supporting course				
1	CSE 551	Computer Applications for Agricultural Extension Education	2+1	III
Compulsory Non Creditable Courses				
1	PGS 505	Agriculture Research Ethics and Rural Development Programmes	1+0	III
2	PGS 506	Disaster Management	1+0	III
Total credits		**10+4+3+2**	**19**	

SEMESTER IV				
1	EXT 599	Master's Research	0+15	IV
Total credits			**15**	

SCHEME OF EXAMINATION
(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	**THEORY**			**PRACTICALS**		
T+P	**Total**	**Mid- Session**	**End Term**	**Total**	**Mid- Session**	**End Term**
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50	-	50
3+2	60	25 (20+5#)	35	40	-	40
0+3	0	0	0	100	50	50

#Assignments marks

M.Sc. Ag. (Agricultural Extension)

Course Contents

EXT 501

DEVELOPMENT PERSPECTIVES OF EXTENSION EDUCATION

Credit: 1+1
Contact Hours: 14+28

Mid-session exam: 20(15+5#)
Practical Exam: 50
End-semester exam: 30

Objective: The course is intended to orient the students with the concept of extension education and its importance in Agriculture development and also to expose the students with various rural development programmes aimed at poverty alleviation and to increase employment opportunities and their analysis. Besides, the students will be learning about the new innovations being brought into the Agricultural Extension in India.

Theory

Units	Contents	Lectures
I	Extension Education – Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions – Extension Education as a Profession – Adult Education and Distance Education.	4
II	Pioneering Extension efforts and their implications in Indian Agricultural Extension – Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University.	4
III	Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes –NREGP,Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development.	3
IV	Current Approaches in Extension: Decentralised Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farmer Field School, ATIC, Kisan Call Centres, NAIP.	3

Practical

1.	Visit to Gram Panchayat to study on-going Rural Development Programmes.	3
2.	Visit to KVK	3
3.	NGOs, State Agricultural University and its Research and Extension Centres/Stations and State Departments.	3
4.	Bottom up planning in Agricultural Extension	3
5.	Report preparation and presentations.	2

Suggested Readings

Chandrakandan KM, Senthil Kumar & Swatilaxmi. PS**.** 2005. *Extension Education What? And What Not ?* RBSA Publ.

Gallagher K. 1999. *Farmers Field School (FFS) – A Group Extension Process based on Non-Formal Education Methods*. Global EPM Facility, FAO.

Ganesan R, Iqbal IM & Anandaraja N. 2003. *Reaching the Unreached: Basics of Extension Education*. Associated Publishing Co.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension*. Concept Publ.

Khan PM. 2002. *Textbook of Extension Education*. Himalaya Publ.

Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ. Van Den Ban AW & Hawkins HS. 1998. *Agricultural Extension* .2nd Ed. CBS.

Viswanathan M. 1994. *Women in Agriculture and Rural Development*. Printwell Publ.

EXT 502

DEVELOPMENT COMMUNICATION AND INFORMATION MANAGEMENT

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: In this course, students will learn about the concept, meaning and process of communication and various methods andmodern media of communication. Besides, the students will also learn the information management and journalistic writing of various information materials and also study their readability.

Theory

Units	Contents	Lectures
I	Communication process – concept, elements and their characteristics – Models and theories of communication – Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication – Barriers in communication, Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.	4
II	Methods of communication – Meaning and functions, classification. Forms of communication – Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication. Key communicators – Meaning, characteristics and their role in development.	4
III	Media in communication – Role of mass media in dissemination of farm technology, Effect of media mix for Rural People. Modern communication media – Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications.	3
IV	Agricultural Journalism as a means of mass communication, Its form and role in rural development, Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders. Techniques of collection of materials for news stories and feature articles; Rewriting Art of clear writing, Readability and comprehension testing procedures; photo journalism, communicating with pictures, Radio and TV Journalism, Techniques of writing scripts for Radio and TV.	3

Practical

1.	Message Distortion	1
2.	Identification of Key Communicators.	1
3.	Preparation of News story, farm bulletins, folders etc.	3
4.	Designing and layout of charts, posters, flash cards etc.	2
5.	Power point presentations.	2
6.	Generating computer aided presentation graphics.	2
7.	Techniques of writing scripts for Radio and TV.	2
8.	Scanning and evaluation of visuals.	1

Suggested Readings

Dahama OP & Bhatnagar OP. 2005. *Education and Communication for Development.* Oxford & IBH.

Grover I, Kaushik S, Yadav L & Varma SK. 2002. *Communication and Instructional Technology*. Agrotech Publ. Academy.

Jana BL & Mitra KP. 2005. *Farm Journalism*. Agrotech Publ. Academy. Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ. Rayudu CS.2002. *Communication*. Himalaya Publ. House.

Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.

Sandhu AS. 2004. *Textbook on Agricultural Communication Process and Methods*. Oxford & IBH.

EXT 503

DIFFUSION AND ADOPTION OF INNOVATIONS

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: The students will learn how the agricultural innovations spread among the farmers in the society by getting into the insights of diffusion concept and adoption process, stages of adoption and innovation decision process, adopter categories and their characteristics, opinion leaders and their characteristics, attributes of innovations, and factors influencing adoption. In addition, the students would be learning various concepts related to diffusion and adoption of innovations.

Theory

Units	Contents	Lectures
I	Diffusion – concept and meaning, elements; traditions of research on diffusion; the generation of innovations; innovation-development process; tracing the innovation-development process, converting research into practice.	4
II	The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process – a critical appraisal of the new formulation.	4
III	Adopter categories – Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption.	3
IV	Diffusion effect and concept of over adoption, opinion leadership- measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations; Types of innovation-decisions – Optional, Collective and Authority and contingent innovation decisions; Consequences of Innovation-Decisions – Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making – meaning, theories, process, steps, factors influencing decision – making.	3

Practical

1.	Case studies in individual and community adoption process, content analysis of adoption studies.	2
2.	Identification of adopter categories on a selected technology.	2
3.	Study of attributes of current farm technologies.	2
4.	Identification of opinion leaders.	2
5.	Sources of information at different stages of adoption on a selected technology.	3
6.	Study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.	3

Suggested Readings

Dasgupta. 1989. *Diffusion Agricultural Innovations in Village India*. Wiley Eastern.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension.* Concept Publ. Co.

Ray GL. 2005. *Extension Communication and Management*. Kalyani Publ.

Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla. Rogers EM. 2003. Diffusion of Innovations. 5th Ed. The Free Press, New York.

EXT 504

RESEARCH METHODS IN BEHAVIOURAL SCIENCE

Credits: 2+1
Contact hours: 28+28

Mid-sessional exam: 25(20+5#)
Practical exam: 35
End-semester exam: 40

Objective: This course is designed with a view to provide knowledge and skills in methods of behavioural sciences research and student will learn the Statistical Package for Social Sciences (SPSS) for choosing appropriate statistics for data analysis.

Theory

Units	Contents	Lectures
I	Research – Meaning, importance, characteristics. Behavioural sciences research – Meaning, concept and problems in behavioural sciences research. Types and methods of Research – Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study. Review of literature – Need, Search Procedure, Sources of literature, Planning the review work. Research problem – Selection and Formulation of research problem and guiding principles in the choice of research problem, Factors and criteria in selection of research problem, statement of research problem and development of theoretical orientation of the research problem.	4
II	Objectives – Meaning, types and criteria for judging the objectives. Concept and Construct – Meaning, role of concepts in research and Conceptual frame work development in research. Variable – Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, types and their role in research. Hypothesis – Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis. Measurement – Meaning, postulates and levels of measurement, Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research. Validity – Meaning and methods of testing. Reliability – Meaning and methods of testing. Sampling – Universe, Sample and Sampling-Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors – Methods of elimination and minimizing, Maximincon Principle, Sampling – Types of sampling and sampling procedures.	4
III	Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of each design. Experimental design – Advantages and limitations. Data Collection devices - Interview – Meaning, purpose, types, techniques of interviewing and advantages and limitations. Enquiry forms and Schedules – Meaning, types of questions used, steps in construction and advantages and limitations in its use. Questionnaires – Meaning, difference between schedule and questionnaire, types of questions to be used, pre – testing of the questionnaires or schedules and advantages and limitations. Check lists – Meaning, steps in construction, advantages and limitations in its use. Rating scales – Meaning, types, limits in construction, advantages and limitations in its use.	3

	Observation – Meaning, types, tips in observation, advantages and limitations in its use. Case studies – Meaning, types, steps in conducting, advantages and limitations in its use. Social survey – Meaning, objectives, types and steps in conducting, advantages and limitations.	
IV	Data processing – Meaning, coding, preparation of master code sheet, analysis and tabulation of data, Statistical Package for Social Sciences (SPSS) choosing appropriate statistics for data analysis based on the level of measurement of variables. Report writing – Meaning, guidelines to be followed in scientific report writing, References in reporting.	3

Practical

1.	Selection and formulation of research problem.	1
2.	Formulation of objectives and hypothesis	1
3.	Selection of variables based on objectives	1
4.	Developing the conceptual framework of research	1
5.	Operationally defining the selected variables	1
6.	Development of data collection devices.	1
7.	Testing the validity and reliability of the data collection instruments.	1
8.	Pre-testing of the data collection instrument	1
9.	Techniques of interviewing and collection of data using the data collection instruments	1
10.	Data processing, hands on experiences on SPSS, coding, tabulation and analysis	2
11.	Formulation of secondary tables based on objectives of research.	1
12.	Writing report	1
13.	Writing of thesis and research articles-Presentation of reports.	1

Suggested Readings

Chandrakandan K, Venkatapirabu J, Sekar V & Anand Kumar V. 2000. *Tests and Measurements in Social Research*. APH Publ.

Kerlinger FN. 1973. *Foundations of Behavioural Research*. Holt Rhinehart. Kothari CR.1984. *Research Methodology, Methods and Techniques*. Chaitanya Publ. House.

Krishnaswami OR & Ranganatham M. 2005. *Methodology of Research in Social Sciences*. Himalaya Publ. House.

Mulay S & Sabaratnam VE.1983. *Research Methods in Extension Education*. Manasavan.

Ranjit Kumar. 1999. *Research Methodology - A Step by Step Guide for Beginners*. Sage Publ.

Ray GL & Sagar Mondal. 1999. *Research methods in Social Sciences and Extension Education*. Naya Prokash.

Wilkinson TS & Bhandarkar PC.1993. *Methodology and Techniques of Social Research*. Himalaya Publ.Home.

EXT 505

E- EXTENSION

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: Students will gain knowledge and skills in understanding the concepts of Information and communication technologies and how these ICT tools can be used for Agricultural Extension. Besides, he studies various ICT projects which are successful in delivering the services to the clientele fulfilling the objective of Transfer of Technology i.e. Reaching the unreached.

Theory

Units	Contents	Lectures
I	ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities.	4
II	ICTs projects, case studies in India and developing world. Different approaches (models) to ICTs. ICT use in field of extension- Expert systems on selected crops and enterprises; Self learning CDs on package of practices, diseases and pest management, Agricultural web sites and portals related crop production and marketing etc.	4
III	Community Radio, Web, Tele, and Video conferencing. Computer Aided Extension. Knowledge management, Information kiosks, Multimedia. Online, Offline Extension. Tools-Mobile technologies, e-learning concepts.	3
IV	ICT Extension approaches-pre-requisites, information and science needs of farming community. Need integration. Human resource information. Intermediaries. E-chaupal. Kisan Call Centre. Basic e-extension training issues. ICT enabled extension pluralism. Emerging issues in ICT.	3

Practical

1.	Agri. content analysis of ICT Projects.	2
2.	Handling of ICT tools.	2
3.	Designing extension content.	3
4.	Online extension service.	2
5.	Project work on ICT enabled extension.	2
6.	Creation of extension blogs.	2
7.	Visit to ICT extension projects.	2

Suggested Readings

Batnakar S & Schware R. 2000. *Information and Communication Technology in Development-Cases from India*. Sage Publ.

Meera SN. 2008. *ICTs in Agricultural Extension: Tactical to Practical*. Ganga-Kaveri Publ. House. JangamWadiMath, Varanasi.

Willem Zip. 1994. *Improving the Transfer and Use of Agricultural Information - A Guide to Information Technology*. The World Bank, Washington.

EXT 506

ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT IN EXTENSION

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: The first part of the course is intended to provide overall picture of planning and development of enterprises for extending sustainable livelihoods for rural people. The second part of the course is structured to help the students to gain knowledge and skills in different concepts and techniques of management in extension organizations.

Theory

Units	Contents	Lectures
I	Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development. Agri – entrepreneurship – Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs – Risk taking, Leadership, Decision making, Planning, Organising, Coordinating and Marketing, Types of Entrepreneurs. Stages of establishing enterprise – Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects.	4
II	Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC industries. Micro financing – meaning, Sources of Finance, Banks, Small scale industries development organizations. Marketing for enterprises – Concept, planning for marketing, target marketing, Competition, market survey and strategies, Product sales and promotion. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Success and Failure stories for enterprises – Issues relating to success and failure of enterprises – Personal, Production, Finance, Social, Marketing.	4
III	Management–Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Making planning effective. Change Management – factors, process and procedures. Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions. Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations.	3
IV	Coordination – Concept, Need, Types, Techniques of Coordination. Interpersonal relations in the organization. Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods. Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles. Organizational Communication – Concept, Process, Types, Net Works, Barriers to Communication. Managing work motivation – Concept,	3

	Motivation and Performance, Approaches to motivation. Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision. Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.	

Practical

1.	Field visit to Successful enterprises.	1
2.	Study of Characteristics of Successful entrepreneurs.	1
3.	Development of Project Proposal.	2
4.	Case Studies of Success / Failure enterprises.	1
5.	Exercise on Market Survey.	1
6.	Field visit to Financial institutions.	1
7.	Simulated exercise to understand management process.	1
8.	Field visit to extension organizations to understand the functions of management.	2
9.	Group exercise on development of short term and long term plan.	1
10.	Simulated exercise on techniques of decision making.	1
11.	Designing organizational structure.	1
12.	Group activity on leadership development skills.	1

Suggested Readings

Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand & Sons.
Indu Grover. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public Academy.
Khanka SS. 1999. *Entrepreneurial Development*. S. Chand & Co. Singh D. 1995. *Effective Managerial Leadership*. Deep & Deep Publ.
Tripathi PC & Reddy PN. 1991. *Principles of Management*. Tata McGraw Hill. Vasanta Desai. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.

EXT 507

HUMAN RESOURCE DEVELOPMENT (HRD)

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: To orient the students about key concepts importance, scope & conceptual frame work, growth & development of Human Resource Development, Subsystems of Human Resource Development for extension organization and process of HRD.

Theory

Units	Contents	Lectures
I	Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions – Different Experiences; Selection, Development & Growth- Selection, Recruitment, Induction Staff Training and Development, Career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure, society in transition; Organizational and Managerial values and ethics, organizational commitment ; Motivation productivity - job description – analysis and evaluation; Performance Appraisal. Professional Manager; Managerial skills and Soft Stills required for Extension workers; Decision Making: Decision Making models, Management by Objectives; Behavioural Dynamics: Leadership styles – Group dynamics.	5
II	Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): What is HRA? Why HRA? Information Management for HRA and Measurement in HRA; Intra personal processes: Collective behaviour, learning, and perception ; Stress and coping mechanisms; Inter-Personal Process, Helping Process – communication and Feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning, Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counseling and Mentoring; Role of a Professional Manager: Task of Professional Manager – Responsibility of Professional Manager; Managerial skills and Soft Stills required for Extension workers; Decision Making: Decision Making models, Management by Objectives; Behavioural Dynamics :Leadership styles – Group dynamics.	5
III	Training – Meaning, determining training need and development strategies – Training types, models, methods and evaluation; Facilities for training – Trainers training – techniques for trainees participation; Research studies in training extension personnel; Main issues in HRD: HRD culture and climate – organizing for HRD – emerging trends and Prospective.	4

Practical

1.	Visit to different training organizations to review on going activities & facilities.	2
2.	Analysis of Training methods followed by training institutions for farmers and extension workers.	3
3.	Studies on evaluation of training programmes.	3
4.	Study of HRD in organization in terms of performance, organizational development, employees welfare and improving quality of work life and Human resource information.	4
5.	Presentation of reports.	2

Suggested Readings

Agochiya D. 2002. *Every Trainer's Handbook.* Sage Publ.

David Gross. 1997. *Human Resource Management - The Basics*. TR Publ.

Davis Keth & Newston W John 1989. Human Behaviour at Work. 8th Ed. McGraw-Hill.

Hersey Paul & Balanchard H Kenneth. 1992. *Management of Organizational Behaviour Utilizing Human Resource*. 5th Ed. Prentice-Hall of India.

Knoontz Harold & Weihhrich Heinz 1990. *Essentials of Management*. 5th Ed. McGraw-Hill.

Lynton RP & Pareek U. 1993. *Training for Development*. DB. Taraporewale Sons & Co.

Punna Rao P & Sudarshan Reddy M. 2001. *Human Resource Development Mechanisms for Extension Organization*. Kalyani Publ.

Rao TV. 2003. *Readings in Human Resource Development*. Oxford Publ. Co.

Silberman Mel. 1995. *Active Training*. Press Johnston Publ. Co., New Delhi. Singh RP. 2000. *Management of Training Programmes*. Anmol Publ.

Subba Rao P. 2005. *Management & Organizational Behaviour*. Himalaya Publ. House.

Sundaram RM, Gupta V, George SS. 2006. *Case Studies in Human Resource Management*. ICFAI, Hyderabad.

Tripati & Reddy. 2004. *Principles of Management*. Tata McGraw-Hill. Wayne MR & RobertMN. 2005. *Human Resource Management*. International Ed. Pearson Prentice Hall.

Minor Courses

AG ECON-505

AGRICULTURAL MARKETING

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: To impart adequate knowledge and analytical skills in the field of agricultural marketing issues, and enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities.

Details of course:

Units	Contents	Lectures
I	Review of Concepts in Agricultural Marketing - Characteristic of Agricultural product and Production – Problems in Agricultural Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role - Need for regulation in the present context - Marketable & Marketed surplus estimation. Marketing Efficiency - Structure Conduct and Performance analysis - Vertical and Horizontal integration - Integration over space, time and form-Vertical coordination.	6
II	Marketing Co-operatives – APMC Regulated Markets - Direct marketing, Contract farming and Retailing - Supply Chain Management - State trading, Warehousing and other Government agencies -Performance and Strategies – Market infrastructure needs, performance and Government role - Value Chain Finance.	6
III	Role of Information Technology and telecommunication in marketing of agricultural commodities - Market Research-Market information service - electronic auctions (e-bay), e-Chaupals, Agmarket and Domestic and Export market Intelligence Cell (DEMIC) – Market extension.	5
IV	Spatial and temporal price relationship – price forecasting – time series analysis – time series models – spectral analysis. Price policy and economic development – non-price instruments.	5
V	Theory of storage - Introduction to Commodities markets and future trading - Basics of commodity futures - Operation Mechanism of Commodity markets – Price discovery - Hedging and Basis - Fundamental analysis - Technical Analysis -Role of Government in promoting commodity trading and regulatory measures.	6

Practical

Practical	Practical Description	No. of practicals
1.	Supply and demand elasticities in relation to problems in agricultural marketing.	1
2.	Price spread and marketing efficiency analysis.	1
3.	Marketing structure analysis through concentration ratios.	1
4.	Performance analysis of Regulated market and marketing societies.	1
5.	Analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products.	1
6.	Chain Analysis - quantitative estimation of supply chain efficiency.	1
7.	Market Intelligence – Characters, Accessibility, and Availability Price forecasting.	1
8.	Online searches for market information sources and interpretation of market intelligence reports – commodity outlook.	2
9.	Technical Analysis for important agricultural commodities.	2
10.	Fundamental Analysis for important agricultural commodities.	1
11.	Presentation of the survey results and wrap-up discussion, operational mechanism of future markets.	2

Suggested Readings

Purecell WD & Koontz SR. 1999. *Agricultural Futures and Options: Principles and Strategies*. 2nd Ed. Prentice-Hall.
Rhodes VJ. 1978. *The Agricultural Marketing System*. Grid Publ., Ohio.
Shepherd SG & Gene AF. 1982. *Marketing Farm Products*. Iowa State Univ. Press.
Singhal AK. 1986. *Agricultural Marketing in India*. Annual Publ., New Delhi.

MBA 565

PROJECT MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT

Credits: 3+1 Mid-sessional exam: 30 (25+5#)
Contact hours: 42+28 Practical Exam: 25
End-semester exam: 45

Objective: The objective of this course is to expose the learner to the fields of project management and entrepreneurship development. Focus will be to train the students to develop new projects and encouraging them to start their own ventures.

Theory

Units	Contents	Lectures
I	Concept, characteristics of projects, types of projects, project identification, and Project's life cycle.	8
II	Project feasibility- market feasibility, technical feasibility, financial feasibility, and economic feasibility, social cost-benefit analysis, project risk analysis.	8
III	Network Methods: Meaning, Network Analysis, Requirements for Network Analysis, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT), Project scheduling and resource allocation.	8
IV	Financial appraisal/evaluation techniques- discounted/non-discounted cash flows; Net present values, profitability index, Internal rate of returns; Cost benefits ratio; Accounting rate of return, Payback period, Project implementation; Cost overrun, Project control and information system.	8
V	Entrepreneurship, Significance of entrepreneurship in economic development qualities of entrepreneur, entrepreneurship development programs and role of various institutions in developing entrepreneurship, life cycles of new business, environmental factors affecting success of a new business, reasons for the failure and visible problems for business, Developing effective business plans, Procedural steps in setting up of an industry.	10

Practical

1.	Field visit to successful enterprises-study of characteristics of successful entrepreneurs	2
2.	Development of project proposal-case studies of success/failure enterprises	2
3.	Exercise on market survey	2
4.	Field visit to financial institutions	2
5.	Simulated exercise to understand management process	1
6.	Field visit to extension organizations to understand the functions of management	1
7.	Group exercise on development of short term and long term plan	1
8.	Simulated exercise on techniques of decision making	1
9.	Designing organizational structure	1
10.	Group activity on leadership development skills	1

Suggested Readings

Chandra P. 2005. *Project Management*. Tata McGraw Hill.
Gopal Krishan P & Nagarajan K. 2005. *Project Management*. New Age. Hisrich RD & Peters MP. 2002. *Entrepreneurship*. Tata McGraw Hill. Kaplan JM. 2003. *Patterns of Entrepreneurship*. John Wiley & Sons.
Nandan H. 2007. *Fundamentals of Entrepreneurship Management*. Prentice Hall. Ramamoorthy VE. 2005. *Textbook of Project Management*. MacMillan.

MBA 567

FINANCIAL MANAGEMENT

Credits: 3+1 Mid-sessional exam: 30(25+5#)
Contact hours: 42+28 Practical exam: 25
End-semester exam: 45

Objective: The course aims to make students proficient in concepts and techniques of financial management. Focus will be on developing understanding of the application of Financial and investment decisions.

Theory

Units	Contents	Lectures
I	Introduction to Financial Management**,** Its meaning and functions, Interface of financial management with other functional areas of a business. Financial Statements and Analysis - Performa Balance Sheet and Income Statements, ratio, time series, common size and Du-Pont analysis.	7
II	Capital Structure, Determinants of size and composition of Capital Structure, Capital Structure Theories; Long term financing and Cost of Capital.	7
III	Working Capital Management, Determinants of Size and Composition of Working Capital, Cash and receivables management, Working Capital Management Theories, Financing of Working Capital.	7
IV	Financial planning and Forecasting, Financial planning for mergers & acquisition, Capital Budgeting**,** Undiscounted and Discounted cash flow methods of Investment Appraisal; Hybrid finance and lease finance.	7
V	Business Financing System in India, Money and Capital Markets, Regional and All - India Financial Institutions; venture capital financing and its stages, micro finance and International financial management.	7
VI	Project approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project appraisal techniques-Undiscounted measures. Time value of money-Use of discounted measures-B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Network Techniques-PERT and CPM.	7

Practical

1.	Demand and supply of institutional credit and over dues: an overview	2
2.	Rural lending programmes of commercial banks	2
3.	Preparation of district credit plan	2
4.	Co-operative credit	2
5.	Preparation of financial statements using farm level data	1
6.	Farm credit appraisal techniques and farm financial analysis	1
7.	Performance of micro financing institutions	1
8.	Identification and formulation of investment projects	1
9.	Project appraisal techniques	1
10.	Financial risks and risk management strategies-crop insurance schemes	1

Suggested Readings

Chandra P. 2000. *Financial Management*. Tata McGraw Hill.
Khan MY & Jain PK. 2004. *Financial Management: Text, Problems and Cases*. Tata McGraw Hill.
Pandey IM. 1997. *Financial Management*. Vikas Publ.
Ramachandran N & Kakani RK. 2005. *Financial Accounting forManagement*. Tata McGraw Hill.
Van Horne JC. 1997. *Financial Management and Policy*. Prentice Hall.

Compulsory Non Creditable Courses

PGS 501

LIBRARY INFORMATION SERVICES

Credits: 0+1 Mid-sessional Practical: 50
Contact Hours: 0+28 End-semester Practical: 50

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical	**Practical Description**	
1.	Introduction to library and its services; Role of libraries in education, research and technology transfer;	1
2.	Classification systems and organization of library;	3
3.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources;	1
4.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);	2
5.	Tracing information from reference sources;	1
6.	Literature survey; Citation techniques/Preparation of bibliography;	1
7.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services;	2
8.	Use of Internet including search engines and its resources; e-resources access methods	3
Practical	**Practical Description**	
1.	Introduction to library and its services; Role of libraries in education, research and technology transfer.	4
2.	Classification systems and organization of library.	3
3.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources.	3
4.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.).	4
5.	Tracing information from reference sources.	3
6.	Literature survey; Citation techniques/Preparation of bibliography.	3
7.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services.	4
8.	Use of Internet including search engines and its resources; e-resources access methods.	4

S. No. Reference Books

1. Singh, Ajay Pratap, 2013. Information Communication and Society. New Delhi: EssEss Publishers.

2. Kumar Krishan, 2013. Reference Service. 5th Rev ed. New Delhi: Vikas.
3. Dhiman, Anil Kumar, 2005. Information and Reference Sources and Service. New Delhi: EssEss.
4. Ranganathan, S.R.1989. Reference Service. 2nd Rev. ed. Banglore: Sharda Endowment for Library Science.
5. Mukjerjee, A.K. 1971. Reference Work and its Tools. 2nd ed. Calcutta: World Press.
6. Sinha, Pradeep K. 2007. Computer Fundamentals. 4th ed. Delhi: BPB Publications.

PGS 502

TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 0+1 Mid-sessional Practical: 50
Contact Hours: 0+28 End-semester Practical: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical	Practical Description	
1.	Technical Writing- Various forms of scientific writings- thesis, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface,.	3
2.	Technical Writing- Introduction, review of literature, material and methods, experimental results and discussion);	2
3.	Technical Writing- Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions;	3
4.	Technical Writing- pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups;	3
5.	Technical Writing- Editing and proof-reading; Writing of a review article.	2
6.	Communication Skills -Grammar (Tenses, parts of speech, clauses, punctuation marks);	3
7.	Communication Skills -Error analysis (Common errors);	2
8.	Communication Skills -Concord; Collocation; Phonetic symbols and transcription;	3
9.	Communication Skills -Accentual pattern: Weak forms in connected speech:	2
10.	Communication Skills -Participation in group discussion: Facing an interview;	3
11.	Communication Skills -presentation of scientific papers.	2

S. No. Reference Books

1. *Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.*
2. *Collins' Cobuild English Dictionary. 1995. Harper Collins.*
3. *Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.*
4. *Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.*
5. *James HS. 1994. Handbook for Technical Writing. NTC Business Books.*
6. *Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.*
7. *Mohan K. 2005. Speaking English Effectively. MacMillan India.*
8. *Richard WS. 1969. Technical Writing. Barnes & Noble.*
9. *Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek. Sethi J &*
10 *Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.*
11. *Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.*

PGS 503

INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Units	Contents	Lectures
I	Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement;	3
II	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection	4
III	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity	4
IV	International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	3

S. No. Reference Books

1. *Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.*
2. *Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.*
3. *Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.*
4. *Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.*
5. *Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.*
6. *Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.*
7. *The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;*
8. *Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.*

PGS 504

BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credits: 0+1 Mid-session Practical: 50
Contact hours: 0+28 End-semester Practical: 50

Objective: To acquaint the students on the basics of commonly used techniques in laboratory.

Practical	**Practical Description**	
1.	Safety measures while in Lab; Handling of chemical substances;	2
2.	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;	2
3.	Washing, drying and sterilization of glassware;	2
4.	Drying of solvents/chemicals.	2
5.	Weighing and preparation of solutions of different strengths and their dilution;	2
6.	Handling techniques of solutions;	1
7.	Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids;	2
8.	Neutralisation of acid and bases;	1
9.	Preparation of buffers of different strengths and pH values.	2
10.	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;	2
11.	Electric wiring and earthing.	2
12.	Preparation of media and methods of sterilization;	2
13.	Seed viability testing,	2
14.	testing of pollen viability;	2
15.	Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	2

S. No. Reference Books

1. *Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.*

2. *Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.*

PGS 505

AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMME

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

Units	Contents	Lectures
I	History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International	3
II	Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	3
III	Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. Concept and connotations of rural development, rural development policies and strategies.	4
IV	Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.	4

S. No.	Reference Books
1.	Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
2.	Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
3.	Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
4.	Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

PGS 506

DISASTER MANAGEMENT

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Units	Contents	Lectures
I	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion	4
II	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents	3
III	Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media.	4
IV	Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.	3

S. No. Reference Books

1. Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
2. Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
3. Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

Supporting Courses

STAT 501

MATHEMATICAL AND STATISTICAL TECHNIQUES

Credits: 2+1
Contact hours: 28+28

Mid-sessional exam: 25(20+5#)
Practical exam: 35
End-semester exam: 40

Objective: To impart adequate knowledge and analytical skills in the field of mathematics and statistical tools and techniques for the development of models and enhance expertise in using such techniques in deriving estimates for the parameters of economic relationship. Use of techniques/methods in reducing fluctuations in the time series data and working out various indices.

Theory

Units	Contents	Lectures
I	Differentiation and Optimisation: Partial and total derivatives, Homogenous functions, Euler's rule, finding of maximum and minimum of a function with two variables: With and without a single equality constraint. Simple economic application such as elasticity and nature of commodity, consumer's and producer's optimisation problems	7
II	Integration, Differential equations, linear programming: Indefinite and definite integration of a function with a single variable, method of substitution. Economic applications. Differential equations: Variable separable case, homogeneous case, standard linear differential equations, Bernoulli's form, exact equations, linear differential equations with constant coefficients. Linear programming: Setting up of the problem, various definitions, solution by graphical method	7
III	Statistical methods: Measures of central tendency, dispersion, skewness and kurtosis. Index number analysis, time series, correlation and regression, probability: Methods of trend measurement: Quadratic, exponential, modified exponential, Gompertz and logistic forms. Measurement of seasonal indices: Simple average, ratio of moving average, ratio of trend. Multiple and partial correlation involving three variables, multiple regression with two explanatory variables, regression coefficients, definitions of r, r^2, R^2. Probability: classical and axiomatic definitions, additive and multiplicative rules, random variable and expected values, probability distributions: cases of binomial, Poisson, normal.	7
IV	Sampling and census method: Types of sampling and sampling errors, statistical inference and hypothesis testing: Parameters and estimates, sampling distribution of a statistic, standard error and distribution of sample mean properties of an ideal estimator, interval estimation and confidence interval. Basic terminology of hypothesis testing, large and small sample tests, tests of significance of means, single proportion, difference between two proportions, simple correlation coefficient, regression coefficient, tests involving F and X^2 distributions.	7

Practical

1.	Application of difference and differential equations in the formulation and solving economic problems.	2
2.	Computation of trends and index numbers.	3
3.	Use of correlation and regression techniques both for time series and cross-sectional data.	3
4.	Interpretation of results.	3
5.	Meaning and use of parametric tests.	3

Suggested Readings

Chiang, A.C. (Latest): *Fundamental Methods* of *Mathematical Economics,* McGraw Hill
Yamane, Taro (1972), *Mathematical for Economists,* Prentice Hall, N Delhi.
Allen, RGD. (Latest) : *Mathematical Analysis for Economists,* Macmillan.
S.P Gupta: *Statistical Methods,* Sultan Chand Publication
Freund, J.E. (Latest): *Mathematical Statistics,* Prentice Hall India, 5th Edition.
Arora, P.N., Sumeet Arora and S. Arora (Latest) : *Comprehensive Statistical Methods,* S. Chand & Company Ltd.

CSE 551

COMPUTER APPLICATIONS FOR AGRICULTURAL EXTENSION EDUCATION

Credits: 2+1
Contact hours: 28+28

Mid-sessional exam: 25(20+5#)
Practical exam: 35
End-semester exam: 40

Objective: The basic objective of this subject is to provide knowledge about computer application in agricultural economics.

Theory

Units	Contents	Lectures
I	Information: Information concepts and processing; Evaluation of information processing techniques; Data; Information language and communication computer organization: Central processing unit; Storage devices: Primary and secondary storage devices; Input-Output devices; Generations of computer system and growth of personal computers. Memory buffers: Input/Output buffers; Graphic interfaces; I/O processors and multi-user environment.	6
II	Overview: Languages; Compilers; Interpreters; Assemblers; OOPS; SQL; Java (an introduction). Use of MS-Office: Basics of MS-Word, MS-Excel and MS-Power Point; SPSS, application of software's for documentations and making reports; Preparation of questionnaires, presentation, tables and reports (practical).	6
III	Introduction to operating system: Concept of an operating system; Operating system as resource manager and co-ordinator of devices and jobs; Elements of window operating system; Use of menus, tools and commands of window 2010/2015 operating systems. Computer networking: Single and multi-user; Multi-task computer systems; File maintenance; Concept of computer network: Functions and scope of LAN, WAN network; Internet; Email.	6
IV	Internet and its uses: Architecture and functioning of internet; World-wide web and its structure; Role of internet service providers; Website development related to different specializations of economics; Searching and downloading from internet and uploading of websites in some cases; Updating of some simple websites	5
V	Microsoft accesses and spread sheet: Concept of data base creation and modification of data base files; Expressions and functions. Application: Information technology (IT) applied to various functional areas of agricultural economic such as production/operations, marketing, human resource, finance and material inputs management	5

Practical

1.	Conversion of different number types	2
2.	Creation of flow chart	2
3.	Conversion of algorithm/flow chart to programme	1
4.	Mathematical operators	1
5.	Operator precedence	1
6.	Sequence, control and iteration	1
7.	Arrays and string processing; pointers and file processing.	1
8.	Network and mail configuration; using network services	1

9.	Browsing of internet	1
10.	Creation of web pages	1
11.	Creation of websites using HTML and creation of websites using DHTML	2

Suggested Readings

Awad, Elias M.; *Electronic Commerce: Vision to Fulfilment.* (2007). Electronic Commerce, (New Delhi: Pearson Education).

Basandra S K- .2003. *Computers Today* (Gal gotia).

Cyganski- *Information Technology: Inside and Outside* (Pearson)

Kolkata, Ravi and Marcia Robinson. 2001. *Business 2.0: Roadmap for Success.*

Leaon. Alexis & Mathews: *Information Technology* (Vikas)

Leon A and Leon M-.1999. *Introduction to Computers* (Leon Tech world..

Loudon, Kenneth C. and Carol Guercio Traver: *E-commerce: business, technology, society.* ., (New Delhi ; Pearson Education).

Lucas Jr HC- *Information technology for management* (Tata McGraw-Hill), 6th ed,

P.R. and Dave Chaffey. 2005. E-*Marketing E-Excellence; The Heart of e-Business,* Smith, (UK: Elsevier Ltd.)

S.Saxena 2003. *A first course in computers.* Vikas publications.

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR
HIMACHAL PRADESH

Study Scheme & Syllabus

For

M. Sc. Ag. (Agronomy)
(First to Fourth Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

Programme Structure

M. Sc. Ag. (Agronomy)

1.Minor Field: Soil Science, Plant Pathology

2.Supporting Field: Statistics (Mandatory Course) + One course other than Minor field

3.Minimum credits load for award of degree: 62

4.Credit load distribution:

Major Field: 21

Minor Field:09

Supporting:05

Master's Seminar: 01

Master's Research:20

Compulsory non credit course:06

Total :62

M.Sc. Ag. (Agronomy)
Semester wise Syllabus Scheme

S. No.	Course Code	Course title	Credit	Semester
Semester I				
Major Courses				
1	AGRON 501	Modern Concepts in Crop Production	3+0	I
2	AGRON 503	Principles and Practices of Weed Management	2+1	I
3	AGRON 513	Principles and Practices of Organic Farming	2+1	I
Minor Courses				
1	SOILS 504	Soil Mineralogy, Genesis, Classification and Soil Survey	2+1	I
Compulsory Non Creditable Courses				
1	PGS 501	Library and Information Services	0+1	I
2	PGS 502	Technical Writing and Communication Skills	0+1	I
Total		**3+3+3+3+2**	**14**	
SEMESTER II				
Major Courses				
1	AGRON 502	Principles and Practices of Soil Fertility and Nutrient Management	2+1	II
2	AGRON 508	Agronomy of Medicinal, Aromatic and Under-Utilized Crops	2+1	II
3	AGRON 599	Master's Research	0+2	II
Minor Courses				
1	PL PATH 506	Principles of Plant Disease Management	2+1	II
Supporting Course				
1	STAT 512	Experimental Designs	2+1	II
Compulsory Non Creditable Courses				
1	PGS 503	Intellectual Property and Its Management in Agriculture	1+0	II
2	PGS 504	Basic Concepts in Laboratory Techniques	0+1	II
Total		**8+3+3+2**	**16**	
SEMESTER III				
Major Courses				
1	AGRON 504	Principles and Practices of Water Management	2+1	III
2	AGRON 506	Agronomy of Cereals and Pulses	2+1	III
3	AGRON 591	Master's Seminar	1+0	III
4	AGRON 599	Master's Research	0+3	
Minor Courses				
1	SOIL 513	Management of Problem Soils and Waters	2+1	III
Supporting course				
1	SPG 503	Remote Sensing and Geographical Information System	1+1	III
Compulsory Non Creditable Courses				
1	PGS 505	Agriculture Research Ethics and Rural Development Programmes	1+0	III
2	PGS 506	Disaster Management	1+0	III
Total credits		**10+3+2+2**	**17**	
SEMESTER IV				
1	AGRON 599	Master's Research	0+15	IV
Total credits			**15**	

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

M.Sc. Ag. (Agronomy)

Course Contents

AGRON 501 MODERN CONCEPTS IN CROP PRODUCTION

Credits: 3 + 0 Mid-Session Exam: 40
Contact hours: 42+0 End-Semester Exam: 60

Objective: To teach the basic concepts of soil management and crop production.

Theory

Units	Content	Lecture
I	Crop growth analysis in relation to environment; Agro-ecological zones of India.	6
II	Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.	8
III	Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.	10
IV	Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.	8
V	Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture	10

Suggested Readings:

Balasubramaniyan, P. &Palaniappan, S.P. 2001. Principles and Practices of Agronomy. Agrobios (India), Jodhpur, India.
Fageria, N.K. 1992. Maximizing Crop Yields. Marcel Dekker Inc., New York.
Havlin, J.L., Beaton, J.D., Tisdale, S.L. & Nelson, W.L. 2006. Soil Fertility and Fertilizers. 7 th Ed., Pearson/Prentice Hall, Upper Saddle River, New Jersey.
Paroda, R.S. 2003. Sustaining our Food Security, Konark Publishers Pvt. Ltd., A-149, Main Vikas Marg, New Delhi.
Reddy, S.R. 2000. Principles of Crop Production. Kalyani Publishers, New Delhi.
Sankaran, S. &Mudaliar, T.V.S. 1997. Principles of Agronomy. The Bangalore Printing & Publishers, Bangalore.
Singh, S.S. 2006. Principles and Practices of Agronomy. Kalyani Publishers, New Delhi.
Yellamanda Reddy, T. &SankaraReddi,G.H. 2002.Principles ofAgronomy, KalyaniPublishers, New Delhi.

AGRON-502 PRINCIPLES AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart knowledge of fertilizers and manures as sources of plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil fertility.

Theory

Units	Content	Lecture
I	Soil fertility and productivity- factors affecting; Features of a good soil management; Problems of supply and factors affecting availability of nutrients; Relation between nutrient supply and crop growth; Organic farming – basic concepts and definitions	7
II	Criteria of essentiality of nutrients; Essential plant nutrients- their functions and deficiency symptoms; Transformation and dynamics of major plant nutrients in the soil.	6
III	Preparation and use of farmyard manure, compost, green manure, vermicompost, biofertilizers and other organic concentrates, their composition, availability and crop responses; Recycling of organic wastes and residue management.	5
IV	Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency. Fertilizer mixers and grades; agronomic, chemical and physiological methods of estimating and techniques of increasing fertilizer use efficiency; nutrient interactions.	5
V	Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermicompost and residue wastes in crops.	5

Practical

Units	Content	
1	Determination of soil pH, ECe, organic C, total N, available N, P, K and S in soils	5
2	Determination of total N, P, K and S in plants	5
3	Interpretation of interaction effects and computation of economic and yield optima	4

*****Assignment marks

Suggested Readings

Brady NC and Weil RR 2002. The Nature and Properties of soils. 13th Ed. Pearson Edu.

Fageria NK, Baliger VC and Jones CA 1991. Growth and mineral nutrition of Field Crops. Marcel Dekker. Havlin JL, Beaton JD, Tisdale SL and Nelson WL. 2006. Soil Fertility and Fertilizers. 7th Ed. Prentice Hall. Mengel, K and Kirkby EA. Principles of Plant Nutrition. Kluver Academic Publishers.

Prasad R and Power JF 1997. Soil Fertility Management for Sustainable Agriculture. CRC Press. Yawalkar KS, Agarwal JP and Bokde S. 2000. Manures and Fertilizers. Agri-Horti Publ.

AGRON-503 PRINCIPLES AND PRACTICES OF WEED MANAGEMENT

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To familiarize the students about the weeds, herbicides and methods of weed control.

Theory

Units	Content	Lecture
I	Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices.	6
II	Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.	6
III	Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio-herbicides, myco-herbicides and allelochemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation	6
IV	Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control.	6
V	Integrated weed management; cost: benefit analysis of weed management.	4

Practical:

Units	Content	2
1	Identification of important weeds of different crops	2
2	Preparation of a weed herbarium	2
3	Weed survey in crops and cropping systems	1
4	Crop-weed competition studies	1
5	Preparation of spray solutions of herbicides for high and low-volume sprayers	1
6	Use of various types of spray pumps and nozzles and calculation of swath width	1
7	Economics of weed control	1
8	Herbicide resistance analysis in plant and soil	1
9	Bioassay of herbicide resistance	1
10	Calculation of herbicidal requirement	1

*****Assignment marks

Suggested Readings :

Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.

Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley Inter-Science. Gupta OP. 2007. *Weed Management – Principles and Practices.* Agrobios.

Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ. Rao VS. 2000. *Principles of Weed Science*. Oxford & IBH.

Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani.

Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic. Press

AGRON 504 PRINCIPLES AND PRACTICES OF WATER MANAGEMENT

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam : 40

Objective: To teach the principles of water management and practices to enhance the water productivity.

Theory:

Units	Content	Lecture
I	Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.	6
II	Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition.	6
III	Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; microirrigation system; fertigation; management of water in controlled environments and polyhouses.	6
IV	Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency.	6
V	Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.	4

Practical:

S.No.	Topic	
1	Measurement of soil water potential by using tensiometer, and pressure plate and membrane apparatus	2
2	Soil-moisture characteristics curves	2
3	Water flow measurements using different devices	2
4	Determination of irrigation requirements	2
5	Calculation of irrigation efficiency	2
6	Determination of infiltration rate	2
7	Determination of saturated/unsaturated hydraulic conductivity	2

*****Assignment marks

Suggested Readings

Lenka D. 1999. *Irrigation and Drainage*. Kalyani
Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.
Paliwal KV. 1972. *Irrigation with Saline Water*. IARI Monograph, New Delhi.
Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.
Prihar SS & Sandhu BS. 1987. *Irrigation of Food Crops - Principles and Practices*. ICAR.
Reddy SR. 2000. *Principles of Crop Production*. Kalyani.
Singh Pratap & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publ.

AGRON 506 AGRONOMY OF CEREALS AND PULSES

Credits: 2 + 1 (20+5#)
Contact hours: 28+28

Mid-Session Exam: 25
Practical Exam: 35
End-Semester Exam : 40

Objective: To teach the crop husbandry of cereals, pulses, fodder and green manures crops.

Theory

Units	Content	Lecture
I	**Rabi cereals:** Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production.	7
II	**Kharif cereals:** Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production.	7
III	**Rabi pulses:** Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production.	7
IV	**Kharif pulses** Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production.	7

PRACTICAL

S. No.	Topic	
1	Estimation of crop yield on the basis of yield attributes	1
2	Estimation of crop yield on the basis of yield attributes	1
3	Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities	1
4	Working out growth indices (CER, CGR, RGR, NAR, LAD), aggressiveness, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems of different crops	2
5	Estimation of protein content in pulses	1
6	Planning and layout of field experiments	1
7	Judging of physiological maturity in different crops	1
8	Intercultural operations in different crops	1
9	Determination of cost of cultivation of different crops	1
10	Working out harvest index of various crops	1
11	Study of seed production techniques in various crops	1
12	Visit of field experiments on cultural, fertilizer, weed control and water management aspects	1
13	Visit to nearby villages for identification of constraints in crop production	1

*****Assignment marks

Suggested readings

Das NR. 2007. Introduction to Crops of India. Scientific Publ.
Hunsigi G & Krishna KR. 1998. Science of Field Crop Production. Oxford & IBH.
Jeswani LM &Baldev B. 1997. Advances in Pulse Production Technology. ICAR.
Prasad, Rajendra. 2002. Text Book of Field Crop Production. ICAR.
Singh, SS. 1998. Crop Management. Kalyani.

AGRON-508 AGRONOMY OF MEDICINAL, AROMATIC AND UNDER-UTILIZED CROPS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: Study the importance, classification, agronomic practices of various medicinal and aromatic plants and their use.

Theory

Units	Content	Lecture
I	Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and uses.	7
II	Climate and soil requirements; cultural practices; yield and important constituents of medicinal plants (Isabgol, Rauwolfia, Poppy, Aloe vera, Satavar, Stevia, Safed Musli, Kalmegh, Asaphoetida, Nux vomica, Rosadleetc).	7
III	Climate and soil requirements; cultural practices; yield and important constituents of aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium etc.)	7
IV	Climate and soil requirements; cultural practices; yield of under-utilized crops (Rice bean, Lathyrus, Sesbania, Clusterbean, French bean, Fenugreek, Grain Amaranth, Coffee, Tea and Tobacco)	7

Practical

S. No.	Topic	
1	Identification of crops based on morphological and seed characteristics	4
2	Raising of herbarium of medicinal, aromatic and under-utilized plants	4
3	Quality characters in medicinal and aromatic plants	3
4	Methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants	3

*****Assignment marks

Suggested Readings

Chadha KL & Gupta R. 1995. Advances in Horticulture. Vol. II. Medicinal and Aromatic Plants. Malhotra Publ.

Das NR. 2007. Introduction to Crops of India. Scientific Publ.

Handa SS. 1984. Cultivation and Utilization of Medicinal Plants. RRL, CSIR, Jammu.

Hussain A. 1984. Essential Oil Plants and their Cultivation. CIMAP, Lucknow.

Hussain A. 1993. Medicinal Plants and their Cultivation. CIMAP, Lucknow.

ICAR 2006. Hand Book of Agriculture. ICAR, New Delhi.

Kumar N, Khader Md. Abdul, Rangaswami JBM & Irulappan 1997. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford & IBH.

Prajapati ND, Purohit SS, Sharma AK & Kumar T. 2003. A Hand Book of Medicinal Plants: A Complete Source Book. Agrobios.

Sharma R. 2004. Agro-Techniques of Medicinal Plants. Daya Publ. House.

AGRON-513 PRINCIPLES AND PRACTICES OF ORGANIC FARMING

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact hours: 28+28 Practical Exam: 35
End-Semester Exam : 40

Objective: To study the principles and practices of organic farming for sustainable crop production.

Theory

Units	Content	Lecture
I	Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.	6
II	Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers.	6
III	Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.	5
IV	Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides.	4
V	Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.	5

Practical

Units	Content	
1	Aerobic and anaerobic methods of making compost	3
2	Making of vermicompost	3
3	Identification and nursery raising of important agro-forestry tress and tress for shelter belts	2
4	Efficient use of biofertilizers, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum*, and PSB cultures in field	2
5	Visit to an organic farm	2
6	Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms	2

*****Assignment marks

Suggested Readings

Ananthakrishnan TN. (Ed.). 1992. Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH.

Gaur AC. 1982. A Manual of Rural Composting, FAO/UNDP Regional Project Document, FAO.

Lampin N. 1990. Organic Farming. Press Books, lpswitch, UK.

Palaniappan SP &Anandurai K. 1999. Organic Farming – Theory and Practice. Scientific Publ.

Rao BV Venkata. 1995. Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective: Publ.3, ParisaraprajnaParishtana, Bangalore.

Reddy MV. (Ed.). 1995. Soil Organisms and Litter Decomposition in the Tropics. Oxford & IBH.

Sharma A. 2002. Hand Book of Organic Farming. Agrobios.

Singh SP. (Ed.) 1994. Technology for Production of Natural Enemies. PDBC, Bangalore.

Subba Rao NS. 2002. Soil Microbiology. Oxford & IBH.

Trivedi RN.1993. A Text Book of Environmental Sciences, Anmol Publ.

Veeresh GK, Shivashankar K &Suiglachar MA. 1997. Organic Farming and Sustainable Agriculture. Association for Promotion of Organic Farming, Bangalore.

WHO. 1990. Public Health Impact of Pesticides Used in Agriculture.

Woolmer PL & Swift MJ. 1994. The Biological Management of Tropical Soil Fertility. TSBF & Wiley.

Minor Courses

SOILS 504 SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SOIL SURVEY

Credits: 2+1 Mid Sessional Exam : 25 (20+5*)
Contact hours: 28+28 Practical: 35
End Term Exam : 40

Objective: To study the principles and practices of soil mineralogy, genesis, and classification and soil survey

Theory

Units	Content	Lecture
I	Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.	4
II	Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non crystalline clay minerals, identification techniques, amorphous soil constituents and other non crystalline silicate minerals and their identification; clay minerals in Indian soils.	6
III	Factors of soil formation, soil formation models, soil forming processes, weathering of rocks and mineral transformations, soil profile, weathering sequences of minerals with special reference to Indian soils.	5
IV	Concept of soil individual, soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy, soil classification, soil mineralogy and soil maps usefulness.	5
V	Soil survey and its types, soil survey techniques conventional and modern, soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations soil survey interpretations, soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.	5
VI	Landform – soil relationship major soil groups of India with special reference to respective states, land capability classification and land irritability classification land evaluation and land use type (LUT)	3

Practical:

1	Identification and quantification of minerals in soil fractions	2
2	Morphological properties of soil profile in different landforms	2
3	Classification of soils using soil taxonomy	2
4	Calculation of soils using soil taxonomy	2
5	Calculation of weathering indices and its application in soil formation	2
6	Grouping soils using available data base in terms of soil quality	1
7	Aerial photo and satellite data interpretation for soil and land use	1
8	Cartographic techniques for preparation of base maps and thematic maps processing of field sheets, compilation and obstruction of maps in different scales	2

*****Assignment marks (No marks for attendance). Mandatory to have 75% attendance to appearing final exam.

Suggested Readings:

Brady NC & Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.
Buol EW, Hole ED, Mac Cracken RJ & Southard RJ 1997. Soil Genesis and Classification 4th Ed. Panima Publ.
Dixon JB & Weed SB. 1989. Minerals in Soil Environments, 2nd Ed. Soil Science
Grim RE. 1968. Clay Mineralogy, 2nd Edn. McGraw Hill, New York Indian Society of Soil Science 2002. Fundamentals of Soil Science, ISSS, New Delhi.
Sehgal, J. 1986. Introductory Pedology : Soil Genesis, Survey and Classification, Kalyani Publ., New Delhi.
Sehgal, J. 2002. Pedology-Concepts and Applications, Kalyani Publ., New Delhi, 485p. USDA. 1999. Soil Taxonomy. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.
Wade FA & Mattox RB. 1960. Elements of Crystallography and Mineralogy. Oxford & IBH.
Wilding LP &Smeck NE. 1983. Pedogenesis and Soil Taxonomy : II. The Soil Orders. Elsevier.
Wilding NE & Holl GF. (Eds.) 1983. Pedogenesis and soil taxonomy. I . Concept and Interaction. Elsevier.

PL PATH 506 PRINCIPLES OF PLANT DISEASE MANAGEMENT

Credits: 2+1 Mid sessional exam : 25 (20+5#)
Contact hours: 28+28 Practical : 35
End-semester exam : 40

Objectives: To acquaint with different strategies for management of plant diseases.

Unit	Contents	Lectures
I	Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management	12
II	Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.	10
III	History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.	6

Practical

1.	*In vitro* and *in vivo* evaluation of chemicals against plant pathogens	4
2.	ED and MIC values	5
3.	Study of structural details of sprayers and dusters	5

Suggested Readings

Fry WE. 1982. *Principles of Plant Disease Management*. Academic Press, New York.
Hewitt HG. 1998. *Fungicides in Crop Protection*. CABI, Wallington.
Marsh RW. 1972. *Systemic Fungicides*. Longman, New York
Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. Oxford & IBH, New Delhi

Palti J. 1981. *Cultural Practices and Infectious Crop Diseases*. Springer- Verlag, New York
Vyas SC. 1993 *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill, New Delhi.

SOILS 513 MANAGEMENT OF PROBLEM SOILS AND WATERS

Credits: 2+1
Contact hours: 28+28

Mid sessional exam : 25 (20+5#)
Practical : 35
End-semester exam : 40

Objective: To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

Units	Contents	Lectures
I	Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible**.**	4
II	Morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties.	6
III	Management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils.	6
IV	Acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management.	4
V	Quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality.	4
VI	Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.	4

Practical

I	Characterization of acid, acid sulfate, salt-affected and calcareous soils	4
II	Determination of cations (Na^+, K^+, Ca^{++} and Mg^{++}) in ground water and soil samples	4
III	Determination of anions (Cl^-, SO_4^{--}, CO_3^{--} and HCO_3^-) in ground waters and soil samples	3
IV	Lime and gypsum requirements of acid and sodic soils	3

Suggested Readings

Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.
Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.
USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

Supporting Courses

STAT 512 EXPERIMENTAL DESIGNS

Credits: 2+1 Mid-session exam: 25 (20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Units	Contents	Lectures
I	Need for designing of experiments, characteristics of a good design. Basic principles of designs- rand omization, replication and local control. Uniformity trials, size and shape of plots and blocks.	6
II	Analysis of variance; Completely randomized design, randomized block design and Latin square design. Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.	8
III	Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications~ Lattice design, alpha design- concepts, randomisation procedure, analysis and interpretation of results.	8
IV	Response surfaces. Experiments with mixtures. Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.	6

Practical		
1.	Uniformity trial data analysis, formation of plots and blocks,	1
2.	Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD	4
3.	Analysis of factorial experiments without and with confounding	1
4.	Analysis with missing data	1
5.	Split plot and strip plot designs	2
6.	Transformation of data	1
7.	Analysis of resolvable designs	2
8.	Fitting of response surfaces.	1
9	Uniformity data analysis, formation of plots and blocks, Fair field Smith Laee.	1

Suggested Readings

Readings Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
Federer WT. 1985. Experimental Designs. MacMillan.
Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
Design Resources Server: www.iasri.res.in/design.
#Assignments marks

SPG 503 REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

Credits: 1+1
Contact hours: 14+28

Mid-session exam: 20 (15+5#)
Practical Exam: 50
End-semester exam : 30

Objective: It introduces the participant to the basic concepts of Geo-informatics, Image processing, Optical Physics and the operational skills necessary to acquire remotely sensed data and extract biophysical properties of earth recourses from them. Students will also gain the ability to extract data from real world.

Theory

Units	Contents	Lectures
I	The use of arieal photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-reference.	5
II	The integration of spatial data analysis system with knowledge-based systems and/ or simulation systems for the development of information/decision support systems.	4
III	Future prospects of remote sensing in India, software used in remote sensing, GIS versus remote sensing, Introduction to GIS software.	3
IV	Global positioning system (GPS) components and its function and uses in data collection for GIS	3

Practical

1.	Use of various photogrammnetry instrument	4
2.	Recognition and identification of objects on photography	4
3.	Compilation of map and their interpretation,	3
4.	Hands on practical on remote sensing and GIS, software.	3

Suggested Readings

DeMers, M. N. 2003. Fundamentals of geographic information systems.
J. Wiley. Chrisman, N. 2002. Exploring Geographic Information Systems, J W and Sons, New York.
Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.
Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.
Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall.
#Assignments marks

Compulsory Non Creditable Courses

PGS 501 LIBRARY AND INFORMATION SERVICES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical	Practical Description	
1.	Introduction to library and its services; Role of libraries in education, research and technology transfer;	1
2.	Classification systems and organization of library;	3
3.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources;	1
4.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);	2
5.	Tracing information from reference sources;	1
6.	Literature survey; Citation techniques/Preparation of bibliography;	1
7.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services;	2
8.	Use of Internet including search engines and its resources; e-resources access methods	3

Suggested Readings

Singh, Ajay Pratap, 2013. Information Communication and Society. New Delhi: EssEss Publishers.
Kumar Krishan, 2013. Reference Service. 5th Rev ed. New Delhi: Vikas.
Dhiman, Anil Kumar, 2005. Information and Reference Sources and Service. New Delhi: EssEss.
Ranganathan, S.R.1989. Reference Service. 2nd Rev. ed. Banglore: Sharda Endowment for Library Science.
Mukjerjee, A.K. 1971. Reference Work and its Tools. 2nd ed. Calcutta: World Press.
Sinha, Pradeep K. 2007. Computer Fundamentals. 4th ed. Delhi: BPB Publications.
#Assignments mark

PGS 502 TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 0+1 Mid-session exam: 50
Contact Hours: 28 End-semester exam: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical	Practical Description	
1.	Technical Writing- Various forms of scientific writings- thesis, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface,.	2
2.	Technical Writing- Introduction, review of literature, material and methods, experimental results and discussion);	2
3.	Technical Writing- Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions;	2
4.	Technical Writing- pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups;	1
5.	Technical Writing- Editing and proof-reading; Writing of a review article.	1
6.	Communication Skills -Grammar (Tenses, parts of speech, clauses, punctuation marks);	1
7.	Communication Skills -Error analysis (Common errors);	1
8.	Communication Skills -Concord; Collocation; Phonetic symbols and transcription;	1
9.	Communication Skills -Accentual pattern: Weak forms in connected speech:	1
10.	Communication Skills -Participation in group discussion: Facing an interview;	1
11.	Communication Skills -presentation of scientific papers.	1

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
James HS. 1994. Handbook for Technical Writing. NTC Business Books.
Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. Speaking English Effectively. MacMillan India.
Richard WS. 1969. Technical Writing. Barnes & Noble.
Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek. Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Units	Contents	Lectures
I	Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement;	3
II	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection	4
III	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity	4
IV	International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	3

Suggested Readings

Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To acquaint the students on the basics of commonly used techniques in laboratory.

Theory

Practical	Practical Description	
1.	Safety measures while in Lab; Handling of chemical substances;	2
2.	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;	2
3.	Washing, drying and sterilization of glassware;	2
4.	Drying of solvents/chemicals.	2
5.	Weighing and preparation of solutions of different strengths and their dilution;	2
6.	Handling techniques of solutions;	2
7.	Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids;	2
8.	Neutralisation of acid and bases;	2
9.	Preparation of buffers of different strengths and pH values.	2
10.	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;	2
11.	Electric wiring and earthing.	2
12.	Preparation of media and methods of sterilization;	2
13.	Seed viability testing,	2
14.	testing of pollen viability;	2
15.	Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	2

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES

Credits: 1 + 0 Mid-session exam : 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Units	Contents	Lectures
I	History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International	3
II	Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	3
III	Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. Concept and connotations of rural development, rural development policies and strategies.	4
IV	Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.	4

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

PGS 506 DISASTER MANAGEMENT

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion	4
II	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents	3
III	Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media.	4
IV	Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.	3

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR
HIMACHAL PRADESH

Study Scheme & Syllabus

For

M. Sc. Ag. (Entomology)

(First to Fourth Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

PROGRAMME STRUCTURE

M. Sc. Ag. (Entomology)

1. Minor Field : Plant Pathology
2. Supporting Field: Statistics (Mandatory Course) + One course other than Minor field
3. Credit load distribution:

Major Field : 20

Minor field :09

Supporting :05

Master's Research : 20

Seminar :01

Compulsory Non Credit Course:06

Total :61

M. Sc. Ag. Entomology
Semester wise Syllabus Scheme

S. No.	Course code	Course title	Credit hours	Semester
Semester I				
Major				
1	ENT 501	Insect Morphology	1+1	I
2	ENT 502	Insect Anatomy, Physiology and Nutrition	2+1	I
3	ENT 504	Classification of Insects	2+1	I
4	ENT 507	Biological Control of Crop Pests and Weeds	1+1	I
Minor				
5	PL PATH 504	Principles of Plant Pathology	3+0	I
Compulsory Non Creditable Courses				
6	PGS 501	Library and Information Services	0+1	I
7	PGS 502	Technical Writing and Communication Skills	0+1	I
Total		**10+3+2**	**15**	
SEMESTER II				
Major				
1	ENT 505	Insect Ecology	1+1	II
2	ENT 508	Toxicology of Insecticides	2+1	II
3	ENT 512	Pests of Horticultural and Plantation Crops	1+1	II
4	ENT 599	Master's Research	0+2	II
Minor				
5	PL PATH 506	Principles of Plant Disease Management	2+1	II
Supporting course				
6	STAT 512	Experimental Designs	2+1	II
Compulsory Non Creditable Courses				
7	PGS 503	Intellectual Property and Its Management in Agriculture	1+0	II
8	PGS 504	Basic Concepts in Laboratory Techniques	0+1	II
Total		**9+3+3+2**	**17**	
SEMESTER III				
Major				
1	ENT 510	Principles of Integrated Pest Management	1+1	III
2	ENT 518	Techniques in Plant Protection	0+1	III
3	ENT 591	Master's Seminar	1+0	III
4	ENT 599	Master's Research	0+3	III
Minor				
5	PL PATH-516	Integrated Disease Management	2+1	III
Supporting course				
6	SPG 503	Remote Sensing and Geographical Information System	1+1	III
Compulsory Non Creditable Courses				
7	PGS 505	Agriculture Research Ethics and Rural Development Programmes	1+0	III
8	PGS 506	Disaster Management	1+0	III
Total credits		**7+3+2+2**	**14**	
SEMESTER IV				
1	ENT 599	Master's Research	0+15	IV
Total credits			**15**	

SCHEME OF EXAMINATION
(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

M.Sc. Ag. (Entomology)

Course Contents

ENT 501 INSECT MORPHOLOGY

Credits: 1 + 1 Mid-Session Exam : 20 (15+5#)
Contact hours: 14 + 28 Practical Exam: 50
End-Semester Exam: 30

Objective: To acquaint the students with external morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions.

Units	Contents	Lectures
I	Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.	3
II	Head- Origin, **s**tructure and modification; types of mouthparts and antennae, tentorium and neck sclerites.	4
III	Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications.	4
IV	Abdomen- Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemoreceptors).	3

S. No.	Practical Description	Practicals
1.	Study of insect segmentation, various tagmata and their appendages	7
2.	Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia	7

Suggested Readings

Chapman RF. 1998. The Insects: Structure and Function. Cambridge Univ. Press, Cambridge.
David BV & Ananthkrishnan TN. 2004. General and Applied Entomology. Tata McGraw Hill, New Delhi.
Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi
Saxena RC & Srivastava RC. 2007. Entomology: At a Glance. Agrotech Publ. Academy, Jodhpur.
Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman & Hall, London.
Snodgross RE. 1993. Principles of Insect Morphology. Cornell Univ. Press, Ithaca.
Blackwelder RE. 1967. Taxonomy - A Text and Reference Book. John Wiley & Sons, New York.
Kapoor VC. 1983. Theory and Practice in Animal Taxonomy. Oxford & IBH, New Delhi
Mayr E. 1971. Principles of Systematic Zoology. Tata McGraw-Hill, New Delhi.
Quicke DLJ. 1993. Principles and Techniques of Contemporary Taxonomy. Blackie, London.

#Assignments marks

ENT 502 INSECT ANATOMY, PHYSIOLOGY AND NUTRITION

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart knowledge to the students on basic aspects of anatomy of different systems, elementary physiology, nutritional physiology and their application in entomology.

Units	Contents	Lectures
I	Scope and importance of insect anatomy and physiology.	2
II	Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands.	15
III	Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapause.	5
IV	Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.	6

S. No.	Practical Description	Practicals
1.	Dissection of different insects to study comparative anatomical details of different systems	2
2.	Preparation of permanent mounts of internal systems;	2
3.	Chromatographic analysis of free amino acids of haemolymph	2
4.	Examination of insect haemocytes	1
5.	Determination of chitin in insect cuticle	1
6.	Determination of respiratory quotient	1
7.	Preparation and evaluation of various diets	3
8.	Consumption, utilization and digestion of natural and artificial diets	2

Suggested Readings

Chapman RF.1998. Insects: Structure and Function. ELBS Ed., London
Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
Kerkut GA & Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York.
Patnaik BD. 2002. Physiology of Insects. Dominant, New Delhi
Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Vol. 1. Structure, Physiology and Development. Chapman & Hall, New York.
Saxena RC & Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Jodhpur
Wigglesworth VB.1984. Insect Physiology. 8th Ed. Chapman & Hall, New York

#Assignments marks

ENT 504 CLASSIFICATION OF INSECTS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects.

Units	Contents	Lectures
I	Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained	6
II	Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera.	8
III	Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Subclass: Pterygota, Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.	7
IV	Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.	7

S. No.	Practical Description	Practicals
1.	Study of orders of insects and their identification using taxonomic keys.	4
2.	Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera.	5
3.	Field visits to collect insects of different orders.	5

Suggested Reading

CSIRO 1990. The Insects of Australia: A Text Book for Students and Researchers. 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca

Freeman S & Herron JC. 1998. Evolutionary Analysis. Prentice Hall, New Delhi

Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman & Hall, London

Ross HH.1974. Biological Systematics. Addison Wesley Publ. Co.

Triplehorn CA & Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects. 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

#Assignments marks

ENT 505 INSECT ECOLOGY

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To teach the students the concepts of ecology, basic principles of distribution and abundance of organisms and their causes. Study life tables, organization of communities, diversity indicies. Train students in sampling methodology, calculation of diversity indicies, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

Units	Contents	Lectures
I	History and Definition. Basic Concepts. Organisation of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology.	5
II	Basic concepts of abundance- Model vs Real world. Population growth basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation.	8
III	Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions - The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of nicheecological homologues, competitive exclusion. Prey-predator interactions- Basic model- Lotka-Volterra Model, Volterra's principle. Functional and numerical response. Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.	9
IV	Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's *d/w*, Relation between the two and their association with Dyar's Law and Przibram's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity- stability debate, relevance to pest management. Pest management as applied ecology.	6

Practical

S. No.	Practical Description	Practicals
1.	Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial.	3
2.	Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two.	3

3.	Assessing and describing niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms.	3
4.	Calculation of some diversity indices- Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values. Problem solving in ecology.	3
5.	Field visits to understand different ecosystems and to study insect occurrence in these systems.	2

Suggested Readings

Chapman JL & Reiss MJ. 2006. Ecology: Principles & Applications. 2nd Ed. Cambridge Univ. Press, Cambridge

Gotelli NJ & Ellison AM. 2004. A Primer of Ecological Statistics. Sinauer Associates, Inc., Sunderland, MA

Gotelli NJ. 2001. A Primer of Ecology. 3rd Ed. Sinauer Associates, Inc., Sunderland, MA

Gupta RK. 2004. Advances in Insect Biodiversity. Agrobios, Jodhpur.

Krebs CJ. 1998. Ecological Methodology. 2nd Ed. Benjamin-Cummings Publ. Co., New York

Krebs CJ. 2001. Ecology: The Experimental Analysis of Distribution and Abundance. 5th Ed. Benjamin-Cummings Publ. Co., New York.

Southwood TRE & Henderson PA. 2000. Ecological Methods. 3rd Ed. Methuen & Co. Ltd., London.

Speight MR, Hunta MD & Watt AD. 2006. Ecology of Insects: Concepts and Application. Elsevier Science Publ., The Netherlands.

#Assignments marks

ENT 507 BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS

Credits: 1 + 1
Contact hours: 14 + 28

Mid-Session Exam : 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic microorganisms.

Units	Contents	Lectures
I	History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation.	4
II	Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects.	4
III	Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation.	3
IV	Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.	4

S. No.	Practical Description	Practicals
1.	Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers.	3
2.	Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds.	3
3.	Field collection of parasitoids and predators.	3
4.	Hands-on training in culturing, identification of common insect pathogens.	3
5.	Quality control and registration standards for biocontrol agents.	2

Suggested Readings

Burges HD & Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London.
De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman & Hall, New York.
Dhaliwal GS & Arora R. 2001. Integrated Pest Management: Concepts and Approaches. Kalyani Publ., New Delhi.
Gerson H & Smiley RL. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman & Hall, New York.
Huffaker CB & Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London.
Saxena AB. 2003. Biological Control of Insect Pests. Anmol Publ., New Delhi.
#Assignments marks

ENT 508 TOXICOLOGY OF INSECTICIDES

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Units	Contents	Lectures
I	Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.	3
II	Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc.	9
III	Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.	6
IV	Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.	5
V	Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.	5

S. No.	Practical Description	Practicals
1.	Insecticide formulations and mixtures; quality control of pesticide formulations.	3
2.	Laboratory and field evaluation of bioefficacy of insecticides	2
3.	Bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action.	3
4.	Toxicity to beneficial insects.	3
5.	Pesticide appliances. Working out doses and concentrations of pesticides.	2
6.	Visit to toxicology laboratories. Good laboratory practices.	1

Suggested Readings

Chattopadhyay SB. 1985. Principles and Procedures of Plant Protection. Oxford & IBH, New Delhi.
Gupta HCL.1999. Insecticides: Toxicology and Uses. Agrotech Publ., Udaipur.
Ishaaya I & Degheele (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi.
Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. Insecticides in Agriculture and Environment. Narosa Publ. House, New Delhi.
Prakash A & Rao J. 1997. Botanical Pesticides in Agriculture. Lewis Publ., New York.
#Assignments marks

ENT 510 PRINCIPLES OF INTEGRATED PEST MANAGEMENT

Credits: 1 + 1
Contact hours: 14 + 28

Mid-Session Exam : 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL, implementing IPM programmes.

Units	Contents	Lectures
I	History and origin, definition and evolution of various related terminologies.	3
II	Concept and philosophy, ecological principles, economic threshold concept, and economic consideration.	3
III	Tools of pest management and their integration- legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys;	4
IV	Political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.	4

	Practical Description	Practicals
1.	Characterization of agro-ecosystems; sampling methods and factors affecting sampling.	3
2.	Population estimation methods.	3
3.	Crop loss assessment: direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses.	4
4.	Computation of EIL and ETL; crop modeling; designing and implementing IPM system.	4

Suggested Readings

Dhaliwal GS & Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publ., New Delhi.
Dhaliwal GS, Singh R & Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publ., New Delhi.
Horowitz AR & Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi.
Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi.
Norris RF, Caswell-Chen EP & Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi.
#Assignments marks

ENT 512 PESTS OF HORTICULTURE AND PLANTATION CROPS

Credits: 1 + 1
Contact hours: 14 + 28

Mid-Session Exam : 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To impart knowledge on major pests of horticultural and plantation crops regarding the extent and nature of loss, seasonal history, their integrated management.

Units	Contents	Lectures
I	Fruit Crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, *ber*, fig, citrus, *aonla*, pineapple, apple, peach and other temperate fruits.	4
II	Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, French beans, chow-chow, brinjal, okra, all gourds, gherkin, drumstick, leafy vegetables etc.	4
III	Plantation crop- coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc.; Spices and Condiments- pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, beetlevine etc.	3
IV	Ornamental, medicinal and aromatic plants and pests in polyhouses/protected cultivation.	3

S. No.	Practical Description	Practicals
1.	Collection and identification of important pests and their natural enemies on different crops.	7
2.	Study of life history of important insect pests and non insect pests.	7

Suggested Readings

Atwal AS & Dhaliwal GS. 2002. Agricultural Pests of South Asia and their Management. Kalyani Publ., New Delhi.

Butani DK & Jotwani MG. 1984. Insects and Vegetables. Periodical Expert Book Agency, New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. Essential of Agricultural Entomology. Kalyani Publ., New Delhi.

Srivastava RP.1997. Mango Insect Pest Management. International Book Distr., Dehra Dun.

Verma LR, Verma AK & Goutham DC. 2004. Pest Management in Horticulture Crops: Principles and Practices. Asiatech Publ., New Delhi.

#Assignments marks

ENT 518 TECHNIQUES IN PLANT PROTECTION

Credits: 0 + 1 Mid-session exam: 50
Contact hours: 0 + 28 End-semester exam: 50

Objective: To acquaint the students with appropriate use of plant protection equipments and techniques related to microscopoy, computation, pest forecasting, electrophoresis etc.

S. No.	Practical Description	Practicals
1.	Pest control equipments, principles, operation, maintenance, selection, application of pesticides and biocontrol agents, seed dressing, soaking, root-dip treatment, dusting, spraying, application through irrigation water.	3
2.	Soil sterilization, solarization, deep ploughing, flooding, techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers	3
3.	Use of light, transmission and scanning electron microscopy.	2
4.	Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE.	2
5.	Use of tissue culture techniques in plant protection.	2
6	Computer application for predicting/forecasting pest attack and identification.	1

Suggested Readings

Alford DV. 1999. A Textbook of Agricultural Entomology. Blackwell Science, London.
Crampton JM & Eggleston P. 1992. Insect Molecular Science. Academic Press, London.
#Assignments marks

Minor Courses

PL PATH 504 PRINCIPLES OF PLANT PATHOLOGY

Credits: 3 + 0 Mid-Session Exam: 40
Contact hours: 42+0 End-Semester Exam: 60

Objective: To introduce the subject of Plant Pathology, its concepts and principles.

Unit	Contents	Lectures
I	Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.	**5**
II	Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development	**8**
III	Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens	**15**
IV	Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.	**10**
V	Disease management strategies	**4**

Suggested Readings

Agrios GN. 2005. *Plant Pathology*. 5 th Ed. Academic Press, New York.

Heitefuss R & Williams PH. 1976. *Physiological Plant Pathology*. Springer Verlag, Berlin, New York.

Mehrotra RS & Aggarwal A. 2003. *Plant Pathology*. 2nd Ed. Oxford & IBH, New Delhi.

Singh RS. 2002. *Introduction to Principles of Plant Pathology*. Oxford & IBH, New Delhi.

Singh DP & Singh A. 2007. *Disease and Insect Resistance in Plants*.Oxford & IBH, New Delhi

Upadhyay RK & Mukherjee KG. 1997. *Toxins in Plant Disease Development and Evolving Biotechnology* . Oxford & IBH, New Delhi

PL PATH 506 PRINCIPLES OF PLANT DISEASE MANAGEMENT

Credits: 2+1
Contact hours: 28+28

Mid Sessional Exam : 25 (20+5*)
Practical : 35
End-Semester Exam : 40

Objectives: To acquaint with different strategies for management of plant diseases.

Unit	Contents	Lectures
I	Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management	12
II	Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.	10
III	History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.	6

Practical

1.	*In vitro* and *in vivo* evaluation of chemicals against plant pathogens	4
2.	ED and MIC values	5
3.	Study of structural details of sprayers and dusters	5

Suggested Readings

Fry WE. 1982. *Principles of Plant Disease Management*. Academic Press, New York.

Hewitt HG. 1998. *Fungicides in Crop Protection*. CABI, Wallington.

Marsh RW. 1972. *Systemic Fungicides*. Longman, New York

Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. Oxford & IBH, New Delhi

Palti J. 1981. *Cultural Practices and Infectious Crop Diseases*. Springer- Verlag, New York

Vyas SC. 1993 *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill, New Delhi.

PL PATH 516 INTEGRATED DISEASE MANAGEMENT

Credits: 2+1 Mid Sessional Exam: 25 (20+5*)
Contact hours: 28+28 End-Semester Exam: 40
Practical : 35

Objective: To emphasize the importance and need of IDM in the management of diseases of portant crops.

Theory

Unit	Contents	Lectures
I	Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications	**10**
II	Development of IDM- basic principles, biological, chemical and cultural disease management.	**8**
III	IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed-mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.	**10**

Practical

1.	Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM	7
2.	Demonstration of IDM in certain crops as project work.	7

Suggested Readings

Gupta VK & Sharma RC. (Eds). 1995. *Integrated Disease Management and Plant Health*. Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases*. Daya Publ. House, New Delhi.

Sharma RC & Sharma JN. (Eds). 1995. *Integrated Plant Disease Management*. Scientific Publ., Jodhpur.

Supporting Courses

STAT 512 EXPERIMENTAL DESIGNS

Credits: 2+1
Contact hours: 28+28

Mid-session exam: 25 (20+5#)
Practical exam: 35
End-semester exam: 40

Objective: This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Units	Contents	Lectures
I	Need for designing of experiments, characteristics of a good design. Basic principles of designs- rand omization, replication and local control. Uniformity trials, size and shape of plots and blocks.	6
II	Analysis of variance; Completely randomized design, randomized block design and Latin square design. Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.	8
III	Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications~ Lattice design, alpha design- concepts, randomisation procedure, analysis and interpretation of results.	8
IV	Response surfaces. Experiments with mixtures. Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.	6

Practical		
1.	Uniformity trial data analysis, formation of plots and blocks,	1
2.	Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD	4
3.	Analysis of factorial experiments without and with confounding	1
4.	Analysis with missing data	1
5.	Split plot and strip plot designs	2
6.	Transformation of data	1
7.	Analysis of resolvable designs	2
8.	Fitting of response surfaces.	1
9	Uniformity data analysis, formation of plots and blocks, Fair field Smith Laee.	1

Suggested Readings

Readings Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
Federer WT. 1985. Experimental Designs. MacMillan.
Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
Design Resources Server: www.iasri.res.in/design.
#Assignments marks

SPG 503 REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

Credits: 1+1 Mid-session exam: 20 (15+5#)
Contact hours: 14+28 Practical Exam: 50
End-semester exam : 30

Objective: It introduces the participant to the basic concepts of Geo-informatics, Image processing, Optical Physics and the operational skills necessary to acquire remotely sensed data and extract biophysical properties of earth recourses from them. Students will also gain the ability to extract data from real world.

Units	Contents	Lectures
I	The use of arieal photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-reference.	5
II	The integration of spatial data analysis system with knowledge-based systems and/ or simulation systems for the development of information/decision support systems.	4
III	Future prospects of remote sensing in India, software used in remote sensing, GIS versus remote sensing, Introduction to GIS software.	3
IV	Global positioning system (GPS) components and its function and uses in data collection for GIS	3

Practical

1.	Use of various photogrammnetry instrument	4
2.	Recognition and identification of objects on photography	4
3.	Compilation of map and their interpretation,	3
4.	Hands on practical on remote sensing and GIS, software.	3

Suggested Readings

DeMers, M. N. 2003. Fundamentals of geographic information systems.
J. Wiley. Chrisman, N. 2002. Exploring Geographic Information Systems, J W and Sons, New York.
Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.
Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.
Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall.
#Assignments marks

Compulsory Non Creditable Courses

PGS 501 LIBRARY AND INFORMATION SERVICES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical	Practical Description	
1.	Introduction to library and its services; Role of libraries in education, research and technology transfer;	1
2.	Classification systems and organization of library;	3
3.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources;	1
4.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);	2
5.	Tracing information from reference sources;	1
6.	Literature survey; Citation techniques/Preparation of bibliography;	1
7.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services;	2
8.	Use of Internet including search engines and its resources; e-resources access methods	3

Suggested Readings

Singh, Ajay Pratap, 2013. Information Communication and Society. New Delhi: EssEss Publishers.
Kumar Krishan, 2013. Reference Service. 5th Rev ed. New Delhi: Vikas.
Dhiman, Anil Kumar, 2005. Information and Reference Sources and Service. New Delhi: EssEss.
Ranganathan, S.R.1989. Reference Service. 2nd Rev. ed. Banglore: Sharda Endowment for Library Science.
Mukjerjee, A.K. 1971. Reference Work and its Tools. 2nd ed. Calcutta: World Press.
Sinha, Pradeep K. 2007. Computer Fundamentals. 4th ed. Delhi: BPB Publications.
#Assignments mark

PGS 502 TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical	Practical Description	
1.	Technical Writing- Various forms of scientific writings- thesis, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface,.	2
2.	Technical Writing- Introduction, review of literature, material and methods, experimental results and discussion);	2
3.	Technical Writing- Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions;	2
4.	Technical Writing- pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups;	1
5.	Technical Writing- Editing and proof-reading; Writing of a review article.	1
6.	Communication Skills -Grammar (Tenses, parts of speech, clauses, punctuation marks);	1
7.	Communication Skills -Error analysis (Common errors);	1
8.	Communication Skills -Concord; Collocation; Phonetic symbols and transcription;	1
9.	Communication Skills -Accentual pattern: Weak forms in connected speech:	1
10.	Communication Skills -Participation in group discussion: Facing an interview;	1
11.	Communication Skills -presentation of scientific papers.	1

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
James HS. 1994. Handbook for Technical Writing. NTC Business Books.
Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. Speaking English Effectively. MacMillan India.
Richard WS. 1969. Technical Writing. Barnes & Noble.
Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek. Sethi J &
Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.
#Assignments mark

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement;	3
II	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection	4
III	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity	4
IV	International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	3

Suggested Readings

Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.
#Assignments marks

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To acquaint the students on the basics of commonly used techniques in laboratory.

Practical	Practical Description	
1.	Safety measures while in Lab; Handling of chemical substances;	2
2.	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;	2
3.	Washing, drying and sterilization of glassware;	2
4.	Drying of solvents/chemicals.	1
5.	Weighing and preparation of solutions of different strengths and their dilution;	2
6.	Handling techniques of solutions;	2
7.	Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids;	2
8.	Neutralisation of acid and bases;	2
9.	Preparation of buffers of different strengths and pH values.	2
10.	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;	1
11.	Electric wiring and earthing.	2
12.	Preparation of media and methods of sterilization;	2
13.	Seed viability testing,	2
14.	testing of pollen viability;	2
15.	Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	2

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
#Assignments marks

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES

Credits: 1 + 0 Mid-session exam : 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International	3
II	Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	3
III	Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. Concept and connotations of rural development, rural development policies and strategies.	4
IV	Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.	4

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.
#Assignments marks

PGS 506 DISASTER MANAGEMENT

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion	4
II	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents	3
III	Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media.	4
IV	Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.	3

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.
#Assignments mark

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

M. Sc. Ag. (Genetics & Plant Breeding)
(I to IV Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

Programme Structure

M. Sc. Ag. (Genetics & Plant Breeding)

1. Minor Field: Plant Pathology
2. Supporting Field: Statistics (Mandatory Course) + one course other than Minor field

Credit load distribution:

Major Field	:	21
Minor Field	:	09
Supporting	:	05
Master's Research	:	20
Master's Seminar	:	01
Compulsory non credit course	:	06
Total	:	**62**

M.Sc. Ag. (Genetics & Plant Breeding)

Semester wise Syllabus Scheme

	Semester I			
S.No.	**Course Code**	**Course Title**	**Credit hours**	**Semester**
	Major Courses			I
1	GP 501	Principles of Genetics	2+1	
2	GP 502	Principles of Cytogenetics	2+1	
3	GP 503	Principles of Plant Breeding	2+1	
	Minor Courses			
4	PL PATH 504	Principles of Plant Pathology	2+1	
	Compulsory Non-Credit Courses			
5	PGS 501	Library and Information Services	0+1	
6	PGS 502	Technical Writing and Communications Skills	0+1	
	Total	**9+3+2**	**14**	
	Semester II			
	Major Courses			II
1	GP 504	Principles of Quantitative Genetics	2+1	
2	GP 508	Cell Biology and Molecular Genetics	2+1	
3	GP 599	Master's Research	0+2	
	Minor Courses			
4	PL PATH 506	Principles of Plant Disease Management	2+1	
	Supporting Courses			
5	STAT 512	Experimental Designs	2+1	
	Compulsory Non-Credit Courses			
6	PGS 503	Intellectual Property and Its Management in Agriculture	1+0	
7	PGS 504	Basic Concepts in Laboratory Techniques	0+1	
	Master's Research			
	Total	**8+3+3+2**	**16**	
	Semester III			
	Major Courses			III
1	GP 509	Biotechnology for Crop Improvement	2+1	
2	GP 507	Heterosis Breeding	1+1	
3	GP 591	Master's Seminar	1+0	
4	GP 599	Master's Research	0+3	
	Minor Courses			
5	PL PATH 516	Integrated Disease Management	2+1	
	Supporting Courses			
6	SPG 503	Remote Sensing and Geographic Information System	1+1	
	Compulsory Non-Credit Courses			
7	PGS-505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0	
8	PGS-506	Disaster Management	1+0	
	Total	**9+3+2+2**	**16**	
	Semester IV			

	Master's Research			IV
1	GP 599	Master's Research	0+15	
	Total	**0+15**	**15**	

SCHEME OF EXAMINATION
(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

M.Sc. Ag. (Genetics & Plant Breeding)

Course Content

GP 501 PRINCIPLES OF GENETICS

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact hours: 28+28 Practical Exam: 35
End-Semester Exam: 40

Objective: This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem solving skills from classical to molecular genetics.

Units	Content	Lectures
I	Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance.	4
II	Multiple alleles, Gene interactions. Sex determination, differentiation and sex-linkage, Sexinfluenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.	4
III	Population - Mendelian population – Random mating population - Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium.	2
IV	Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis.	2
V	Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.	2
VI	Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression. Gene regulation in eukaryotes, RNA editing.	4
VII	Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).	4
VIII	Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.	2
IX	Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts.	2
X	Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.	2

Practical

1	Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms.	2
2	Chromosome mapping using three point test cross; Tetrad analysis.	2
3	Induction and detection of mutations through genetic tests.	3
4	DNA extraction and PCR amplification - Electrophoresis – basic principles and running of amplified DNA - Extraction of proteins and isozymes.	3
5	Use of Agrobacterium mediated method and Biolistic gun; practical demonstrations.	2
6	Detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.	2

* Assignments marks

Suggested Readings:

Gardner EJ & Snustad DP. 1991. *Principles of Genetics*. John Wiley & Sons.
Klug WS & Cummings MR. 2003. *Concepts of Genetics*. Peterson Edu.
Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ.
Russell PJ. 1998. *Genetics*. The Benzamin/Cummings Publ. Co.
Snustad DP & Simmons MJ. 2006. *Genetics*. 4th Ed. John Wiley & Sons. Strickberger MW. 2005. *Genetics (III Ed)*. Prentice Hall, New Delhi, India Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publs.
Uppal S, Yadav R, Subhadra & Saharan RP. 2005. *Practical Manual on Basic and Applied Genetics*. Dept. of Genetics, CCS HAU Hisar.

GP 502 PRINCIPLES OF CYTOGENETICS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.

Units	Content	Lectures
I	Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes.	4
II	Chromosomal theory of inheritance – Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing overmechanisms and theories of crossing over-recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - in situ hybridization and various applications.	6
III	Structural and Numerical variations of chromosomes and their implications - Symbols and terminologies for chromosome numbers - euploidy - haploids, diploids and polyploids ; Utilization of aneuploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes.	4
IV	Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids –- Role of aneuploids in basic and applied aspects of cropbreeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis - Evolutionary and genetic problems in crops with apomixes.	6
V	Reversion of autopolyploids to diploids; Genome mapping in polyploids - Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) – Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids – Bridge species.	4
VI	Fertilization barriers in crop plants at pre-and postfertilization levels- In vitro techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization; case studies – Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.	4

Practical

S. No.	Particulars	
1	Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc.	3
2	Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope; Preparing specimen for observation – Fixative preparation and fixing specimen for light microscopy studies in cereals.	3
3	Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion and Aloe vera - Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds and forage crops - Using micrometers and studying the pollen grain size in various crops Various methods of staining and preparation of temporary and permanent slides.	3
4	Pollen germination in vivo and in vitro; Microtomy and steps in microtomy; Agents employed for the induction of various ploidy levels; Solution preparation and application at seed, seedling level	2
5	Identification of polyploids in different crops - Induction and identification of haploids; Anther culture and Ovule culture – Morphological observations on synthesized autopolyploids - Observations on Cmitosis, learning on the dynamics of spindle fibre assembly.	1
6	Morphological observations on alloployploids - Morphological observations on aneuploids - Cytogenetic analysis of interspecific and intergeneric crosses - Maintenance of Cytogenetic stocks and their importance in crop breeding - Various ploidy levels due to somaclonal variation ; Polyploidy in ornamental crops. -Fluorescent in situ hybridization (FISH)- Genome insitu hybridization GISH.	2

* Assignments marks

Suggested Readings

Becker K & Hardin. 2004. *The World of Cell*. 5th Ed. Pearson Edu.
Carroll M. 1989. *Organelles*. The Guilford Press.
Charles B. 1993. *Discussions in Cytogenetics*. Prentice Hall.
Darlington CD & La Cour LF. 1969. *The Handling of Chromosomes*. Georger Allen & Unwin Ltd.
Elgin SCR. 1995. *Chromatin Structure and Gene Expression*. IRL Press.
Gray P. 1954. *The Mirotomist's Formulatory Guide*. The Blakiston Co.
Gupta PK & Tsuchiya T. 1991. *Chromosome Engineering in Plants:Genetics, Breeding and Evolution*. Part A. Elsevier.
Gupta PK. 2000. *Cytogenetics*. Rastogi Publ.
Johannson DA. 1975. *Plant Microtechnique*. McGraw Hill.
Karp G. 1996. *Cell and Molecular Biology: Concepts and Experiments*.John Wiley & Sons.
Khush GS. 1973. *Cytogenetics of Aneuploids*. Academic Press.
Sharma AK & Sharma A. 1988. *Chromosome Techniques: Theory and Practice*. Butterworth.
Sumner AT. 1982. *Chromosome Banding*. Unwin Hyman Publ.
Swanson CP. 1960. *Cytology and Cytogenetics*. Macmillan & Co.

GP 503 PRINCIPLES OF PLANT BREEDING

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

Units	Content	Lectures
I	History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.	4
II	Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.	4
III	Self-incompatibility and male sterility in crop plants and their commercial exploitation.	3
IV	Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in selfpollinated crops (diallel selective mating approach).	3
V	Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-torow methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and interpopulation improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.	6
VI	Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection.	2
VII	Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding.	2
VIII	Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses.	2
IX	Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.	2

Practical

1	Floral biology in self and cross pollinated species, selfing and crossing techniques.	3
2	Selection methods in segregating populations and evaluation of breeding material.	3
3	Analysis of variance (ANOVA); Estimation of heritability and genetic advance.	3
4	Maintenance of experimental records.	3
5	Learning techniques in hybrid seed production using male-sterility in field crops.	2

* Assignments marks

Suggested Readings

Allard RW. 1981. *Principles of Plant Breeding*. John Wiley & Sons.
Chopra VL. 2001. *Breeding Field Crops*. Oxford & IBH.
Chopra VL. 2004. *Plant Breeding*. Oxford & IBH.
Gupta SK. 2005. *Practical Plant Breeding*. Agribios.
Pohlman JM & Bothakur DN. 1972. *Breeding Asian Field Crops*. Oxford & IBH.
Roy D. 2003. *Plant Breeding, Analysis and Exploitation of Variation*. Narosa Publ. House.
Sharma JR. 2001. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.
Simmonds NW. 1990. *Principles of Crop Improvement*. English Language Book Society.
Singh BD. 2006. *Plant Breeding*. Kalyani.
Singh P. 2002. *Objective Genetics and Plant Breeding*. Kalyani.
Singh P. 2006. *Essentials of Plant Breeding*. Kalyani.
Singh S & Pawar IS. 2006. *Genetic Bases and Methods of Plant Breeding*. CBS.

GP 504 PRINCIPLES OF QUANTITATIVE GENETICS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects.

Units	Content	Lectures
I	Mendelian traits vs polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.	6
II	Principles of Anaylis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.	4
III	Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D2 analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance.	6
IV	Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis – principles and interpretation.	6
V	QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.	6

Practical

S. No.	Particulars	
1	Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Metroglyph analysis - D2 analysis - Grouping of clusters and interpretation - Cluster analysis - Construction of cluster diagrams and dendrograms - interpretation - Correlation analysis - Path analysis - Parent-progeny regression analysis.	3

2	Diallel analysis: Griffing's methods I and II – Diallel analysis: Hayman's graphical approach - Diallel analysis: interpretation of results - NCD and their interpretations - Line x tester analysis and interpretation of results - Estimation of heterosis: standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression.	3
3	Generation mean analysis: Analytical part and Interpretation – Estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions.	2
4	Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies.	2
5	Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross (TTC) – use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model.	2
6	Principal Component Analysis model - Additive and multiplicative model – Shifted multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes.	2

* Assignments marks

Suggested Readings

Bos I & Caligari P. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall. Falconer DS & Mackay J. 1998. *Introduction to Quantitative Genetics*. Longman.

Mather K & Jinks JL. 1971. *Biometrical Genetics*. Chapman & Hall.

Mather K & Jinks JL. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.

Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani.

Naryanan SS & Singh P. 2007. *Biometrical Techniques in Plant Breeding. Kalyani.*

Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*. Kalyani.

Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics*. Kalyani.

Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates. Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

GP 507 HETEROSIS BREEDING

Credits: 1 + 1
Contact hours: 14+28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 30
End-Semester Exam: 50

Objective: To provide understanding about mechanisms of heterosis and its exploitation for yield improvement through conventional and biotechnological approaches.

Units	Content	Lectures
I	Historical aspect of heterosis - Nomenclature and definitions of heterosis - Heterosis in natural population and inbred population; Evolutionary aspects - Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops crops.	2
II	Pre Mendelian and Post-Mendelian ideas - Genetic theories of heterosis – Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; - Evolutionary concepts of heterosis.	2
III	Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies. - Relationship between genetic distance and expression of heterosis – case studies; Divergence and Genetic Distance analyses-morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis.	3
IV	Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of selfincompatibility in development of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids.	3
V	Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops; Male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagated crops; problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid.	2
VI	Organellar heterosis and complementation - Creation of male sterility through genetic engineering and its exploitation in heterosis.	1
VII	Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.	1

Practical

S. No.	Particulars	
1	Selection indices and selection differential – Calculations and interpretations.	3
2	Male sterile line characterization in millets; Using morphological descriptors; Restorer line identification and diversification of male sterile sources.	3
3	Male sterile line creation in dicots comprising oilseeds, pulses and cotton; problems in creation of CGMS system; Ways of overcoming them - Male sterile line creation, diversification and restoration in forage crops.	2
4	Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops.	2
5	Estimation from the various models for heterosis parameters -Hybrid seed production in field crops – an account on the released hybrids; their potential.	2
6	Problems and ways of overcoming it; hybrid breeding at National and International level; Opportunities ahead.	2

* Assignments marks

Suggested Readings

Proceedings of *Genetics and Exploitation of Heterosis in Crops* – An International Symposium CIMMYT, 1998.

Akin E. 1979. *The Geometry of Population Genetics*. Springer-Verlag.

Ben Hiu Lin. 1998. *Statistical Genomics – Linkage, Mapping and QTL Analysis*. CRC Press.

De Joung G. 1988. *Population Genetics and Evolution*. Springer-Verlag.

Hartl DL. 2000. *A Primer of Population Genetics*. 3rd Ed. Sinauer Assoc.

Mettler LE & Gregg TG. 1969. *Population Genetics and Evolution*. Prentice-Hall.

Montgomery DC. 2001. *Design and Analysis of Experiments*. 5th Ed., Wiley & Sons.

Richards AJ. 1986. *Plant Breeding Systems*. George Allen & Unwin.

Srivastava S & Tyagi R. 1997. *Selected Problems in Genetics*. Vols. I, II. Anmol Publ.

GP 508 CELL BIOLOGY AND MOLECULAR GENETICS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart knowledge in theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

Units	Content	Lectures
I	Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles – nucleus, plastidschloro/ chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.	6
II	Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus-Structure and chemical composition; Cell division and physiology of cell division.	6
III	Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors.	8
IV	Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.	8

Practical

S. No.	Particulars	
1	Morphological and Gram staining of natural bacteria; Cultivation of bacteria in synthetic medium.	4
2	Determination of growth rate and doubling time of bacterial cells in culture; Demonstration of bacteriophage by plaque assay method; Determination of soluble protein content in a bacterial culture.	4
3	Isolation, purification and raising clonal population of a bacterium; Biological assay of bacteriophage and determination of phage population in lysate.	4
4	Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; Quantitative estimation of DNA, RNA and protein in an organism; Numericals: problems and assignments.	2

* Assignments marks (No marks for attendance). Mandatory to have 75% attendance for appearing in final examination.

Suggested Readings

Bruce A.2004. *Essential Cell Biology*. Garland.
Karp G.2004. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley.
Klug WS & Cummings MR 2003. *Concepts of Genetics*. Scot, Foreman & Co.
Lewin B. 2008. *IX Genes*. John Wiley & Sons
Lodish H, Berk A & Zipursky SL. 2004. *Molecular Cell Biology*. 5th Ed. WH Freeman.
Nelson DL & Cox MM. 2005. *Lehninger's Principles of Biochemistry*. WH Freeman & Co.

GP 509 BIOTECHNOLOGY FOR CROP IMPROVEMENT

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart knowledge and practical skills to use biotechnological tools in crop improvement.

Units	Content	Lectures
I	Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.	2
II	Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.	3
III	Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH).	4
IV	Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.	3
V	Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.	3
VI	Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.	4
VII	Biotechnology applications in male sterility/hybrid breeding, molecular farming.	2
VIII	MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights	3
IX	Bioinformatics & Bioinformatics tools.	2
X	Nanotechnology and its applications in crop improvement programmes.	2

Practical

S. No.	Particulars	
1	Requirements for plant tissue culture laboratory-Techniques in plant tissue culture. Media components and media preparation -Aseptic manipulation of various explants.	5
2	observations on the contaminants occurring in media – interpretations - Inoculation of explants; Callus induction and plant regeneration; Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures. Visit to commercial micropropagation unit.	5
3	Transformation using Agrobacterium strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.	4

* Assignments marks

Suggested Readings

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.

Gupta PK. 1997. *Elements of Biotechnology*. Rastogi Publ.

Hackett PB, Fuchs JA & Messing JW. 1988. *An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation.* 2nd Ed. Benjamin Publ. Co.

Sambrook J & Russel D. 2001. *Molecular Cloning* - a Laboratory Manual.3rd Ed. Cold Spring Harbor Lab. Press. Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani.

Minor Courses

PL PATH 504 PRINCIPLES OF PLANT PATHOLOGY

Credits: 3 + 0 Mid-Session Exam: 40
Contact hours: 42+0 End-Semester Exam: 60

Objective: To introduce the subject of Plant Pathology, its concepts and principles.

Unit	Contents	Lectures
I	Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.	**5**
II	Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development	**8**
III	Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens	**15**
IV	Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.	**10**
V	Disease management strategies	**4**

Suggested Readings

Agrios GN. 2005. *Plant Pathology*. 5 th Ed. Academic Press, New York.

Heitefuss R & Williams PH. 1976. *Physiological Plant Pathology*. Springer Verlag, Berlin, New York.

Mehrotra RS & Aggarwal A. 2003. *Plant Pathology*. 2nd Ed. Oxford & IBH, New Delhi.

Singh RS. 2002. *Introduction to Principles of Plant Pathology*. Oxford & IBH, New Delhi.

Singh DP & Singh A. 2007. *Disease and Insect Resistance in Plants*.Oxford & IBH, New Delhi

Upadhyay RK & Mukherjee KG. 1997. *Toxins in Plant Disease Development and Evolving Biotechnology* . Oxford & IBH, New Delhi

PL PATH 506 PRINCIPLES OF PLANT DISEASE MANAGEMENT

Credits: 2+1 Mid sessional exam : 25 (20+5*)
Contact hours: 28+28 Practical : 35
End-semester exam : 40

Objectives: To acquaint with different strategies for management of plant diseases.

Theory

Unit	Contents	Lectures
I	Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management	**12**
II	Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.	**10**
III	History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.	**6**

Practical

1.	*In vitro* and *in vivo* evaluation of chemicals against plant pathogens	4
2.	ED and MIC values	5
3.	Study of structural details of sprayers and dusters	5

Suggested Readings

Fry WE. 1982. *Principles of Plant Disease Management*. Academic Press, New York.

Hewitt HG. 1998. *Fungicides in Crop Protection*. CABI, Wallington.

Marsh RW. 1972. *Systemic Fungicides*. Longman, New York

Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. Oxford & IBH, New Delhi

Palti J. 1981. *Cultural Practices and Infectious Crop Diseases*. Springer- Verlag, New York

Vyas SC. 1993 *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill, New Delhi.

PL PATH 516 INTEGRATED DISEASE MANAGEMENT

Credits: 2+1
Contact hours: 28+28

Mid Sessional Exam: 25 (20+5*)
End-Semester Exam: 40
Practical : 35

Objective: To emphasize the importance and need of IDM in the management of diseases of portant crops.

Theory

Unit	Contents	Lectures
I	Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications	**10**
II	Development of IDM- basic principles, biological, chemical and cultural disease management.	**8**
III	IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed- mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.	**10**

Practical

1.	Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM	7
2.	Demonstration of IDM in certain crops as project work.	7

Suggested Readings

Gupta VK & Sharma RC. (Eds). 1995. *Integrated Disease Management and Plant Health*. Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases*. Daya Publ. House, New Delhi.

Sharma RC & Sharma JN. (Eds). 1995. *Integrated Plant Disease Management*. Scientific Publ., Jodhpur.

Supporting Courses

STAT 512 EXPERIMENTAL DESIGNS

Credits: 2+1 Mid-session exam: 25 (20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Units	Contents	Lectures
I	Need for designing of experiments, characteristics of a good design. Basic principles of designs- rand omization, replication and local control. Uniformity trials, size and shape of plots and blocks.	6
II	Analysis of variance; Completely randomized design, randomized block design and Latin square design. Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.	8
III	Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications~ Lattice design, alpha design- concepts, randomisation procedure, analysis and interpretation of results.	8
IV	Response surfaces. Experiments with mixtures. Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.	6

Practical		
1.	Uniformity trial data analysis, formation of plots and blocks,	1
2.	Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD	4
3.	Analysis of factorial experiments without and with confounding	1
4.	Analysis with missing data	1
5.	Split plot and strip plot designs	2
6.	Transformation of data	1
7.	Analysis of resolvable designs	2
8.	Fitting of response surfaces.	1
9.	Uniformity data analysis, formation of plots and blocks, Fair field Smith Laee.	1

Suggested Readings

Readings Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
Federer WT. 1985. Experimental Designs. MacMillan.
Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
Design Resources Server: www.iasri.res.in/design.
#Assignments marks

SPG 503 REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

Credits: 1+1
Contact hours: 14+28

Mid-session exam: 20 (15+5#)
Practical Exam: 50
End-semester exam : 30

Objective: It introduces the participant to the basic concepts of Geo-informatics, Image processing, Optical Physics and the operational skills necessary to acquire remotely sensed data and extract biophysical properties of earth recourses from them. Students will also gain the ability to extract data from real world.

Units	Contents	Lectures
I	The use of arieal photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-reference.	5
II	The integration of spatial data analysis system with knowledge-based systems and/ or simulation systems for the development of information/decision support systems.	4
III	Future prospects of remote sensing in India, software used in remote sensing, GIS versus remote sensing, Introduction to GIS software.	3
IV	Global positioning system (GPS) components and its function and uses in data collection for GIS	3

Practical

1.	Use of various photogrammnetry instrument	4
2.	Recognition and identification of objects on photography	4
3.	Compilation of map and their interpretation,	3
4.	Hands on practical on remote sensing and GIS, software.	3

Suggested Readings

DeMers, M. N. 2003. Fundamentals of geographic information systems.
J. Wiley. Chrisman, N. 2002. Exploring Geographic Information Systems, J W and Sons, New York.
Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.
Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.
Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall.
#Assignments marks

Compulsory Non Creditable Courses

PGS 501 LIBRARY AND INFORMATION SERVICES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical	Practical Description	
1.	Introduction to library and its services; Role of libraries in education, research and technology transfer;	1
2.	Classification systems and organization of library;	3
3.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources;	1
4.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);	2
5.	Tracing information from reference sources;	1
6.	Literature survey; Citation techniques/Preparation of bibliography;	1
7.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services;	2
8.	Use of Internet including search engines and its resources; e-resources access methods	3

Suggested Readings

Singh, Ajay Pratap, 2013. Information Communication and Society. New Delhi: EssEss Publishers.
Kumar Krishan, 2013. Reference Service. 5th Rev ed. New Delhi: Vikas.
Dhiman, Anil Kumar, 2005. Information and Reference Sources and Service. New Delhi: EssEss.
Ranganathan, S.R.1989. Reference Service. 2nd Rev. ed. Banglore: Sharda Endowment for Library Science.
Mukjerjee, A.K. 1971. Reference Work and its Tools. 2nd ed. Calcutta: World Press.
Sinha, Pradeep K. 2007. Computer Fundamentals. 4th ed. Delhi: BPB Publications.
#Assignments mark

PGS 502 TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc.
To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical	Practical Description	
1.	Technical Writing- Various forms of scientific writings- thesis, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface,.	2
2.	Technical Writing- Introduction, review of literature, material and methods, experimental results and discussion);	2
3.	Technical Writing- Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions;	2
4.	Technical Writing- pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups;	1
5.	Technical Writing- Editing and proof-reading; Writing of a review article.	1
6.	Communication Skills -Grammar (Tenses, parts of speech, clauses, punctuation marks);	1
7.	Communication Skills -Error analysis (Common errors);	1
8.	Communication Skills -Concord; Collocation; Phonetic symbols and transcription;	1
9.	Communication Skills -Accentual pattern: Weak forms in connected speech:	1
10.	Communication Skills -Participation in group discussion: Facing an interview;	1
11.	Communication Skills -presentation of scientific papers.	1

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
James HS. 1994. Handbook for Technical Writing. NTC Business Books.
Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. Speaking English Effectively. MacMillan India.
Richard WS. 1969. Technical Writing. Barnes & Noble.
Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek. Sethi J &
Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.
#Assignments mark

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement;	3
II	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection	4
III	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity	4
IV	International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	3

Suggested Readings

Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.
#Assignments marks

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To acquaint the students on the basics of commonly used techniques in laboratory.

Practical	Practical Description	
1.	Safety measures while in Lab; Handling of chemical substances;	2
2.	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;	2
3.	Washing, drying and sterilization of glassware;	2
4.	Drying of solvents/chemicals.	2
5.	Weighing and preparation of solutions of different strengths and their dilution;	2
6.	Handling techniques of solutions;	2
7.	Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids;	2
8.	Neutralisation of acid and bases;	2
9.	Preparation of buffers of different strengths and pH values.	2
10.	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;	2
11.	Electric wiring and earthing.	2
12.	Preparation of media and methods of sterilization;	2
13.	Seed viability testing,	2
14.	testing of pollen viability;	1
15.	Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	1

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
#Assignments marks

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES

Credits: 1 + 0 Mid-session exam : 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International	3
II	Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	3
III	Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. Concept and connotations of rural development, rural development policies and strategies.	4
IV	Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.	4

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.
#Assignments marks

PGS 506 DISASTER MANAGEMENT

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion	4
II	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents	3
III	Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media.	4
IV	Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.	3

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.
#Assignments mark

Study Scheme & Syllabus

For

M.Sc. Ag. (Plant Pathology)

(First to Fourth Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

PROGRAMME STRUCTURE

M. Sc. Ag. (Plant Pathology)

1.Minor Field : Entomology

2.Supporting Field: Statistics (Mandatory Course) + One course other than Minor field

3.Credit load distribution:

Major Field : 20

Minor field :09

Supporting :05

Master's Research : 20

Seminar :01

Compulsory Non Credit Course:06

Total **:**61

M. Sc. Ag. (Plant Pathology)

Semester wise Syllabus Scheme

S. No.	Course Code	Course title	Credit	Semester
Semester I				
Major Courses				
1	PL PATH-501	Mycology	2+1	I
2	PL PATH-502	Plant Virology	2+1	I
3	PL PATH-504	Principles of Plant Pathology	3+0	I
4	PL PATH-505	Detection and Diagnosis of Plant Diseases	0+2	I
Minor Courses				
1	ENT 504	Classification of Insects	2+1	I
Compulsory Non Creditable Courses				
1	PGS 501	Library and Information Services	0+1	I
2	PGS 502	Technical Writing and Communication Skills	0+1	I
Total		**1+3+2**	**16**	
SEMESTER II				
Major Courses				
1	PL PATH 503	Plant Bacteriology	2+1	II
2	PL PATH 506	Principles of Plant Disease Management	2+1	II
3	PL PATH 599	Master's Research	0+2	II
Minor Courses				
1	ENT 508	Toxicology of Insecticides	2+1	II
Supporting Course				
1	STAT 512	Experimental Designs	2+1	II
Compulsory Non Creditable Courses				
1	PGS 503	Intellectual Property and Its Management in Agriculture	1+0	II
2	PGS 504	Basic Concepts in Laboratory Techniques	0+1	II
Total		**8+3+3+2**	**16**	
SEMESTER III				
Major Courses				
1	PL PATH 516	Integrated Disease Management	2+1	III
2	PL PATH 591	Master's Seminar	1+0	III
3	PL PATH 599	Master's Research	0+3	III
Minor Courses				
1	ENT 510	Principles of Integrated Pest Management	1+1	III
2	ENT 518	Techniques in Plant Protection	0+1	III
Supporting course				
1	SPG 503	Remote Sensing and Geographical Information System	1+1	III
Compulsory Non Creditable Courses				
1	PGS 505	Agriculture Research Ethics and Rural Development Programmes	1+0	III
2	PGS 506	Disaster Management	1+0	III
Total credits		**7+3+2+2**	**14**	
SEMESTER IV				
1	PL PATH 599	Master's Research	0+15	IV
Total credits			**15**	

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

M. Sc. Ag. (Plant Pathology)

Course Contents

PL PATH 501
MYCOLOGY

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact hours: 28+28 Practical Exam: 35
End-Semester Exam: 40

Objective: To study the nomenclature, classification and characters of fungi.

Unit	Contents	Lectures
I	Introduction, definition of different terms, basic concepts.	3
II	Importance of mycology in agriculture, relation of fungi to human affairs, history of mycology.	6
III	Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi.	6
IV	The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: (a) Myxomycota and (b) Eumycota i) Mastigomycotina ii) Zygomycotina, iii) Ascomycotina, iv) Basidiomycotina, v) Deuteromycotina. Lichens types and importance, fungal genetics and variability in fungi.	13

Practical

1.	Detailed comparative study of different groups of fungi	5
2.	collection, identification and preservation of specimens	5
3.	Isolation and identification of plant pathogenic fungi.	4

Suggested Readings

Ainsworth GC, Sparrow FK & Susman HS. 1973. The Fungi – An Advanced Treatise. Vol. IV (A & B). Academic Press, New York.
Alexopoulos CJ, Mims CW & Blackwell M.2000. Introductory Mycology. 5th Ed. John Wiley & Sons, New York.
Mehrotra RS & Arneja KR. 1990. An Introductory Mycology. Wiley Eastern, New Delhi.
Sarbhoy AK. 2000. Text book of Mycology. ICAR, New Delhi.
Singh RS. 1982. Plant Pathogens – The Fungi. Oxford & IBH, New Delhi

PL PATH 502
PLANT VIROLOGY

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint with the structure, virus-vector relationship, biology and management of plant viruses.

Unit	Contents	Lectures
I	History of plant viruses, composition and structure of viruses	3
II	Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host virus interaction, virus vector relationship.	6
III	Virus nomenclature and classification, genome organization, replication and movement of viruses	5
IV	Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics.	5
V	Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions. Principles of the working of electron-microscope and ultra-microtome.	3
VI	Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.	6

Practical

1.	Study of symptoms caused by viruses	2
2.	Transmission, assay of viruses	2
3.	Physical properties	2
4.	Purification	2
5.	Method of raising antisera	1
6.	Serological tests	1
7.	Electron microscopy and ultratomy	2
8.	PCR	2

Suggested Readings

Bos L. 1964. Symptoms of Virus Diseases in Plants. Oxford & IBH., New Delhi
Brunt AA, Krabtree K, Dallwitz MJ, Gibbs AJ & Watson L. 1995. Virus of Plants: Descriptions and Lists from VIDE Database. CABI, Wallington
Gibbs A & Harrison B. 1976. Plant Virology - The Principles . Edward Arnold, London
Hull R. 2002. Mathew's Plant Virology. 4th Ed. Academic Press, New York.
Noordam D. 1973. Identification of Plant Viruses, Methods and Experiments. Oxford & IBH, New Delhi.

PL PATH 503
PLANT BACTERIOLOGY

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint with plant pathogenic prokaryote (procarya) and their structure, nutritional requirements, survival and dissemination.

Unit	Contents	Lectures
I	History and introduction to phytopathogenic procarya, viz., bacteria, MLOs, spiroplasmas and other fastidious procarya. Importance of phytopathogenic bacteria.	8
II	Evolution, classification and nomenclature of phytopathogenic procarya and important diseases caused by them.	2
III	Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya	4
IV	General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios	8
V	Procaryotic inhibitors and their mode of action against phytopathogenic bacteria.	3
VI	Survival and dissemination of phytopathogenic bacteria.	3

S. No.	Practical	
1.	Isolation, purification, identification and host inoculation of phytopathogenic bacteria	4
2.	Staining methods	4
3.	Biochemical and serological characterization	4
4.	Isolation of plasmid and use of antibacterial chemicals/antibiotics	2

Suggested Readings

Goto M. 1990. Fundamentals of Plant Bacteriology. Academic Press, New York.
Jayaraman J & Verma JP. 2002. Fundamentals of Plant Bacteriology . Kalyani Publ., udhiana
Mount MS & Lacy GH. 1982. Phytopathogenic Prokaryotes. Vols. I, II. Academic Press, ew York.
Verma JP, Varma A & Kumar D. (Eds). 1995. Detection of Plant Pathogens and their Management. Angkor Publ., New Delhi.
Verma JP. 1998. The Bacteria. Malhotra Publ. House, New Delhi.

PL PATH 504
PRINCIPLES OF PLANT PATHOLOGY

Cedits: 3+0 Mid Sessional Exam: 40
Contact hours: 42 End Semester Exam : 60

Objective: To introduce the subject of Plant Pathology, its concepts and principles.

Unit	Contents	Lectures
I	Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.	5
II	Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development	8
III	Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens	15
IV	Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.	10
V	Disease management strategies	4

Suggested Readings

Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.
Heitefuss R & Williams PH. 1976. Physiological Plant Pathology. Springer Verlag, Berlin, New York.
Mehrotra RS & Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi.
Singh RS. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi.
Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants.Oxford & IBH, New Delhi
Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH, New Delhi

PL PATH 505
DETECTION AND DIAGNOSIS OF PLANT DISEASES

Credits: 0+2 Mid sessional exam: 50
Contact hours: 0+56 End-semester exam: 50

Objective: To impart training on various methods/techniques/instruments used in the study of plant diseases/pathogens.

Unit	Practical	Practicals
I	Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens.	9
II	Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida.	9
III	Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of references.	10

Suggested Readings

Baudoin ABAM, Hooper GR, Mathre DE & Carroll RB. 1990. Laboratory
Exercises in Plant Pathology: An Instructional Kit. Scientific Publ., Jodhpur. Dhingra OD & Sinclair JB. 1986. Basic Plant Pathology Methods . CRC Press, London, Tokyo.
Fox RTV. 1993. Principles of Diagnostic Techniques in Plant Pathology. CABI Wallington.
Mathews REF. 1993. Diagnosis of Plant Virus Diseases. CRC Press, Boca Raton, Tokyo.
Pathak VN. 1984. Laboratory Manual of Plant Pathology. Oxford & IBH, New Delhi.
Forster D & Taylor SC. 1998. Plant Virology Protocols: From Virus Isolation to Transgenic Resistance. Methods in Molecular Biology . Humana Press, Totowa, New Jersey.
Matthews REF. 1993. Diagnosis of Plant Virus Diseases. CRC Press, Florida.
Noordam D. 1973. Identification of Plant Viruses, Methods and Experiments. Cent. Agic. Pub. Doc. Wageningen.
Trigiano RN, Windham MT & Windham AS. 2004. Plant Pathology- Concepts and Laboratory Exercises. CRC Press, Florida.
Chakravarti BP. 2005. Methods of Bacterial Plant Pathology. Agrotech, Udaipur.

PL PATH 506
PRINCIPLES OF PLANT DISEASE MANAGEMENT

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objectives: To acquaint with different strategies for management of plant diseases.

Unit	Contents	Lectures
I	Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management	12
II	Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.	10
III	History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.	6

Practicals

1.	*In vitro* and *in vivo* evaluation of chemicals against plant pathogens	5
2.	ED and MIC values	5
3.	Study of structural details of sprayers and dusters	4

Suggested Readings

Fry WE. 1982. Principles of Plant Disease Management. Academic Press, New York.
Hewitt HG. 1998. Fungicides in Crop Protection. CABI, Wallington.
Marsh RW. 1972. Systemic Fungicides. Longman, New York
Nene YL & Thapliyal PN. 1993. Fungicides in Plant Disease Control. Oxford & IBH, New Delhi
Palti J. 1981. Cultural Practices and Infectious Crop Diseases. Springer- Verlag,
New York
Vyas SC. 1993 Handbook of Systemic Fungicides. Vols. I-III. Tata McGraw Hill, New Delhi.

PL PATH 516
INTEGRATED DISEASE MANAGEMENT

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To emphasize the importance and need of IDM in the management of diseases of important crops.

Unit	Contents	Lectures
I	Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications	10
II	Development of IDM- basic principles, biological, chemical and cultural disease management.	8
III	IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed- mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.	10

Practicals

1.	Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM	7
2.	Demonstration of IDM in certain crops as project work.	7

Suggested Readings

Gupta VK & Sharma RC. (Eds). 1995. Integrated Disease Management and Plant Health. Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. Biotechnological Approaches for the Integrated Management of Crop Diseases. Daya Publ. House, New Delhi.

Sharma RC & Sharma JN. (Eds). 1995. Integrated Plant Disease Management. Scientific Publ., Jodhpur.

Minor Courses

ENT 504
CLASSIFICATION OF INSECTS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects.

Units	Contents	Lectures
I	Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained	6
II	Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera.	8
III	Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Subclass: Pterygota, Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.	7
IV	Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.	7

S. No.	Practical Description	Practicals
1.	Study of orders of insects and their identification using taxonomic keys.	4
2.	Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera.	5
3.	Field visits to collect insects of different orders.	5

Suggested Reading

CSIRO 1990. The Insects of Australia: A Text Book for Students and Researchers. 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca

Freeman S & Herron JC. 1998. Evolutionary Analysis. Prentice Hall, New Delhi

Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman & Hall, London

Ross HH.1974. Biological Systematics. Addison Wesley Publ. Co.

Triplehorn CA & Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects. 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

#Assignments marks

ENT 508
TOXICOLOGY OF INSECTICIDES

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Units	Contents	Lectures
I	Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.	3
II	Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc.	9
III	Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides-synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.	6
IV	Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.	5
V	Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.	5

S. No.	Practical Description	Practicals
1.	Insecticide formulations and mixtures; quality control of pesticide formulations.	3
2.	Laboratory and field evaluation of bioefficacy of insecticides	2
3.	Bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action.	3
4.	Toxicity to beneficial insects.	3
5.	Pesticide appliances. Working out doses and concentrations of pesticides.	2
6.	Visit to toxicology laboratories. Good laboratory practices.	1

Suggested Readings

Chattopadhyay SB. 1985. Principles and Procedures of Plant Protection. Oxford & IBH, New Delhi.
Gupta HCL.1999. Insecticides: Toxicology and Uses. Agrotech Publ., Udaipur.
Ishaaya I & Degheele (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi.
Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. Insecticides in Agriculture and Environment. Narosa Publ. House, New Delhi.
Prakash A & Rao J. 1997. Botanical Pesticides in Agriculture. Lewis Publ., New York.

ENT 510
PRINCIPLES OF INTEGRATED PEST MANAGEMENT

Credits: 1 + 1 | Mid-Session Exam : 20 (15+5#)
Contact hours: 14 + 28 | Practical Exam: 50
End-Semester Exam: 30

Objective: To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL, implementing IPM programmes.

Units	Contents	Lectures
I	History and origin, definition and evolution of various related terminologies.	3
II	Concept and philosophy, ecological principles, economic threshold concept, and economic consideration.	3
III	Tools of pest management and their integration- legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys;	4
IV	Political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.	4

	Practical Description	Practicals
1.	Characterization of agro-ecosystems; sampling methods and factors affecting sampling.	3
2.	Population estimation methods.	3
3.	Crop loss assessment: direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses.	4
4.	Computation of EIL and ETL; crop modeling; designing and implementing IPM system.	4

Suggested Readings

Dhaliwal GS & Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publ., New Delhi.
Dhaliwal GS, Singh R & Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publ., New Delhi.
Horowitz AR & Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi.
Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi.
Norris RF, Caswell-Chen EP & Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi.
#Assignments marks

ENT 518
TECHNIQUES IN PLANT PROTECTION

Credits: 0 + 1 Mid-session exam: 50
Contact hours: 0 + 28 End-semester exam: 50

Objective: To acquaint the students with appropriate use of plant protection equipments and techniques related to microscopoy, computation, pest forecasting, electrophoresis etc.

S. No.	Practical Description	Practicals
1.	Pest control equipments, principles, operation, maintenance, selection, application of pesticides and biocontrol agents, seed dressing, soaking, root-dip treatment, dusting, spraying, application through irrigation water.	3
2.	Soil sterilization, solarization, deep ploughing, flooding, techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers	3
3.	Use of light, transmission and scanning electron microscopy.	2
4.	Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE.	2
5.	Use of tissue culture techniques in plant protection.	2
6	Computer application for predicting/forecasting pest attack and identification.	1

Suggested Readings

Alford DV. 1999. A Textbook of Agricultural Entomology. Blackwell Science, London.

Crampton JM & Eggleston P. 1992. Insect Molecular Science. Academic Press, London.

#Assignments marks

Supporting Courses

STAT 512
EXPERIMENTAL DESIGNS

Credits: 2+1
Contact hours: 28+28

Mid-session exam: 25 (20+5#)
Practical exam: 35
End-semester exam: 40

Objective: This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Units	Contents	Lectures
I	Need for designing of experiments, characteristics of a good design. Basic principles of designs- rand omization, replication and local control. Uniformity trials, size and shape of plots and blocks.	6
II	Analysis of variance; Completely randomized design, randomized block design and Latin square design. Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.	8
III	Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications~ Lattice design, alpha design- concepts, randomisation procedure, analysis and interpretation of results.	8
IV	Response surfaces. Experiments with mixtures. Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.	6
Practical		
1.	Uniformity trial data analysis, formation of plots and blocks,	1
2.	Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD	4
3.	Analysis of factorial experiments without and with confounding	1
4.	Analysis with missing data	1
5.	Split plot and strip plot designs	2
6.	Transformation of data	1
7.	Analysis of resolvable designs	2
8.	Fitting of response surfaces.	1
9	Uniformity data analysis, formation of plots and blocks, Fair field Smith Laee.	1

Suggested Readings

Readings Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
Federer WT. 1985. Experimental Designs. MacMillan.
Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
Design Resources Server: www.iasri.res.in/design.
#Assignments marks

SPG 503
REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

Credits: 1+1 Mid-session exam: 20 (15+5#)
Contact hours: 14+28 Practical Exam: 50
End-semester exam : 30

Objective: It introduces the participant to the basic concepts of Geo-informatics, Image processing, Optical Physics and the operational skills necessary to acquire remotely sensed data and extract biophysical properties of earth recourses from them. Students will also gain the ability to extract data from real world.

Units	Contents	Lectures
I	The use of arieal photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-reference.	5
II	The integration of spatial data analysis system with knowledge-based systems and/ or simulation systems for the development of information/decision support systems.	4
III	Future prospects of remote sensing in India, software used in remote sensing, GIS versus remote sensing, Introduction to GIS software.	3
IV	Global positioning system (GPS) components and its function and uses in data collection for GIS	3

Practical

1.	Use of various photogrammnetry instrument	4
2.	Recognition and identification of objects on photography	4
3.	Compilation of map and their interpretation,	3
4.	Hands on practical on remote sensing and GIS, software.	3

Suggested Readings

DeMers, M. N. 2003. Fundamentals of geographic information systems.
J. Wiley. Chrisman, N. 2002. Exploring Geographic Information Systems, J W and Sons, New York.
Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.
Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.
Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall.
#Assignments marks

Compulsory Non Creditable Courses

PGS 501
LIBRARY AND INFORMATION SERVICES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical	Practical Description	
1.	Introduction to library and its services; Role of libraries in education, research and technology transfer;	1
2.	Classification systems and organization of library;	3
3.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources;	1
4.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);	2
5.	Tracing information from reference sources;	1
6.	Literature survey; Citation techniques/Preparation of bibliography;	1
7.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services;	2
8.	Use of Internet including search engines and its resources; e-resources access methods	3

Suggested Readings

Singh, Ajay Pratap, 2013. Information Communication and Society. New Delhi: EssEss Publishers.
Kumar Krishan, 2013. Reference Service. 5th Rev ed. New Delhi: Vikas.
Dhiman, Anil Kumar, 2005. Information and Reference Sources and Service. New Delhi: EssEss.
Ranganathan, S.R.1989. Reference Service. 2nd Rev. ed. Banglore: Sharda Endowment for Library Science.
Mukjerjee, A.K. 1971. Reference Work and its Tools. 2nd ed. Calcutta: World Press.
Sinha, Pradeep K. 2007. Computer Fundamentals. 4th ed. Delhi: BPB Publications.
#Assignments mark

PGS 502
TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical	Practical Description	
1.	Technical Writing- Various forms of scientific writings- thesis, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface.	2
2.	Technical Writing- Introduction, review of literature, material and methods, experimental results and discussion);	2
3.	Technical Writing- Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions;	2
4.	Technical Writing- pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups;	1
5.	Technical Writing- Editing and proof-reading; Writing of a review article.	1
6.	Communication Skills -Grammar (Tenses, parts of speech, clauses, punctuation marks);	1
7.	Communication Skills -Error analysis (Common errors);	1
8.	Communication Skills -Concord; Collocation; Phonetic symbols and transcription;	1
9.	Communication Skills -Accentual pattern: Weak forms in connected speech:	1
10.	Communication Skills -Participation in group discussion: Facing an interview;	1
11.	Communication Skills -presentation of scientific papers.	1

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
James HS. 1994. Handbook for Technical Writing. NTC Business Books.
Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. Speaking English Effectively. MacMillan India.
Richard WS. 1969. Technical Writing. Barnes & Noble.
Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek. Sethi J &
Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.
#Assignments mark

PGS 503
INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 + 0 Mid-Session Exam: 40
Contact hours: 14+0 End-Semester Exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement;	3
II	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection	4
III	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity	4
IV	International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	3

Suggested Readings

Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.
#Assignments marks

PGS 504
BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To acquaint the students on the basics of commonly used techniques in laboratory.

Practical	**Practical Description**	
1.	Safety measures while in Lab; Handling of chemical substances;	2
2.	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;	2
3.	Washing, drying and sterilization of glassware;	2
4.	Drying of solvents/chemicals.	2
5.	Weighing and preparation of solutions of different strengths and their dilution;	2
6.	Handling techniques of solutions;	2
7.	Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids;	2
8.	Neutralisation of acid and bases;	2
9.	Preparation of buffers of different strengths and pH values.	2
10.	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;	2
11.	Electric wiring and earthing.	2
12.	Preparation of media and methods of sterilization;	2
13.	Seed viability testing,	2
14.	testing of pollen viability;	1
15.	Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	1

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
#Assignments marks

PGS 505
AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES

Credits: 1 + 0 Mid-session exam : 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International	3
II	Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	3
III	Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. Concept and connotations of rural development, rural development policies and strategies.	4
IV	Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.	4

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.
#Assignments marks

PGS 506 DISASTER MANAGEMENT

Credits: 1 + 0 Mid-Session Exam: 40
Contact hours: 14+0 End- Session Exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion	4
II	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents	3
III	Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media.	4
IV	Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.	3

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.
#Assignments mark

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

M. Sc. Ag. (Soil Science and Agriculture Chemistry)
(I to IV Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

M. Sc. Ag. (Soil Science & Agriculture Chemistry)

Minor Field: Agronomy

Subject	**Credit hours as per BSMA ICAR for Master's programme**
Major	21
Minor	09
Supporting	05
Seminar	01
Master's Research	20
Total Credits	**56**
Compulsory Non-Credit Courses	06
Grand Total	**62**

Syllabus Scheme

Semester wise

S. No.	Course Code	Course Title	Credit hrs	Semester
Semester I				
Major courses				
1	SOILS 501	Soil Physics	2+1	I
2	SOILS 502	Soil Fertility and Fertilizer use	3+1	I
3	SOILS 513	Management of Problem Soils and Waters	2+1	I
Minor courses				
4	AGRON-501	Modern Concepts in Crop Production	3+0	I
Compulsory Non-Credit Courses				
5	PGS-501	Library and Information Services	0+1	I
6	PGS-502	Technical Writing and Communications Skills	0+1	I
Total Credits			**15**	
Semester II				
Major courses				
1	SOILS 503	Soil Chemistry	2+1	II
2	SOILS 504	Soil Mineralogy, Genesis, Classification and	2+1	II
3	SOILS 599	Master's Research	0+2	II
Minor courses				
4	AGRON 502	Principles and Practices of Soil Fertility and Nutrient Management	2+1	II
Supporting courses				
5	STAT-512	Experimental Designs	2+1	II
Compulsory Non-Credit Courses				
6	PGS-503	Intellectual Property and Its Management in	1+0	II
7	PGS-504	Basic Concepts in Laboratory Techniques	0+1	II
Total			**16**	

S. No.	Course Code	Course Title	Credit hrs	Semester
Semester III				
Major courses				
1	SOILS 506	Soil Biology and Biochemistry	2+1	III
2	SOILS 511	Analytical Techniques and Instrumental Methods in Soil and Plant Analysis	0+2	III
3	SOILS 591	Masrer's Seminar	1+0	III
4	SOILS 599	Master's Research	0+3	III
Minor courses				
1	AGRON 504	Principles and Practices of Water Management	2+1	III
Supporting courses				
1	SPG-503	Remote Sensing and Geographic Information System	1+1	III
Compulsory Non-Credit Courses				
1	PGS-505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0	III
2	PGS-506	Disaster Management	1+0	III
Total Credit			**16**	
Semester IV				
1	SOILS-599	Master's Research	0+15	IV
Total Credits			**15**	

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

SOIL SCIENCE AND AGRICULTURE CHEMISTRY

Course Contents

SOILS 501
SOIL PHYSICS

Credits: 2 + 1
Contact hours: 28 + 28

Mid-session exam: 25 (20+5#)
Practical exam: 35
End-semester exam: 40

Objective: To impart basic knowledge about soil physical properties and processes in relation to plant growth.

Theory

Units	Contents	Lectures
I	Scope of soil physics and its relation with other branches of soil science; soil as a three phase system.	3
II	Soil texture, textural classes, mechanical analysis, specific surface.	3
III	Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts.	3
IV	Soil structure - genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation.	4
V	Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential.	3
VI	Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils.	3
VII	Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum.	3
VIII	Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management.	3
IX	Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.	3

Practical

1.	Mechanical analysis by pipette and international methods	1
2.	Measurement of Atterberg limits	1
3.	Aggregate analysis - dry and wet	1
4.	Measurement of soil-water content by different methods	1

5.	Measurement of soil-water potential by using tensiometer and gypsum blocks	1
6.	Determination of soil-moisture characteristics curve and computation of pore-size distribution	1
7.	Determination of hydraulic conductivity under saturated and unsaturated conditions	1
8.	Determination of infiltration rate of soil	1
9.	Determination of aeration porosity and oxygen diffusion rate	2
10.	Soil temperature measurements by different methods	2
11.	Estimation of water balance components in bare and cropped fields	2

Suggested Readings

Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.

Ghildyal BP & Tripathi RP. 2001. *Soil Physics*. New Age International. Hanks JR & Ashcroft GL. 1980. *Applied Soil Physics*. Springer Verlag.

Hillel D. 1972. *Optimizing the Soil Physical Environment toward Greater Crop Yields*. Academic Press.

Hillel D. 1980. *Applications of Soil Physics*. Academic Press.

Hillel D. 1980. *Fundamentals of Soil Physics*. Academic Press.

Hillel D. 1998. *Environmental Soil Physi*cs. Academic Press.

Hillel D. 2003. *Introduction to Environmental Soil Physics*. Academic Press.

Indian Society of Soil Science. 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley-Interscience.

Kohnke H. 1968. *Soil Physics*. McGraw Hill.

Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.

Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

Saha AK. 2004. *Text Book of Soil Physics*. Kalyani.

SOILS 502

SOIL FERTILITY AND FERTILIZER USE

Credits: 3 + 1 Mid-session exam: 30 (25+5[#])
Contact hours: 42 + 28 Practical exam: 25
End-semester exam: 45

Objective: To impart knowledge about soil fertility and its control, and to understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.

Theory

Units	Contents	Lectures
I	Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms.	4
II	Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation - types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.	6
III	Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions.	6
IV	Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.	6
V	Sulphur - source, forms, fertilizers and their behavior in soils; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.	4
VI	Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.	4
VII	Common soil test methods for fertilizer recommendations; quantity–intensity relationships; soil test crop response correlations and response functions.	4
VIII	Fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management.	4
IX	Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.	4

Practical

1.	Principles of colorimetry	4
2.	Flame-photometry and atomic absorption spectroscopy	4
3.	Chemical analysis of soil for total and available nutrients	3
4.	Analysis of plants for essential elements	3

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed.
Pearson Edu.
Kabata-Pendias A & Pendias H. 1992. *Trace Elements in Soils and Plants*. CRC Press.
Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers*
Technology. Scientific Publ.
Leigh JG. 2002. *Nitrogen Fixation at the Millennium*. Elsevier.
Mengel K & Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.
Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.
Pierzinsky GM, Sims TJ & Vance JF. 2002. *Soils and Environmental Quality*. 2nd Ed. CRC Press.
Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.
Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers*. 5th Ed. Prentice Hall of India.
Troeh FR & Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.

SOILS 503
SOIL CHEMISTRY

Credits: 2 + 1 Mid-session exam: 25 (20+5#)
Contact hours: 28 + 28 Practical exam: 35
End-semester exam: 40

Objective: To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

Theory

Units	Contents	Lectures
I	Chemical (elemental) composition of the earth's crust and soils.	2
II	Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.	2
III	Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions.	6
IV	Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange - innersphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.	6
V	Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects.	3
VI	Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity.	3
VII	Chemistry of salt-affected soils and amendments; soil pH, EC_e, ESP, SAR and important relations; soil management and amendments.	3
VIII	Chemistry and electrochemistry of submerged soils.	3

Practical

1.	Determination of CEC and AEC of soils	1
2.	Analysis of equilibrium soil solution for pH, EC, E_h by the use of E_h-pH meter and conductivity meter	2
3.	Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method	2
4.	Potentiometric and conductometric titration of soil humic and fulvic acids	1
5.	(E_4/E_6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the Δ (E_4/E_6) values at two pH values	2
6.	Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm	1
7.	Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved	2
8.	Determination of titratable acidity of an acid soil by $BaCl_2$-TEA method	1
9.	Determination of lime requirement of an acid soil by buffer method	1
10.	Determination of gypsum requirement of an alkali soil	1

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil.* Oxford and IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.

Greenland DJ & Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.

McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press. Sposito G. 1981. *The Thermodynamics of Soil Solutions.* Oxford Univ. Press.

Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.

Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.

Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.

Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SOILS 504
SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY

Credits: 2 + 1 | Mid-session exam: 25 (20+5#)
Contact hours: 28 + 28 | Practical exam: 35
End-semester exam: 40

Objective: To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis in terms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

Units	Contents	Lectures
I	Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.	4
II	Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils.	6
III	Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.	6
IV	Concept of soil individual; soil classification systems - historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness.	4
V	Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.	4
VI	Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.	4

Practical

1.	Identification and quantification of minerals in soil fractions	1
2.	Morphological properties of soil profile in different landforms	2
3.	Classification of soils using soil taxonomy	2
4.	Calculation of weathering indices and its application in soil formation	2
5.	Grouping soils using available data base in terms of soil quality	2
6.	Aerial photo and satellite data interpretation for soil and land use	2
7.	Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales	2
8.	Land use planning exercises using conventional and RS tools	1

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.

Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.

Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi

Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.

USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.

Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.

Wilding LP & Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*. Elsevier.

Wilding NE & Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*. I. *Concept and Interaction*. Elsevier.

SOILS 506
SOIL BIOLOGY AND BIOCHEMISTRY

Credits: 2 + 1 Mid-session exam: 25 (20+5#)
Contact hours: 28 + 28 Practical exam: 35
End-semester exam: 40

Objective: To teach students the basics of soil biology and biochemistry, including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

Theory

Units	Contents	Lectures
I	Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota.	4
II	Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora.	6
III	Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, humus formation; cycles of important organic nutrients.	6
IV	Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.	4
V	Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost	4
VI	Biofertilizers – definition, classification, specifications, method of production and role in crop production.	4

Practical

1.	Determination of soil microbial population	2
2.	Soil microbial biomass	2
3.	Elemental composition, fractionation of organic matter and functional groups	2
4.	Decomposition of organic matter in soil	2
5.	Soil enzymes	2
6.	Measurement of important soil microbial processes such as ammonification, nitrification, N_2 fixation, S oxidation, P solubilization and mineralization of other micro nutrients	2
7.	Study of rhizosphere effect	2

Suggested Readings

Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
Metting FB. 1993. *Soil Microbial Ecology – Applications in Agricultural and Environmental Management*. Marcel Dekker.
Paul EA & Ladd JN. 1981. *Soil Biochemistry*. Marcel Dekker.
Reddy MV. (Ed.). *Soil Organisms and Litter in the Tropics*. Oxford & IBH.

Russel RS. 1977. *Plant Root System: Their Functions and Interaction with the Soil*. ELBS & McGraw Hill.
Stotzky G & Bollag JM. 1993. *Soil Biochemistry*. Vol. VIII. Marcel Dekker.
Sylvia DN. 2005. *Principles and Applications of Soil Microbiology*. Pearson Edu.
Wild A. 1993. *Soil and the Environment - An Introduction*. Cambridge Univ. Press.

SOILS 511
ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS

Credits: 0+2 Mid-session exam: 50
Contact hours: 56 End-semester exam: 50

Objective: To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Practical

Units	Contents	Practical
I	Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidationreduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.	4
II	Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.	4
III	Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods.	4
IV	Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.	4
V	Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.	4
VI	Determination of lime and gypsum requirement of soil; drawing normalized exchange isotherms; measurement of redox potential.	4
VII	Analysis of soil extracts and irrigation waters for their soluble cations and anions and interpretation of results.	4

Suggested Readings

Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons.
Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.
Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.
Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
Piper CE. *Soil and Plant Analysis*. Hans Publ.
Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis - A Methods Manual*. IARI, New Delhi.
Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.
Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.
Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

SOILS 513

MANAGEMENT OF PROBLEM SOILS AND WATERS

Credits: 2 + 1
Contact hours: 28 + 28

Mid-session exam: 25 (20+5#)
Practical exam: 35
End-semester exam: 40

Objective: To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

Units	Contents	Lectures
I	Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible**.**	4
II	Morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties.	6
III	Management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils.	6
IV	Acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management.	4
V	Quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality.	4
VI	Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.	4

Practical

I	Characterization of acid, acid sulfate, salt-affected and calcareous soils	4
II	Determination of cations (Na^+, K^+, Ca^{++} and Mg^{++}) in ground water and soil samples	4
III	Determination of anions (Cl^-, SO_4^{--}, CO_3^{--} and HCO_3^-) in ground waters and soil samples	3
IV	Lime and gypsum requirements of acid and sodic soils	3

Suggested Readings

Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.

Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.

USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

Supporting courses

STAT 512
EXPERIMENTAL DESIGNS

Credits: 2+1 Mid-session exam: 25 (20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Units	Contents	Lectures
I	Need for designing of experiments, characteristics of a good design. Basic principles of designs- rand omization, replication and local control. Uniformity trials, size and shape of plots and blocks.	6
II	Analysis of variance; Completely randomized design, randomized block design and Latin square design. Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.	8
III	Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications~ Lattice design, alpha design- concepts, randomisation procedure, analysis and interpretation of results.	8
IV	Response surfaces. Experiments with mixtures. Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.	6

Practical	Practical Description	
1.	Uniformity trial data analysis, formation of plots and blocks,	3
2.	Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD	3
3.	Analysis of factorial experiments without and with confounding	3
4.	Analysis with missing data	1
5.	Split plot and strip plot designs	1
6.	Transformation of data	1
7.	Analysis of resolvable designs	1
8.	Fitting of response surfaces.	1

S. No.	Reference Books
1.	Readings Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
2.	Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
3.	Federer WT. 1985. Experimental Designs. MacMillan.
4.	Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
5.	Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
6.	Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
7.	Design Resources Server: www.iasri.res.in/design.

#Assignments

SPG 503

REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

Credits: 1+1
Contact hours: 14+28

Mid-session exam: 20 (15+5#)
Practical Exam: 50
End-semester exam:30

Objective: It introduces the participant to the basic concepts of Geo-informatics, Image processing, Optical Physics and the operational skills necessary to acquire remotely sensed data and extract biophysical properties of earth recourses from them. Students will also gain the ability to extract data from real world.

Units	Contents	Lectures
I	The use of arieal photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-reference.	4
II	The integration of spatial data analysis system with knowledge-based systems and/ or simulation systems for the development of information/decision support systems.	4
III	Future prospects of remote sensing in India, software used in remote sensing, GIS versus remote sensing, Introduction to GIS software.	3
IV	Global positioning system (GPS) components and its function and uses in data collection for GIS	3

Practical	Practical Description	
1.	Use of various photogrammnetry instrument	4
2.	Recognition and identification of objects on photography	4
3.	Compilation of map and their interpretation,	3
4.	Hands on practical on remote sensing and GIS, software.	3

S. No.	Reference Books
1.	DeMers, M. N. 2003. Fundamentals of geographic information systems.
2.	J. Wiley. Chrisman, N. 2002. Exploring Geographic Information Systems, J W and Sons, New York.
3.	Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.
4.	Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.
5.	Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall.

#Assignments marks

Compulsory Non Creditable Courses

PGS 501

LIBRARY AND INFORMATION SERVICES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical	Practical Description	
1.	Introduction to library and its services; Role of libraries in education, research and technology transfer;	1
2.	Classification systems and organization of library;	3
3.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources;	1
4.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);	2
5.	Tracing information from reference sources;	1
6.	Literature survey; Citation techniques/Preparation of bibliography;	1
7.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services;	2
8.	Use of Internet including search engines and its resources; e-resources access methods	3

S. No.	Reference Books
1.	Singh, Ajay Pratap, 2013. Information Communication and Society. New Delhi: EssEss Publishers.
2.	Kumar Krishan, 2013. Reference Service. 5th Rev ed. New Delhi: Vikas.
3.	Dhiman, Anil Kumar, 2005. Information and Reference Sources and Service. New Delhi: EssEss.
4.	Ranganathan, S.R.1989. Reference Service. 2nd Rev. ed. Banglore: Sharda Endowment for Library Science.
5.	Mukjerjee, A.K. 1971. Reference Work and its Tools. 2nd ed. Calcutta: World Press.
6.	Sinha, Pradeep K. 2007. Computer Fundamentals. 4th ed. Delhi: BPB Publications.

#Assignments marks

PGS 502

TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical	**Practical Description**	
1.	Technical Writing- Various forms of scientific writings- thesis, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface	2
2.	Technical Writing- Introduction, review of literature, material and methods, experimental results and discussion);	1
3.	Technical Writing- Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions;	2
4.	Technical Writing- pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups;	2
5.	Technical Writing- Editing and proof-reading; Writing of a review article.	1
6.	Communication Skills -Grammar (Tenses, parts of speech, clauses, punctuation marks);	1
7.	Communication Skills -Error analysis (Common errors);	1
8.	Communication Skills -Concord; Collocation; Phonetic symbols and transcription;	1
9.	Communication Skills -Accentual pattern: Weak forms in connected speech:	1
10.	Communication Skills -Participation in group discussion: Facing an interview;	1
11.	Communication Skills -presentation of scientific papers.	1

S. No.	**Reference Books**
1.	Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
2.	Collins' Cobuild English Dictionary. 1995. Harper Collins.
3.	Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
4.	Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.

5.	James HS. 1994. Handbook for Technical Writing. NTC Business Books.
6.	Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
7.	Mohan K. 2005. Speaking English Effectively. MacMillan India.
8.	Richard WS. 1969. Technical Writing. Barnes & Noble.
9.	Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek. Sethi J &
10	Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
11.	Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

#Assignments marks

PGS 503

INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement;	3
II	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection	4
III	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity	4
IV	International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	3

S. No.	Reference Books
1.	Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
2.	Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
3.	Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
4.	Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
5.	Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
6.	Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
7.	The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
8.	Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

#Assignments marks

PGS 504

BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To acquaint the students on the basics of commonly used techniques in laboratory.

Practical	**Practical Description**	
1.	Safety measures while in Lab; Handling of chemical substances;	2
2.	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;	2
3.	Washing, drying and sterilization of glassware;	2
4.	Drying of solvents/chemicals.	2
5.	Weighing and preparation of solutions of different strengths and their dilution;	2
6.	Handling techniques of solutions;	2
7.	Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids;	2
8.	Neutralisation of acid and bases;	2
9.	Preparation of buffers of different strengths and pH values.	2
10.	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;	2
11.	Electric wiring and earthing.	2
12.	Preparation of media and methods of sterilization;	2
13.	Seed viability testing,	2
14.	testing of pollen viability;	1
15.	Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	1

S. No.	**Reference Books**
1.	Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
2.	Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

#Assignments marks

PGS 505

AGRICULTURALRESEARCH,RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMME

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International	3
II	Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	3
III	Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. Concept and connotations of rural development, rural development policies and strategies.	4
IV	Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.	4

S. No.	Reference Books
1.	Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
2.	Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
3.	Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
4.	Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

#Assignments marks

PGS 506

DISASTER MANAGEMENT

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion	4
II	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents	3
III	Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media.	4
IV	Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.	3

S. No.	Reference Books
1.	Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
2.	Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
3.	Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

#Assignments marks

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

M.Sc. Biotechnology

(First to Fourth Semester)

Dr. Khem Singh Gill Akal College of Agriculture

M.Sc. Programme in Biotechnology at the Eternal University Baru Sahib, Himachal Pradesh					
Semester	**Course No.**	**Course Title**	**Theory**	**Seminar**	**Practical**
		Semester-I			
Sem -I	BT-501	Cell and Molecular Biology	3		
Sem-I	MICRO-511	General Microbiology	3		
Sem-I	BIOCHEM-511	General Biochemistry	3		
Sem-I	BT-504	General Genetics	3		
Sem-I	BT-505	Computational Biology & Biostatistics	3		
Sem-I	BT-506	Techniques in Biotechnology-I			3
		Total	**15**	**0**	**3**
		Semester-II			
Sem-II	BT-507	Plant and Animal Biotechnology	3		
Sem-II	BT-508	Cell Communication and Cell Signaling	3		
Sem-II	BT-509	Instrumental methods of analysis	3		
Sem-II	BT-510	Immunology	2		
Sem-II	BT-511	Bioprocess Engineering and Technology	3		
Sem-II	BT-512	Techniques in Biotechnology-II			3
Sem-II	BT-591	Seminar-I		1	
		Total	**14**	**1**	**3**
		Semester-III			
Sem-III	BT-513	Genetic Engineering	3		
Sem-III	BIOCHEM-513	Enzymology	3		
Sem-III	BT-515	Biosafety, Bioethics & IPR	3		
Sem-III		Optional Course*	2		
Sem-III		Optional Course*	2		
Sem-III	BT-516	Techniques in Biotechnology-III			3
Sem-III	BT-591	Visit to a Laboratory (ICAR/CSIR/DBT/ICMR) & Report writing		1	
	BT-600	Dissertation (Synopsis)			3
		Total	**13**	**1**	**6**
	Option-I				

*Students can take only two courses within any of the three options.

	BT-517	Transgenic Plants	2		
	FT-516	Food Biotechnology	2		
	BT-519	Plant Molecular Breeding	2		
	Option-II				
	BT-520	Molecular Plant Physiology	2		
	BT-521	Genomics and Proteomics	2		
	BT-522	Nano-Biotechnology	2		
	Option-III				
	BT-523	Environmental Biotechnology	2		
	BT-524	Microbial Biotechnology	2		
	BT-525	Biosystematics and Biodiversity	2		
		Semester-IV			
Sem-IV	BT-591	Evaluation Seminar		1	
Sem-IV	BT-600	Dissertation			17
		Total		**1**	**17**
		Grand Total	**42**	**3**	**29**

M.Sc. Biotechnology

Course Contents

BT-501
Cell and Molecular Biology

Credits: 3 + 0 Mid-session exam: 40
Contact hours: 42 + 0 End-semester exam: 60

Objective: To expose students with various types of cells, cell organelles and their functions, organization and function of genetic material and processes involved in its replication and cell division.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	Evolution of cell and biological macromolecules, general features of prokaryotic and eukaryotic cells.	2
2.	Structure and function of plasma membrane, molecular organization of cytoskeleton, endoplasmic reticulum- structure, role in glycosylation, lipid biosynthesis, intracellular transport and secretion, golgi apparatus- organization and role in cell secretion, lysosomes, peroxisomes, glyoxisomes, chloroplasts, mitochondria, centriols, nucleus-organization of DNA into chromosomes.	10
3.	Chromosome organization, chromatin structure, complexity of eukaryotic chromosome, cot curve.	4
4.	Cell division and cell cycle, cell-cell interaction, cell differentiation, signal transduction, malignant growth, apoptosis.	5
5.	DNA replication in prokaryote and eukaryotes, enzymes and accessory proteins, telomere replication.	5
6.	Transcription process in prokaryote and eukaryotes, types of RNAs, transcriptional factors, regulation of transcription, RNA processing and RNPs- spliceosome, post-transcriptional modifications of mRNA, tRNA and rRNA, nuclear export and stability of mRNA, micro RNA, RNAi.	10
7.	Translation process- genetic code, translation mechanism of prokaryote and eukaryotes, translational control, post translation modification.	6
	Total	42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/ Reprint
1.	Alberts, B, Johnson, A., Laws, J., Raff, M., Robert, K. and Walter, P., "Molecular Biology of the cell" 4th edition, Garaland Publishing.	2002
2.	Watson, J.D., Baker, T. A., Bell, S. P., Gann, A., Levine, N. and Lovisk, R., "Molecular Biology of the gene "5th Edition, Pearson Education.	2004
3.	Lewis, B., "Gene VI" 8th edition. John Wiley and sons	2006
4.	Swanson C.P., and Webster P.L., "The Cell" 5th edition, Prentice Hall	2004

MICRO-511
General Microbiology

Credits: 3 + 0 Mid-session exam: 40
Contact hours: 42 + 0 End-semester exam: 60

Objective: To make students familiar with microorganisms and their use as tools for various applications in human health and environment.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	History and Scope of Microbiology	5
2.	Characterization, Classification and Identification of Microorganisms, Introduction to Bergey's Manual of Systematic Bacteriology	6
3.	Bacteria shapes, arrangement and sizes, isolation, enumeration and cultivation, Mixed and pure culture, Microscopic examination of microorganisms.	5
4.	Microbial growth, physiology, Bacterial Genetics	5
5.	Viruses and Bacteriophages, Control of microorganisms (physical and chemical agents), Diseases caused by microorganisms, resistance and defence mechanisms	5
6.	Microbiology of soil and water, Industrial microbiology, Food Microbiology Host microbe interactions, Biological fixation of nitrogen & biofertilizers	8
7.	Microbes in human welfare: Biopesticides, biofuel production and biodegradation of agro-waste.	8
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Pelczar, M. J., "Microbiology", Tata McGraw-Hill Publication	1997
2.	Prescott, Harley and Klein, "Microbiology", W. C. Brown Publications.	1996
3.	Talaron, k., Talaron, A., Pelczar, C. and Reid, A., „Foundations in Microbiology", W. C. Brown Publications.	1993

BIOCHEM-511
General Biochemistry

Credits: 3 + 0
Contact hours: 42 + 0

Mid-session exam: 40
End-semester exam: 60

Objective: To impart knowledge of basic biochemistry for understanding many important problems of biology.

Details of Course:

S. No.	Particulars	No.
1.	Fundamental principles governing life- structure of water, acid base concept and buffers, pH, stabilizing interactions, classification, structure and function of biomolecules (carbohydrates, lipids and biomembranes, proteins and nucleic acids).	10
2.	Structure and biological function of vitamins, enzymes classification, kinetics and inhibition of enzymes, enzyme specificity and active site, co-enzymes and allosteric action.	6
3.	Plant Biochemistry- photosynthesis, photorespiration, starch and sucrose metabolism, nitrogen metabolism, sulphur assimilation.	8
4.	Biological transducers and bioenergetics, carbohydrate metabolism-glycolysis, citric acid cycle, electron transport chain, oxidative phosphorylation, gluconeogenesis.	10
5.	Lipid metabolism- fatty acid biosynthesis, β-oxidation, biosynthesis of steroids, lipoproteins, biosynthesis of purines and pyrimidines	8
	Total	42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/ Reprint
1.	Stryer, L., "Biochemistry" 4th edition, W. H. Freeman.	2002
2.	Horton, H.R., Moran, L.A., Ochs R.A., Rawn, J. D. and Scrimgeor, R.S., "Principles of Biochemistry", 3rd edition Prentice Hall,.	2001
3.	Voet, D. and Voet, J. G., "Biochemistry" 3rd edition, John Wiley and Sons.	2004
4.	Nelson, D.L. and Cox, M.M., "Lehninger Principles of Biochemistry", 5th edition, W.H. Freeman.	2009
5	Wilson, K. and Walker, J., "Principles and Techniques of Practical Biochemistry" 5th edition, Cambridge University Press.	2000

BT-504
General Genetics

Credits: 3 + 0
Contact hours: 42 + 0

Mid-session exam: 40
End-semester exam: 60

Objective: To impart fundamental knowledge of genetics in understanding the basis of inheritance.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	Introduction and general background (chromosome structure and organization, gene structure).	5
2.	Early concepts of inheritance, Mendelian principles of genetics, applications of Mendelian principles.	7
3.	Chromosomal basis of inheritance and linkage, linkage and crossing over, genetic mapping in eukaryotes and prokaryotes, construction of genetic and physical maps.	7
4.	replication of genetic material, genetic code, central dogma and protein biosynthesis, extrachromosomal inheritance, sex determination, male sterility, split genes, transposable genetic elements, overlapping genes, pseudogenes, oncogenes, gene families, gene regulation.	5
5.	Numerical and structural chromosomal changes and gene mutations, types of mutations, consequences of mutations, occurrence and causes of mutations.	6
6.	Population and evolutionary genetics- Hardy Weinberg equilibrium, speciation, genetics of inbreeding depression and heterosis, inheritance of quantitative traits.	5
7.	Genetic disorders and genetic counseling, applications of genetics, genetic advances in agriculture and medicine, eugenics.	7
	Total	42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Gardner, Simmons and Snustad, S., "Principles of Genetics", John Wiley & Sons Inc. Hoboken.	2003
2.	Klug, W. S. and Cummings, M.R., "Concepts of Genetics", Pearson Education Inc.	1999
3.	Russel, P. J., "Genetics", 6th edition, Benjamin Cumming Comp. Inc.	2004
4.	Lewin, B, "*Genes IX*" Jones and Bartlett Publication.	2008

BT-505
Computational Biology & Biostatistics

Credits: 3 + 0
Contact hours: 42 + 0

Mid-session exam: 40
End-semester exam: 60

Objective: To expose student to the rapidly growing field of Bio-informatics through data mining and computational approach.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	Introduction and definition of biostatistics, concept of variables in biological systems, collection, classification, tabulation, graphical and diagrammatic representation of numerical data, measure of central tendency, measure of dispersion, correlation and regression, linear and quadratic regressions, concept of standard errors. hypothesis testing (null & alternative hypothesis).	8
2.	Test of significance based on Z, χ^2, t and F statistics, correlation and regression, curve fitting by least squares methods.	7
3.	Introduction, biological and chemical databases- Database models, storage, mining and retrieval, Laboratory Information management systems (LIMS)	5
4.	Protein and gene information resources- PIR, SWISSPROT, PDB, Genebank, DDBJ, protein structures and drug discovery.	5
5.	Introduction to sequence comparison, global and multiple sequence alignment, multiple sequence alignment using FASTA, Sequence alignment using CLUSTAL W, BLAST and PSI BLAST, Use of sequences to determine phylogenetic relationship.	7
6.	DNA microarrays, databases, data management cluster analysis	3
7.	Gene finding algorithms and softwares, Hidden Markov Models (HMM), annotation of genomic and protein sequences prediction of protein secondary and tertiary structures.	4
8.	Protein-Protein interactions, proteomics, protein microarrays chips and data analysis	3
	Total	42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Higgins, D. and Taylor, W., "Bioinformatics – Sequence, Structure and Databanks", Oxford University Press.	2003
2.	Lacroix, Z. and Critchlow, T., "Bioinformatics – Managing Scientific Data", Morgan Kaufmann Publishers.	2003
3.	Bourne, E.,P. and Weissig H., "Structural Bioinformatics"' John Wiley and Sons.	2003
4.	Arora, P.N. and Malha, P.K., "Biostatistics",	2003
5.	Rosner, B., "Fundamentals of Biostatistics" Thomson and Brooks/Cole	2006
6.	Mahajan, B.K., "Methods in Biostatistics", Jaypee Publishers	2002

BT-506
Techniques in Biotechnology-I

Credits: 0 + 3
Contact hours: 0 + 84

Mid-session exam: 50
End-semester exam: 50

Objective: To provides hands on training on basic techniques involved in biochemistry, microbiology, genetics, bioinformatics and biostatistics.

Details of Course:

S. No.	Particulars	No. of practical
1.	Good lab Practices, preparation of buffers and reagents.	2
2.	General tests for the detection of carbohydrates, amino acids, and proteins	3
3.	Principle and types of centrifugation	3
4.	Chromatographic techniques for separation of carbohydrates and lipids TLC, Gel Filtration, on exchange, Affinity Chromatography)	3
5.	Study of enzyme kinetics	2
6.	SDS-PAGE for protein separation	3
7.	Preparation and sterilization of culture media	3
8.	Isolation of bacteria from different sources (soil, water and air)	3
9.	Identification of isolated bacterial colonies using microscopic and staining techniques, plotting growth curve from isolated bacterial strain.	3
10.	Mitotic and meiotic cell divisions.	2
11.	Demonstration of genetic principles using laboratory organisms	3
12.	Inheritance and linkage analysis	3
13.	Development of mapping populations	3
14.	Tetrad analysis, induction and detection of mutations through genetic tests.	3
15.	Introduction to databases, ANOVA and chi square test.	3

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA and Struhl K. Short protocols in Molecular Biology. John Wiley.	2002
2.	Wilson and Walker "Practical Biochemistry". Cambridge Univ. Press	7th edition 2010
3.	Kun LY, Microbial Biotechnology. World Scientific.	2006
4.	Sambrook J, Russel DW and Maniatis T. Molecular cloning: a laboratory manual. Cold Spring harbor laboratory.	2001

BT-507
Plant and Animal Biotechnology

Credits: 3 + 0
Contact hours: 42 + 0

Mid-session exam: 40
End-semester exam: 60

Objective: To provide the knowledge of various aspects of plant and animal biotechnology including plant and animal tissue culture, genetic engineering and transformation in plants and animals.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Historical perspectives, laboratory organization and tissue culture media.	3
2.	Production of virus free plants by meristem culture and micropropagation of disease free plants, callus induction and plant regeneration, somatic embryos and synthetic seeds.	5
3.	Protoplast isolation, culture and applications, somatic hybrids and cybrids and their applications in crop improvement.	4
4.	Somaclonal variation, production of haploid plants, embryo rescue and wide hybridization, cell suspension culture, production of secondary metabolites, biotransformation, cryopreservation.	6
5.	Vectorless and vector mediated transformation, development of insect, herbicide, salt and drought resistant plants, edible vaccines, some successful examples (transgenic papaya, Bt cotton, flavr savr tomato, golden rice).	6
6.	Molecular markers and construction of maps, molecular breeding and DNA fingerprinting, genomics.	4
7.	Structure of animal cell and history of animal cell culture.	2
8.	Different types of culture media and cell cultures, development, characterization, maintenance and cryopreservation of cell lines, application of animal cell culture.	4
9.	*In vitro* fertilization, embryo transfer technology and animal cloning.	3
10.	Stem cells- applications in medicine and tissue engineering, transgenic animals, methods and applications of transgenic animals.	5
	Total	**42**

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Old, R.W. and Primrose S.B., "Principles of Gene Manipulation: An Introduction to Genetic Engineering", Blackwell Science Publications.	1993
2.	Bhojwani, S.S. and Razdan, M.K., "Plant Tissue Culture Theory and Practice", Elsevier Publication.	2003
3.	Singh, B.D., "Text Book of Biotechnology", Kalyan Publishers.	1998

4.	Gupta, P.K., “Plant Biiotechnology”, rastogi Publications.	2010
5.	Chawla, H.S., “Introduction to Plant Biotechnology”, Science Publishers.	2002
6.	Freshney, I.R., “Culture of Animal Cells: A Manual of Basic Technique, Fifth Edition, John Wiley and Sons Inc.	2005
7.	Sasidhara, R., “Animal Biotechnology”, MJP Publishers.	2006
8.	Ranga, M.M., “Animal Biotechnology” Agrobios India Limited.	2006

BT-508
Cell Communication & Cell Signaling

Credits: 3 + 0 Mid-session exam: 40
Contact hours: 42 + 0 End-semester exam: 60

Objective: To make students aware about the cell and different activities about cell cycle, cancer and signal transduction along with signal and their receptors so that they could know the complete response and stimulus network.

Details of Course:

S.No.	Course Content	Hours
1	Host parasite interaction, Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens.	6
2	Virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells	4
3	Cell signaling, Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways,	6
4	Bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.	5
5	Cellular communication, Regulation of hematopoiesis, general principles of cell communication, cell adhesion	6
6	Roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.	4
7	Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle	5
8	Virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.	6
	Total	**42**

Suggested Books:

S. No.	Authors/Name of Book/Publisher	Year
1.	The Cell: A Molecular Approach. Geoffrey M Cooper	2013
2.	The Cell Signaling. Wendell Lim and Bruce Mayer	2014
3.	Cell Signaling. John T Hancock	2015

BT-509
Instrumental Methods of Analysis

Credits: 3 + 0 Mid-session exam: 40
Contact hours: 42 + 0 End-semester exam: 60

Objective: To impart knowledge of advanced analytical techniques in modern biology.

Details of Course:

S. No.	Particulars	No. of lecture
1.	Microscopy -light, phase contrast, fluorometery, confocal, scanning and transmission electron microscopy.	6
2.	Radioisotopy- radioactive tracer techniques, autoradiography, Cerenkovradiation,liquidscintillationcounting,radio immunological assays, safety.	5
3.	Chromatography- TLC, exclusion, adsorption, gel filtration, ion-exchange, affinity chromatography, HPLC and GC.	7
4.	Electrophoresis, denaturing and non-denaturing gels, isoelectric focusing, 2DE, pulsed-field gel electrophoresis and immuno-electrophoresis.	7
5.	Dialysis, microfiltration, sedimentation, ultra centrifugation and hydrodynamic methods	7
6	Automated methods of DNA and peptide sequencing and synthesis	5
7	Spectroscopy- UV-visible, IR, NMR, ORD, CD, MS, atomic absorption and plasma emission spectroscopy, imaging techniques	5
	Total	42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Pungor, E., "A Practical Guid to Instrumental Analysis", CRC Press.	1995
2.	Rickwood, D. and Hames, B.D., "HPLC, Gel Electrophoresis, Oligonucleotide Synthesis, Soild Phase Peptide Synthesis, Th Practical Approach Series", IRL Press.	1994
3.	Glasel, J.A. and Deutscher, M.P., "Introduction to Biophysica Method for Protein and Nucleic Acid Research", Academic press.	1995
4.	Campbell, I.D., and Dwek, R.A., "Biological spectroscopy", Benjamin Cummins.	1984
5.	Wilson, K. and Walker, J., "Principles and Techniques of Practical Biochemistry" 5th edition, Cambridge University Press.	2000

BT-510
Immunology

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28 + 0 End-semester exam: 60

Objective: To impart knowledge of basic concepts of immunology and its applications in diagnostics.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	General principles and evolution of immune system, cells and tissues of the immune system, blast formation, T-cells, differentiation into effector and memory cells, phagocytes and lymphoid tissues.	3
2.	Molecular structure of antibodies, antibody diversity, types and functions of antibodies, antigen-antibody interaction, B-cell maturation, rearrangement of immunoglobulin genes, expression of different classes of immunoglobulins, class switching	8
3.	Discovery and structure of MHC, genomic organization and regulation of MHC expression, antigen processing and presentation to T cells, MHC restricted CD4 and CD8 T cells physiological significance, receptors and co-receptors involved in T cell.	7
4.	B cell activation and antibody production; Regulation of immune responses- immunological tolerance, allergy, suppressor T cells, idiotypic regulation, feedback, factors determining nature and magnitude of immune response; Cytokines; Hypersensitivity reactions, regulation of IgE, mast cells, basophils, allergy.	6
5.	The complement system- alternate and classical pathways, regulation of complement, biological function of complement proteins.	5
6.	Production and purification of antibodies, hybridomas, isolation and fractionation of lymphocytes, precipitation techniques immunoelectrophoresis, radiommunoassay (RIA), enzyme linked immunosorbant assay (ELISA), immunocytochemistry, immunohistochemistry and immunodiagnostics.	7
7	Immunogenetics- blood group and transplantation antigen, HLA and disease association, immunodeficiency disorders including AIDS	3
8.	Immunity to infection, viruses, bacteria, fungi and parasites, autoimmune diseases and treatment.	3
	Total	42

Suggested Books:

S. No.	Name of Books/Authors	Year of Publication/Reprint
1.	Hildeman, W.H., "Essentials of immunology", Elsevier Scientific.	2002
2.	Abbas, A.K., Litchman, A.H. and Pobes, J,S,, WB "Cellular and Molecular Immunology", Saunders Co.	2000
3.	Sites, D.P., Stobo, J.D. and Wells, J.U., "Basic and clinical immunology", Prentice Hall.	1982
4.	Kuby, J., "Immunology", W.H. Freeman.	2000

BT-511
Bioprocess Engineering and Technology

Credits: 3 + 0 Mid-session exam: 40
Contact hours: 42 + 0 End-semester exam: 60

Objective: To acquaint students with industrial production and design strategies of major biotech products.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Introduction, bioreactors; isolation, preservation and maintenance of industrial microorganisms, kinetic of microbial growth and death, media for industrial fermentation, air and media sterilization.	6
2.	Types of fermentation processes, analysis of batch, fed-batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.)	8
3.	Measurements and control of bioprocess parameters, networking in bioprocesses- neural networks, mathematical modeling, role of computers in bioprocess control and applications.	5
4.	Whole cell immobilization and their industrial applications	4
5.	Industrial production of chemicals- alcohol (ethanol), acids (citric and acetic), solvents (glycerol and butanol), antibiotics (penicillin), amino acids (lysine, glutamic acid), vitamins and single cell proteins- algal, fungal and yeast biomass.	6
6	Use of microbes in mineral and oil recovery	3
7	Downstream processing- introduction, removal of microbial cells and solid matter, foam reparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment- BOD and COD treatment and disposal of effluents, Biotransformation.	10
	Total	42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm	2000
2.	Shuler, M. L., Kargi, F. "Bioprocess Engineering: Basic concepts" Prentice Hall Pub.	2002
3.	Doran, P. M., "Bioprocess engineering principles" Academic Press.	1995
4.	Vieth, W. R., "Bioprocess Engineering: kinetics, mass	1994

BT-512
Techniques in Biotechnology-II

Credits: 0 + 3 Mid-session exam: 50
Contact hours: 0 + 84 End-semester exam: 50

Objective: To provides hands on training on advanced molecular biology techniques.

Details of Course:

S. No.	Experiments	No. of practicals
1.	Isolation of genomic and plasmid DNA	3
2.	Quantification of DNA through agarose gel electrophoresis techniques and spectrophotometer based DNA quantificatior	3
3.	PCR and molecular marker analysis	2
4.	Restriction enzyme digestion	3
5.	Hybridization techniques	2
6.	Transformation and screening of transformants (blue/white colonies)	3
7.	Plant tissue culture- lab set up, media preparation, handling and sterilization of plant material.	3
8.	Cell and explant culture, subculturing and regeneration,	3
9.	Embryo rescue, Anther culture	3
10.	Genetic transformation through particle bombardment, GUS assay.	3
11.	Radio immunoassay (RIA)	2
12.	Immunoelectrophoresis	3
13.	Enzyme immunoassays including ELISA	3
14.	Isolation of industrially important microorganisms for microbial processes	3
15.	Production and estimation of alkaline protease	3

Suggested Readings

Sr. No.	Authors/ Name of Books/Publisher	Year of Publication / Reprint
1	Kindt TJ, Goldsby RA & Osbrne BA. Kuby"s Immunology. WH Freeman.	2007
2	Bhojwani SS. Plant Tissue Culture: Theory andPractice. Elsevier.	1983
3	Hermn EB. Media and Techniques for Growth, Regeneration and Storage. Agritech Publ.	2005-08

4	Becker JM, Coldwell GA & Zachgo EA. Biotechnology – a Laboratory Course. Academic Press.	2007
5	Sambrook J, Fritsch T & Maniatis T. Molecular Cloning – a Laboratory Manual. 2nd Ed. Cold Spring Harbour Laboratory Press.	2001

BT-513
Genetic Engineering

Credits: 3 + 0 Mid-session exam: 40
Contact hours: 42 + 0 End-semester exam: 60

Objective: To impart knowledge of various techniques employed in the field of genetic engineering and its applications.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Scope and milestones in genetic engineering	2
2.	Cloning vectors for *E. coli*- plasmids, lambda phage vectors, cosmids, single stranded DNA phage vectors, cloning vectors for organisms other than *E. coli*- Ti plasmid, YACs, PACs, BACs, TACs, mini chromosomes, expression vectors	8
3.	Purification of DNA from living cell, gel electrophoresis of DNA, recovery of DNA from gels, transformation and selection of recombinant clones	4
4.	Extraction, purification and analysis of mRNA from eukaryotic cells, reverse transcription	6
5.	Construction and screening of genomics and cDNA libraries, restriction mapping of DNA fragments, nucleic acid sequencing, preparation of DNA and RNA probes, DNA primers, linkers, adaptors and probes, polymerase chain reaction and its variants, site directed mutagenesis.	8
6.	Expression in heterologous systems, vector engineering and codon optimization, expression of cloned genes in *E. coli*, yeast, insect, plants and mammalian cells, detection and analysis of proteins expressed from cloned genes, protein-protein interactions- yeast two hybrid assay and phage display libraries.	7
7.	Genetic manipulation of higher animals and plants, application of genetic engineering, possible risks and safety aspects of genetic engineering.	7
	Total	42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Sambrook, J., Fritsch, E.F., and Maniatis, T., "Molecular cloning: A laboratory Manual", Cold Spring Harbor Laboratory.	2001
2.	Brown, T.A., "Gene Cloning and DNA Analysis", Blackwell Science.	2001
3.	Winnacker, E.L., "From Genes to Clones: An Introduction to Gene Technology", VCH.	1989
4.	Old, R.W. and Primrose S.B., "Principles of Gene Manipulation" , Blackwell Scientific Publication.	1999
5	Gupta, P.K., "Biotechnology and Genomics", Rastogi Publications.	2004

BIOCHEM-513
Enzymology

Credits: 3 + 0 Mid-session exam: 40
Contact hours: 42 + 0 End-semester exam: 60

Objective: To impart knowledge of fundamental principles of enzyme catalysis and applications of enzyme technology.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	Introduction, nomenclature and classification of enzymes, structure of enzymes- active site structure determination, identification of binding and catalytic sites, trapping of enzyme substrate complex.	8
2.	Extraction, purification, assay and analysis of enzymes	3
3.	Catalysis and kinetics, factors affecting rates of reaction, kinetics of single substrate enzyme catalyzed reactions, Michaelis- Menton equation, Briggs- Haldane modification, Lineweaver- Burk plot, kinetics of multisubstrate enzyme catalysed reactions, ping-pong, random order and compulsory order mechanisms, enzyme inhibition – competitive, uncompetitive and non competitive, substrate and irreversible inhibition.	12
4.	Investigation of reaction mechanisms- steady and non-steady state methods, monomeric enzymes- serine proteases, oligomeric enzymes, lactate dehydrogenase and lactose synthase, mechanism of enzyme catalysis, metals and coenzymes.	7
5.	Binding of ligands to enzymes, cooperativity, allosteric enzymes and metabolic regulation, sub-cellular compartmentalization.	5
6.	Clinical aspects of enzymes- plasma enzymes, inborn errors of metabolism, enzymes as reagents, large scale production and purification of enzymes, immobilized enzymes- preparation and application, application of enzymes and enzyme technology.	7
	Total	42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Chaplin, M.F. and Bucke, C., "Enzyme technology," Cambridge University Press.	1992
2.	Palmer, T., "Understanding Enzymes", Prentice Hall.	1985
3.	Boyer, P.D., "The Enzymes V", , Academic Press	1992
4.	Buchholz, K., Kasche, V. and Bornscheuer, U. T., "Biocatalysts and Enzyme Technology", Wiley-VCH.	2005
5.	Shanmugam, S., **"**Enzyme Technology**",** I. K. International.	2009

BT-515
Biosafety, Bioethics & IPR

Credits: 3 + 0 Mid-session exam: 40
Contact hours: 42 + 0 End-semester exam: 60

Objective: To expose students to the biosafety and bioethical issues related to biotechnology and giving information about intellectual property rights.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	Introduction to bioethics and biosafety, social and ethical issues in biotechnology, biosafety for human health and environment.	6
2.	Biosafety and risk assessment issues, biosafety guidelines and regulatory framework, National biosafety policies and law, The Cartagena Protocol on biosafety, WTO and other international agreements related to biosafety, risk management issues-containment.	6
3.	General principles for the laboratory and environmental biosafety, health aspects, toxicology, allegencity, antibiotic resistance, etc, impact on environment, gene flow in natural and artificial ecologies, sources of gene escape, tolerance of target organisms, creation of superweeds/superviruses.	7
4.	Regulatory affairs- regulatory affairs for drugs and biologics, GLP, GMP	6
5.	Ecological aspects of GMOs and impact on biodiversity, monitoring strategies and methods for detecting transgenics, benefits of transgenics to human health, society, society and environment	7
6.	The WTO and other international agreements, Intellectual properties, copyrights, Indian patent act and amendments, patent filing, trademarks, trade secrets, patents, geographical indications, etc, protection of plant variety and farmers right act, seed act, conventions on biological diversity, biological diversity act, National biodiversity authority, implications of intellectual property rights on the commercialization of biotechnology products	10
	Total	42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Sasson, A., "Biotechnologies and Development", UNESCO Publications.	1988
2.	Sateesh, M.K., "Bioethics and Biosafety", I. K. International Pub. Hosue Pvt. Ltd. New Delhi.	2008
3.	Singh, K., "Intellectual rights on Biotechnology", BCIL, New Delhi	
4.	Erbisch, F. H. and Maredia, K. M., "Intellectual property rights in agricultural Biotechnology", CABI, Publishing.	2004

BT-516
Techniques in Biotechnology-III

Credits: 0 + 3 Mid-session exam: 50
Contact hours: 0 + 84 End-semester exam: 50

Objective: To provides hands on training on advanced molecular biology, genetic engineering and some basic enzymology techniques.

Details of Course:

S. No.	Experiments	No. of practical
1.	Miniprep isolation of plasmid DNA	3
2.	Large preparation of plant/animal DNA	3
3.	Restriction Digestion of plasmid DNA and electrophoresis	3
4.	Ethidium Bromide staining and Gel Documentation	3
5.	Cloning DNA in a pBlueScript vector	3
6.	Identification and characterization of transformed colonies	3
7	Restriction of DNA, PAGE and preparation of Southern blot	3
8	Labeling DNA probe with biotin and Southern Hybridization	3
9	Polymerase chain reaction and resolution of amplicons	3
10	Sequencing methods	3
11	*Agrobacterium* mediated genetic transformation	3
12	Enzyme purification through gel filteration	3
13	Effect of pH and temperature on enzyme activity and stability	3
14	Enzyme kinetics analysis	3

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Sambrook, J. and Russel D.W. "Molecular Cloning: A laboratory Manual", Cold Spring Harbor Laboratory Press.	2001
2.	Brown, T. A. "Gene Cloning and DNA analysis", Blackwell Science Ltd.	2001
3.	Old, R. W. and Primrose, S. B. "Principles of Gene Manipulation: An introduction to Genetic Engineering", Blackwell Science Publications.	1993

BT-517
Transgenic Plants

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28 + 0 End-semester exam: 60

Objective: The objective of this course is to introduce students to the basic biological concepts, methodologies and issues associated with transgenic crop plants.

Details of Course:

S. No.	Contents	Lectures
1.	History and development of various methods of genetic transformation of plants	3
2.	Different types of cloned genes, transformation cassettes, reporter genes, selectable markers; removal of markers and marker free transformation, terminator technology	4
3.	Transgenic plants for tolerance to various abiotic stresses	3
4.	Transgenic plants for resistance to biotic stresses	4
5.	Transgenic plants for improvement of shelf life and nutritional quality	3
6.	Molecular pharming, edible vaccines and pathway engineering	3
7.	Methods and advantages of chloroplast transformation and use of mini-chromosomes	2
8.	Use of insertional mutants, RNAi and VIGS for functional genomics	4
9.	Future prospects and commercialization of transgenic plants	2
	Total	28

Suggested Books:

S. No.	Authors/Name of Book/Publisher	Lectures
1.	Galun. E., and Breiman, A "Transgenic plants", Imperial college press.	1997
2.	Curtis, I. S. "Transgenic crops of the world", Springer.	2004
3.	Hiatt, T. "Transgenic plants: fundamentals and applications", M. Dekker.	1993
4.	Vasil, I. K. "Molecular improvement of cereal crops", Springer	1999

FT-516
Food Biotechnology

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28 + 0 End-semester exam: 60

Objective: To provide a balanced account of various theoretical and applied aspects of subjects that highlights the environmental factors and potential use of microorganisms in food and food products.

Details of Course:

S. No.	Particulars	Contact Hours
1.	Introduction, factors affecting the growth and survival of microorganisms in food.	3
2.	Microbial spoilage of food-milk, meat, plant products.	2
3.	Bacterial agents of food borne illness- *Clostridium, Listeria, Salmonella, Shigella, Staphylococcus, Vibrio Yersinia.*	3
4.	Non-bacterial agents of food borne illness- helminthes and protozoa, taxogenic algae, taxogenic fungi, food borne viruses.	3
5.	Fermented and microbial foods- fermented milk, cheese sauerkraut, fermented meat, beer, vinegar, mould fermentation.	3
6.	Microbiological examination of foods- direct examination, culture techniques, MPN count and dye reduction assay; Immunological methods, advance techniques.	3
7.	Microbiology of food preservation- physical, chemical and biological based preservation system.	3
8.	Quality control using microbiological criteria- facilities and operation, cleaning and disinfection code for good manufacturing practices, hazard analysis and critical control points (HACCP).	3
9.	Myths and facts about food biotechnology, recombinant DNA technology derived food- benefits, safety, substantial equivalence, allergenicity, toxicity, labelling, rDNA technology derived microorganisms, yeasts, enzymes etc.	5
	Total	28

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/ Reprint
1.	Adams, M. R. and Moss-Food, M. O., "Microbiology", Royal Society of chemistry	2000
2.	Michael, P.D., Larry R.B. and Thomas, J., "Food microbiology- Fundamentals and Frontiers", ASM Press	2001
3.	James, M.J., "Modern food microbiology", Aspen Publications	2000

BT-519
Plant Molecular Breeding

Credits: 2 + 0
Contact hours: 28 + 0

Mid-session exam: 40
End-semester exam: 60

Objective: To familiarize the students about the use of molecular biology tools in plant breeding.

Details of Course:

S. No.	Particulars	Contact Hours
1.	Principles of plant breeding, breeding methods for self and cross-pollinated crops, hetrosis breeding, limitations of conventional breeding	5
2.	Introduction to molecular breeding, molecular markers, development of sequence based markers- SSRs and SNPs, DArT markers	4
3.	Advanced methods of genotyping, mapping genes for qualitative and quantitative traits	4
4.	QTL mapping using structured populations, AB-QTL analysis, association mapping of QTL, fine mapping of gene/QTL, overcoming yield barriers	5
5.	Map Based gene cloning and development of gene based markers, Allele mining by TILLING and Eco-TILLING, use of markers in plant Breeding	5
6.	Markers assisted selection (MAS) in backcross and heterosis breeding, foreground and background selection, MAS for gene introgression and pyramiding, MAS for specific traits with examples, Transgenic breeding.	5
	Total	28

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Chittranjan K, "Genome Mapping and Molecular Breeding in Plants" Vols. I-VII. Springer	2006-07
2.	Newbury H. J. "Plant Molecular Breeding" Blackwell Publication	2003
3.	Weising, K., Nybom H, Wolff K and Kahl G "DNA fingerprinting in plants: Principles, Methods and Applications". Taylor and Francis	2005
4.	Günter K, Khalid M. "The handbook of plant functional genomics" Wiley Publications	2008

BT-520
Molecular Plant Physiology

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28 + 0 End-semester exam: 60

Objectives: To enrich the students comprehensively about diferent physiological activities in the plants and their in depth pathway inside cells.

Details of Course:

S. No.	Particulars	No. of lectures
1.	**Light Control of Plant Development:** Skotomorphogenesis and photomorphogenesis; Discovery of phytochromes and cryptochromes, their structure, biochemical properties and cellular distribution; Molecular mechanisms of light perception, signal transduction and gene regulation; Biological clocks and their genetic and molecular determinants.	4
2.	**Floral Induction and Development:** Photoperiodism and its significance; Vernalization and hormonal control; Inflorescence and floral determination; Molecular genetics of floral development and floral organ differentiation.	4
3.	**Biosynthesis of Plant Hormones and Elicitors: S**tructure and metabolism of auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, salicylic acid, jasmonates and related compounds.	6
4.	**Molecular Mechanism of Hormone Action:** Hormone signal perception, transduction and regulation of gene expression during plant development; Role of mutants in understanding hormone action; Phospholipids and Ca^{2+}-calmodulin cascade; MAP kinase cascade; Twocomponent sensor-regulator system.	6
5.	**Seed Development, Dormancy and Seed Germination:** Hormonal control of seed development; Seed maturation and dormancy; Hormonal control of seed germination and seedling growth; Mobilization of food reserves during seed germination.	4
6.	**Senescence and Programmed Cell Death (PCD)** -- Senescence and its regulation; Hormonal and environmental control of senescence; PCD in the life cycle of plants.	4
	Total	28

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	**Buchanan, B.B., Gruissem, W. and Jones, R.L.** -Eds. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, USA.
2.	**Heldt, H.W.** (2005) Plant Biochemistry. Academic Press, USA.

3.	**Hopkins, W.G. and Huner, N.P.A.** (2004) Introduction to Plant Physiology. John Wiley, UK.
4.	**Srivastava, L.M.** (2002) Plant Growth and Development: Hormones and Environment. Academic Press, USA.
5.	**Taiz, L. and Zeiger, E.** -Eds. (2006) Plant Physiology. Sinauer Associates Inc. Publishers, USA.

BT-521
Genomics & Proteomics

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28 + 0 End-semester exam: 60

Objectives: To provide knowledge of advanced molecular biology, comparative genomics and analysis of the nucleic acid/protein sequence and structure data. To monitor the properties of entire complement of proteins from a given cell or organism.

Details of the Course:

S. No.	Particulars	No. of lectures
1.	**Overview of Genome Anatomy:** Anatomy of prokaryotic and eukaryotic genome. Characteristics of Human Genome - sequence repeats, transposable elements, gene structure and pseudogenes. Analyzing gene expression – DNA microarray- design, analysis, visualization of data and Stanford microarray database.	5
2.	**Objective and Overview of Genome Comparisons, Genome Alignments:** (BLAST2, MUMmer, PipMaker, VISTA), Comparative Genomics:- (Viruses, Microbes, Pathogens, Eukaryotes). Comparative Genomics Databases: (COG, VirGen, CORG, HOBACGEN, Homophila, XREFdb, Gramene)	5
3.	**Genomic Mapping:** Different types of Genome maps and their uses, Genetic and Physical mapping techniques. Map resources. Practical uses of genome maps. Genetic Markers -RFLP, Mini- and Micro satellite, STS, SSCP, RAPD.	6
4.	**Overview of proteomics:** Introduction to proteomics technology; Experimental Techniques, Current Applications of proteomics in varied biological system; Bioinformatics in proteomics; basics of proteome analysis; Microarrays and proteomics, Protein folding. Comparative proteomics- Differential 2D gel, plant proteomics research and pharmacogenomics.	6
5.	**Protein-Protein Interaction Networks, databases and software:** (DIP (Database of Interacting Proteins), PPI Server, BIND - Biomolecular Interaction Network Database, PIM –Hybrigenics, PathCalling Yeast Interaction Database, MINT – a Molecular Interactions Database, GRID - The General Repository for Interaction Datasets, InterPreTS - protein interaction prediction through tertiary structure	6

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Richard P. Simpson (2004) Proteins and Proteomics. A Laboratory Manual. Cold Spring Harbor Laboratory Press, New York.
2.	T.A. Brown (2002) Genomes. John Wiley & Sons (Asia) Pvt. Ltd. Singapore.
3.	T.B.Kitano (2003), Handbook of Comparative Genomics: Principles and Methodology, Graziano Pesole.
4.	Primrose and Twyman (2003) Principles of Genome Analysis. Blackwell Publishing, Oxford.
5.	Gibson and Muse, (2003) A Primer of Genome Science. Sinauer Associates Inc. Publishers, Sunderlands, New York.
6.	Dov Stekal (2003) Microarray Bioinformatics, Cambridge University Press, Cambridge.
7.	Daniel C. Liebler, (2001), Introduction to Proteomics: Tools for the New Biology, Humana Press
8.	Pennington S. MJ Dunn. (2001) Proteomics: From Sequence to Function. Bios, Scientific Pub.Ltd. Oxford.
9.	Philip E. Bourne, Helge Weissig. (2003) Structural Bioinformatics. John Wiley & Sons (Asia), Singapore.
10.	Timothy Palzkill, (2002), Proteomics, Kluwer Academic Publisher.
11.	Reiner Westermeier, Tom Naven. (2002) Proteomics in Practice. Wiley – VCH, Weinheim.
12.	P.Clate & R.Backofen (1998), Computational Molecular Biology, Willy Publication

BT-522
Nano-Biotechnology

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28 + 0 End-semester exam: 60

Objectives:

- Thorough knowledge of the general principles of nanotechnology and nanobiotechnology that play a role on the nanometer scale of materials.
- Insight into the materials, fabrication and other experimental techniques that can be used on the nanoscale, as well as their limitations.
- Understanding of the formation of complex nano systems which are unique in their operations and possess new functionalities.
- In-depth knowledge of a specialisation area within the field of nanoscience and nanotechnology.
- Extensive analytic and synthetic problem-solving capacities and proficiency in translating this knowledge into useful technological applications.
- The programme is strongly connected to the latest innovations in the field and is embedded in ongoing research programmes.

Details of the Course:

S. No.	Particulars	No. of lectures
1.	**Bio-mineralised Inorganic Nanomaterials:** Nanostructures and Dynamics of Biocompatible surfactant monolayers and bilayers, Bio-interface, Bio-conjugation, Bio-matrix based on bioinspired phospholipids polymers.	6
2.	**Properties and Characterizations:** Optical (UV-Vis/Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy, light scattering, Zetapotential), Surface and composition (ECSA, EDAX, AFM/STM etc), Vibrational (FT-IR and RAMAN), SERS, Magnetic, Electrical and Electrochemical.	6
3.	**Applications of Nano-Materials in Biosystems:** Proteins - Lipids - RNA and DNA Protein Targeting - Small Molecule/Nanomaterial - Protein Interactions, Nanomaterial-Cell interactions-Manifestations of Surface Modification (Polyvalency), DNA based artificial nanostructures: fabrication, properties and applications, Nucleic acid engineered nanomaterials and their applications: Protein patterning for applications in biomaterials and biodevices.	6
4.	**Nanomaterials and Diagnostics/Drug Delivery and Therapeutics:** MRI, Imaging Surface Modified Nanoparticles MEMS/NEMS based on Nanomaterials Peptide/DNA Coupled Nanoparticles Lipid Nanoparticles For Drug Delivery Inorganic Nanoparticles For Drug Delivery Metal/Metal Oxide Nanoparticles (antibacterial/anti fungal/anti viral) Anisotropic and Magnetic Particles (Hyperthermia).	7
5.	**Nanomaterials and Toxicity Evaluation:** Cyto-toxicity, Geno-toxicity In vivo tests/assays etc.	3

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	H.S. Nalwa (Ed) Handbook of Nanostructured Bioaterials and their applications in nanobiotechnology, American Scientific Publishers.2005.
2.	Nano bio-technology: Concepts, Applications and Perspectives, Christ of M. Niemeyer, Wiley, 2004.
3.	Microcapsules and Nano particles in Medicine and Pharmacy; M. Donbrow (Editor), CRC Press, 1992.
4.	Liposomes in Biological Systems; G. Gragoradias & C. Allison, Wiley; 1980 4. Methods in Enzymology, Vol. 112.
5.	DNA Arrays: Technologies and experimental strategies ed. E.V. Grigorenko, CRC Press 2002.
6.	Robert.W.Kelsall, Ian.W.Hamley, Mark Geoghegan, Nano Scale Science And Technology, John Wiley and son, ltd., 2005.
7.	H.Fujita (Ed), Micromachines As Tools For Nanotechnology, Springer, 2003.
8.	Gunter Schmid (Ed), Nano Particles , Jhon wiley and sons limited, 2004 9. K.K.Jain, Nano Biotechnology, Horizions Biosciences, 2006.

BT-523
Environmental Biotechnology

Credits: 2 + 0
Contact hours: 28 + 0

Mid-session exam: 40
End-semester exam: 60

Objective: To introduce applications of biotechnology to environmental conservation and management.

Details of Course:

S. No.	Particulars	Contact Hours
1.	Status and scope of biotechnology in environmental protection, types of environmental pollutants, problems arising from high-input agriculture, soil and water pollution, global environmental problems.	4
2.	Waste water management, waster water flow, waste water treatment methods- physical, chemical and biological processes, aerobic and anaerobic biological treatment	5
3.	Solid waste management- treatment schemes for industrial, domestic and hazardous solid wastes, collection haulage, composting, incineration and disposal.	5
4.	Bioremediation and phytoremediation, environment biosensors for detection of pollution, xenobiotics, biological detoxification of PAH, biotechniques for air pollution control, biofertilizers, biopesticides, biodiversity and its conservations.	6
5.	Renewable and non-renewable resources of energy, energy from solid waste, conventional fuels and their environmental impact, biodegradation of lignin and cellulose, etc.	5
6.	Environmental protection act, environmental laws and policies, UN declaration, ecoplanning and sustainable development.	3
	Total	28

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/ Reprint
1.	Jordening, J.H. and Winter, J., "Environmental Biotechnology", John Wiley Publications.	2005
2.	Evans, G.G. and Furlong, J., "Environmental Biotechnology: Theory and Applications", John Wiley Publications.	2011
3.	Young, M.M., Anderson, W.A. and Chakrabarty, A.M., "Environ--mental Biotechnology: Principles and Applications", Springer	1996
4.	Srinivas, T., "Environmental Biotechnology", New Age International Press.	2008

BT-524

Microbial Biotechnology

Credits: 2 + 0 Mid-session exam: 40

Contact hours: 28 + 0 End-semester exam: 60

Objective: To impart knowledge on the principles and processes involved in industrial microbiology.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	Microbial biotechnology, scope and techniques, bioprospecting of microbial diversity, isolation and preservation of industrially important microorganisms. Genomics, Transcriptomics, Proteomic Metabolomics, metagenomics and systems biology.	6
2.	Production of proteins and enzymes in bacteria yeast and fungus, recombinant and synthetic vaccines, microbial polysaccharides and polyesters, Microbes as biocontrol agents microbial insecticides (Baculoviruses, entomopathogenic fungi, *Bacillus thurinigiensis Bacillus sphaericus Bacillus popilae*, microbe derived inhibitors.	6
3.	Microbial biomass production, utilization of plant biomass by microorganisms (lignocellulose biodegradation), ethanol production, amino acids, antibiotics, biotransformation of steroid and non steroid compounds, metabolic engineering.	6
4.	Biology of nitrogen fixation, preparation of different, types of inoculants (nitrogen fixers phosphate solubilizers, plant growth promoting rhizobacteria, PGPR, composting).	4
5.	Introduction to the use of microbes in environmental applications, bioremediation, bioaugemntation, bioemulsifiers, biosurfactants MEOR, leaching of ores, microbial fuels (Methane, Hydrogen), biogas, microbial hydrogen production; conversion of sugar to alcohol, gasohol, vermiculture.	6
	Tota	28

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Alexander N. G. and Hiroshi N., "Microbial Biotechnology", Cambridge University Press.	2007
2.	Yuan, K.L., "Microbial Biotechnology: Principles and Applications", World Scientific Publishing	2006
3.	Saikia, R., "Microbial Biotechnology", New India Publishing	2008
4.	Alagawadi, A.R., "Microbial Biotechnology", Narosa Publishing House	2006
5.	Bilgrami, K.S. and Reddy, S.M., "Microbial Biotechnology", Scientific Publishers.	1997

BT-525

Biosystematics & Biodiversity

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28 + 0 End-semester exam: 60

Objective: To acquaint the students about the trends in classification, nomenclature, ecosystem and biodiversity.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	Definitions and basic concepts of biosystematics and taxonomy, importance and applications of biosystematics in biology, trends in biosystematics- binomial nomenclature; chemotaxonomy cytotaxonomy, molecular taxonomy, scientific names, taxonomic hierarchy, principles used in assessing relationships and delimitation taxa.	**7**
2.	International Code of Botanical Nomenclature (ICBN) - salient features-principles; important rules and recommendations, provisions for the governance of the code.	**4**
3.	Biodiversity- definition, scope and constraints, levels of biodiversity: genetic, species, community, agro-biodiversity and ecosystem.	**4**
4.	Magnitude and distribution- methods for biodiversity monitoring, mega diversity zones and hot spots.	**3**
5.	Threats to biodiversity- causes of biodiversity loss, species extinction; vulnerability of species to extinction, IUCN threat categories; Red data book.	**4**
6.	Strategies for biodiversity conservation- *in-situ* and *ex-situ* conservation strategies, biodiversity acts and conventions.	**3**
7.	Biodiversity and biotechnology, bioprospecting, biopiracy, IPRs, indigenous knowledge systems.	**3**
	Total	**28**

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Gurcharan Singh. Plant Systematics: Theory and practic Oxford and YBH PublishingCo. Pvt. Ltd., New Delhi.	2004
2.	Stace, C.A. Plaul. Taxonomy and Biosystematics Etwae Arnold, London.	1989
3.	Stuessy T. F. Plant taxonomy. The systematic Evaluation of comparative data. BiseuSigh Mahendra Pal Sign PehraDuk.	2002
4.	Plant Taxonomy and Biosystematics. Staceclive. A Edward Arnold.	1984

Study Scheme & Syllabus

For

M.Sc. Horticulture

(Floriculture and Landscape Architecture)

(First to Fourth Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

PROGRAMME STRUCTURE

M. Sc. Horticulture (Floriculture and Landscape Architecture)

1.Minor Field : Plant Pathology, Soil Science

2.Supporting Field: Statistics (Mandatory course) + one course other than Minor field

3.Minimum credits load for award of degree : 61

4.Credit load distribution:

Major Field : 21

Minor field :09

Supporting :05

Master's Research : 20

Seminar :01

Compulsory non credit course:06

Total :62

M.Sc. Horticulture (Floriculture and Landscape Architecture)

Semester wise Syllabus Scheme

First Semester				
S.No.	**Course Code**	**Course title**	**Credit hours**	**Semester**
		Major Course		
1	FLA 501	Breeding of Flower Crops and Ornamental Plants	2+1	I
2	FLA 502	Production Technology of Cut Flowers	2+1	I
3	FLA 503	Production Technology of Loose Flowers	2+1	I
		Minor Course		
1	SOILS 504	Soil Mineralogy, Genesis, Classification and Soil Survey	2+1	I
		Compulsory Non credit course		
1	PGS 501	Library and Information Services	0+1	I
2	PGS 502	Technical Writing and Communication Skills	0+1	I
		TOTAL CREDITS =9+3+2=14		
		Second Semester		
		Major Course		
1	FLA 504	Landscaping and Ornamental Gardening	2+1	II
2	FLA 505	Protected Floriculture	2+1	II
3	FLA 599	Master's Research	0+2	II
		Minor Course		
1	PL PATH 506	Principles of Plant Disease Management	2+1	II
		Supporting course		
1	STAT 512	Experimental Designs	2+1	II
		Compulsory non credit course		
1	PGS 503	Intellectual Property and Its Management in Agriculture	1+0	II
2	PGS 504	Basic Concepts in Laboratory Techniques	0+1	II
		TOTAL CREDITS-8+3+3+2=16		
		Third Semester		
		Major Course		
1	FLA 506	Value Addition in Flowers	2+1	III
2	FLA 507	Turfing and Turf Management	2+1	III
3	FLA 591	Master's Seminar	1+0	III
4	FLA 599	Master's Research	0+3	III
		Minor Course		
1	PL PATH 516	Integrated Disease Management	2+1	III
		Supporting course		
1	SPG 503	Remote Sensing and Geographical Information System	1+1	III
		Compulsory non credit course		
1	PGS 505	Agriculture Research Ethics and Rural Development Programmes	1+0	III
2	PGS 506	Disaster Management	1+0	III
		TOTAL CREDITS =10+3+2+2=17		
		Fourth semester		
1	FLA 599	Master's Research	0+15	IV
		TOTAL CREDITS =15		

SCHEME OF EXAMINATION
(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	**THEORY**			**PRACTICALS**		
T+P	**Total**	**Mid- Session**	**End Term**	**Total**	**Mid- Session**	**End Term**
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

Course Contents

M.Sc. HORTICULTURE (FLORICULTURE AND LANDSCAPE ARCHITECTURE)

FLA 501
BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: To impart comprehensive knowledge about the principles and practices of breeding of flower crops and ornamental plants.

Theory

Units	Contents	Lectures
I	Principles -- Evolution of varieties, origin, distribution, genetic resources, genetic divergence- Patents and Plant Variety Protection in India.	6
II	Genetic inheritance -- of flower colour, doubleness, flower size, fragrance, post harvest life.	6
III	Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants-- introduction, selection, domestication, polyploid and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops.	6
IV	Breeding constraints and achievements made in commercial flowers - rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliums, nerium.	6
V	Breeding constraints and achievements made in ornamental plants – petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliages– Introduction and selection of plants for waterscaping and xeriscaping.	4

Practical

1.	Description of botanical features– Cataloguing of cultivars, varieties and species in flowers, floral biology	3
2.	Selfing and crossing, evaluation of hybrid progenies	3
3.	Seed production-Induction of mutants through physical and chemical mutagens	2
4.	Induction of polyploidy	2
5.	Screening of plants for biotic, abiotic stresses and environmental pollution	2
6.	*in vitro* breeding in flower crops and ornamental plants	2

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Chadha KL & Choudhury B.1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Chaudhary RC. 1993. *Introduction to Plant Breeding.* Oxford & IBH. Singh BD. 1990. *Plant Breeding*. Kalyani.

FLA 502
PRODUCTION TECHNOLOGY OF CUT FLOWERS

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: To impart basic knowledge about the importance and production technology of cut flowers grown in India.

Theory

Units	Contents	Lectures
I	Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.	6
II	Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO_2 on growth and flowering.	6
III	Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.	6
IV	Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.	6
V	Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.	4

Crops: Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

Practical

1.	Botanical description of varieties	2
2.	Propagation techniques	2
3.	Mist chamber operation	2
4.	Training and pruning techniques	1
5.	Practices in manuring	1
6.	Drip and fertigation	1
7.	Foliar nutrition	1
8.	Growth regulator applicatio pinching, disbudding, staking, harvesting techniques	1
9.	Post-harvest handling, cold chain	1
10.	Project preparation for regionally important cut flowers	1
11.	Visit to commercial cut flower units and case study	1

Suggested Readings

Arora JS. 2006. *Introductory Ornamental horticulture.* Kalyani.
Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.
Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India.* Allied Publ.

Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 503
PRODUCTION TECHNOLOGY FOR LOOSE FLOWERS

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: To impart basic knowledge about the importance and management of loose flowers grown in India.

Theory

Units	Contents	Lectures
I	Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shadenets, transplanting techniques	6
II	Soil and climate requirements, field preparation, systems of planting, precision farming techniques.	6
III	Water and nutrient management, weed management, rationing, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM.	6
IV	Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation.	6
V	Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packing and storage, value addition, concrete and essential oil extraction, trasportation and marketing, export potential, institutional support, Agri Export Zones.	4

Crops: Jasmine, scented rose, chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, lilies, tecoma, champaka, pandanus).

Practical

1.	Botanical description of species and varieties	2
2.	Propagation techniques	2
3.	Mist chamber operation	2
4.	Training and pruning techniques	1
5.	Practices in manuring, drip and fertigation	1
6.	Foliar nutrition	1
7.	Growth regulator application	1
8.	Pinching, disbudding, staking, harvesting techniques	1
9.	Post-harvest handling, storage and cold chain	1
10.	Project preparation for regionally important commercial loose flowers	1
11.	Visits to fields, essential oil extraction units and markets	1

Suggested Readings

Arora JS. 2006. *Introductory Ornamental Horticulture*. Kalyani.
Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Chadha KL & Chaudhury B.1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.
Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India.* Allied Publ.

Sheela VL. 2007. *Flowers in Trade*. New India Publ. Agency.

Valsalakumari PK, Rajeevan PK, Sudhadevi PK & Geetha CK. 2008. *Flowering Trees*. New India Publ. Agency.

FLA 504
LANDSCAPING AND ORNAMENTAL GARDENING

Credits: 2+1
Contact hours: 28+28

Mid-sessional exam: 25(20+5#)
Practical exam: 35
End-semester exam: 40

Objective: Familiarization with principles and practices of landscaping and ornamental gardening.

Theory

Units	Contents	Lectures
I	Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens	6
II	Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates.	6
III	Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves; Production technology for selected ornamental plants.	6
IV	Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves.	6
V	Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.	4

Practical

1.	Selection of ornamental plants	2
2.	Practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates	4
3.	Avenue planting	1
4.	Practices in planning and planting of special types of gardens	2
5.	Burlapping, lawn making	1
6.	Planting herbaceous and shrubbery borders	1
7.	Project preparation on landscaping for different situations	1
8.	Visit to parks and botanical gardens	1
9.	Case study on commercial landscape gardens.	1

Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.
Nambisan KMP.1992. *Design Elements of Landscape Gardening*. Oxford & IBH.
Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.

Valsalakumari et al. 2008. *Flowering Trees*. New India Publ. Agency. Woodrow MG.1999.
Gardening in India. Biotech Books.

FLA 505

PROTECTED FLORICULTURE

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: Understanding the principles, theoretical aspects and developing skills in protected cultivation of flower crops.

Theory

Units	Contents	Lectures
I	Prospects of protected floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures – economics of cultivation; Location specific designs; Structural components; Suitable flower crops for protected cultivation.	6
II	Environment control – management and manipulation of temperature, light, humidity, air and CO_2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.	6
III	Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM.	6
IV	Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation.	6
V	Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards.	4

Practical

1.	Study of various protected structures	1
2.	Practices in design, layout and erection of different types of structures	3
3.	Practices in preparatory operations, soil decontamination techniques	2
4.	Practices in environmental control systems	2
5.	Practices in drip and fertigation techniques	1
6.	Special horticultural practices	1
7.	Determination of harvest indices and harvesting methods	1
8.	Postharvest handling, packing methods	1
9.	Project preparation	1
10.	Visit to commercial greenhouses	1

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.
Nelson PV. 1978. *Green House Operation and Management*. Reston Publ. Co.
Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 506 VALUE ADDITION IN FLOWERS

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: To develop understanding of the scope and ways of value addition in flowers.

Theory

Units	Contents	Lectures
I	Prospects of value addition, National and global scenario, production and exports, Women empowerment through value added products making, supply chain management.	7
II	Types of value added products, value addition in loose flowers, garlands, veni, floats, floral decorations, value addition in cut flowers, flower arrangement, styles, Ikebana, morebana, free style, bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands, etc.; Selection of containers and accessories for floral products and decorations.	7
III	Dry flowers– Identification and selection of flowers and plant parts; Raw material procurement, preservation and storage; Techniques in dry flower making – Drying, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement – dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; Packing and storage.	7
IV	Concrete and essential oils; Selection of species and varieties (including non-conventional species), extraction methods, Packing and storage, Selection of species and varieties, Types of pigments, carotenoids, anthocyanin, chlorophyll, betalains; Significance of natural pigments, Extraction methods; Applications.	7

Practical

1.	Practices in preparation of bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands with fresh flowers	4
2.	Techniques in flower arrangement	1
3.	Techniques in floral decoration	1
4.	Identification of plants for dry flower making	1
5.	Practices in dry flower making	2
6.	Preparation of dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths, etc	4
7.	Visit to dry flower units, concrete and essential oil extraction units	1

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Chadha KL.1995. *Advances in Horticulture*. Vol.XII. Malhotra Publ. House.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.

Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.

Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007.*Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 507
TURFING AND TURF MANAGEMENT

Credits: 2+1 Mid-sessional exam: 25(20+5#)
Contact hours: 28+28 Practical exam: 35
End-semester exam: 40

Objective: To develop understanding of the principles and management of turfing.

Theory

Units	Contents	Lectures
I	Prospects of landscape industry; History of landscape gardening, site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment.	6
II	Turf grasses - Types, species, varieties, hybrids; Selection of grasses for different locations; Grouping according to climatic requirementAdaptation; Turfing for roof gardens.	6
III	Preparatory operations; Growing media used for turf grasses - Turf establishment methods, seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing.	6
IV	Turf management – Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing -- mowing equipments, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs.	6
V	Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, etc.	4

Practical

1.	Identification of turf grasses	1
2.	Preparatory operations in turf making	1
3.	Practices in turf establishment	1
4.	Layout of macro and micro irrigation systems	2
5.	Water and nutrient management	2
6.	Special practices – mowing, raking, rolling, soil top dressing, weed management	2
7.	Biotic and abiotic stress management	1
8.	Project preparation for turf establishment	1
9.	Visit to IT parks, model cricket and golf grounds, airports, corporates, Govt. organizations	1
10.	Renovation of lawns	1
11.	Turf economics	1

Suggested Readings

Nick-Christians 2004. *Fundamentals of Turfgrass Management*. www.amazon.com

Minor Courses

SOILS 504

SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SOIL SURVEY

Credits: 2+1 Mid Sessional Exam: 25 (20+5*)
Contact hours: 28+28 Practical : 35
End Term Exam : 40

Objective: To study the principles and practices of soil mineralogy, genesis, classification and soil survey

Theory

Units	Content	Lecture
I	Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.	4
II	Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non crystalline clay minerals, identification techniques, amorphous soil constituents and other non crystalline silicate minerals and their identification; clay minerals in Indian soils.	6
III	Factors of soil formation, soil formation models, soil forming processes, weathering of rocks and mineral transformations, soil profile, weathering sequences of minerals with special reference to Indian soils.	5
IV	Concept of soil individual, soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy, soil classification, soil mineralogy and soil maps usefulness.	5
V	Soil survey and its types, soil survey techniques conventional and modern, soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations soil survey interpretations, soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.	5
VI	Landform – soil relationship major soil groups of India with special reference to respective states, land capability classification and land irritability classification land evaluation and land use type (LUT)	3

Practical:

1	Identification and quantification of minerals in soil fractions	2
2	Morphological properties of soil profile in different landforms	2
3	Classification of soils using soil taxonomy	2
4	Calculation of soils using soil taxonomy	2
5	Calculation of weathering indices and its application in soil formation	2
6	Grouping soils using available data base in terms of soil quality	1

7	Aerial photo and satellite data interpretation for soil and land use	1
8	Cartographic techniques for preparation of base maps and thematic maps processing of field sheets, compilation and obstruction of maps in different scales	2

*****Assignment marks

Suggested Readings:

Brady NC & Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.

Buol EW, Hole ED, Mac Cracken RJ & Southard RJ 1997. Soil Genesis and Classification 4th Ed. Panima Publ.

Dixon JB & Weed SB. 1989. Minerals in Soil Environments, 2nd Ed. Soil Science

Grim RE. 1968. Clay Mineralogy, 2nd Edn. McGraw Hill, New York Indian Society of Soil Science 2002. Fundamentals of Soil Science, ISSS, New Delhi.

Sehgal, J. 1986. Introductory Pedology : Soil Genesis, Survey and Classification, Kalyani Publ., New Delhi.

Sehgal, J. 2002. Pedology-Concepts and Applications, Kalyani Publ., New Delhi, 485p. USDA. 1999. Soil Taxonomy. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.

Wade FA & Mattox RB. 1960. Elements of Crystallography and Mineralogy. Oxford & IBH.

Wilding LP &Smeck NE. 1983. Pedogenesis and Soil Taxonomy : II. The Soil Orders. Elsevier.

Wilding NE & Holl GF. (Eds.) 1983. Pedogenesis and soil taxonomy. I . Concept and Interaction. Elsevier.

PL PATH-506

PRINCIPLES OF PLANT DISEASE MANAGEMENT

Credits: 2+1
Contact hours: 28+28

Mid sessional exam : 25 (20+5*)
Practical : 35
End-semester exam : 40

Objectives: To acquaint with different strategies for management of plant diseases.

Theory

Unit	Contents	Lectures
I	Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management	**12**
II	Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.	**10**
III	History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.	**6**

Practical

1.	*In vitro* and *in vivo* evaluation of chemicals against plant pathogens	4
2.	ED and MIC values	5
3.	Study of structural details of sprayers and dusters	5

Suggested Readings

Fry WE. 1982. *Principles of Plant Disease Management*. Academic Press, New York.

Hewitt HG. 1998. *Fungicides in Crop Protection*. CABI, Wallington.

Marsh RW. 1972. *Systemic Fungicides*. Longman, New York

Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. Oxford & IBH, New Delhi

Palti J. 1981. *Cultural Practices and Infectious Crop Diseases*. Springer- Verlag,

New York

Vyas SC. 1993 *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill, New Delhi.

PL PATH 516

INTEGRATED DISEASE MANAGEMENT

Credits: 2+1 Mid Sessional Exam: 25 (20+5*)
Contact hours: 28+28 End-Semester Exam: 40
Practical : 35

Objective: To emphasize the importance and need of IDM in the management of diseases of portant crops.

Theory

Unit	Contents	Lectures
I	Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications	**10**
II	Development of IDM- basic principles, biological, chemical and cultural disease management.	**8**
III	IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed-mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.	**10**

Practical

1.	Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM	7
2.	Demonstration of IDM in certain crops as project work.	7

Suggested Readings

Gupta VK & Sharma RC. (Eds). 1995. *Integrated Disease Management and Plant Health*. Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases*. Daya Publ. House, New Delhi.

Sharma RC & Sharma JN. (Eds). 1995. *Integrated Plant Disease Management*. Scientific Publ., Jodhpur.

Supporting Courses

STAT 512 EXPERIMENTAL DESIGNS

Credits: 2+1
Contact hours: 28+28

Mid-session exam: 25 (20+5#)
Practical exam: 35
End-semester exam: 40

Objective: This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Units	Contents	Lectures
I	Need for designing of experiments, characteristics of a good design. Basic principles of designs- rand omization, replication and local control. Uniformity trials, size and shape of plots and blocks.	6
II	Analysis of variance; Completely randomized design, randomized block design and Latin square design. Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.	8
III	Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications~ Lattice design, alpha design- concepts, randomisation procedure, analysis and interpretation of results.	8
IV	Response surfaces. Experiments with mixtures. Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.	6

Practical		
1.	Uniformity trial data analysis, formation of plots and blocks,	1
2.	Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD	4
3.	Analysis of factorial experiments without and with confounding	1
4.	Analysis with missing data	1
5.	Split plot and strip plot designs	2
6.	Transformation of data	1
7.	Analysis of resolvable designs	2
8.	Fitting of response surfaces.	1
9	Uniformity data analysis, formation of plots and blocks, Fair field Smith Laee.	1

Suggested Readings

Readings Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.

Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.

Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.

Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.

Design Resources Server: www.iasri.res.in/design.

#Assignments marks

SPG 502

REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

Credits: 1+1 Mid-session exam: 20 (15+5#)
Contact hours: 14+28 Practical Exam: 50
End-semester exam : 30

Objective: It introduces the participant to the basic concepts of Geo-informatics, Image processing, Optical Physics and the operational skills necessary to acquire remotely sensed data and extract biophysical properties of earth recourses from them. Students will also gain the ability to extract data from real world.

Units	Contents	Lectures
I	The use of arieal photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-reference.	5
II	The integration of spatial data analysis system with knowledge-based systems and/ or simulation systems for the development of information/decision support systems.	4
III	Future prospects of remote sensing in India, software used in remote sensing, GIS versus remote sensing, Introduction to GIS software.	3
IV	Global positioning system (GPS) components and its function and uses in data collection for GIS	3

Practical

1.	Use of various photogrammnetry instrument	4
2.	Recognition and identification of objects on photography	4
3.	Compilation of map and their interpretation,	3
4.	Hands on practical on remote sensing and GIS, software.	3

Suggested Readings

DeMers, M. N. 2003. Fundamentals of geographic information systems.

J. Wiley. Chrisman, N. 2002. Exploring Geographic Information Systems, J W and Sons, New York.

Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.

Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.

Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall.

#Assignments marks

Compulsory Non Creditable Courses

PGS 501

LIBRARY AND INFORMATION SERVICES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical	Practical Description	
1.	Introduction to library and its services; Role of libraries in education, research and technology transfer;	1
2.	Classification systems and organization of library;	3
3.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources;	1
4.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);	2
5.	Tracing information from reference sources;	1
6.	Literature survey; Citation techniques/Preparation of bibliography;	1
7.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services;	2
8.	Use of Internet including search engines and its resources; e-resources access methods	3

Suggested Readings

Singh, Ajay Pratap, 2013. Information Communication and Society. New Delhi: EssEss Publishers.

Kumar Krishan, 2013. Reference Service. 5th Rev ed. New Delhi: Vikas.

Dhiman, Anil Kumar, 2005. Information and Reference Sources and Service. New Delhi: EssEss.

Ranganathan, S.R.1989. Reference Service. 2nd Rev. ed. Banglore: Sharda Endowment for Library Science.

Mukjerjee, A.K. 1971. Reference Work and its Tools. 2nd ed. Calcutta: World Press.

Sinha, Pradeep K. 2007. Computer Fundamentals. 4th ed. Delhi: BPB Publications.

#Assignments marks

PGS 502

TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical	Practical Description	
1.	Technical Writing- Various forms of scientific writings- thesis, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface,.	2
2.	Technical Writing- Introduction, review of literature, material and methods, experimental results and discussion);	2
3.	Technical Writing- Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions;	2
4.	Technical Writing- pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups;	1
5.	Technical Writing- Editing and proof-reading; Writing of a review article.	1
6.	Communication Skills -Grammar (Tenses, parts of speech, clauses, punctuation marks);	1
7.	Communication Skills -Error analysis (Common errors);	1
8.	Communication Skills -Concord; Collocation; Phonetic symbols and transcription;	1
9.	Communication Skills -Accentual pattern: Weak forms in connected speech:	1
10.	Communication Skills -Participation in group discussion: Facing an interview;	1
11.	Communication Skills -presentation of scientific papers.	1

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995. Harper Collins.

Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.

Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.

James HS. 1994. Handbook for Technical Writing. NTC Business Books.

Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.

Mohan K. 2005. Speaking English Effectively. MacMillan India.

Richard WS. 1969. Technical Writing. Barnes & Noble.

Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek. Sethi J &

Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.

Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

#Assignments marks

PGS 503

INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement;	3
II	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection	4
III	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity	4
IV	International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	3

Suggested Readings

Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.
#Assignments marks

PGS 504

BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To acquaint the students on the basics of commonly used techniques in laboratory.

Practical	Practical Description	
1.	Safety measures while in Lab; Handling of chemical substances;	2
2.	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;	2
3.	Washing, drying and sterilization of glassware;	2
4.	Drying of solvents/chemicals.	2
5.	Weighing and preparation of solutions of different strengths and their dilution;	2
6.	Handling techniques of solutions;	2
7.	Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids;	2
8.	Neutralisation of acid and bases;	2
9.	Preparation of buffers of different strengths and pH values.	2
10.	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;	2
11.	Electric wiring and earthing.	2
12.	Preparation of media and methods of sterilization;	2
13.	Seed viability testing,	2
14.	testing of pollen viability;	1
15.	Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	1

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

#Assignments marks

PGS 505

AGRICULTURALRESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES

Credits: 1 + 0 Mid-session exam : 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International	3
II	Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	3
III	Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. Concept and connotations of rural development, rural development policies and strategies.	4
IV	Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.	4

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.

Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.

Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

#Assignments marks

PGS 506

DISASTER MANAGEMENT

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion	4
II	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents	3
III	Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media.	4
IV	Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.	3

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

#Assignments marks

Study Scheme & Syllabus

For

M.Sc. Horticulture (Fruit Science)

(First to Fourth Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

PROGRAMME STRUCTURE

M. Sc. Horticulture (Fruit Science)

1. Minor Field : Plant Pathology, Soil Science
2. Supporting Field: Statistics (Mandatory Course) + one course other than Minor field
3. Minimum credits load for award of degree : 61
4. Credit load distribution:

Major Field : 20

Minor field :09

Supporting :05

Master's Research : 20

Seminar :01

Compulsory non credit course:06

Total :61

M.Sc. Horticulture (Fruit Science)

Semester wise Syllabus Scheme

S. No.	Course name	Course title	Credit hours	Semester
Semester I				
Major				
1	FSC 501	Tropical and Dry Land Fruit Production	2+1	I
2	FSC 502	Subtropical and Temperate Fruit Production	2+1	I
3	FSC 503	Biodiversity and Conservation of Fruit Crops	2+1	I
Minor				
1	SOILS 504	Soil Mineralogy, Genesis, Classification and Soil Survey	2+1	I
Compulsory Non Creditable Courses				
1	PGS 501	Library and Information Services	0+1	I
2	PGS 502	Technical Writing and Communication Skills	0+1	I
Total		**9+3+2**	**14**	
SEMESTER II				
Major				
1	FSC 505	Propagation and Nursery Management for Fruit Crops	2+1	II
2	FSC 506	Breeding of Fruit crops	2+1	II
3	FSC 599	Master's Research	0+2	II
Minor				
1	PL PATH 506	Principles of Plant Disease Management	2+1	II
Supporting course				
1	STAT 512	Experimental Designs	2+1	II
Compulsory Non Creditable Courses				
1	PGS 503	Intellectual Property and Its Management in Agriculture	1+0	II
2	PGS 504	Basic Concepts in Laboratory Techniques	0+1	II
Total		**8+3+3+2**	**16**	
SEMESTER III				
Major				
1	FSC 509	Biotechnology of Horticultural Crops	2+1	III
2	FSC 504	Canopy Management in Fruit Crops	1+1	III
3	FSC 591	Master's Seminar	1+0	III
4	FSC 599	Master's Research	0+3	III
Minor				
1	PL PATH 516	Integrated Disease Management	2+1	III
Supporting course				
1	SPG 503	Remote Sensing and Geographical Information System	1+1	III
Compulsory Non Creditable Courses				
1	PGS 505	Agriculture Research Ethics and Rural Development Programmes	1+0	III
2	PGS 506	Disaster Management	1+0	III
Total credits		**9+3+2+2**	**16**	

SEMESTER IV				
1	FSC 599	Master's Research	0+15	IV
Total Credits			**15**	

SCHEME OF EXAMINATION
(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	**THEORY**			**PRACTICALS**		
T+P	**Total**	**Mid- Session**	**End Term**	**Total**	**Mid- Session**	**End Term**
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

M.Sc. Horticulture (FRUIT SCIENCE*)*

Course Contents

FSC 501

TROPICAL AND DRY LAND FRUIT PRODUCTION

Credits: 2+1 Mid-Sessional Exam: 25(20+5#)

Contact hours: 28+28 Practical Exam: 35

End-Semester Exam: 40

Objective: To impart basic knowledge of tropical and dry land fruit production in India.

Theory

Units	Contents	Lectures
I	Mango and Banana: Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.	6
II	Citrus and Papaya: Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.	6
III	Guava, Sapota and Jackfruit : Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.	6
IV	Pineapple, Annonas and Avocado: Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading,	6

	packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.	
V	Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics: Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.	4

Practical

1.	Identification of important cultivars	2
2.	Observations on growth and development	2
3.	Practices in growth regulation	3
4.	Malady diagnosis	2
5.	Analyses of quality attributes	2
6.	Visit to tropical and arid zone orchards	2
7.	Project preparation for establishing commercial orchards.	2

Suggested Readings

Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits - Horticulture*. Allied Publ.

Bose TK, Mitra SK & Sanyal D. 2001. (Eds.). *Fruits -Tropical and Subtropical*. Naya Udyog.

Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vols. II- IV. Malhotra Publ. House.

Nakasone HY & Paul RE. 1998. *Tropical Fruits*. CABI.

Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency.

Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Singh HP, Negi JP & Samuel JC. (Eds.). 2002. *Approaches for Sustainable Development of Horticulture*. National Horticultural Board.

Singh HP, Singh G, Samuel JC & Pathak RK. (Eds.). 2003. *Precision Farming in Horticulture*. NCPAH, DAC/PFDC, CISH, Lucknow.

FSC 502

SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION

Credits: 2+1 Mid-Sessional Exam : 25(20+5#)
Contact hours: 28+28 Practical Exam: 35
End-Semester Exam: 40

Objective: To impart basic knowledge of subtropical and temperate fruit production.

Theory

Units	Contents	Lectures
I	Apple, pear, quince, grapes: Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.	6
II	Plums, peach, apricot, cherries, hazelnut: Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.	6
III	Litchi, loquat, persimmon, kiwifruit, strawberry: Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.	6
IV	Nuts- walnut, almond, pistachio, pecan : Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic	6

	factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.	
V	Minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate: Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.	4

Practical

1.	Identification of important cultivars	2
2.	Observations on growth and development	2
3.	Practices in growth regulation	3
4.	Malady diagnosis	2
5.	Analyses of quality attributes	2
6.	Visit to tropical, subtropical, humid tropical and temperate orchards	2
7.	Project preparation for establishing commercial orchards	2

Suggested Readings

Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.

Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.

Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.

Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

FSC 503
BIODIVERSITY AND CONSERVATION OF FRUIT CROPS

Credits: 2+1
Contact hours: 28+28

Mid-Sessional Exam: 25(20+5[#)]
Practical Exam: 35
End-Semester Exam: 40

Objective: Understanding the biodiversity and conservation of fruit crops.

Theory

Units	Contents	Lectures
I	**Mango, sapota, citrus, guava, banana, papaya**: Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.	6
II	**Grapes, jackfruit, custard, apple, ber**: Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ.*	6
III	**Aonla, malus, *Prunus* sp, litchi, nuts** : Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.	6
IV	**Coffee, tea, rubber, cashew, coconut**: Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.	6
V	**Cocoa, palmyrah, arecanut, oil palm and betelvine**: GIS and documentation of local biodiversity, Geographical indication.	4

Practical

1.	Documentation of germplasm – maintenance of passport data and other records of accessions	2
2.	Field exploration trips	3
3.	Exercise on *ex situ* conservation – cold storage pollen/seed storage, cryopreservation	3
4.	Visits to National Gene Bank and other centers of PGR activities	2
5.	Detection of genetic constitution of germplasm, core sampling	2
6.	Germplasm characterization using molecular techniques	2

Suggested Readings

Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow*. Cambridge University Press.

Peter KV & Abraham Z. 2007. *Biodiversity in Horticultural Crops*. Vol. I. Daya Publ. House.

Peter KV. 2008. *Biodiversity of Horticultural Crops*. Vol. II. Daya Publ. House.

FSC 504
CANOPY MANAGEMENT IN FRUIT CROPS

Credits: 1+1
Contact hours: 14+28

Mid-Sessional Exam: 20(15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To impart knowledge about the principles and practices in canopy management of fruit crops.

Theory

Units	Contents	Lectures
I	Canopy management - importance and advantages; factors affecting canopy development.	3
II	Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies.	3
III	Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion.	3
IV	Canopy management through plant growth inhibitors, training and pruning and management practices.	3
V	Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passion fruits, mango, sapota, guava, citrus and ber.	2

Practical

1.	Study of different types of canopies	3
2.	Training of plants for different canopy types	3
3.	Canopy development through pruning	2
4.	Use of plant growth inhibitors	2
5.	Geometry of planting	2
6	Study on effect of different canopy types on production and quality of fruits	2

Suggested Readings

Chadha KL & Shikhamany SD. 1999. *The Grape, Improvement, Production and Post Harvest Management*. Malhotra Publ. House.

Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. New India Publ. Agency.

FSC 505

PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS

Credits: 2+1
Contact hours: 28+28

Mid-Sessional Exam: 25(20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: Familiarization with principles and practices of propagation and nursery management for fruit crops.

Theory

Units	Contents	Lectures
I	Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.	6
II	Seed quality, treatment, packing, storage, certification, testing. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.	6
III	Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working – Progeny orchard and scion bank.	6
IV	Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.	5
V	Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.	5

Practical

1.	Anatomical studies in rooting of cutting and graft union	2
2.	Construction of propagation structures	2
3.	Study of media and PGR	2
4.	Hardening – case studies, micropropagation, explant preparation, media preparation	2
5.	Culturing – *in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture	2
6.	Direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening	2

Suggested Readings

Hartmann HT & Kester DE. 1989. *Plant Propagation – Principles and Practices*. Prentice Hall of India.

Bose TK, Mitra SK & Sadhu MK. 1991. *Propagation of Tropical and Subtropical Horticultural Crops*. Naya Prokash.

Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.

Singh SP. 1989 *Mist Propagation*. Metropolitan Book Co.

Rajan S & Baby LM. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

FSC 506

BREEDING OF FRUIT CROPS

Credits: 2+1 Mid-Sessional Exam: 25(20+5[#)]

Contact hours: 28+28 Practical Exam: 35

End-Semester Exam: 40

Objective: To impart comprehensive knowledge about the principles and practices of breeding of fruit crops.

Theory

Units	Contents	Lectures
I	**Mango, banana and pineapple :** Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.	6
II	**Citrus, grapes, guava and sapota :** Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.	6
III	**Jackfruit, papaya, custard apple, aonla, avocado and ber :** Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.	6
IV	**Mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam and nuts :** Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.	5
V	**Apple, pear, plums, peach, apricot, cherries and strawberry :** Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.	5

Practical

1.	Characterization of germplasm	2
2.	Blossom biology, study of anthesis, estimating fertility status	2
3.	Practices in hybridization	2
4.	Ploidy breeding	2
5.	Mutation breeding	2
6	Evaluation of biometrical traits and quality traits	1
7.	Screening for resistance	1
8.	Developing breeding programme for specific traits	1
9.	Visit to research stations working on tropical subtropical and temperate fruit improvement	1

Suggested Readings

Bose TK, Mitra SK & Sanyol D. (Eds.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.

Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.

Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.

Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

FSC 509
BIOTECHNOLOGY OF HORTICULTURAL CROPS

Credits: 2+1 Mid-Sessional Exam: 25(20+5[#)]
Contact hours: 28+28 Practical Exam: 35
End-Semester Exam: 40

Objective: Understanding the principles, theoretical aspects and developing skills in biotechnology of horticultural crops.

Theory

Units	Contents	Lectures
I	Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.	6
II	Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.	6
III	Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants.	6
IV	Physiology of hardening - hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.	5
V	Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering in horticulture crops, use of molecular markers. *In vitro* selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.	5

Practical

1.	An exposure to low cost, commercial and homestead tissue culture laboratories, , , , ,	2
2.	Media preparation, inoculation of explants for clonal propagation, callus induction and culture	2
3.	Regeneration of plantlets from callus, sub-culturing, techniques on anther, ovule, embryo culture	2
4.	Somaclonal variation, *in vitro* mutant selection against abiotic stress	2
5.	Protoplast culture, fusion technique	2
6	Development of protocols for mass multiplication	2
7.	Project development for establishment of commercial tissue culture laboratory.	2

Suggested Readings

Bajaj YPS. (Ed.).1989. *Biotechnology in Agriculture and Forestry*. Vol. V, *Fruits*. Springer.
Brown TA. 2001. *Gene Cloning and DNA Analysis and Introduction.*
Blackwell Publ.

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology – Concepts, Methods and Applications.* Oxford & IBH.
Gorden H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ.

Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer*.Orient & Longman (Universal Press).

Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. Vols. I, II. New India Publ. Agency.

Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.

Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.

Skoog F & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro. Symp. Soc. Exp. Biol.* 11: 118-131

Vasil TK, Vasi M, While DNR & Bery HR.1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture*. Planum Press.

Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V. Academic Press.

Minor Courses

SOILS 504

SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SOIL SURVEY

Credits: 2+1 Mid Sessional Exam: 25 (20+5*)
Contact hours: 28+28 Practical : 35
End Term Exam : 40

Objective: To study the principles and practices of soil mineralogy, genesis, classification and soil survey

Theory

Units	Content	Lecture
I	Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.	4
II	Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non crystalline clay minerals, identification techniques, amorphous soil constituents and other non crystalline silicate minerals and their identification; clay minerals in Indian soils.	6
III	Factors of soil formation, soil formation models, soil forming processes, weathering of rocks and mineral transformations, soil profile, weathering sequences of minerals with special reference to Indian soils.	5
IV	Concept of soil individual, soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy, soil classification, soil mineralogy and soil maps usefulness.	5
V	Soil survey and its types, soil survey techniques conventional and modern, soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations soil survey interpretations, soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.	5
VI	Landform – soil relationship major soil groups of India with special reference to respective states, land capability classification and land irritability classification land evaluation and land use type (LUT)	3

Practical:

1	Identification and quantification of minerals in soil fractions	2
2	Morphological properties of soil profile in different landforms	2
3	Classification of soils using soil taxonomy	2
4	Calculation of soils using soil taxonomy	2
5	Calculation of weathering indices and its application in soil formation	2
6	Grouping soils using available data base in terms of soil quality	1
7	Aerial photo and satellite data interpretation for soil and land use	1
8	Cartographic techniques for preparation of base maps and thematic maps processing of field sheets, compilation and obstruction of maps in different scales	2

*****Assignment marks

Suggested Readings:

Brady NC & Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.

Buol EW, Hole ED, Mac Cracken RJ & Southard RJ 1997. Soil Genesis and Classification 4th Ed. Panima Publ.

Dixon JB & Weed SB. 1989. Minerals in Soil Environments, 2nd Ed. Soil Science

Grim RE. 1968. Clay Mineralogy, 2nd Edn. McGraw Hill, New York Indian Society of Soil Science 2002. Fundamentals of Soil Science, ISSS, New Delhi.

Sehgal, J. 1986. Introductory Pedology : Soil Genesis, Survey and Classification, Kalyani Publ., New Delhi.

Sehgal, J. 2002. Pedology-Concepts and Applications, Kalyani Publ., New Delhi, 485p. USDA. 1999. Soil Taxonomy. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.

Wade FA & Mattox RB. 1960. Elements of Crystallography and Mineralogy. Oxford & IBH.

Wilding LP &Smeck NE. 1983. Pedogenesis and Soil Taxonomy : II. The Soil Orders. Elsevier.

Wilding NE & Holl GF. (Eds.) 1983. Pedogenesis and soil taxonomy. I . Concept and Interaction. Elsevier.

PL PATH 506

PRINCIPLES OF PLANT DISEASE MANAGEMENT

Credits: 2+1
Contact hours: 28+28

Mid sessional exam : 25 (20+5*)
Practical : 35
End-semester exam : 40

Objectives: To acquaint with different strategies for management of plant diseases.

Theory

Unit	Contents	Lectures
I	Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management	**12**
II	Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.	**10**
III	History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.	**6**

Practical

1.	*In vitro* and *in vivo* evaluation of chemicals against plant pathogens	4
2.	ED and MIC values	5
3.	Study of structural details of sprayers and dusters	5

Suggested Readings

Fry WE. 1982. *Principles of Plant Disease Management*. Academic Press, New York.

Hewitt HG. 1998. *Fungicides in Crop Protection*. CABI, Wallington.

Marsh RW. 1972. *Systemic Fungicides*. Longman, New York

Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. Oxford & IBH, New Delhi

Palti J. 1981. *Cultural Practices and Infectious Crop Diseases*. Springer- Verlag, New York

Vyas SC. 1993 *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill, New Delhi.

PL PATH 516

INTEGRATED DISEASE MANAGEMENT

Credits: 2+1 Mid Sessional Exam: 25 (20+5*)
Contact hours: 28+28 End-Semester Exam: 40
Practical : 35

Objective: To emphasize the importance and need of IDM in the management of diseases of portant crops.

Theory

Unit	Contents	Lectures
I	Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications	10
II	Development of IDM- basic principles, biological, chemical and cultural disease management.	8
III	IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed-mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.	10

Practical

1.	Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM	7
2.	Demonstration of IDM in certain crops as project work.	7

Suggested Readings

Gupta VK & Sharma RC. (Eds). 1995. *Integrated Disease Management and Plant Health*. Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases*. Daya Publ. House, New Delhi.

Sharma RC & Sharma JN. (Eds). 1995. *Integrated Plant Disease Management*. Scientific Publ., Jodhpur.

Supporting Courses

STAT 512 EXPERIMENTAL DESIGNS

Credits: 2+1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Units	Contents	Lectures
I	Need for designing of experiments, characteristics of a good design. Basic principles of designs- rand omization, replication and local control. Uniformity trials, size and shape of plots and blocks.	6
II	Analysis of variance; Completely randomized design, randomized block design and Latin square design. Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.	8
III	Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications~ Lattice design, alpha design- concepts, randomisation procedure, analysis and interpretation of results.	8
IV	Response surfaces. Experiments with mixtures. Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.	6

Practical		
1.	Uniformity trial data analysis, formation of plots and blocks,	1
2.	Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD	4
3.	Analysis of factorial experiments without and with confounding	1
4.	Analysis with missing data	1
5.	Split plot and strip plot designs	2
6.	Transformation of data	1
7.	Analysis of resolvable designs	2
8.	Fitting of response surfaces.	1
9.	Uniformity data analysis, formation of plots and blocks, Fair field Smith Laee.	1

Suggested Readings

Readings Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.

Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.

Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.

Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.

Design Resources Server: www.iasri.res.in/design.

#Assignments marks

SPG 502

REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

Credits: 1+1
Contact hours: 14+28

Mid-session exam: 20 (15+5#)
Practical Exam: 50
End-semester exam: 30

Objective: It introduces the participant to the basic concepts of Geo-informatics, Image processing, Optical Physics and the operational skills necessary to acquire remotely sensed data and extract biophysical properties of earth recourses from them. Students will also gain the ability to extract data from real world.

Units	Contents	Lectures
I	The use of arieal photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-reference.	5
II	The integration of spatial data analysis system with knowledge-based systems and/ or simulation systems for the development of information/decision support systems.	4
III	Future prospects of remote sensing in India, software used in remote sensing, GIS versus remote sensing, Introduction to GIS software.	3
IV	Global positioning system (GPS) components and its function and uses in data collection for GIS	3

Practical

1.	Use of various photogrammnetry instrument	4
2.	Recognition and identification of objects on photography	4
3.	Compilation of map and their interpretation,	3
4.	Hands on practical on remote sensing and GIS, software.	3

Suggested Readings

DeMers, M. N. 2003. Fundamentals of geographic information systems.
J. Wiley. Chrisman, N. 2002. Exploring Geographic Information Systems, J W and Sons, New York.
Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.
Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.
Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall.
#Assignments marks

Compulsory Non Creditable Courses

PGS 501

LIBRARY AND INFORMATION SERVICES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical	Practical Description	
1.	Introduction to library and its services; Role of libraries in education, research and technology transfer;	1
2.	Classification systems and organization of library;	3
3.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources;	1
4.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);	2
5.	Tracing information from reference sources;	1
6.	Literature survey; Citation techniques/Preparation of bibliography;	1
7.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services;	2
8.	Use of Internet including search engines and its resources; e-resources access methods	3

Suggested Readings

Singh, Ajay Pratap, 2013. Information Communication and Society. New Delhi: EssEss Publishers.
Kumar Krishan, 2013. Reference Service. 5th Rev ed. New Delhi: Vikas.
Dhiman, Anil Kumar, 2005. Information and Reference Sources and Service. New Delhi: EssEss.
Ranganathan, S.R.1989. Reference Service. 2nd Rev. ed. Banglore: Sharda Endowment for Library Science.
Mukjerjee, A.K. 1971. Reference Work and its Tools. 2nd ed. Calcutta: World Press.
Sinha, Pradeep K. 2007. Computer Fundamentals. 4th ed. Delhi: BPB Publications.
#Assignments mark

PGS 502

TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical	Practical Description	
1.	Technical Writing- Various forms of scientific writings- thesis, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface,.	2
2.	Technical Writing- Introduction, review of literature, material and methods, experimental results and discussion);	2
3.	Technical Writing- Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions;	2
4.	Technical Writing- pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups;	1
5.	Technical Writing- Editing and proof-reading; Writing of a review article.	1
6.	Communication Skills -Grammar (Tenses, parts of speech, clauses, punctuation marks);	1
7.	Communication Skills -Error analysis (Common errors);	1
8.	Communication Skills -Concord; Collocation; Phonetic symbols and transcription;	1
9.	Communication Skills -Accentual pattern: Weak forms in connected speech:	1
10.	Communication Skills -Participation in group discussion: Facing an interview;	1
11.	Communication Skills -presentation of scientific papers.	1

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
James HS. 1994. Handbook for Technical Writing. NTC Business Books.
Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. Speaking English Effectively. MacMillan India.
Richard WS. 1969. Technical Writing. Barnes & Noble.
Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek. Sethi J &
Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.
#Assignments mark

PGS 503

INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement;	3
II	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection	4
III	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity	4
IV	International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	3

Suggested Readings

Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.
#Assignments marks

PGS 504

BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To acquaint the students on the basics of commonly used techniques in laboratory.

Practical	**Practical Description**	
1.	Safety measures while in Lab; Handling of chemical substances;	2
2.	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;	2
3.	Washing, drying and sterilization of glassware;	2
4.	Drying of solvents/chemicals.	2
5.	Weighing and preparation of solutions of different strengths and their dilution;	2
6.	Handling techniques of solutions;	2
7.	Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids;	2
8.	Neutralisation of acid and bases;	2
9.	Preparation of buffers of different strengths and pH values.	2
10.	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;	2
11.	Electric wiring and earthing.	2
12.	Preparation of media and methods of sterilization;	2
13.	Seed viability testing,	2
14.	testing of pollen viability;	1
15.	Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	1

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

#Assignments marks

PGS 505

AGRICULTURALRESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES

Credits: 1 + 0 Mid-session exam : 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International	3
II	Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	3
III	Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. Concept and connotations of rural development, rural development policies and strategies.	4
IV	Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.	4

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.
#Assignments marks

PGS 506

DISASTER MANAGEMENT

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion	4
II	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents	3
III	Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media.	4
IV	Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.	3

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

#Assignments marks

Study Scheme & Syllabus

For

M. Sc. Horticulture (Vegetable Science)

(First to Fourth Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

PROGRAMME STRUCTURE

M. Sc. Horticulture (Vegetable Science)

1. Minor Field : Plant Pathology, Soil Science
2. Supporting Field: Statistics (Mandatory Course) + One course other than Minor field
3. Credit load distribution:

   Major Field : 21

   Minor field :09

   Supporting :05

   Master's Research : 20

   Seminar :01

   Compulsory non credit course:06

   Total :62

M.Sc. Horticulture (Vegetable Science)
Semester wise Syllabus Scheme

S. No.	Course code	Course title	Credit hours	Semester
Semester I				
Major				
1	VSC 501	Production Technology of Cool Season Vegetable Crops	2+1	I
2	VSC 503	Breeding of Vegetable Crops	2+1	I
3	VSC 504	Growth and Development of Vegetable Crops	2+1	I
Minor				
1	SOILS 504	Soil Mineralogy, Genesis, Classification and Soil Survey	2+1	I
Compulsory Non Creditable Courses				
1	PGS 501	Library and Information Services	0+1	I
2	PGS 502	Technical Writing and Communication Skills	0+1	I
Total		9+3+2	14	
SEMESTER II				
Major				
1	VSC 502	Production Technology of Warm Season Vegetable Crops	2+1	II
2	VSC 505	Seed Production Technology of Vegetable Crops	2+1	II
3	VSC 599	Master's Research	0+2	II
Minor				
1	PL PATH 506	Principles of Plant Disease Management	2+1	II
Supporting course				
1	STAT 512	Experimental Designs	2+1	II
Compulsory Non Creditable Courses				
1	PGS 503	Intellectual Property and Its Management in Agriculture	1+0	II
2	PGS 504	Basic Concepts in Laboratory Techniques	0+1	II
Total		8+3+3+2	16	
SEMESTER III				
Major				
1	VSC 507	Production Technology of Underexploited Vegetable Crops	1+1	III
2	VSC 508	Organic Vegetable Production Technology	1+1	III
3	VSC 509	Fundamentals of Processing of Vegetables	1+1	III
4	VSC 591	Master's Seminar	1+0	III
5	VSC 599	Master's Research	0+3	III
Minor				
1	PL PATH 516	Integrated Disease Management	2+1	III
Supporting course				
1	SPG 503	Remote Sensing and Geographical Information System	1+1	III
Compulsory Non Creditable Courses				
1	PGS 505	Agriculture Research Ethics and Rural Development Programmes	1+0	III
2	PGS 506	Disaster Management	1+0	III
Total credits		10+3+2+2	17	
SEMESTER IV				
1	VSC 599	Master's Research	0+15	IV
Total credits			15	

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

VSC 501

Production Technology of Cool Season Vegetable Crops

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To educate production technology of cool season vegetables.

Theory

Units	Contents	Lectures
I	**Cole crops: cabbage, cauliflower, knoll kohl, sprouting broccoli, Brussels sprout:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of: Potato	7
II	**Root crops: carrot, radish, turnip and beetroot:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of: Potato	7
III	**Bulb crops: onion and garlic:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of: Potato	7
IV	**Peas and broad bean, green leafy cool season vegetables:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of: Potato	7

Practical		
1.	Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics.	3
2.	Experiments to demonstrate the role of mineral elements, plant growth substances and herbicides	3
3.	Study of physiological disorders	3
4.	Preparation of cropping scheme for commercial farms	3
5.	Visit to commercial greenhouse/ polyhouse	2

Suggested Readings

Bose TK & Som MG. (Eds.). 1986. Vegetable Crops in India. Naya Prokash.
Bose TK, Som G & Kabir J. (Eds.). 2002. Vegetable Crops. Naya Prokash.
Bose TK, Som MG & Kabir J. (Eds.). 1993. Vegetable Crops. Naya Prokash.
Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003.Vegetable Crops. Vols. I-III. Naya Udyog.
Chadha KL & Kalloo G. (Eds.). 1993-94. Advances in Horticulture Vols. V-X. Malhotra Publ. House.
Chadha KL. (Ed.). 2002. Hand Book of Horticulture. ICAR.
Chauhan DVS. (Ed.). 1986. Vegetable Production in India. Ram Prasad & Sons.
Decoteau DR. 2000. Vegetable Crops. Prentice Hall.
Edmond JB, Musser AM & Andrews FS. 1951. Fundamentals of Horticulture. Blakiston Co.
Fageria MS, Choudhary BR & Dhaka RS. 2000. Vegetable Crops: Production Technology. Vol. II. Kalyani.
Gopalakrishanan TR. 2007. Vegetable Crops. New India Publ. Agency.
Hazra P & Som MG. (Eds.). 1999. Technology for Vegetable Production and Improvement. Naya Prokash.
Rana MK. 2008. Olericulture in India. Kalyani Publ.
Rana MK. 2008. Scientific Cultivation of Vegetables. Kalyani Publ.
Principles, Production and Nutritive Values. Chapman & Hall.
Saini GS. 2001. A Text Book of Oleri and Flori Culture. Aman Publ.
House.
Salunkhe DK & Kadam SS. (Ed.). 1998. Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing. Marcel Dekker.
Shanmugavelu KG. 1989. Production Technology of Vegetable Crops.
Oxford & IBH.
Singh DK. 2007. Modern Vegetable Varieties and Production Technology.
International Book Distributing Co.
Singh SP. (Ed.). 1989. Production Technology of Vegetable Crops. Agril.
Comm. Res. Centre.
Thamburaj S & Singh N. (Eds.). 2004. Vegetables, Tuber Crops and Spices. ICAR.
Thompson HC & Kelly WC. (Eds.). 1978. Vegetable Crops. Tata McGraw- Hill.
#Assignments marks

VSC 502

Production Technology of Warm Season Vegetable Crops

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To teach production technology of warm season vegetables.

Theory

Units	Contents	Lectures
I	**Okra, beans, cowpea and clusterbean:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of: Tomato, eggplant, hot and sweet peppers	7
II	**Cucurbitaceous crops:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of: Tomato, eggplant, hot and sweet peppers	7
III	**Tapioca and sweet potato:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of: Tomato, eggplant, hot and sweet peppers	7
IV	**Green leafy warm season vegetables:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of: Tomato, eggplant, hot and sweet peppers	7

Practical		
1.	Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics	2
2.	Study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms	2
3.	Experiments to demonstrate the role of mineral elements, physiological disorders	2

4.	Plant growth substances and herbicides; seed extraction techniques	2
5.	Identification of important pests and diseases and their control	2
6.	Maturity standards	2
7.	Economics of warm season vegetable crops.	2

Suggested Readings

Bose TK & Som MG. (Eds.). 1986. Vegetable Crops in India. Naya Prokash.
Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003.
Vegetable Crops. Vols. I-III. Naya Udyog.
Bose TK, Som MG & Kabir J. (Eds.). 2002. Vegetable Crops. Naya Prokash.
Brown HD & Hutchison CS. Vegetable Science. JB Lippincott Co.
Chadha KL & Kalloo G. (Eds.). 1993-94. Advances in Horticulture. Vols.V-X. Malhotra Publ. House.
Chadha KL. (Ed.). 2002. Hand Book of Horticulture. ICAR.
Chauhan DVS. (Ed.). 1986. Vegetable Production in India. Ram Prasad & Sons.
Decoteau DR. 2000. Vegetable Crops. Prentice Hall.
Edmond JB, Musser AM & Andrews FS. 1964. Fundamentals of Horticulture. Blakiston Co
Fageria MS, Choudhary BR & Dhaka RS. 2000. Vegetable Crops: Production Technology. Vol. II. Kalyani.
Gopalakrishanan TR. 2007. Vegetable Crops. New India Publ. Agency.
Hazra P & Som MG. (Eds.). 1999. Technology for Vegetable Production and Improvement. Naya Prokash.
Kalloo G & Singh K (Ed.). 2000. Emerging Scenario in Vegetable Research and Development. Research Periodicals & Book Publ. House.
Nayer NM & More TA 1998. Cucurbits. Oxford & IBH Publ.
Palaniswamy & Peter KV. 2007. Tuber Crops. New India Publ. Agency.
Pandey AK & Mudranalay V. (Eds.). Vegetable Production in India: Important Varieties and Development Techniques.
Rana MK. 2008. Olericulture in India. Kalyani.
Rana MK. 2008. Scientific Cultivation of Vegetables. Kalyani.
Rubatzky VE & Yamaguchi M. (Eds.). 1997. World Vegetables: Principles, Production and Nutritive Values. Chapman & Hall.
Saini GS. 2001. A Text Book of Oleri and Flori Culture. Aman Publ.House.
Salunkhe DK & Kadam SS. (Ed.). 1998. Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing. Marcel Dekker.

#Assignments marks

VSC 503

BREEDING OF VEGETABLE CROPS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To educate principles and practices adopted for breeding of vegetable crops.

Theory

Units	Contents	Lectures
I	**Eggplant, hot pepper, sweet pepper and okra:** Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act. Potato and tomato	7
II	**Peas and beans, amaranth, chenopods and lettuce:** Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act. Potato and tomato	7
III	**Gourds, melons, pumpkins and squashes:** Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act. Potato and tomato	7
IV	**Cabbage, cauliflower, carrot, beetroot, radish, sweet potato and tapioca:** Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act. Potato and tomato	7

Practical	Practical Description	
1.	Selection of desirable plants from breeding population observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations	4
2.	Induction of flowering, palanological studies, selfing and crossing techniques in vegetable crops	4

3.	Hybrid seed production of vegetable crops in bulk. Screening techniques for insect-pests, disease and environmental stress resistance in above mentioned crops, demonstration of sib-mating and mixed population	4
4.	Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques. Visit to breeding blocks	2

Suggested Readings

Allard RW. 1999. Principles of Plant Breeding. John Wiley & Sons.
Basset MJ. (Ed.). 1986. Breeding Vegetable Crops. AVI Publ.
Dhillon BS, Tyagi RK, Saxena S. & Randhawa GJ. 2005. Plant Genetic Resources: Horticultural Crops. Narosa Publ. House.
Fageria MS, Arya PS & Choudhary AK. 2000. Vegetable Crops: Breeding and Seed Production. Vol. I. Kalyani.
Gardner EJ. 1975. Principles of Genetics. John Wiley & Sons.
Hayes HK, Immer FR & Smith DC. 1955. Methods of Plant Breeding.
McGraw-Hill.
Hayward MD, Bosemark NO & Romagosa I. (Eds.). 1993. Plant Breeding- Principles and Prospects. Chapman & Hall.
Kalloo G. 1988. Vegetable Breeding. Vols. I-III. CRC Press.
Kalloo G. 1998. Vegetable Breeding. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
Kumar JC & Dhaliwal MS. 1990. Techniques of Developing Hybrids in Vegetable Crops. Agro Botanical Publ.
Paroda RS & Kalloo G. (Eds.). 1995. Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Region. FAO.
Peter KV & Pradeepkumar T. 2008. Genetics and Breeding of Vegetables.
Revised, ICAR.
Rai N & Rai M. 2006. Heterosis Breeding in Vegetable Crops. New India Publ. Agency.
Ram HH. 1998. Vegetable Breeding: Principles and Practices. Kalyani.
Simmonds NW. 1978. Principles of Crop Improvement. Longman.
Singh BD. 1983. Plant Breeding. Kalyani.
Singh PK, Dasgupta SK & Tripathi SK. 2004. Hybrid Vegetable Development. International Book Distributing Co.
Swarup V. 1976. Breeding Procedure for Cross-pollinated Vegetable Crops. ICAR.

#Assignments marks

VSC 504
GROWTH AND DEVELOPMENT OF VEGETABLE CROPS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To teach the physiology of growth and development of vegetable crops

Units	Contents	Lectures
I	Cellular structures and their functions; definition of growth and development, growth analysis and its importance in vegetable production.	4
II	Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellilns, cyktokinins and abscissic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.	6
III	Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops; apical dominance.	6
IV	Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening.	6
V	Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops.	6

Practical		
1.	Preparation of solutions of plant growth substances and their application	4
2.	Experiments in breaking and induction of dormancy by chemicals	4
3.	Induction of parthenocarpy and fruit ripening; application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables	4
4.	Growth analysis techniques in vegetable crops	2

Suggested Readings

Bleasdale JKA. 1984. Plant Physiology in Relation to Horticulture. 2nd Ed.MacMillan.
Gupta US. (Ed.). 1978. Crop Physiology. Oxford & IBH.
Krishnamoorti HN. 1981. Application Plant Growth Substances and Their Uses in Agriculture. Tata-McGraw Hill.
Peter KV. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency.
Saini RS, Sharma KD, Dhankhar OP & Kaushik RA. (Eds.). 2001.
Laboratory Manual of Analytical Techniques in Horticulture. Agrobios.
Wien HC. (Ed.). 1997. The Physiology of Vegetable Crops. CABI.
#Assignments marks

VSC 505
SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To educate principles and methods of quality seed and planting material production in vegetable crops.

Theory

Units	Contents	Lectures
I	Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India.	4
II	Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production.	6
III	Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.	6
IV	Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.	6
V	Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.	6

Practical		
1.	Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing	2
2.	Testing, releasing and notification procedures of varieties	2
3.	Floral biology	2
4.	Rouging of off-type	1
5.	Methods of hybrid seed production in important vegetable and spice crops	1
6.	Seed extraction techniques; handling of seed processing and seed testing equipments	2
7.	Seed sampling	1
8.	Testing of vegetable seeds for seed purity, germination, vigour and health	2
9.	Visit to seed processing units, seed testing laboratory and seed production farms	1

Suggested Readings

Agrawal PK & Dadlani M. (Eds.). 1992. Techniques in Seed Science and Technology. South Asian Publ.
Agrawal RL. (Ed.). 1997. Seed Technology. Oxford & IBH.
Bendell PE. (Ed.). 1998. Seed Science and Technology: Indian Forestry Species. Allied Publ.
Fageria MS, Arya PS & Choudhary AK. 2000. Vegetable Crops: Breeding and Seed Production. Vol. I. Kalyani.
George RAT. 1999. Vegetable Seed Production. 2nd Ed. CABI.
Kumar JC & Dhaliwal MS. 1990. Techniques of Developing Hybrids in Vegetable Crops. Agro Botanical Publ.
More TA, Kale PB & Khule BW. 1996. Vegetable Seed production Technology. Maharashtra State Seed Corp.
Rajan S & Baby L Markose. 2007. Propagation of Horticultural Crops. New India Publ. Agency.
Singh SP. 2001. Seed Production of Commercial Vegetables. Agrotech Publ. Academy.
Singh NP, Singh DK, Singh YK & Kumar V. 2006. Vegetable Seed Production Technology. International Book Distributing Co.
#Assignments marks

VSC 507

PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To educate production technology of underutilized vegetable crops.

Theory

Units	Contents	Lectures
I	**Brussels's sprout, Chinese cabbage, broccoli, kale and artichoke:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of: Asparagus, artichoke and leek	7
II	**Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu (chenopods) and chekurmanis:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of: Asparagus, artichoke and leek	7
III	**Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean:** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of: Asparagus, artichoke and leek	7
IV	**Sweet gourd, spine gourd, pointed gourd, Oriental pickling melon and little gourd (kundru):** Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of: Asparagus, artichoke and leek	7

Practical		
1.	Identification of seeds; botanical description of plants	3
2.	Layout and planting	3
3.	Cultural practices.	3
4.	Short-term experiments of underexploited vegetables	3

Suggested Readings

Bhat KL. 2001. Minor Vegetables - Untapped Potential. Kalyani.

lndira P & Peter KV. 1984. Unexploited Tropical Vegetables. Kerala Agricultural University, Kerala.

Peter KV. (Ed.). 2007-08. Underutilized and Underexploited Horticultural Crops. Vols. I-IV. New India Publ. Agency.

Rubatzky VE & Yamaguchi M. (Eds.). 1997. World Vegetables: Principles, Production and Nutritive Values. Chapman & Hall

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. 2001. Minimal Descriptors of Agri-Horticultural Crops. Part-II: Vegetable Crops. NBPGR, New Delhi.

#Assignments marks

VSC 508

ORGANIC VEGETABLE PRODUCTION TECHNOLOGY

Credits: 1+ 1
Contact hours: 14+28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To educate principles, concepts and production of organic farming in vegetable crops.

Theory

Units	Contents	Lectures
I	Importance, principles, perspective, concept and component of organic production of vegetable crops.	3
II	Organic production of vegetables crops, *viz.,* solanaceous crops, cucurbits, cole crops, root and tuber crops.	3
III	Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.	3
IV	Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavvya, Biodynamics, preparation etc Pest and disease management in organic farming; ITK's in organic farming. Role of botanicals and bio-control agents.	3
V	GAP and GMP- Certification of organic products; organic production and export - opportunity and challenges.	2

Practical	Practical Description	
1.	Method of preparation of compost, vermicomposting, biofertilizers, soil solarization, bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production, water management, organic soil amendment for root disease, weed management in organic horticulture.	12
2.	Visit to organic fields and marketing centers.	2

Suggested Readings

Dahama AK. 2005. Organic Farming for Sustainable Agriculture. 2nd Ed. Agrobios.
Shivashankar K. 1997. Food Security in Harmony with Nature. 3rd IFOAM- ASIA, Scientific Conf.. 1- 4 December, 1997, UAS, Bangalore.
Gehlot G. 2005. Organic Farming; Standards, Accreditation Certification and Inspection. Agrobios.
Palaniappan SP & Annadorai K. 2003. Organic Farming, Theory and Practice. Scientific Publ.
Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008.
#Assignments marks

VSC 509

FUNDAMENTALS OF PROCESSING OF VEGETABLES

Credits: 1+ 1
Contact hours: 14+28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To educate principles and practices of processing of vegetable crops.

Theory

Units	Contents	Lectures
1.	History of food preservation. Present status and future prospects of vegetable preservation industry in India.	2
2.	Spoilage of fresh and processed horticultural produce; biochemical changes and enzymes associated with spoilage of horticultural produce; principal spoilage organisms, food poisoning and their control measures. Role of microorganisms in food preservation.	2
3.	Raw materials for processing. Primary and minimal processing; processing equipments; Layout and establishment of processing industry, FPO licence. Importance of hygiene; Plant sanitation.	2
4.	Quality assurance and quality control, TQM, GMP. Food standards – FPO, PFA, etc. Food laws and regulations.	2
5.	Food safety – Hazard analysis and critical control points (HACCP). Labeling and labeling act, nutrition labeling.	2
6.	Major value added products from vegetables. Utilization of byproducts of vegetable processing industry; Management of waste from processing factory.	2
7.	Investment analysis. Principles and methods of sensory evaluation of fresh and processed vegetables.	2

Practical	Practical Description	
1.	Study of machinery and equipments used in processing of horticultural produce	2
2.	Chemical analysis for nutritive value of fresh and processed vegetables	2
3.	Study of different types of spoilages in fresh as well as processed horticultural produce	2
4.	Classification and identification of spoilage organisms	2
5.	Study of biochemical changes and enzymes associated with spoilage	2
6.	Laboratory examination of vegetable products; Sensory evaluation of fresh and processed vegetables	1
7.	Study of food standards – National, international, CODEX Alimentarius	2
8.	Visit to processing units to study the layout, equipments, hygiene, sanitation and residual / waste management	1

Suggested Readings

Arthey D & Dennis C. 1996. Vegetable Processing. Blackie/Springer- Verlag.
Chadha DS. 2006. The Prevention of Food Adulteration Act. Confed. of Indian Industry.
Desrosier NW. 1977. Elements and Technology. AVI Publ. Co.
FAO. 1997. Fruit and Vegetable Processing. FAO.
FAO. CODEX Alimentarius: Joint FAO/WHO Food Standards Programme.
2nd Ed. Vol. VB. Tropical Fresh Fruits and Vegetables. FAO.
FAO. Food Quality and Safety Systems – Training Manual on Food Hygiene and HACCP. FAO.
Fellow's P. 1988. Food Processing Technology. Ellis Horwood International.
Frazier WC & Westhoff DC. 1995. Food Microbiology. 4th Ed. Tata McGraw Hill.
Giridharilal GS, Siddappa & Tandon GL. 1986. Preservation of Fruits and Vegetables. ICAR.
Gisela J. 1985. Sensory Evaluation of Food – Theory and Practices. Ellis Horwood.
Graham HD. 1980. Safety of Foods. AVI Publ. Co.
Hildegrade H & Lawless HT. 1997. Sensory Evaluation of Food. CBS.
Joslyn M & Heid. Food Processing Operations. AVI Publ. Co.
Mahindru SN. 2004. Food Safety: Concepts and Reality. APH Publ. Corp.
Ranganna S. 1986. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Ed. Tata-McGraw Hill.
Shapiro R. 1995. Nutrition Labeling Handbook. Marcel Dekker.
Srivastava RP & Kumar S. 2003. Fruit and Vegetable Preservation: Principles and Practices. 3rd Ed. International Book Distri. Co.
Tressler & Joslyn MA. 1971. Fruit and Vegetable Juice Processing Technology. AVI Publ. Co.
Verma LR & Joshi VK. 2000. Post-harvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management. Indus Publ. Co.
#Assignments marks

Minor Courses

SOILS 504
SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SOIL SURVEY

Credits: 2+1 Mid Sessional Exam : 25 (20+5*)
Contact hours: 28+28 Practical: 35
End Term Exam : 40

Objective: To study the principles and practices of soil mineralogy, genesis, classification and soil survey

Theory

Units	Content	Lecture
I	Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.	4
II	Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non crystalline clay minerals, identification techniques, amorphous soil constituents and other non crystalline silicate minerals and their identification; clay minerals in Indian soils.	6
III	Factors of soil formation, soil formation models, soil forming processes, weathering of rocks and mineral transformations, soil profile, weathering sequences of minerals with special reference to Indian soils.	5
IV	Concept of soil individual, soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy, soil classification, soil mineralogy and soil maps usefulness.	5
V	Soil survey and its types, soil survey techniques conventional and modern, soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations soil survey interpretations, soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.	5
VI	Landform – soil relationship major soil groups of India with special reference to respective states, land capability classification and land irritability classification land evaluation and land use type (LUT)	3

Practical:

1	Identification and quantification of minerals in soil fractions	2
2	Morphological properties of soil profile in different landforms	2
3	Classification of soils using soil taxonomy	2
4	Calculation of soils using soil taxonomy	2
5	Calculation of weathering indices and its application in soil formation	2
6	Grouping soils using available data base in terms of soil quality	1
7	Aerial photo and satellite data interpretation for soil and land use	1
8	Cartographic techniques for preparation of base maps and thematic maps processing of field sheets, compilation and obstruction of maps in different scales	2

*****Assignment marks (No marks for attendance). Mandatory to have 75% attendance to appearing final exam.

Suggested Readings:

Brady NC & Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.
Buol EW, Hole ED, Mac Cracken RJ & Southard RJ 1997. Soil Genesis and Classification 4th Ed. Panima Publ.
Dixon JB & Weed SB. 1989. Minerals in Soil Environments, 2nd Ed. Soil Science
Grim RE. 1968. Clay Mineralogy, 2nd Edn. McGraw Hill, New York Indian Society of Soil Science 2002. Fundamentals of Soil Science, ISSS, New Delhi.
Sehgal, J. 1986. Introductory Pedology : Soil Genesis, Survey and Classification, Kalyani Publ., New Delhi.
Sehgal, J. 2002. Pedology-Concepts and Applications, Kalyani Publ., New Delhi, 485p. USDA. 1999. Soil Taxonomy. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.
Wade FA & Mattox RB. 1960. Elements of Crystallography and Mineralogy. Oxford & IBH.
Wilding LP &Smeck NE. 1983. Pedogenesis and Soil Taxonomy : II. The Soil Orders. Elsevier.
Wilding NE & Holl GF. (Eds.) 1983. Pedogenesis and soil taxonomy. I . Concept and Interaction. Elsevier.

PL PATH 506
PRINCIPLES OF PLANT DISEASE MANAGEMENT

Credits: 2+1 Mid sessional exam : 25 (20+5*)
Contact hours: 28+28 Practical : 35
End-semester exam : 40

Objectives: To acquaint with different strategies for management of plant diseases.

Theory

Unit	Contents	Lectures
I	Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management	12
II	Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.	10
III	History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.	6

Practical

1.	*In vitro* and *in vivo* evaluation of chemicals against plant pathogens	4
2.	ED and MIC values	5
3.	Study of structural details of sprayers and dusters	5

Suggested Readings

Fry WE. 1982. *Principles of Plant Disease Management*. Academic Press, New York.

Hewitt HG. 1998. *Fungicides in Crop Protection*. CABI, Wallington.

Marsh RW. 1972. *Systemic Fungicides*. Longman, New York

Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. Oxford & IBH, New Delhi

Palti J. 1981. *Cultural Practices and Infectious Crop Diseases*. Springer- Verlag, New York

Vyas SC. 1993 *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill, New Delhi.

PL PATH 516
INTEGRATED DISEASE MANAGEMENT

Credit hours: 2+1
Contact hours: 28+28

Mid Sessional Exam: 25 (20+5*)
End-Semester Exam: 40
Practical : 35

Objective: To emphasize the importance and need of IDM in the management of diseases of portant crops.

Theory

Unit	Contents	Lectures
I	Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications	10
II	Development of IDM- basic principles, biological, chemical and cultural disease management.	8
III	IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed- mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.	10

Practical

1.	Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM	7
2.	Demonstration of IDM in certain crops as project work.	7

Suggested Readings

Gupta VK & Sharma RC. (Eds). 1995. *Integrated Disease Management and Plant Health*. Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases*. Daya Publ. House, New Delhi.

Sharma RC & Sharma JN. (Eds). 1995. *Integrated Plant Disease Management*. Scientific Publ., Jodhpur.

Supporting Courses

STAT 512
EXPERIMENTAL DESIGNS

Credits: 2+1
Contact hours: 28+28

Mid-session exam: 25 (20+5#)
Practical exam: 35
End-semester exam: 40

Objective: This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

Units	Contents	Lectures
I	Need for designing of experiments, characteristics of a good design. Basic principles of designs- rand omization, replication and local control. Uniformity trials, size and shape of plots and blocks.	6
II	Analysis of variance; Completely randomized design, randomized block design and Latin square design. Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.	8
III	Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications~ Lattice design, alpha design- concepts, randomisation procedure, analysis and interpretation of results.	8
IV	Response surfaces. Experiments with mixtures. Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.	6

Practical		
1.	Uniformity trial data analysis, formation of plots and blocks,	1
2.	Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD	4
3.	Analysis of factorial experiments without and with confounding	1
4.	Analysis with missing data	1
5.	Split plot and strip plot designs	2
6.	Transformation of data	1
7.	Analysis of resolvable designs	2
8.	Fitting of response surfaces.	1
9	Uniformity data analysis, formation of plots and blocks, Fair field Smith Laee.	1

Suggested Readings

Readings Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
Federer WT. 1985. Experimental Designs. MacMillan.
Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
Design Resources Server: www.iasri.res.in/design.
#Assignments marks

SPG 503
REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

Credits: 1+1
Contact hours: 14+28

Mid-session exam: 20 (15+5#)
Practical Exam: 50
End-semester exam : 30

Objective: It introduces the participant to the basic concepts of Geo-informatics, Image processing, Optical Physics and the operational skills necessary to acquire remotely sensed data and extract biophysical properties of earth recourses from them. Students will also gain the ability to extract data from real world.

Theory

Units	Contents	Lectures
I	The use of arieal photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-reference.	5
II	The integration of spatial data analysis system with knowledge-based systems and/ or simulation systems for the development of information/decision support systems.	4
III	Future prospects of remote sensing in India, software used in remote sensing, GIS versus remote sensing, Introduction to GIS software.	3
IV	Global positioning system (GPS) components and its function and uses in data collection for GIS	3

Practical

1.	Use of various photogrammnetry instrument	4
2.	Recognition and identification of objects on photography	4
3.	Compilation of map and their interpretation,	3
4.	Hands on practical on remote sensing and GIS, software.	3

Suggested Readings

DeMers, M. N. 2003. Fundamentals of geographic information systems.
J. Wiley. Chrisman, N. 2002. Exploring Geographic Information Systems, J W and Sons, New York.
Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.
Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.
Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall.
#Assignments marks

Compulsory Non Creditable Courses

PGS 501
LIBRARY AND INFORMATION SERVICES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical	Practical Description	
1.	Introduction to library and its services; Role of libraries in education, research and technology transfer;	1
2.	Classification systems and organization of library;	3
3.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources;	1
4.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);	2
5.	Tracing information from reference sources;	1
6.	Literature survey; Citation techniques/Preparation of bibliography;	1
7.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services;	2
8.	Use of Internet including search engines and its resources; e-resources access methods	3

Suggested Readings

Singh, Ajay Pratap, 2013. Information Communication and Society. New Delhi: EssEss Publishers.
Kumar Krishan, 2013. Reference Service. 5th Rev ed. New Delhi: Vikas.
Dhiman, Anil Kumar, 2005. Information and Reference Sources and Service. New Delhi: EssEss.
Ranganathan, S.R.1989. Reference Service. 2nd Rev. ed. Banglore: Sharda Endowment for Library Science.
Mukjerjee, A.K. 1971. Reference Work and its Tools. 2nd ed. Calcutta: World Press.
Sinha, Pradeep K. 2007. Computer Fundamentals. 4th ed. Delhi: BPB Publications.
#Assignments mark

PGS 502
TECHNICAL WRITING AND COMMUNICATION SKILLS

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical	Practical Description	
1.	Technical Writing- Various forms of scientific writings- thesis, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface,.	2
2.	Technical Writing- Introduction, review of literature, material and methods, experimental results and discussion);	2
3.	Technical Writing- Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions;	2
4.	Technical Writing- pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups;	1
5.	Technical Writing- Editing and proof-reading; Writing of a review article.	1
6.	Communication Skills -Grammar (Tenses, parts of speech, clauses, punctuation marks);	1
7.	Communication Skills -Error analysis (Common errors);	1
8.	Communication Skills -Concord; Collocation; Phonetic symbols and transcription;	1
9.	Communication Skills -Accentual pattern: Weak forms in connected speech:	1
10.	Communication Skills -Participation in group discussion: Facing an interview;	1
11.	Communication Skills -presentation of scientific papers.	1

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
James HS. 1994. Handbook for Technical Writing. NTC Business Books.
Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. Speaking English Effectively. MacMillan India.
Richard WS. 1969. Technical Writing. Barnes & Noble.
Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek. Sethi J &
Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

#Assignments mark

PGS 503
INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	Lectures
I	Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement;	3
II	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection	4
III	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity	4
IV	International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	3

Suggested Readings

Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

#Assignments marks

PGS 504
BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credits: 0+1 Mid-session exam: 50
Contact hours: 28 End-semester exam: 50

Objective: To acquaint the students on the basics of commonly used techniques in laboratory.

Practical	Practical Description	
1.	Safety measures while in Lab; Handling of chemical substances	2
2.	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets	2
3.	Washing, drying and sterilization of glassware	2
4.	Drying of solvents/chemicals.	2
5.	Weighing and preparation of solutions of different strengths and their dilution	2
6.	Handling techniques of solutions	2
7.	Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids	2
8.	Neutralisation of acid and bases	2
9.	Preparation of buffers of different strengths and pH values.	2
10.	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath	2
11.	Electric wiring and earthing.	2
12.	Preparation of media and methods of sterilization	2
13.	Seed viability testing	2
14.	testing of pollen viability	1
15.	Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	1

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
#Assignments marks

PGS 505
AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES

Credits: 1 + 0 Mid-session exam : 40
Contact hours: 14+0 End-semester exam: 60

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Units	Contents	Lectures
I	History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International	3
II	Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	3
III	Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. Concept and connotations of rural development, rural development policies and strategies.	4
IV	Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.	4

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.
#Assignments marks

PGS 506
DISASTER MANAGEMENT

Credits: 1 + 0 Mid-session exam: 40
Contact hours: 14+0 End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Units	Contents	Lectures
I	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion	4
II	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents	3
III	Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media.	4
IV	Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.	3

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.
#Assignments mark

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

Ph. D. Agronomy

(I to VI Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

Programme Structure

Ph. D Agronomy

Minimum Credit Requirements

Subject	Minimum Credit Requirements as per BSMA, ICAR Guidelines	Proposed Minimum Credit Requirements to be Followed
Major	15	16
Minor	08	08
Supporting	05	05
Seminar	02	02
Research	45	45
Total Credits	75	76

Note:

Minor Subjects

The student shall have the option to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subjects viz. Plant Pathology, Entomology, Soil Science Biochemistry, Plant Physiology and Microbiology in 500 series courses.

Supporting Subjects

The student shall have the option to take minimum five credits in the supporting subject in 500 series /600 series courses. The supporting subject will not be related to the major subject. It could be any subject considered relevant for students research work.

Allotment of Research Credits

As per the decision taken in the Board of Studies meeting held on 02/06/2021, the allotment of Research Credits in a particular semester will be at the discretion of Major Advisor, Advisory Committee and the student concerned depending upon his/her work load.

Ph. D Agronomy

Syllabus Semester wise

Semester I				
S.No	**Course Code**	**Course Title**	**Credit Hours**	**Semester**
Major Courses				
1	**AGRON 601**	**Current Trends in Agronomy**	**3+0**	**I**
2	**AGRON 602**	**Crop Ecology**	**2+0**	**I**
3	**AGRON 603**	**Crop Production and System Modeling**	**2+1**	**I**
4	**AGRON 699**	**Doctoral Research**	**0+2**	**I**
Minor Courses				
The student shall have the option to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subjects viz. Plant Pathology, Entomology, Soil Science, Biochemistry, Plant Physiology and Microbiology in 500 series courses. In the 1st Semester he / she has to register for minimum **four** credits in the split minor subjects.				
Supporting Courses				
The student shall have the option to take minimum five credits in the supporting subject in 500 series / 600 series courses. The supporting subject may be from major or any other subject. It could be any subject considered relevant for students research work. In the 1st semester, the student has to register for minimum **three** credits in the supporting subject.				
Total=10+4+3=17				

Semester II				
Major Courses				
1	**AGRON 604**	**Advances in Crop Growth and Productivity**	**2+1**	**II**
2	**AGRON 605**	**Irrigation Management**	**2+1**	**II**
3	**AGRON 606**	**Advances in Weed Management**	**2+0**	**II**
4	**AGRON 691**	**Doctoral Seminar I**	**1+0**	**II**
5	**AGRON 699**	**Doctoral Research**	**0+3**	**II**
Minor Courses				
The student shall have the option to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subjects viz. Plant Pathology, Entomology, Soil Science, Biochemistry, Plant Physiology and Microbiology in 500 series courses. In the 2nd Semester he / she has to register for minimum **four** credits in the split minor subjects.				
Supporting Courses				
The student shall have the option to take minimum five credits in the supporting subject in 500 series / 600 series courses. The supporting subject may be from major or any other subject. It could be any subject considered relevant for students research work. In the 2nd semester, the student has to register for minimum **two** credits in the supporting subject.				
Total=12+4+2=18				

III Semester				
Major Courses				
1	**AGRON 692**	**Doctoral Seminar II**	**1+0**	**III**
2	**AGRON 699**	**Doctoral Research**	**0+10**	**III**
Total=11				
IV Semester				
1	**AGRON 699**	**Doctoral research**	**0+10**	**IV**
Total = 10				
V Semester				
1	**AGRON 699**	**Doctoral research**	**0+10**	**V**
Total = 10				
VI Semester				
1	**AGRON 699**	**Doctoral Research / Thesis Submission**	**0+10**	**VI**
Total = 10				
Grand Total = 76 Credits				

Major Guidelines

Synopsis of Thesis

The synopsis of the thesis must be finalized by the major advisor in consultation with the advisory committee before the commencement of mid-session examination of the 2nd registered semester. Prior to this, the student has to deliver the synopsis seminar in the department.

Comprehensive Examination

After having successfully completed 75% of the total credit hours of the prescribed in major (core) and 100% of minor (specialization) courses with minimum OGPA of 6.50/ 10.00, a Ph. D student shall have to pass comprehensive examination. The comprehensive examination shall consist of both written and oral tests, the former preceding the letter. A candidate shall be given only two chances to appear in the comprehensive examination, written or oral.

There shall be four written papers. i.e., Paper-I ans Paper-II in major subject (Core) and Paper-III and Paper-IV in minor subjects (specialization). Each paper shall be of four hours duration and shall be conducted after a minimum gap of one week. He/ She has to appear in the written comprehensive examination for both the minor subjects.

The syllabus for two papers of major (core) courses and the paper in minor subject shall be decided by the Major Advisor in consultation with the Members concerning minor subject in the Advisory Committee and Head of the Department.

The candidate shall be graded as 'Satisfactory' or 'Unsatisfactory'. To obtain 'Satisfactory' grade, a student must secure not less than 60% Marks in each paper.

Oral Comprehensive Examination

The Oral Comprehensive Examination shall cover both major/ core and minor fields/ specialization and shall be conducted by the Examining Committee comprising the Advisory Committee and one External Examiner who shall be appointed by the Dean PGS. The external examiner shall be a specialist in the students' major field from outside the University.

Recommendations of Board of Studies meeting held on 02/06/2021

It was recommended that Synopsis of Thesis may be submitted in the 1st semester in place of 2nd semester. It was further recommended that the synopsis should be finalized by the student with the help of concerned Major Advisor and all the Advisory Committee Members.

It was recommended that the student may give pre oral comprehensive examination in front of Major Advisor and Advisory Committee Members before the final oral comprehensive examination.

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

Ph. D Agronomy

Course Contents

AGRON 601
CURRENT TRENDS IN AGRONOMY

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42 End-Semester Exam: 60

Objective: To acquaint the students about recent advances in agricultural production.

Theory

Units	Contents	Lectures
I	Agro-physiological basis of variation in yield, recent advances in soil plant-water relationship.	8
II	Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification; labeling and accreditation procedures.	9
III	Crop residue management in multiple cropping systems; latest developments in plant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy.	9
IV	GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.	8
V	Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.	8

Suggested Readings

Agarwal RL. 1995. *Seed Technology*. Oxford & IBH. Dahiya BS & Rai KN. 1997. *Seed Technology*. Kalyani.
Govardhan V. 2000. *Remote Sensing and Water Management in Command Areas: Agroecological Prospectives*. IBDC.
ICAR. 2006. *Hand Book of Agriculture*. ICAR.
Narasaiah ML. 2004. *World Trade Organization and Agriculture*. Sonali Publ.
Palaniappan SP & Annadurai K. 2006. *Organic Farming - Theory and Practice*. Scientific Publ.
Sen S & Ghosh N. 1999. *Seed Science and Technology*. Kalyani.
Tarafdar JC, Tripathi KP & Mahesh Kumar 2007. *Organic Agriculture*. Scientific Publ.

AGRON 602
CROP ECOLOGY

Credits: 2 + 0 Mid-Session Exam: 40
Contact Hours: 28 End-Semester Exam: 60

Objective: To acquaint the students about the agricultural systems, agro-ecological regions, and adaptation of crops to different agro-climatic conditions.

Theory

Units	Contents	Lectures
I	Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply.	5
II	Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.	5
III	Physiological response of crop plants to light, temperature, CO_2, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.	7
IV	Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production.	5
V	Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices; improvement of unproductive lands through crop selection and management.	6

Suggested Readings

Ambasht RS. 1986. *A Text Book of Plant Ecology*. 9th Ed. Students' Friends & Co.
Chadha KL & Swaminathan MS. 2006. *Environment and Agriculture*. Malhotra Publ. House.
Dwivedi P, Dwivedi SK & Kalita MC. 2007. *Biodiversity and Environmental Biotechnology.* Scientific Publ.
Hemantarajan A. 2007. *Environmental Physiology*. Scientific Publ.
Kumar HD. 1992. *Modern Concepts of Ecology*. 7th Ed. Vikas.Publ. Lenka D. 1998. *Climate, Weather and Crops in India*. Kalyani.
Misra KC. 1989. *Manual of Plant Ecology*. 3rd Ed. Oxford & IBH.
Pandey SN & Sinha BK. 1995. *Plant Physiology*. Vikas Publ.
Sharma PD. 1998. *Ecology and Environment*. Rastogi Publ.
Singh J & Dhillon SS. 1984. *Agricultural Geography.* Tata McGraw Hill. Taiz L & Zeiger E. 1992. *Plant Physiology*. Benjamin/Cummings Publ.

AGRON 603
CROP PRODUCTION AND SYSTEM MODELING

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To familiarize the students about systems approach and to simulate yields and growth of several crops under varied soil and weather conditions with different management practices and their optimization.

Theory

Units	Contents	Lectures
I	Systems classification; flow charts, modeling techniques and methods of integration - state, rates and driving variables, feedbacks and relational diagrams.	5
II	Elementary models for crop growth based on basic methods of classical growth analysis.	5
III	Crop modeling methods for crop-weather interaction, climate change and variability components.	7
IV	Potential production: leaf and canopy CO_2 assimilation, respiration, dry matter accumulation, crop phenology and dry matter distribution and development in different crops.	5
V	Production by moisture availability, potential evapotranspiration, water balance of the soil, and production with nutrient and moisture limitations.	6

Practical

1.	Simulation of elementary models for crop growth	3
2.	Simulation of potential production	3
3.	Simulation with limitations of water and nutrient management options	4
4.	Sensitivity analysis using different climatic years and crop management practices	4

Suggested Readings

Gordan G. 1992. *System Simulation.* 2nd Ed. Prentice Hall.

Kropff MJ & Vann Laar HH. (Ed.). 1993. *Modelling Crop Weed Interactions*. ISBN. Mathews RB, Kropff MJ, Bachelet D & Vaan Laar HH. (Eds.). 1993. *Modelling the Impact of Climate Change on Rice Production in Asia.* CABI.

Penning de Vries FWT & Van Laar HH. (Eds.). 1982. *Simulation of Plant Growth and Crop Production*. Wageningen Centre for Agricultural Publications and Documentation, Netherlands.

Ritchie JT & Hanks J. 1991. *Modelling Plant and Soil Systems*. American Society of Agronomy, Madison.

Zeigler BP. 1976. *Theory of Modeling and Simulation*. John Wiley & Sons.

AGRON 604

ADVANCES IN CROP GROWTH AND PRODUCTIVITY

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To study the physiology of vegetative and reproductive growth in relation to productivity of different crops in various environments.

Theory

Units	Contents	Lectures
I	Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.	7
II	Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.	7
III	Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units	7
IV	Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.	7

Practical

1.	Field measurement of root-shoot relationship in crops at different growth stages	2
2.	Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth	2
3.	Computation of harvest index of various crops	2
4.	Assessment of crop yield on the basis of yield attributing characters	2
5.	Construction of crop growth curves based on growth analysis data	2
6.	Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping	1
7.	Senescence and abscission indices	1
8.	Analysis of productivity trend in un-irrigated areas	1
9.	Analysis of productivity trend in irrigated areas	1

Suggested Readings

Chopra VL & Paroda RS. 1984. *Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants*. Oxford and IBH.
Delvin RM & Vitham FH. 1986. *Plant Physiology*. CBS Publ.
Evans LT. 1975. *Crop Physiology*. Cambridge Univ. Press.
Evans LT. 1996. *Crop Evolution, Adaptation and Yield*. Cambridge Univ. Press.
Gupta US. (Ed.). 1995. *Production and Improvement of Crops for Drylands*. Oxford & IBH.
Gupta US. 1988. *Progress in Crop Physiology*. Oxford and IBH.
Kramer PJ & Boyer JS. 1995. *Water Relations of Plant and Soils.*
Academic Press.
Mukherjee S & Ghosh AK. 1996. *Plant Physiology*. Tata McGraw Hill.
Narwal SS, Politycka B & Goswami CL. 2007. *Plant Physiology: Research Methods.* Scientific Publishers.

AGRON 605

IRRIGATION MANAGEMENT

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)

Contact Hours: 28 + 28 Practical Exam: 35

End-Semester Exam: 40

Objective: To teach students about optimization of irrigation in different crops under variable agro climatic conditions.

Theory

Units	Contents	Lectures
I	Water resources of India, irrigation projects; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.	5
II	Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity.	5
III	Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.	5
IV	Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.	5
V	Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.	4
VI	Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation	4

Practical

1.	Determination of water infiltration characteristics and water holding capacity of soil profiles	3
2.	Moisture extraction pattern of crops	3
3.	Consumptive use, water requirement of a given cropping pattern for optimum/variable productivity	3
4.	Crop planning at the farm and project level	3
5.	Agronomic evaluation of irrigation projects, case studies	2

Suggested Readings

FAO. 1984. *Irrigation Practice and Water Management.* Oxford & IBH.
Michael AM. 1978. *Irrigation: Theory and Practice*.Vikas Publ.
Mishra RR & Ahmad M. 1987. *Manual on Irrigation and Agronomy*.
Oxford & IBH.
Panda SC. 2003. *Principles and Practices of Water Management*.
Agrobios.
Reddy SR. 2000. *Principles of Crop Production*. Kalyani.
Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.
Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.

AGRON 606
ADVANCES IN WEED MANAGEMENT

Credits: 2 + 0 Mid-Session Exam: 40
Contact Hours: 28 End-Semester Exam: 60

Objective: To teach about the changing weed flora, new herbicides, their resistance, toxicity, antidotes and residue management under different cropping systems.

Theory

Units	Contents	Lectures
I	Crop-weed competition in different cropping situations; changes in weed flora, various causes and affects.	5
II	Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.	5
III	Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants.	5
IV	Advances in herbicide application techniques; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides.	5
V	Development of transgenic herbicide resistant crops; herbicide development, registration procedures.	4
VI	Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides, allelochemical herbicide bioassays.	4

Suggested Readings

Aldrich RJ & Kramer R.J. 1997. *Principles in Weed Management*. Panama Publ.
Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed.
Wiley-Inter Science.
Gupta OP. 2000. *Weed Management – Principles and Practices*. Agrobios.
Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.
Rao VS. 2007. *Principles of Weed Science*. Oxford & IBH.
Ross MA & Carola Lembi A. 1999. *Applied Weed Science.* 2nd Ed. Prentice Hall.
Subramanian SAM & Kumar R.J. 1997. *All About Weed Control*. Kalyani.
Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

Optional Courses

AGRON 607
INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE

Credits: 2 + 0 Mid-Session Exam: 40
Contact Hours: 28 End-Semester Exam: 60

Objective: To apprise about different enterprises suitable for different agro-climatic conditions for sustainable agriculture.

Theory

Units	Contents	Lectures
I	Farming systems: definition and importance; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises.	6
II	Concept of sustainability in farming systems; efficient farming systems; natural resources - identification and management.	6
III	Production potential of different components of farming systems; interaction and mechanism of different production factors; stability in different systems through research; eco-physiological approaches to intercropping.	6
IV	Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems.	6
V	New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.	4

Suggested Readings

Ananthakrishnan TN. (Ed.) 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.

Balasubramanian P & Palaniappan SP 2006. *Principles and Practices of Agronomy*. Agrobios.

Joshi M & Parbhakarasetty TK. 2005. *Sustainability through Organic Farming*. Kalyani. Lampin N. 1990. *Organic Farming*. Farming Press Books.

Palaniappan SP & Anandurai K. 1999. *Organic Farming - Theory and Practice*. Scientific Publ.

Panda SC. 2004. *Cropping systems and Farming Systems*. Agribios.

Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.

Sharma AK. 2001. *A Hand Book of Organic Farming*. Agrobios.

Singh SP. (Ed) 1994. *Technology for Production of Natural Enemies*.
PDBC, Bangalore.

Trivedi RN. 1993. *A Text Book of Environmental Sciences*. Anmol Publ.

Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.

Venkata Rao BV. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*. Publ. 3. Parisaraprajna Parishtana, Bangalore.

AGRON 608
SOIL CONSERVATION AND WATERSHED MANAGEMENT

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To teach about different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

Theory

Units	Contents	Lectures
I	Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion	6
II	Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.	6
III	Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.	6
IV	Land use capability classification, alternate land use systems; agro-forestry; ley farming; *jhum* management - basic concepts, socio-ethnic aspects, its layout.	6
V	Drainage considerations and agronomic management; rehabilitation of abandoned *jhum* lands and measures to prevent soil erosion.	4

Practical

1.	Study of different types of erosion	3
2.	Field studies of different soil conservation measures	3
3.	Run-off and soil loss measurements	2
4.	Laying out run-off plot and deciding treatments	2
5.	Identification of different grasses and trees for soil conservation	2
6.	Visit to a soil conservation research centre, demonstration and training centre	2

Suggested Readings

Arakeri HR & Roy D. 1984. *Principles of Soil Conservation and Water Management*. Oxford & IBH.

Dhruvanarayana VV. 1993. *Soil and Water Conservation Research in India*. ICAR.

FAO. 2004. *Soil and Water Conservation in Semi-Arid Areas. Soils Bull.,* Paper 57.

Frederick RT, Hobbs J, Arthur D & Roy L. 1999. *Soil and Water Conservation: Productivity and Environment Protection.* 3rd Ed. Prentice Hall.

Gurmel Singh, Venkataraman CG, Sastry B & Joshi P. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Murthy VVN. 1995. *Land and Water Management Engineering*. Kalyani.

Tripathi RP & Singh HP. 1993. *Soil Erosion and Conservation*. Wiley Eastern.

Yellamanda Reddy T & Sankara Reddy GH. 1992. *Principles of Agronomy*. Kalyani.

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

Ph. D. Biotechnology

(I to VI Semester)

Dr. Khem Singh Gill Akal College of Agriculture

Ph.D. Programme in Biotechnology at the Eternal University Baru Sahib, Himachal Pradesh

Compulsory Courses						
Semester	**Course No.**	**Course Title**	**Theory**	**Seminar**	**Practical**	**Dissertation**
Sem-I	BT-601	Research Methodology	3	0	0	0
Sem-I	BT-602	Instrumental Methods of Analysis	3	0	0	0
Sem-I	BT-691	Seminar	0	1	0	0
Sem-I	BT-701	Dissertation	0	0	0	5
Optional Courses (Any two courses taking one from each option)						
Option-I						
Sem-I	BT-505	Computational Biology and Biostatistics	3	0	0	0
Sem-I	BT-513	Genetic Engineering	3	0	0	0
Option-II						
Sem-I	BT-514	Enzymes and Enzyme Technology	3	0	0	0
Sem-I	BT-519	Plant Molecular Breeding	2	0	0	0
Sem-I	BT-523	Environmental Biotechnology	2	0	0	0
		Semester-I Total	11/12	1	0	0
Sem-II*	BT-692	Synopsis Seminar	0	1	0	0
Sem-II	BT-701	Dissertation	0	0	0	15
Sem-III	BT-701	Dissertation	0	0	0	15
Sem-IV	BT-701	Dissertation	0	0	0	15
Sem-V	BT-701	Dissertation	0	0	0	15
Sem-VI	BT-701	Dissertation	0	0	0	15
Total			**11 /12**	**2**	**0**	**80**

*In second semester, each student will have to achieve 50% marks in comprehensive written examination and satisfactory performance in oral examination.

Ph.D. Biotechnology

Course Contents

BT-601

Research Methodology

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42 + 0 End-Semester Exam: 60

Objective: The goal of the course is to give students an understanding of the principles and methods of planning, executing, reporting and exploiting research.

Details of Course:

S. No	Contents	No. of Lectures
1.	History, myths and ethnic practices; need, importance and impact of research; types of research; research process	4
2.	Synopsis writing; Selecting research problem; formulation of research projects; survey of literature; allied and critical literature; research infrastructure; experimental designs; sampling designs; recording of observations ; measurement and scaling techniques; GLPs	7
3.	Financial support and various funding agencies; Multidisciplinary, multi-institutional research network initiatives; writing research proposal	4
4.	Computer and informatics; introduction; word processing, excel, power point presentation; graph and figure plotting; web browsing; information resources and various databases.	7
5.	Formulation and types of hypothesis; collection, maintenance, storage and analysis of data; measures of central tendencies and relationships and error analysis; tests of significance	7
6.	Compilation and presentation of results, Writing of manuscripts; research reports and thesis; organization of reference material using endnote; bibliography; plagiarism; IPR and patent application	6
7.	Scale up of protocols; pilot plants; institute-industry linkages; venture capital; entrepreneurship	4
8.	Research as career; Current status and future prospects of research	3
Total		**42**

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication
1.	C. R. Kothari, Research methodology-methods and techniques, Wiley eastern Ltd.	1985
2.	Ranjeet Kumar, Research methodology-A step by step guide for beginners, 2nd edn. Pearson Education	2005
3.	Research Methods and Statistics, Sherri Jackson, Wadsworth Cengage Learning	2009

BT-602
Instrumental methods of Analysis

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42 + 0 End-Semester Exam: 60

Objective: To impart knowledge of advanced analytical techniques in modern biology.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Microscopy -light, phase contrast, fluorometery, confocal, scanning and transmission electron microscopy.	6
2.	Radioisotopy- radioactive tracer techniques, autoradiography, Cerenkov radiation, liquid scintillation counting, radio immunological assays, safety.	5
3.	Chromatography- TLC, exclusion, adsorption, gel filtration, ion-exchange, affinity chromatography, HPLC and GC.	7
4.	Electrophoresis, denaturing and non-denaturing gels, isoelectric focusing, 2DE, pulsed-field gel electrophoresis and immuno-electrophoresis.	7
5.	Dialysis, microfiltration, sedimentation, ultra-centrifugation and hydrodynamic methods	7
6	Automated methods of DNA and peptide sequencing and synthesis	5
7	Spectroscopy- UV-visible, IR, NMR, ORD, CD, MS, atomic absorption and plasma emission spectroscopy, imaging techniques	5
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Pungor, E., "A Practical Guid to Instrumental Analysis", CRC Press.	1995
2.	Rickwood, D. and Hames, B.D., "HPLC, Gel Electrophoresis, Oligonucleotide Synthesis, Soild Phase Peptide Synthesis, The Practical Approach Series", IRL Press.	1994
3.	Glasel, J.A. and Deutscher, M.P., "Introduction to Biophysical Method for Protein and Nucleic Acid Research", Academic press.	1995
4.	Campbell, I.D., and Dwek, R.A., "Biological spectroscopy", Benjamin Cummins.	1984
5.	Wilson, K. and Walker, J., "Principles and Techniques of Practical Biochemistry" 5th edition, Cambridge University Press.	2000

BT-505

Computational Biology & Biostatistics

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42 + 0 End-Semester Exam: 60

Objective: To expose student to the rapidly growing field of Bio-informatics through data mining and computational approach.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	Introduction and definition of biostatistics, concept of variables in biological systems, collection, classification, tabulation, graphical and diagrammatic representation of numerical data, measure of central tendency, measure of dispersion, correlation and regression, linear and quadratic regressions, concept of standard errors, hypothesis testing (null & alternative hypothesis).	8
2.	Test of significance based on Z, χ_2, t and F statistics, correlation and regression, curve fitting by least squares methods.	7
3.	Introduction, biological and chemical databases- Database models, storage, mining and retrieval, Laboratory Information management systems (LIMS)	5
4.	Protein and gene information resources- PIR, SWISSPROT, PDB, Genebank, DDBJ, protein structures and drug discovery.	5
5.	Introduction to sequence comparison, global and multiple sequence alignment, multiple sequence alignment using FASTA, Sequence alignment using CLUSTAL W, BLAST and PSI BLAST, Use of sequences to determine phylogenetic relationship.	7
6.	DNA microarrays, databases, data management cluster analysis	3
7.	Gene finding algorithms and softwares, Hidden Markov Models (HMM), annotation of genomic and protein sequences prediction of protein secondary and tertiary structures.	4
8.	Protein-Protein interactions, proteomics, protein microarrays chips and data analysis	3
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Higgins, D. and Taylor, W., "Bioinformatics – Sequence, Structure and Databanks", Oxford University Press.	2003
2.	Lacroix, Z. and Critchlow, T., "Bioinformatics – Managing Scientific Data", Morgan Kaufmann Publishers.	2003
3.	Bourne, E.,P. and Weissig H., "Structural Bioinformatics"" John Wiley and Sons.	2003
4.	Arora, P.N. and Malha, P.K., "Biostatistics",	2003
5.	Rosner, B., "Fundamentals of Biostatistics" Thomson and Brooks/Cole	2006
6.	Mahajan, B.K., "Methods in Biostatistics", Jaypee Publishers	2002

BT-513
Genetic Engineering

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42 + 0 End-Semester Exam: 60

Objective: To impart knowledge of various techniques employed in the field of genetic engineering and its applications.

Details of Course:

S. No.	Particulars	No. of lectures
1.	Scope and milestones in genetic engineering	2
2.	Cloning vectors for *E. coli*- plasmids, lambda phage vectors, cosmids, single stranded DNA phage vectors, cloning vectors for organisms other than *E. coli*- Ti plasmid, YACs, PACs, BACs, TACs, mini chromosomes, expression vectors	8
3.	Purification of DNA from living cell, gel electrophoresis of DNA, recovery of DNA from gels, transformation and selection of recombinant clones	4
4.	Extraction, purification and analysis of mRNA from eukaryotic cells, reverse transcription	6
5.	Construction and screening of genomics and cDNA libraries, restriction mapping of DNA fragments, nucleic acid sequencing, preparation of DNA and RNA probes, DNA primers, linkers, adaptors and probes, polymerase chain reaction and its variants, site directed mutagenesis.	8
6.	Expression in heterologous systems, vector engineering and codon optimization, expression of cloned genes in *E. coli*, yeast, insect, plants and mammalian cells, detection and analysis of proteins expressed from cloned genes, protein-protein interactions- yeast two hybrid assay and phage display libraries.	7
7.	Genetic manipulation of higher animals and plants, application of genetic engineering, possible risks and safety aspects of genetic engineering.	7
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Sambrook, J., Fritsch, E.F., and Maniatis, T., "Molecular cloning: A laboratory Manual", Cold Spring Harbor Laboratory.	2001
2.	Brown, T.A., "Gene Cloning and DNA Analysis", Blackwell Science.	2001
3.	Winnacker, E.L., "From Genes to Clones: An Introduction to Gene Technology", VCH.	1989
4.	Old, R.W. and Primrose S.B., "Principles of Gene Manipulation" , Blackwell Scientific Publication.	1999
5	Gupta, P.K., "Biotechnology and Genomics", Rastogi Publications.	2004

BT-514

Enzymes and Enzyme Technology

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42 + 0 End-Semester Exam: 60

Objective: To impart knowledge of fundamental principles of enzyme catalysis and applications of enzyme technology.

Details of Course:

S. No.	Particulars	No. of Lecture
1.	Introduction, nomenclature and classification of enzymes, structure of enzymes- active site structure determination, identification of binding and catalytic sites, trapping of enzyme substrate complex.	8
2.	Extraction, purification, assay and analysis of enzymes	3
3.	Catalysis and kinetics, factors affecting rates of reaction, kinetics of single substrate enzyme catalyzed reactions, Michaelis- Menton equation, Briggs-Haldane modification, Lineweaver- Burk plot, kinetics of multisubstrate enzyme catalysed reactions, ping-pong, random order and compulsory order mechanisms, enzyme inhibition – competitive, uncompetitive and non competitive, substrate and irreversible inhibition.	12
4.	Investigation of reaction mechanisms- steady and non-steady state methods, monomeric enzymes- serine proteases, oligomeric enzymes, lactate dehydrogenase and lactose synthase, mechanism of enzyme catalysis, metals and coenzymes.	7
5.	Binding of ligands to enzymes, cooperativity, allosteric enzymes and metabolic regulation, sub-cellular compartmentalization.	5
6.	Clinical aspects of enzymes- plasma enzymes, inborn errors of metabolism, enzymes as reagents, large scale production and purification of enzymes, immobilized enzymes- preparation and application, application of enzymes and enzyme technology.	7
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Chaplin, M.F. and Bucke, C., “Enzyme technology,” Cambridge University Press.	1992
2.	Palmer, T., “Understanding Enzymes”, Prentice Hall.	1985
3.	Boyer, P.D., “The Enzymes V”, , Academic Press	1992
4.	Buchholz, K., Kasche, V. and Bornscheuer, U. T., “Biocatalysts and Enzyme Technology”, Wiley-VCH.	2005
5.	Shanmugam, S., **“**Enzyme Technology**”,** I. K. International.	2009

BT-519
Plant Molecular Breeding

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To familiarize the students about the use of molecular biology tools in plant breeding.

Details of Course:

S. No.	Particulars	No. of Lectures
1.	Principles of plant breeding, breeding methods for self and cross-pollinated crops, hetrosis breeding, limitations of conventional breeding	5
2.	Introduction to molecular breeding, molecular markers, development of sequence based markers- SSRs and SNPs, DArT markers	4
3.	Advanced methods of genotyping, mapping genes for qualitative and quantitative traits	4
4.	QTL mapping using structured populations, AB-QTL analysis, association mapping of QTL, fine mapping of gene/QTL, overcoming yield barriers	5
5.	Map Based gene cloning and development of gene based markers, Allele mining by TILLING and Eco-TILLING, use of markers in plant Breeding	5
6.	Markers assisted selection (MAS) in backcross and heterosis breeding, foreground and background selection, MAS for gene introgression and pyramiding, MAS for specific traits with examples, Transgenic breeding.	5
Total		28

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Chittranjan K, "Genome Mapping and Molecular Breeding in Plants" Vols. I-VII. Springer	2006-07
2.	Newbury H. J. "Plant Molecular Breeding" Blackwell Publication	2003
3.	Weising, K., Nybom H, Wolff K and Kahl G "DNA fingerprinting in plants: Principles, Methods and Applications". Taylor and Francis	2005
4.	Günter K, Khalid M. "The handbook of plant functional genomics" Wiley Publications	2008

BT-523
Environmental Biotechnology

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To introduce applications of biotechnology to environmental conservation and management.

Details of Course:

S. No.	Particulars	No. of Lectures
1.	Status and scope of biotechnology in environmental protection, types of environmental pollutants, problems arising from high-input agriculture, soil and water pollution, global environmental problems.	4
2.	Waste water management, waster water flow, waste water treatment methods-physical, chemical and biological processes, aerobic and anaerobic biological treatment	5
3.	Solid waste management- treatment schemes for industrial, domestic and hazardous solid wastes, collection haulage, composting, incineration and disposal.	5
4.	Bioremediation and phytoremediation, environment biosensors for detection of pollution, xenobiotics, biological detoxification of PAH, biotechniques for air pollution control, biofertilizers, biopesticides, biodiversity and its conservations.	6
5.	Renewable and non-renewable resources of energy, energy from solid waste, conventional fuels and their environmental impact, biodegradation of lignin and cellulose, etc.	5
6.	Environmental protection act, environmental laws and policies, UN declaration, ecoplanning and sustainable development.	3
Total		28

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Jordening, J.H. and Winter, J., "Environmental Biotechnology", John Wiley Publications.	2005
2.	Evans, G.G. and Furlong, J., "Environmental Biotechnology: Theory and Applications", John Wiley Publications.	2011
3.	Young, M.M., Anderson, W.A. and Chakrabarty, A.M., "Environ--mental Biotechnology: Principles and Applications", Springer	1996
4.	Srinivas, T., "Environmental Biotechnology", New Age International Press.	2008

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

Ph. D. Entomology

(I to VI Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

Programme Structure

Ph. D. Entomology

Minimum Credit Requirements

Subject	Minimum Credit Requirements as per BSMA, ICAR Guidelines	Proposed Minimum Credit Requirements to be Followed
Major	15	16
Minor	08	08
Supporting	05	05
Seminar	02	02
Research	45	45
Total Credits	75	76

Note:

Minor Subjects

The student shall have the option to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subjects viz. Plant Pathology, Agronomy, Soil Science, Vegetable Science, Fruit Science and Biochemistry in 500 series courses.

Supporting Subjects

The student shall have the option to take minimum five credits in the supporting subject in 500 series 600 series courses. The supporting subject will not be related to the major subject. It could be any subject considered relevant for students research work.

Allotment of Research Credits

As per the decision taken in the Board of Studies meeting held on 02/06/2021, the allotment of Research Credits in a particular semester will be at the discretion of Major Advisor, Advisory Committee and the student concerned depending upon his/her work load.

Ph. D. Entomology

Syllabus Semester wise

Semester I				
S. No	**Course Code**	**Course Title**	**Credit Hours**	**Semester**
Major Courses				
1	**ENT 601**	Advanced Insect Systematics	**1+2**	**I**
2	**ENT 602**	Immature Stages of Insects	**1+1**	**I**
3	**ENT 603**	Advanced Insect Physiology	**2+0**	**I**
4	**ENT 604**	Advanced Insect Ecology	**1+1**	**I**
4	**ENT 699**	Doctoral Research	**0+2**	**I**
Minor Courses				
The student shall have the option to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subject's viz. Plant Pathology, Agronomy, Soil Science, Vegetable Science and Fruit Science in 500 series courses. In the 1st Semester he / she has to register for minimum **four** credits in the split minor subjects.				
Supporting Courses				
The student shall have the option to take minimum five credits in the supporting subject in 500 series courses. The supporting subject will not be related to the major subject. It could be any subject considered relevant for students research work. In the 1st semester, the student has to register for minimum **three** credits in the supporting subject.				
Total=11+4+3=18				
Semester II				
Major Courses				
1	**ENT 606**	Recent Trends in Biological Control	**1+1**	**II**
2	**ENT 607**	Advanced Insecticide Toxicology	**2+1**	**II**
3	**ENT 612**	Advanced Insect Pest Management	**2+0**	**II**
4	**ENT 691**	Doctoral Seminar I	**1+0**	**II**
5	**ENT 699**	Doctoral Research	**0+3**	**II**
Minor Courses				
The student shall have the option to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subject's viz. Plant Pathology,				

Agronomy, Soil Science, Vegetable Science and Fruit Science in 500 series courses. In the 2nd Semester he / she has to register for minimum **four** credits in the split minor subjects.

Supporting Courses

The student shall have the option to take minimum five credits in the supporting subject in 500 series courses. The supporting subject will not be related to the major subject. It could be any subject considered relevant for students research work. In the 2nd semester, the student has to register for minimum **two** credits in the supporting subject.

Total=11+4+2=17

III Semester

Major Courses

1	**ENT 692**	Doctoral seminar II	**1+0**	**III**
2	**ENT 699**	Doctoral Research	**0+10**	**III**

Total=11

IV Semester

1	**ENT 699**	Doctoral research	**0+10**	**IV**

Total = 10

V Semester

1	**ENT 699**	Doctoral research	**0+10**	**V**

Total = 10

VI Semester

1	**ENT 699**	Doctoral Research / Thesis Submission	**0+10**	**VI**

Total = 10

Major Guidelines

Synopsis of Thesis

The synopsis of the thesis must be finalized by the major advisor in consultation with the advisory committee before the commencement of mid-session examination of the 2nd registered semester. Prior to this, the student has to deliver the synopsis seminar in the department.

Comprehensive Examination

After having successfully completed 75% of the total credit hours of the prescribed in major (core) and minor (specialization) courses with minimum OGPA of 6.50/ 10.00, a Ph. D student shall have to pass comprehensive examination. The comprehensive examination shall consist of both written and oral tests, the former preceding the letter. A candidate shall be given only two chances to appear in the comprehensive examination, written or oral.

There shall be three written papers. i.e., Paper-I and Paper-II in major subject (core) and Paper-III in minor subject (specialization). Each paper shall be of four hours duration and shall be conducted after a minimum gap of one week.

The syllabus for two papers of major (core) courses and the paper in minor subject shall be decided by the Major Advisor in consultation with the Members concerning minor subject in the Advisory Committee and Head of the Department.

The candidate shall be graded as 'Satisfactory' or 'Unsatisfactory'. To obtain 'Satisfactory' grade, a student must secure not less than 60% Marks in each paper.

Oral Comprehensive Examination

The Oral Comprehensive Examination shall cover both major/ core and minor fields/ specialization and shall be conducted by the Examining Committee comprising the Advisory Committee and one External Examiner who shall be appointed by the Dean PGS. The external examiner shall be a specialist in the students' major field from outside the University.

Recommendations of Board of Studies meeting held on 02/06/2021

It was recommended that Synopsis of Thesis may be submitted in the 1st semester in place of 2nd semester. It was further recommended that the synopsis should be finalized by the student with the help of concerned Major Advisor and all the Advisory Committee Members.

It was recommended that the student may give pre oral comprehensive examination in front of Major Advisor and Advisory Committee Members before the final oral comprehensive examination.

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

Ph. D. Entomology

Course Contents

ENT 601
ADVANCED INSECT SYSTEMATICS

Credits: 1+2
Contact Hours: 14 + 56

Mid-Session Exam: 15 (10+5#)
Practical Exam: 65
End-Semester Exam: 20

Objective: To familiarize the students with different schools of classification, phylogenetics, classical and molecular methods, evolution of different groups of insects. International Code of Zoological Nomenclature. Ethics and procedure for taxonomic publications

Theory

Units	Contents	Lectures
I	Detailed study of three schools of classification- numerical, evolutionary and cladistics. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts and speciation processes and evidences. Zoogeography.	4
II	Study of different views on the evolution of insects- alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times.	4
III	Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN- Ethics.	3
IV	Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications - small publications of species descriptions, revisionary works, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular Taxonomy, barcoding species.	3

Practical

1.	Collection, curation and study of one taxon of insects- literature search	3
2.	Compilation of a checklist, study of characters	3
3.	Development of character table	2
4.	Construction of taxonomic keys for the selected group	3
5.	Development of descriptions	3
6.	Photographing	3
7.	Writing diagrams, and preparation of specimens for "type like" preservation	3
8.	Submission of the collections made of the group	2
9.	Multivariate Analysis techniques for clustering specimens into different taxa, and development of phenograms	3
10.	Rooting and character polarisation for developing cladograms and use of computer programmes to develop cladograms	3

Suggested Readings

CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers.* 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.

Dakeshott J & Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology*. Springer-Verlag, Berlin.

Freeman S & Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.

Hennig W. 1960. *Phylogenetic Systematics*. Urbana Univ. Illinois Press, USA.

Hoy MA. 2003. *Insect Molecular Genetics: An Introduction to Principles and Applications*. 2nd Ed. Academic Press, New York.

Mayr E & Ashlock PD. 1991. *Principles of Systematic Zoology*. 2nd Ed. McGraw Hill, New York.

Mayr E.1969. *Principles of Systematic Zoology.* McGraw-Hill, New York. Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy.*

Blackie Academic and Professional, London.

Ross HH. 1974. *Biological Systematics.* Addison Wesley Publ. Co., London.

Wiley EO. 1981. *Phylogenetics: The Theory and Practices of Phylogenetic Systematics for Biologists*. Columbia Univ. Press, USA.

ENT 602
IMMATURE STAGES OF INSECTS

Credits: 1+1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To impart knowledge on morphology of immature stages of different groups of insects. Train students in identification of common pest species during their immature stages.

Theory

Units	Contents	Lectures
I	Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects	7
II	Comparative study of life history strategies in hemi-metabola and holo-metabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management.	7

Practical

1.	Types of immature stages; their collection, rearing and preservation.	7
2.	Identification of immature insects to orders and families, in endopterygote orders viz., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key.	7

Suggested Readings

Chu HF. 1992. *How to Know Immature Insects*. William Brown Publ., Iowa.Peterson A. 1962. *Larvae of Insects*. Ohio University Press, Ohio.
Stehr FW. 1998. *Immature Insects*. Vols. I, II. Kendall Hunt Publ., Iowa.

ENT 603

ADVANCED INSECT PHYSIOLOGY

Credits: 2+0 Mid-Session Exam: 40
Contact Hours: 28+0 End-Semester Exam: 60

Objective: To impart knowledge to the students on detailed physiology of various secretory and excretory systems, moulting process, chitin synthesis, physiology of digestion, transmission of nerve impulses, nutrition of insects, pheromones etc.

Theory

Units	Contents	Lectures
I	Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in various cuticles, types of sclerotization.	7
II	Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development; physiology of excretion and osmoregulation, water conservation mechanisms.	7
III	Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.	7
IV	Endocrine system and insect hormones, physiology of insect growth and development- metamorphosis, polyphenism and diapause. Energetics of muscle contractions.	7

Suggested Readings

Kerkut GA & Gilbert LI. 1985. *Insect Physiology, Biochemistry and Pharmacology*. Vols. I-XIII. Pergamon Press, Oxford, New York.

Muraleedharan K. 1997. *Recent Advances in Insect Endocrinology*. Assoc. for Advancement of Entomology, Trivandrum, Kerala.

ENT 604

ADVANCED INSECT ECOLOGY

Credits: 1+1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To impart advanced practical knowledge of causal factors governing the distribution and abundance of insects and the evolution of ecological characteristics.

Theory

Units	Contents	Lectures
I	Characterisation of distribution of insects- Indices of Dispersion, Taylor's Power law. Island Biogeography. Population dynamics- Life tables, Leslie Matrix, Stable age distribution, Population projections. Predator-Prey Models- Lotka-Volterra and Nicholson-Bailey Model. Crop Modeling- an introduction.	4
II	Insect Plant Interactions. Fig-figwasp mutualism and a quantitative view of types of Associations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of Insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Host seeking behaviour of parasitoids. Meaning of stress- plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defences.	4
III	Biodiversity and Conservation- RET species, Ecological Indicators. Principles of Population genetics, Hardy Weinberg Law, Computation of Allelic and Phenotypic frequencies, Fitness under selection, Rates of Evolution under selection. Foraging Ecology- Optimal foraging theory, Marginal Value Theorem, and Patch departure rules, central place foraging, Mean-variance relationship and foraging by pollinators, Nutritional Ecology.	3
IV	Reproductive ecology- Sexual selection, Mating systems, Reproductive strategies - timing, egg number, reproductive effort, sibling rivalry and parent-offspring conflict. Agro-ecological vs Natural Ecosystems – Characterisation, Pest Control as applied ecology- case studies.	3

Practical

1.	Methods of data collection under field conditions.	1
2.	Assessment of distribution parameters, Taylor's power law, Iwao's patchiness index, Index of Dispersion, etc.	2
3.	Calculation of sample sizes by different methods. Fitting Poisson and Negative Binomial distributions and working out the data transformation methods.	3
4.	Hardy-Weinberg Law, Computation of Allelic and Phenotypic Frequencies - Calculation of changes under selection, Demonstration of genetic drift.	3
5.	Assessment of Patch Departure rules.	1
6.	Assessment of Resource size by female insects using a suitable insect model, fruit flies/*Goniozus*/Female Bruchids etc. - A test of reproductive effort and fitness.	1
7.	Construction of Life tables and application of Leslie Matrix – population projections,	1
8.	Stable age distribution	1
9.	Exercises in development of Algorithms for crop modeling	1

Suggested Readings

Barbosa P & Letourneau DK. (Eds.). 1988. *Novel Aspects of Insect-Plant Interactions.* Wiley, London.

Elizabeth BA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects.* Chapman & Hall, New York.

Freeman S & Herron JC.1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.

Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics.* Sinauer Associates, Sunderland, MA.

Gotelli NJ. 2001. *A Primer of Ecology*. 3rd Ed., Sinauer Associates, Sunderland, MA, USA.

Krebs C. 1998. *Ecological Methodology.* 2nd Ed. Benjamin-Cummings Publ. Co., New York.

Krebs CJ. 2001 *Ecology: The Experimental Analysis of Distribution and Abundance*. 5th Ed. Benjamin-Cummings Publ. Co., New York.

Magurran AE. 1988. *Ecological Diversity and its Measurement.* Princeton University Press, Princeton.

Real LA & Brown JH. (Eds.). 1991. *Foundations of Ecology: Classic Papers with Commentaries.* University of Chicago Press, USA.

Southwood TRE & Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Wiley Blackwell, London.

Strong DR, Lawton JH & Southwood R. 1984. *Insects on Plants: Community Patterns and Mechanism*. Harward University Press, Harward.

Wratten SD & Fry GLA. 1980. *Field and Laboratory Exercises in Ecology*. Arnold Publ., London.

ENT 606

RECENT TRENDS IN BIOLOGICAL CONTROL

Credits: 1+1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To appraise the students with advanced techniques in handling of different bioagents, modern methods of biological control and scope in cropping system-based pest management in agro-ecosystems.

Theory

Units	Contents	Lectures
I	Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of biocontrol agents *vis-à-vis* target pest populations.	4
II	Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.	4
III	Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of biocontrol agents, bankable project preparation.	3
IV	Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.	3

Practical

1.	Mass rearing and release of some commonly occurring indigenous natural enemies	2
2.	Assessment of role of natural enemies in reducing pest populations	2
3.	Testing side effects of pesticides on natural enemies	2
4.	Effect of semiochemicals on natural enemies	2
5.	Breeding of various biocontrol agents	2
6.	Performance of efficiency analyses on target pests	2
7.	Project document preparation for establishing a viable mass-production unit /insectary.	2

Suggested Readings

Burges HD & Hussey NW. (Eds.). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

Coppel HC & James WM. 1977. *Biological Insect Pest Suppression.* Springer Verlag, Berlin.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, London.

Dhaliwal, GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall, New York.

Huffakar CB & Messenger PS. 1976. *Theory and Practices of Biological Control*. Academic Press, London.

ENT 607

ADVANCED INSECTICIDE TOXICOLOGY

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with the latest advancements in the field of insecticide toxicology, biochemical and physiological target sites of insecticides, and pesticide resistance mechanisms in insects.

Theory

Units	Contents	Lectures
I	Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.	5
II	Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism of insecticides.	6
III	Joint action of insecticides; activation, synergism and potentiation.	3
IV	Problems associated with pesticide use in agriculture: pesticide resistance-resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.	7
V	Estimation of insecticidal residues-sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; insecticide laws and standards, and good agricultural practices.	7

Practical

1.	Sampling, extraction, clean-up and estimation of insecticide residues by various methods.	7
2.	calculations and interpretation of data; biochemical and biological techniques for detection of insecticide resistance in insects.	7

Suggested Readings

Busvine JR. 1971. *A Critical Review on the Techniques for Testing Insecticides.* CABI, London.

Dhaliwal GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.

Hayes WJ & Laws ER.1991. *Handbook of Pesticide Toxicology*. Academic Press, New York.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York. O' Brien RD. 1974. *Insecticides Action and Metabolism.* Academic Press,
New York.

Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House, New Delhi.

Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

ENT 612

ADVANCED INTEGRATED PEST MANAGEMENT

Credits: 2+0 Mid-Session Exam: 40
Contact Hours: 28+0 End-Semester Exam: 60

Objective: To acquaint the students with recent concepts of integrated pest management. Surviellance and data base management. Successful national and international case histories of integrated pest management, non conventional tools in pest management.

Theory

Units	Contents	Lectures
I	Principles of sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modeling.	7
II	Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests.	7
III	Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management-case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' real-time situations.	7
IV	Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.	7

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* Springer, Berlin.

Koul O & Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI, London.

Koul O, Dhaliwal GS & Curperus GW. 2004. *Integrated Pest Management -Potential, Constraints and Challenges.* CABI, London.

Maredia KM, Dakouo D & Mota-Sanchez D. 2003. *Integrated Pest Management in the Global Arena.* CABI, London.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons, New York.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concept in Integrated Pest Management.* Prentice Hall, New Delhi.

Pedigo RL. 1996. *Entomology and Pest Management.* Prentice Hall, New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

Ph. D. (Genetics and Plant Breeding)

(I to VI Semester)

Syllabi Applicable for Admissions in 2022 onwards

Dr. Khem Singh Gill Akal College of Agriculture

Programme Structure

Ph. D. (Genetics and Plant Breeding)

Minimum Credit Requirements

Subject	Minimum Credit Requirements as per BSMA, ICAR Guidelines	Proposed Minimum Credit Requirements to be Followed
Major	15	15
Minor	08	08
Supporting	05	05
Seminar	02	02
Research	45	45
Compulsory Non Credit Course if not studied during Master's programme	06	06
Total Credits	81	81

Note:

Non Credit Compulsory Courses:

Six courses (PGS 501, PGS 502, PGS 503, PGS 504, PGS 505 and PGS 506) are compulsory for Master's programme. Ph.D. students can be exempted from these courses if already studied during Master's degree.

Minor Subjects

The student shall have to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subjects viz. Plant Pathology, Entomology, Biotechnology, Agronomy, Soil Science, Biochemistry, Plant Physiology and Microbiology in 500 series courses.

Supporting Subjects

The student shall have the option to take minimum five credits in the supporting subject in 500 series / 600 series courses. The supporting subjects may be from major or any other subjects. It could be any subject considered relevant for students research work.

Allotment of Research Credits

As per the decision taken in the Board of Studies meeting held on 02/06/2021, the allotment of Research Credits in a particular semester will be at the discretion of Major Advisor, Advisory Committee and the student concerned depending upon his/her work load.

Ph. D. (Genetics and Plant Breeding)

Syllabus Semester Wise

Semester I				
S. No	**Course Code**	**Course Title**	**Credit Hours**	**Semester**
Major Courses				
1	**GP 601**	Plant Genetic Resources and Pre-Breeding	**2+0**	**I**
2	**GP 602**	Advanced Biometrical and Quantitative Genetics	**2+1**	**I**
3	**GP 603**	Genomics in Plant Breeding	**2+1**	**I**
4	**GP 699**	Doctoral Research	**0+2**	**I**
Minor Courses				
The student shall have to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subjects viz. Plant Pathology, Entomology, Biotechnology, Agronomy, Soil Science, Biochemistry, Plant Physiology and Microbiology in 500 series courses. In the 1st Semester he / she has to register for minimum **four** credits in the split minor subjects.				
Supporting Courses				
The student shall have the option to take minimum five credits in the supporting subject in 500 / 600 series courses. The supporting subjects may be from major or any other subjects. It could be any subject considered relevant for students research work. In the 1st semester, the student has to register for minimum **three** credits in the supporting subject.				
Total=10+4+3=17				

Semester II				
Major Courses				
1.	**GP 604**	Molecular and Chromosomal Manipulations for Crop Breeding	**2+0**	**II**
	GP 605	Advances in Plant Breeding Systems	**2+0**	**II**
2.	**GP 608**	Advances in Breeding of Major Field Crops	**3+0**	**II**
3.	**GP 691**	Doctoral Seminar I	**1+0**	**II**
4.	**GP 699**	Doctoral Research	**0+3**	**II**
Minor Courses				
The student shall have to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subjects viz. Plant Pathology, Entomology, Biotechnology, Agronomy, Soil Science, Biochemistry, Plant Physiology and Microbiology in 500 series courses. In the 2nd Semester he / she has to register for minimum **four** credits in the split minor subjects.				
Supporting Courses				
The student shall have the option to take minimum five credits in the supporting subject in 500 / 600 series courses. The supporting subjects may be from major or any other subjects. It could be any subject considered relevant for students research work. In the 2nd semester, the student has to register for minimum **two** credits in the supporting subject.				
Total=11+4+2=17				

III Semester				
Major Courses				
1	**GP 692**	Doctoral seminar II	**1+0**	**III**
2	**GP 699**	Doctoral Research	**0+10**	**III**
Total=11				
IV Semester				
1	**GP 699**	Doctoral Research	**0+10**	**IV**
Total = 10				
V Semester				
1	**GP 699**	Doctoral Research	**0+10**	**V**
Total = 10				
VI Semester				
1	**GP 699**	Doctoral Research / Thesis Submission	**0+10**	**VI**
Total = 10				

Major Guidelines

Synopsis of Thesis

The synopsis of the thesis must be finalized by the major advisor in consultation with the advisory committee before the commencement of mid-session examination of the 2nd registered semester. Prior to this, the student has to deliver the synopsis seminar in the department.

Comprehensive Examination

After having successfully completed 75% of the total credit hours of the prescribed in major (core) and 100% of minor (specialization) courses with minimum OGPA of 6.50/ 10.00, a Ph. D student shall have to pass comprehensive examination. The comprehensive examination shall consist of both written and oral tests, the former preceding the later. A candidate shall be given only two chances to appear in the comprehensive examination, written or oral.

There shall be four written papers. i.e., Paper-I and Paper-II in major subject (Core) and Paper-III and Paper-IV in minor subjects (specialization). Each paper shall be of four hours duration and shall be conducted after a minimum gap of one week. He/ She has to appear in the written comprehensive examination for both the minor subjects.

The syllabus for two papers of major (core) courses and the paper in minor subject shall be decided by the Major Advisor in consultation with the Members concerning minor subject in the Advisory Committee and Head of the Department.

The candidate shall be graded as 'Satisfactory' or 'Unsatisfactory'. To obtain 'Satisfactory' grade, a student must secure not less than 60% Marks in each paper.

Oral Comprehensive Examination

The Oral Comprehensive Examination shall cover both major/ core and minor fields/ specialization and shall be conducted by the Examining Committee comprising the Advisory Committee and one External Examiner who shall be appointed by the Dean PGS. The external examiner shall be a specialist in the students' major field from outside the University.

Recommendations of Board of Studies meeting held on 02/06/2021

It was recommended that Synopsis of Thesis may be submitted in the 1st semester in place of 2nd semester. It was further recommended that the synopsis should be finalized by the student with the help of concerned Major Advisor and all the Advisory Committee Members.

It was recommended that the student may give pre oral comprehensive examination in front of Major Advisor and Advisory Committee Members before the final oral comprehensive examination.

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS T+P*	THEORY			PRACTICALS		
	Total	Mid-Session	End Term	Total	Mid-Session	End Term
1+0 2+0 3+0 4+0 5+0 6+0	100	40 (30+10#)	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5)	40	35	-	35
3+1	75	30 (25+5)	45	25	-	25
4+1	80	35 (30+5)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5)	20	65	-	65
2+2	50	20 (15+5)	30	50		50
3+2	60	25 (20+5)	35	40		40
0+3	0	0	0	100	50	50

*****Any course having tutorial, its credits will be added to the theory credits

Assignments marks (No marks for attendance). Mandatory to have 75% attendance for appearing in final examination.

Ph. D. (Genetics and Plant Breeding)

Course Contents

GP 601

PLANT GENETIC RESOURCES AND PRE-BREEDING

Credits: 2 + 0 Mid-Session exam: 40
Contact Hours: 28+0 End-Semester Exam: 60

Objective: To provide information about collection, evaluation, documentation, maintenance and use of plant genetic resources for crop improvement.

Theory

Units	Contents	Lectures
I	Historical perspectives and need for PGR conservation; Importance of plant genetic resources; Taxonomical classification of cultivated plants; Gene pool: primary, secondary and tertiary; Centres of origin and global pattern of diversity; Basic genetic resources and transgenes.	4
II	Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR; Plant quarantine and phytosanitary certification; Germplasm introduction and exchange; Principles of *in vitro* and cryopreservation.	3
III	Germplasm conservation- *in situ, ex situ*, and on-farm; short, medium and long term conservation strategies for conservation of orthodox seed and vegetatively propagated crops; Registration of plant genetic resources.	3
IV	PGR data base management; Multivariate and clustering analysis, descriptors; National and international protocols for PGR management; PGR for food and agriculture (PGRFA); PGR access and benefit sharing; Role of CGIAR system in the germplasm exchange; PBR, Farmers rights and privileges; Seed Act, *sui generis* system; Geographical indicators, Intellectual property; Patents, copyrights, trademarks and trade secrets.	4
V	Journey from wild to domestication; Genetic enhancement- need for genetic enhancement; Genetic enhancement in pre Mendelian era and 21st century; Genetic enhancement and plant breeding; Reasons for failure in genetic enhancement; Sources of genes/ traits- novel genes for quality.	4
VI	Distant Hybridization: Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer tools and techniques into cultivated species; Validation of transferred genes and their expression.	4
VII	Post-genomic tools for genetic enhancement of germplasm; Prebreeding through chromosome manipulation; Application of biotechnology for Genetic enhancement-Achievements.	3
VIII	Utilization of genetic resources, concept of core and mini-core collections, genetic enchancement/Prebreeding for crop improvement including hybrid development.	3

Suggested Readings

Frankel OH & Bennett E. 1970. *Genetic Resources in Plants – their Exploration and Conservation*. Blackwell.

Gautam PL, Dass BS, Srivastava U & Duhoon SS. 1998. *Plant Germplasm Collecting: Principles and Procedures*. NBPGR, New Delhi.

Painting KA, Perry MC, Denning RA & Ayad WG. 1993. *Guide Book for Genetic Resources Documentation*. IPGRI, Rome, Italy.

Paroda RS & Arora RK. 1991. *Plant Genetic Resources, Conservation and Management. Concepts and Approaches*. IPGRI Regional office for South and South Asia, New Delhi.

Puzone L & Hazekamp TH. 1996. *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, New Delhi.

Rana RS, Sapra RL, Agrawal RC & Gambhir R. 1991. *Plant Genetic Resources, Documentation and Information Management*. NBPGR, New Delhi.

Singh RJ & Jauhar PP. 2005. *Genetic Resources, Chromosomal Engineering and Crop Improvement*. Vol. I. *Grain Legumes*, Vol. II. *Cereals*. CRC Press, Taylor & Francis Group, USA.

GP 602

ADVANCED BIOMETRICAL AND QUANTITATIVE GENETICS

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart theoretical knowledge and computation methods for non-allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

Units	Contents	Lectures
I	Basic principles of Biometrical Genetics; Selection of parents; Advanced biometrical models for combining ability analysis; Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes; Designs and Systems; Selection of stable genotypes.	7
II	Models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; Principal Component Analysis.	7
III	Additive and multiplicative model - Shifted multiplicative model; Analysis and selection of genotypes; Methods and steps to select the best model -Biplots and mapping genotypes.	7
IV	Genetic architecture of quantitative traits; Conventional analyses to detect gene actions - Partitioning of phenotypic/genotypic variance - Construction of saturated linkage maps, concept of framework map development; QTL mapping-Strategies for QTL mapping - desired populations, statistical methods; Marker Assisted Selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on markers - simultaneous selection based on marker and phenotype - Factors influencing MAS; Heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods.	7

Practical

1.	Working out efficiency of selection methods in different populations and interpretation	1
2.	Biparental mating – use of softwares in analysis and result interpretation	1
3.	Triallel analysis– use of softwares in analysis and result interpretation	1
4.	Quadriallel analysis – use of softwares in analysis and result interpretation	1
5.	Triple Test Cross (TTC) – use of softwares in analysis and result interpretation	1
6.	Advanced biometrical models for combining ability analysis	1
7.	Selection of stable genotypes using stability analysis; Models in stability analysis	1
8.	Additive Main Effect and Multiplicative Interaction (AMMI) model	1
9.	Principal Component Analysis model	1
10.	Additive and multiplicative model	1

11.	Shifted multiplicative model	1
12.	Analysis and selection of genotypes	1
13.	Methods and steps to select the best model -Selection systems, Biplots and mapping genotypes	1
14.	Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies.	1

Suggested Readings

Bos I & P Caligari. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.

Falconer DS & Mackay J. 1996. *Introduction to Quantitative Genetics*. Longman.

Mather K & Jinks L. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.

Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani.

Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*. Kalyani.

Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics*. Kalyani.

Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.

Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

GP 603

GENOMICS IN PLANT BREEDING

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart practical skills in advanced molecular techniques in genome mapping structural/functional genomics and development of transgenic crops.

Theory

Units	Contents	Lectures
I	Introduction to the plant genome- Plant nuclear genomes and their molecular description - The chloroplast and the mitochondrial genomes in plants - Genome size and complexity.	4
II	Establishment of plant genome mapping projects - Genome mapping and use of molecular markers in plant breeding; Strategies for mapping genes of agronomic traits in plants- Approaches for mapping quantitative trait loci; Map based cloning of plant genes.	6
III	Regulation of Plant gene expression - Functional genomics - Expression Analysis using Microarrays – Transposon tagging and Insertional mutagenesis- methods and significance- Diversity Array Technology.	4
IV	Genome sequencing in plants–Principles and Techniques; Applications of sequence information in plant genome analyses; Comparative genomics–Genome Comparison Techniques- Classical and advanced approaches.	4
V	Detection of Single Nucleotide Polymorphism; TILLING and Eco-TILLING; Role of transcriptomics, proteomics and metabolomics in linking genome and phenome; Importance of understanding the phenotypes for exploiting the outcome of genomic technologies- Knock out mutant studies and high throughput phenotyping.	6
VI	Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools in structural and functional genomics.	4

Practical

1.	Chromosome analysis in major field crops	1
2.	Fluorescence *in situ* hybridization	1
3.	Comparative genomic hybridization	1
4.	Comparative analysis of plant genomes using molecular markers	1
5.	Genetic map construction using molecular markers	1
6.	Mapping major genes using molecular markers	1
7.	QTL mapping in plants	1
8.	Comparison across mapping populations	1
9.	Understanding the need genetic algorithms in QTL mapping	1
10.	Plant Genome Databases	1

11.	Computational tools to explore plant genome databases	1
12.	Comparative genomics – Comparison of genome sequences using tools of bioinformatics	1
13.	Advanced genomic technologies: TILLING and Eco-TILLING	1
14.	DNA Array Technology, Linking genome sequences to phenotypes: Tools of transcriptomics, proteomics and metabolomics.	1

Suggested Readings

Baxevanis AD & Ouellette BFF. 2001. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.* Wiley Interscience.

Brown TA. 2002. *Genomes*. Wiley-LISS.

Caetano-Anolles G & Gresshoff PM. 1998. *DNA Markers: Protocols, Applications and Overviews*. Wiley-VCH.

Cantor CR & Smith CL (2004). *Genomics*. Wiley, New York.

Galas DJ & McCormack SJ. 2002. *Genomic Technologies: Present and Future*. Calster Academic Press.

Jordan BR. 2001. *DNA Microarrays: Gene Expression Applications*. Springer-Verlag.

Liu BH. 1997. *Statistical Genomics: Linkage, Mapping and QTL Analysis*. CRS Press.

Lynch M & Walsh B. 1998. *Genetics and Analysis of Quantitative Traits.* Sinauer Associates.

Mount DW. 2001. *Bioinformatics. Sequence and Genome Analysis.* Cold Spring Harbor Laboratory Press.

Palzkill T. 2002. *Proteomics*. Kluwer.

Paterson AH. 1996. *Genome Mapping in Plants*. Academic Press.

Pennington SR & Dunn MJ. 2002. *Proteomics: From Protein Sequence to Function*. Viva Books.

Rampal JB. 2001. *DNA Arrays: Methods and Protocols*. Humana Press.

GP 604

MOLECULAR AND CHROMOSOMAL MANIPULATIONS FOR CROP BREEDING

Credits: 2 + 0 Mid-Session Exam: 40
Contact Hours: 28 + 0 End-Semester Exam: 60

Objective: This course focuses on the advanced techniques in analyzing chromosome structure and manipulations for genome analysis in crop species.

Theory

Units	Contents	Lectures
I	Organization and structure of genome – Genome size – Organization of organellar genomes – Nuclear DNA organization – Nuclear and Cytoplasmic genome interactions and signal transduction; Transcriptional and Translational changes, Inheritance and expression of organellar DNA; Variation in DNA content – C value paradox; Sequence complexity – Introns and Exons – Repetitive sequences – Role of repetitive sequence.	6
II	Karyotyping – Chromosome banding and chromosome painting; Tracking introgressions using FISH, GISH, loclalization and mapping of genes/genomic segments; Distant hybridization - Role of polyploids in crop evolution and breeding - auto and allopolyploids.	5
III	Applications of cytogenetical methods for crop improvement; Location and mapping of genes on chromosomes: deficiency method; Interchange-genetic consequence, identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; Multiple interchanges-use in producing inbreds, transfer of genes- linked marker methods; Duplication - production and use; Inversions and location of genes; B/A chromosome translocations and gene location.	6
IV	Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics-methods of production, breeding behavior and location of genes; Intervarietal substitutions-allelic and non-allelic interactions; Telocentric method of mapping.	5
V	Barriers to interspecific and intergeneric hybridization- Behaviour of interspecific and intergeneric crosses; Totipotency of cells – Morphogenesis: *in vivo* and *in vitro* – Meristem culture – anther and pollen culture – ovule, ovary, embryo and endosperm culture – protoplast isolation and culture – protoplast fusion, Different pathways of *in vitro* morphogenesis – organogenesis and somatic embryogenesis; *in vitro* mutant/somaclone selection for biotic and abiotic stresses.	6

Suggested Readings

Clark MS & Wall WJ. 1996. *Chromosomes: The Complex Code*. Chapman & all.
Conger BV. (Ed.). 1981. *Cloning Agricultural Plants via in vitro Techniques*. CRC Press.
Constabel F & Vasil IK. (Eds.). 1988. *Cell Culture and Somatic Cell Genetics of Plants.* Vol. V. *Cell Culture and Phytochemicals in Plant Cell Cultures*. Academic Press.
Lal R & Lal S. (Eds.). 1990. *Crop Improvement Utilizing Biotechnology*. CRC Press.
Mantel SH & Smith H. 1983. *Plant Biotechnology*. Cambridge University Press.
Sen SK & Giles KL. (Eds.). 1983. *Plant Cell Culture in Crop Improvement*. Plenum Press.

GP 605

ADVANCES IN PLANT BREEDING SYSTEMS

Credits: 2 + 0 Mid-Session exam: 40
Contact Hours: 28+0 End-Semester Exam: 60

Objective: To impart theoretical knowledge and computation methods for non allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

Units	Contents	Lectures
I	Facts about plant breeding before the discovery of Mendelism; Evolutionary concepts of genetics and plant breeding - Flower development and its importance; genes governing the whorls formation and various models proposed; Mating systems and their exploitation in crop breeding; Types of pollination, mechanisms promoting cross pollination.	4
II	Self- incompatability and sterility – Types of self incompatability: Homomorphic (sporophytic and gametophytic) and heteromorphic - Breakdown of incompatibility - Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self incompatibility; Sterility: male and female sterility – Types of male sterility: genic, cytoplasmic and cytoplasmic-genic; Exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots – Case studies and breeding strategies; Nucleocytoplasmic interactions with special reference to male sterility – Genetic , biochemical and molecular bases.	5
III	Population formation by hybridization - Types of populations - Mendelian population, gene pool, composites, synthetics etc.; Principles and procedures in the formation of a complex population; Genetic basis of population improvement.	4
IV	Selection in self fertilizing crops; Creation of genetic variability selection methods - Selection methods: mass selection, pureline selection, pedigree method (selection in early generations vs advanced generations); Backcross, polycross and test cross.	5
V	Selection in cross fertilizing crops – Polycross and topcross selections, Mass and recurrent selection methods and their modifications - Mass selection: grided mass selection, ear to row selection, modified ear to row selection; Convergent selection, divergent selection; Recurrent selection: Simple recurrent selection and its modifications (restricted phenotypic selection, selfed progeny selection and full sib recurrent selection) -Recurrent selection for general combining ability (GCA) – Concepts and utilization - Recurrent selection for specific combining ability (SCA) – usefulness in hybrid breeding programmes - Reciprocal recurrent selection (Half sib reciprocal recurrent selection, Half sib reciprocal recurrent selection with inbred tester and Full sib reciprocal recurrent selection); Selection in clonally propagated crops – Assumptions and realities.	5

VI	Genetic engineering technologies to create male sterility; Prospects and problems - Use of self- incompatability and sterility in plant breeding – case studies; - Fertility restoration in male sterile lines and restorer diversification programmes - Conversion of agronomically ideal genotypes into male steriles – Concepts and breeding strategies; Case studies -Generating new cytonuclear interaction system for diversification of male steriles - Stability of male sterile lines – Environmental influence on sterility– Environmentally Induced Genic Male Sterility (EGMS) - Types of EGMS; Influence on their expression, genetic studies; Photo and thermo sensitive genetic male sterility and its use in heterosis breeding -Temperature sensitive genetic male sterility and its use heterosis breeding -Apomixis and its use inheterosis breeding - Incongruity - Factors influencing incongruity - Methods to overcome incongruity mechanisms.	5

Suggested Readings

Agarwal RL. 1996. *Fundamentals of Plant Breeding and Hybrid Seed Production*. Oxford & IBH.

Allard RW. 1966. *Principles of Plant Breeding*. John Wiley & Sons.

Briggs FN & Knowles PF. 1967. *Introduction to Plant Breeding*. Reinhold. Fehr WR. 1987. *Principles of Cultivar Development: Theory and Technique*. Vol I. Macmillan.

Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.

Mandal AK, Ganguli PK & Banerji SP. 1995. *Advances in Plant Breeding*. Vol. I, II. CBS.

Richards AJ. 1986. *Plant Breeding Systems*. George Allen & Unwin.

Sharma JR. 1994. *Principles and Practice of Plant Breeding*. TataMcGraw-Hill.

Simmonds NW. 1979. *Principles of Crop Improvement*. Longman.

Singh BD. 1997. *Plant Breeding: Principles and Methods*. 5th Ed., Kalyani.

Singh P. 1996. *Essentials of Plant Breeding*. Kalyani.

Welsh JR. 1981. *Fundamentals of Plant Genetic and Breeding*. John Wiley.

Williams W. 1964. *Genetical Principles and Plant Breeding*. Blackwell.

GP 608

ADVANCES IN BREEDING OF MAJOR FIELD CROPS

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42+0 End-Semester Exam: 60

Objective: To provide insight into recent advances in improvement of cereals, millets and non-cereal crops using conventional and modern biotechnological approaches.

Theory

Units	Contents	Lectures
I	History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, millets and non cereal crops like Rice, Wheat, Maize, Pearlmillet, Sorghum , Pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc.	9
II	Breeding objectives in rice, wheat, maize, pearlmillet, sorghum, pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Genetic resources and their utilization; Genetics of quantitative and qualitative traits.	9
III	Breeding for value addition and resistance to abiotic and biotic stresses.	8
IV	Conventional (line breeding, population improvement, hybrids) and other approaches (DH Populations, Marker Assisted Breeding, Development of new male sterility systems), transgenics.	8
V	National and International accomplishments in genetic improvement of major field crops and their seed production.	8

Suggested Readings

Chopra VL. 2001. *Breeding Field Crops - Theory and Practice*. Oxford & IBH.

Davis DD.1978. *Hybrid Cotton Specific Problems and Potentials*. Adv. Agron. 30: 129-157.

Heyne EG. 1987. *Wheat and Wheat Improvement*. 2nd Ed. ASA, CSSA, SSSA Inc Publ.

Khairwal, IS, Rai KN & Harinaryanan H. (Eds.). 1999. *Pearl Millet Breeding*. Oxford & IBH.

Khairwal I, Ram C & Chhabra AK. 1990. *Pearl Millet Seed Production and Technology*. Manohar Publ.

Nagarajan S, Singh G & Tyagi BS. 1998. *Wheat Research Needs Beyond 2000 AD*. Narosa.

Nanda JS. 2000. *Rice Breeding and Genetics - Research Priorities and Challenges*. Oxford & IBH.

Rao VS, Singh G & Misra SC. 2004. *Wheat: Technologies for Warmer Areas*. Annamaya Publ.

Reynolds MP, Rajaram S, McNab A. 1996. *Increasing Yield Potential in Wheat: Breaking the Barriers*. Proc. Workshop held in Ciudad, Obregon, Sonora, Mexico.

Seth BL, Sikka SM, Dastur RH, Maheshwari P, Rangaswamy NS & Josi AB. 1960. *Cotton in India – A Monograph*. Vol. I. ICAR.

Singh BD. 2006. *Plant Breeding - Principles and Methods*. Kalyani.

Singh P & Singh S. 1998. *Heterosis Breeding in Cotton*. Kalyani. Singh P. 1998. *Cotton Breeding*. Kalyani.

Singh S & Singh P. 2006. *Trends in Wheat Breeding*. Kalyani Publ.

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

Ph. D. Horticulture (Vegetable Science)

(I to VI Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

Programme Structure

Ph. D. Horticulture (Vegetable Science)

Minimum Credit Requirements

Subject	Minimum Credit Requirements as per BSMA, ICAR Guidelines	Proposed Minimum Credit Requirements to be Followed
Major	15	17
Minor	08	08
Supporting	05	05
Seminar	02	02
Research	45	45
Total Credits	75	77

Note:

Minor Subjects

The student shall have the to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subjects viz. Plant Pathology, Entomology, Genetics and Plant Breeding, Biotechnology and Agronomy, Soil Science, Biochemistry, Plant Physiology and Microbiology in 500 series courses.

Supporting Subjects

The student shall have the option to take minimum five credits in the supporting subject in 500 series / 600 series courses. The supporting subjects may from major or any other subjects. It could be any subject considered relevant for students research work.

Allotment of Research Credits

As per the decision taken in the Board of Studies meeting held on 02/06/2021, the allotment of Research Credits in a particular semester will be at the discretion of Major Advisor, Advisory Committee and the student concerned depending upon his/her work load.

Ph. D. Horticulture (Vegetable Science)

Syllabus Semester wise

Semester I				
S.No	**Course Code**	**Course Title**	**Credit Hours**	**Semester**
Major Courses				
1	**VSC 601**	Advances in Vegetable Production	**2+1**	**I**
2	**VSC 602**	Advances in Breeding of Vegetable Crops	**2+1**	**I**
3	**VSC 603**	Protected Cultivation of Vegetable Crops	**1+1**	**I**
4	**VSC 699**	Doctoral Research	**0+2**	**I**
Minor Courses				
The student shall have to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subjects viz. Plant Pathology, Entomology, Genetics and Plant Breeding, Biotechnology and Agronomy, Soil Science, Biochemistry, Plant Physiology and Microbiology in 500 series courses. In the 1st Semester he / she has to register for minimum **four** credits in the split minor subjects.				
Supporting Courses				
The student shall have the option to take minimum five credits in the supporting subject in 500 / 600 series courses. The supporting subjects may be from major or any other subjects. It could be any subject considered relevant for students research work. In the 1st semester, the student has to register for minimum **three** credits in the supporting subject.				
Total=10+4+3=17				

Semester II				
Major Courses				
1	**VSC 604**	Biotechnology of Vegetable crops	**2+1**	**II**
2	**VSC 605**	Seed Certification, Processing and Storage of Vegetable Crops	**1+1**	**II**
3	**VSC 606**	Abiotic Stress Management in Vegetable Crops	**2+1**	**II**
4	**VSC 691**	Doctoral Seminar I	**1+0**	**II**
5	**VSC 699**	Doctoral Research	**0+3**	**II**
Minor Courses				
The student shall have to take two split minor subjects depending upon his / her research problem (minimum 8 credit hours) in the related subjects viz. Plant Pathology, Entomology, Genetics and Plant Breeding, Biotechnology and Agronomy, Soil Science, Biochemistry, Plant Physiology and Microbiology in 500 series courses. In the 2nd Semester he / she has to register for minimum **four** credits in the split minor subjects.				
Supporting Courses				
The student shall have the option to take minimum five credits in the supporting subject in 500 / 600 series courses. The supporting subjects may be from major or any other subjects. It could				

be any subject considered relevant for students research work. In the 2nd semester, the student has to register for minimum **two** credits in the supporting subject.				
Total=12+4+2=18				
III Semester				
Major Courses				
1	**VSC 692**	Doctoral seminar II	**1+0**	**III**
2	**VSC 699**	Doctoral Research	**0+10**	**III**
Total=11				
IV Semester				
1	**VSC 699**	Doctoral Research	**0+10**	**IV**
Total = 10				
V Semester				
1	**VSC 699**	Doctoral Research	**0+10**	**V**
Total = 10				
VI Semester				
1	**VSC 699**	Doctoral Research / Thesis Submission	**0+10**	**VI**
Total = 10				

Major Guidelines

Synopsis of Thesis

The synopsis of the thesis must be finalized by the major advisor in consultation with the advisory committee before the commencement of mid-session examination of the 2nd registered semester. Prior to this, the student has to deliver the synopsis seminar in the department.

Comprehensive Examination

After having successfully completed 75% of the total credit hours of the prescribed in major (core) and 100% of minor (specialization) courses with minimum OGPA of 6.50/ 10.00, a Ph. D student shall have to pass comprehensive examination. The comprehensive examination shall consist of both written and oral tests, the former preceding the later. A candidate shall be given only two chances to appear in the comprehensive examination, written or oral.

There shall be four written papers. i.e., Paper-I and Paper-II in major subject (Core) and Paper-III and Paper-IV in minor subjects (specialization). Each paper shall be of four hours duration and shall be conducted after a minimum gap of one week. He/ She has to appear in the written comprehensive examination for both the minor subjects.

The syllabus for two papers of major (core) courses and the paper in minor subject shall be decided by the Major Advisor in consultation with the Members concerning minor subject in the Advisory Committee and Head of the Department.

The candidate shall be graded as 'Satisfactory' or 'Unsatisfactory'. To obtain 'Satisfactory' grade, a student must secure not less than 60% Marks in each paper.

Oral Comprehensive Examination

The Oral Comprehensive Examination shall cover both major/ core and minor fields/ specialization and shall be conducted by the Examining Committee comprising the Advisory Committee and one External Examiner who shall be appointed by the Dean PGS. The external examiner shall be a specialist in the students' major field from outside the University.

Recommendations of Board of Studies meeting held on 02/06/2021

It was recommended that Synopsis of Thesis may be submitted in the 1st semester in place of 2nd semester. It was further recommended that the synopsis should be finalized by the student with the help of concerned Major Advisor and all the Advisory Committee Members.

It was recommended that the student may give pre oral comprehensive examination in front of Major Advisor and Advisory Committee Members before the final oral comprehensive examination.

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

Ph. D. Horticulture (Vegetable Science)

Course Contents

VSC 601
ADVANCES IN VEGETABLE PRODUCTION

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To keep abreast with latest developments and trends in production technology of vegetable crops.

Theory

Units	Contents	Lectures
I	**Tomato, brinjal, chilli, sweet pepper and potato** Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing.	6
II	**Cucurbits, cabbage, cauliflower and knol-khol** Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing.	6
III	**Bhendi, onion, peas and beans, amaranthus and drumstick** Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low	6

	cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing.	
IV	**Carrot, beet root and radish** Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing.	5
V	**Sweet potato, tapioca, elephant foot yam and taro** Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing.	5

Practical

1.	Seed hardening treatments	1
2.	Practices in indeterminate and determinate vegetable growing and organic gardening	1
3.	Portrays and ball culture; diagnosis of nutritional and physiological disorders	1
4.	Analysis of physiological factors like anatomy	1
5.	Photosynthesis; light intensity in different cropping situation; assessing nutrient status, use of plant growth regulators	2
6.	Practices in herbicide application	1
7.	Estimating water requirements in relation to crop growth stages, maturity indices	1
8.	Dryland techniques for rainfed vegetable production	1
9.	Production constraints; analysis of different cropping system in various situation like cold and hot set	1
10.	Vegetable waste recycling management	1
11.	Quality analysis	1
12.	Marketing survey of the above crops	1
13.	Visit to vegetable and fruit malls and packing houses.	1

Suggested Readings

Bose TK & Som NG. 1986. *Vegetable Crops of India*. Naya Prokash.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Brewster JL. 1994. *Onions and other Vegetable Alliums*. CABI. FFTC. *Improved Vegetable Production in Asia*. Book Series No. 36.

Ghosh SP, Ramanujam T, Jos JS, Moorthy SN & Nair RG. 1988. *Tuber Crops*. Oxford & IBH.

Gopala krishnan TR. 2007. *Vegetable Crops*. New India Publishing Agency.

Kallo G & Singh K. (Ed.). 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.

Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S & Pallai SV. 1996. *Tropical Tuber Crops, Problems, Prospects andFuture Strategies*. Oxford & IBH. Sin MT & Onwueme IC. 1978. *The Tropical Tuber Crops*. John Wiley & Sons.

Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distr. Co.

Singh PK, Dasgupta SK & Tripathi SK. 2006. *Hybrid Vegetable Development*. International Book Distr. Co.

VSC 602

ADVANCES IN BREEDING OF VEGETABLE CROPS

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

Units	Contents	Lectures
I	**Tomato, brinjal, chilli, sweet pepper and potato** Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance	6
II	**Cucurbits, Cabbage, cauliflower and knoll khol** Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance	6
III	**Bhendi, onion, peas and beans, amaranthus and drumstick** Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance	6

IV	**Carrot, beet root and radish** Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance	5
V	**Sweet potato, tapioca, elephant foot yam and taro** Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance	5

Practical

1.	Designing of breeding experiments	2
2.	Screening techniques for abiotic stresses	2
3.	Screening and rating for pest, disease and nematode resistance	1
4.	Estimation of quality and processing characters	1
5.	Screening for quality improvement	2
6.	Estimation of heterosis and combining ability	2
7.	Induction and identification of mutants and polyploids	2
8.	Distant hybridization and embryo rescue techniques	2

Suggested Readings

Acta Horticulture. Conference on Recent Advance in Vegetable Crops.Vol. 127.
Chadha KL, Ravindran PN & Sahijram L. 2000. *Biotechnology in Horticultural and Plantation Crops*. Malhotra Publ. House.
Chadha KL. 2001. *Hand Book of Horticulture*. ICAR.
Dhillon BS, Tyagi RK, Saxena S & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.
Janick JJ. 1986. *Horticultural Science*. 4th Ed. WH Freeman & Co.
Kaloo G & Singh K. 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals and Book Publ. House.
Kaloo G. 1994. *Vegetable Breeding*. Vols. I-III. Vedams eBooks.
Peter KV & Pradeep Kumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised Ed.). ICAR.
Ram HH. 2001. *Vegetable Breeding*. Kalyani.

VSC 603

PROTECTED CULTIVATION OF VEGETABLE CROPS

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To impart latest knowledge in growing of vegetable crops under protected environmental condition.

Theory

Units	Contents	Lectures
I	Tomato, capsicum, cucumber, melons and lettuce Importance and scope of protected cultivation of vegetable crops; principles used in protected cultivation, energy management, low cost structures; training methods; engineering aspects.	3
II	Tomato, capsicum, cucumber, melons and lettuce Regulatory structures used in protected structures; types of greenhouse/polyhouse/ nethouse, hot beds, cold frames, effect of environmental factors, *viz.* temperature, light, CO_2 and humidity on growth of different vegetables, manipulation of CO_2, light and temperature for vegetable production, fertigation.	3
III	Tomato, capsicum, cucumber, melons and lettuce Nursery raising in protected structures like poly-tunnels, types of benches and containers, different media for growing nursery under cover.	2
IV	Tomato, capsicum, cucumber, melons and lettuce Regulation of flowering and fruiting in vegetable crops, technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures.	3
V	Tomato, capsicum, cucumber, melons and lettuce Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production.	3

Practical

1.	Study of various types of structures	2
2.	Methods to control temperature, CO_2, light, media	2
3.	Training and pruning	2
4.	Maintenance of parental lines and hybrid seed production of vegetables	2
5.	Fertigation and nutrient management	2
6.	Control of insect-pests and disease in greenhouse	2
7.	Economics of protected cultivation	1
8.	Visit to established green/polyhouse/net house/shade house in the region.	1

Suggested Readings

Anonymous 2003. *Proc. All India Seminar on Potential and Prospects for Protective Cultivation*. Organised by Institute of Engineers, Ahmednagar. Dec.12-13, 2003.
Chandra S & SomV. 2000. *Cultivating Vegetables in Green House*. *Indian Horticulture* 45: 17-18.
Prasad S & Kumar U. 2005. *Greenhouse Management for Horticultural Crops*. 2nd Ed. Agrobios.
Tiwari GN. 2003. *Green House Technology for Controlled Environment*. Narosa Publ. House.

VSC 604
BIOTECHNOLOGY IN VEGETABLE CROPS

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5[#])
Practical Exam: 35
End-Semester Exam: 40

Objective: To teach advances in biotechnology for improvement of vegetable crops.

Theory

Units	Contents	Lectures
	Tomato, eggplant, hot and sweet pepper, potato, cabbage, cauliflower, tapioca, onion, cucurbits.	
I	*In vitro* culture methods and molecular approaches for crop improvementin vegetables, production of haploids, disease elimination in horticultural crops, micro grafting, somoclones and identification of somaclonal variants, *in vitro* techniques to overcome fertilization barriers, *in vitro* production of secondary metabolites.	6
II	Protoplast culture and fusion; construction, identification and characterization of somatic hybrids and cybrids, wide hybridization, embryo rescue of recalcitrant species, *in vitro* conservation.	6
III	*In vitro* mutation for biotic and abiotic stresses, recombinant DNA methodology, gene transfer methods, tools, methods, applications of rDNA technology.	6
IV	Quality improvement, improvement for biotic and abiotic stresses, transgenic plants.	5
V	Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars etc., achievements, problems and future thrusts in horticultural biotechnology.	5

Practical

1.	Establishment of axenic explants	1
2.	Callus initiation and multiplication	1
3.	Production of suspension culture, cell and protoplast culture, fusion	2
4.	Regeneration and identification of somatic hybrids and cybrids	1
5.	Identification of embryonic and non-embryonic calli	1
6.	Development of cell lines	1
7.	*in vitro* mutant selection for biotic and abiotic stresses	1
8.	*In vitro* production and characterization of secondary metabolites	1
9.	Isolated microspore culture	1
10.	Isolation and amplification of DNA	1
11.	Gene transfer methods	1
12.	Molecular characterization of transgenic plants	2

Suggested Readings

Bajaj YPS. (Ed.). 1987. *Biotechnology in Agriculture and Forestry*. Vol.XIX. *Hitech and Micropropagation*. Springer.

Chadha KL, Ravindran PN & Sahijram L. (Eds.). 2000. *Biotechnology of Horticulture and Plantation Crops*. Malhotra Publ. House.

Debnath M. 2005. *Tools and Techniques of Biotechnology*. Pointer Publ. Glover MD. 1984. *Gene Cloning: The Mechanics of DNA Manipulation.* Chapman & Hall.

Gorden H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ. Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer*. Orient & Longman (Universal Press).

Keshavachandran R et al. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. New India Publ. Agency.

Panopoulas NJ. (Ed.). 1981. *Genetic Engineering in Plant Sciences*. Praeger Publ.

Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.

Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.

Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2nd Ed. Agro Botanica.

Sharma R. 2000. *Plant Tissue Culture*. Campus Books.

Singh BD.2001. *Biotechnology*. Kalyani.

Skoog Y & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Cultured in vitro.* Attidel. II Symp. On Biotechnology Action of Growth Substance.

Vasil TK, Vasi M, While DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture*. Planum Press.

Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V.

VSC 605
SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To educate the recent trends in the certification, processing and storage of vegetable crops.

Theory

Units	Contents	Lectures
I	Seed certification, objectives, organization of seed certification, minimum seed certification standards of vegetable crops, field inspection, specification for certification.	6
II	Seed processing, study of seed processing equipments seed cleaning and upgrading, Seed packing and handling, equipment used for packaging of seeds, procedures for allocating lot number.	6
III	Pre-conditioning, seed treatment, benefits, types and products, general principles of seed storage, advances in methods of storage, quality control in storage, storage containers, seed longevity and deterioration, sanitation, temperature and relative humidity control.	6
IV	Seed testing; ISTA rules for testing, moisture, purity germination, vigor test, seed sampling, determination of genuineness of varieties, seed viability, seed health testing; seed dormancy and types of dormancy, factors responsible for dormancy.	5
V	Seed marketing, demand forecast, marketing organization, economics of seed production; farmers' rights, seed law enforcement, seed act and seed policy.	5

Practical

1.	Seed sampling	1
2.	Purity and moisture testing	1
3.	Seed viability and seed vigor tests	1
4.	Seed health testing	1
5.	Seed cleaning, grading and packaging	1
6.	Handling of seed testing equipment and processing machines	1
7.	Seed treatment methods, seed priming and pelleting	1
8.	Field and seed inspection, isolation distances	1
9.	Practices in rouging	1
10.	Seed storage	1
11.	Biochemical tests	1
12.	Visit to seed testing laboratories and processing plants	1
13.	Mixing and dividing instruments	1
14.	Visit to seed processing unit and warehouse visit and know aboutsanitation standards	1

Suggested Readings

Agrawal PK & Dadlani M. 1992. *Tecniques in Seed Science and Technology*. South Asian Publ.

Singh N, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distr. Co.

Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

Tanwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, GOI, New Delhi.

VSC 606

ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-semester Exam: 40

Objective: To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

Units	Contents	Lectures
I	Environmental stress and its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress; root stock, use of wild species, use of antitranspirants.	6
II	Mechanism and measurements of tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.	6
III	Soil-plant-water relations under different stress conditions in vegetable crops production and their management practices.	6
IV	Techniques of vegetable growing under water deficit, water logging, salinity and sodicity.	5
V	Techniques of vegetable growing under high and low temperature conditions, use of chemicals in alleviation of different stresses.	5

Practical

1.	Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops	3
2.	Measurement of tolerance to various stresses in vegetable crops	4
3.	Short term experiments on growing vegetable under water deficit, water-logging, salinity and sodicity, high and low temperature conditions	4
4.	Use of chemicals for alleviation of different stresses	3

Suggested Readings

Dwivedi P & Dwivedi RS. 2005. *Physiology of Abiotic stress in Plants*. Agrobios.
Lerner HR (Ed.). 1999. *Plant Responses to Environmental Stresses*. Marcel Decker.
Maloo SR. 2003. *Abiotic Stresses and Crop Productivity*. Agrotech Publ.Academy.

Syllabus for B. Tech. (Food Technology)

As per Fifth Dean's Committee Report of Indian Council of Agriculture Research (ICAR)

Department of Food Technology

Dr. Khem Singh Gill Akal College of Agriculture

Eternal University, Baru sahib

2017

Eternal University, Baru Sahib
Dr. Khem Singh Gill Akal College of Agriculture

B. Tech. Food Technology

Courses offered in Semester – I			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	ENG-101	Comprehension & Communication Skills in English	2 (1+1)
2	MIC-101	General Microbiology	3 (2+1)
3	MATH-111	Basic Mathematics-I	2 (2+0)
4	EE-101	Engineering Drawing and Graphics	3 (1+2)
5	ETE-101	Basics of Electronics Engineering	5 (3+2)
6	EE-102	Workshop Technology	3 (1+2)
7	FT-101	Fundamentals of Food Processing	3 (2+1)
8	ENV-101	Environmental Sciences & Disaster Management	2 (1+1)
9	PHE-101	Physical Education*	1 (0+1)
Total Credit Hours			**23 (13+10)**
*** Non-Credit Course**			

Courses offered in Semester – II			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	FT-101	Food Chemistry of Macronutrients	3 (2+1)
2	FT-102	Food Microbiology	3 (2+1)
3	FT-103	Food Thermodynamics	3 (2+1)
4	EE-103	Fluid Mechanics	4 (3+1)
5	ETE-102	Basics of Electrical Engineering	5 (3+2)
6	MATH-121	Basic Mathematics-II	2 (2+0)
7	FT-104	Post-Harvest Engineering	3 (2+1)
8	STAT-102	Statistics	2(2+0)
9	PHE-102	NCC/NSS *	1 (0+1)
Total Credit Hours			26(18+8)
*** Non-Credit Course**			

Courses offered in Semester – III			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	FT-201	Crop Production Technology	3 (2+1)
2	FT-202	Processing Technology of Liquid Milk	3 (2+1)
3	FT-203	Processing Technology of Cereals	3 (2+1)
4	FT-204	Industrial Microbiology	3 (2+1)
5	FT-205	Food Chemistry of Micronutrients	3 (2+1)
6	FT-206	Heat and Mass Transfer in Food Processing	4 (3+1)
7	FT-207	Unit Operations in Food Processing-I	3 (2+1)
8	CSE-221	Computer Programming and Data Structures	3 (2+1)
Total Credit Hours			25 (17+8)

Courses offered in Semester – IV			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	FT-209	Processing Technology of Dairy Products	3 (2+1)
2	FT-210	Processing Technology of Legumes and Oilseeds	3 (2+1)
3	FT-211	Food Biochemistry and Nutrition	4 (3+1)
4	FT-212	Unit Operations in Food Processing-II	4(3+1)
5	FT-213	Food Biotechnology	3 (2+1)
6	FT-214	Food Refrigeration and Cold Chain	4 (3+1)
7	FT-215	Processing of Spices and Plantation Crops	3 (2+1)
8	BM-201	Business Management and Economics	2 (2+0)
Total Credit Hours			Total 26 (19+7)

Courses offered in Semester – V			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	FT-301	Processing Technology of Fruits and Vegetables	3 (2+1)
2	FT-302	Processing of Meat and Poultry Products	3 (2+1)
3	FT-303	Instrumental Techniques in Food Analysis	4 (3+1)
4	FT-304	ICT Applications in Food Industry	3 (2+1)
5	FT-305	Food Process Equipment Design	3 (2+1)
6	FT-306	Food Storage Engineering	3 (2+1)
7	FT-307	Bakery, Confectionery and Snack Products	3 (2+1)
8	BM-301	Marketing Management and International Trade	2 (2+0)
Total Credit Hours			Total 24 (17+7)

Courses offered in Semester – VI			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	FT-308	Processing Technology of Beverages	3 (2+1)
2	FT-309	Food Plant Sanitation	4(3+1)
3	FT-310	Food Packaging Technology and Equipment	3 (2+1)
4	FT-311	Processing of Fish and Marine Products	3 (2+1)
5	FT-312	Sensory Evaluation of Food Products	3 (2+1)
6	FT-313	Food Additives and Preservatives	2 (1+1)
7	FT-314	Food Quality, Safety Standards and Certification	3 (3+0)
8	FT-315	Instrumentation and Process Control in Food Industry	3 (2+1)
9	BM-302	Project Preparation and Management	2 (2+0)
Total Credit Hours			Total 26 (19+7)

Courses offered in Semester – VII			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	ENL-401	Communication Skills and Personality Development	2 (1+1)
2	BM-403	Entrepreneurship Development	3 (2+1)
3	EXPL-401	Student READY - Experiential Learning Programme - I	14 (0+14)
4	RP-401	Student READY - Research Project	3 (0+3)
5	FT-500	Student READY - Seminar 1	1 (0+1)
Total Credit Hours			Total 23 (3+20)

Courses offered in Semester – VIII			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	INDT-401	Student READY - Industrial Tour	2 (0+2)
2	INDT-402	Student READY - Internship/In-Plant Training	20 (0+20)
Total Credit Hours			Total 22 (0+22)

Courses offered in Semester – I			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	ENG-101	Comprehension & Communication Skills in English	2 (1+1)
2	MIC-101	General Microbiology	3 (2+1)
3	MATH-111	Basic Mathematics-I	2 (2+0)
4	EE-101	Engineering Drawing and Graphics	3 (1+2)
5	ETE-101	Basics of Electronics Engineering	5 (3+2)
6	EE-102	Workshop Technology	3 (1+2)
7	FT-101	Fundamentals of Food Processing	3 (2+1)
8	ENV-101	Environmental Sciences & Disaster Management	2 (1+1)
9	PHE-101	Physical Education*	1 (0+1)
Total Credit Hours			**23 (13+10)**
*** Non-Credit Course**			

B. Tech. Food Technology

Course Contents

ENG-101
Comprehension and Communication Skills in English

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To make the student know about different aspects of English language speaking, reading and writing and to make them understand its significance in communication.

Learning Outcome: Students will gain knowledge on different aspects of English language and will attain practical knowledge on different speaking and vocabulary in language laboratory.

Details of Course:

S. No.	Particulars	No. of lectures
1	Importance of language and communication skills	1
2	Spoken and conversational English, debate and discussion	1
3	Basic sentence patterns in English, sentence structure, subject verb agreement, articles, prepositions, punctuation, parts of speech, narration, active and passive voice, antonym, synonym, prefix and suffix, homophones, homonyms, often confused words.	4
4	Reading comprehension	1
5	Basic rules of composition, précis writing, proposal, letter writing; preparation of CV and resume, covering letter and job applications, synopsis writing and report writing.	4
6	Concept of register, development of vocabulary, dictionary and thesaurus, indexing contents, glossary, reading of texts, dialogues, note taking and note making, development of paragraphs, cohesion, coherence and style.	3
	Total Lectures	**14**

Practical

S. No.	Particulars	No. of practicals
1.	Listening comprehension, listening short talks or lecture, speeches, reading dialogues, various levels of reading	3
2.	Communication: An introduction to Phonetics, stress, intonation, syllables, their types, clarity of voice, speaking and listening practice, improving reading skills	3
3.	Summary and report writing, Elementary knowledge of English sounds with word stress and intonation	3
4.	Interviews: mock interviews, group discussion, team spirit, extempore,	5

	debates and discussions, exercises to help the students in the enrichment of vocabulary based on IELTS, PTE, TOEFL and other competitive examinations.	

Suggested Books/Readings:

S. No.	Authors/ Name of Books/Publisher
1.	Balasubramanian T. 1989. A Text book of Phonetics for Indian Students, Orient Longman, New Delhi.
2.	Balasubrmanyam M. 1985. Business Communication, Vani Educational Books, New Delhi.
3.	Kulbhushan K., 2021. Effective Communication Skills, Khanna Publishing House, New Delhi.
4.	Sharma R C and Krishna Mohan 1978. Business Correspondence, Tata Mc Graw Hill Publishing Company, New Delhi.
5.	O'Connor, J. D. 1991. Better English Pronunciation, Cambridge University Press, Press Syndicate of the University of Cambridge, UK.

MIC-101

General Microbiology

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with the understanding of basic microbiological concepts so as to learn its importance and role in food processing and technology

Details of course:

S. No.	Particulars	Lectures
1	Evolution and scope of microbiology; History of microbiology; Microbial classification, nomenclature and identification; Taxonomic groups; General methods of classifying bacteria.	5
2	Microscopy and microscopes: Smears and staining; Morphology and fine structure of bacteria; Cultivation of bacteria, nutritional requirements; Nutritional classification of bacteria; Phototrophs, chemotrophs, autotrophs and heterotrophs; Obligate parasites; Bacteriological media, Growth of bacteria, Reproduction of bacteria;	7
3	Introduction to fungi, algae and protozoa and virus: Nutrient transport phenomenon: Passive diffusion, facilitated diffusion; Group translocation, active transport.	5
4	Microbial genetics; Bacterial recombination; Bacterial conjugation, transduction; Bacterial transformation.	5
5	Mutations: Types of mutations, mutagenesis; Mutation rate, repair of mutations; Phenotypes of bacterial mutants; Designation of bacterial mutants	6

Practicals:

S. No.	Practicals	No. of practicals
1	Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology.	3
2	Preparation of nutrient agar media and techniques of inoculation.	2
3	Staining methods (monochrome staining, gram staining, negative staining, capsule staining, flagella staining and endospore staining)	3
4	Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics).	3
5	Growth characteristics of fungi: Determination of microbial numbers, direct plate count, generation time; Factors influencing growth: pH, temperature, growth curves for bacteria.	3

Recommended Books

1. Gerard J. Tortora, Berdell R. Funke, Christine L. Case. 2014. Microbiology: An Introduction, 12th Ed. Prentice-Hall, NY, USA.
2. Johanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2013. Prescott's Microbiology, 9th Ed. McGraw-Hill Higher Education, NY, USA.
3. Michael J. Pelczar Jr., E.C.S. Chan and Noel R. Krieg. 1998. Microbiology, 5th Ed. Tata McGraw-Hill Education, New Delhi.

MATH-111

Basic Mathematics-I

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To acquaint the students with the basic mathematical concepts for better understanding of foundation of mathematics, to perform basic computations, the engineering and technology based problem solving skills in coming semesters

Details of course:

S. No.	Particulars	Lectures
1	Mensuration: Mensuration of rectangles, easy examples of garden paths, cost of planting trees and fencing gardens. Area of right-angled triangles area and height of isosceles and equilateral triangles, area of triangles in terms of sides, rent of field. Area of parallelograms, rhombus, quadrilateral and trapezoid. Regular polygons with emphasis on hexagon and octagon. Simple cases of similar figures. Circumference and area of circles. Circular rings. Cost of fencing circular fields and paths.	6
2	Mensuration: Volumes of cubes and rectangular solids. Cubic contents of tanks and cisterns. Volumes of triangular and rectangular prisms, right circular cylinders and segments of cylinders. (**N. B.** Easy numerical examples bearing on science of agriculture only to be set. Proofs of formulae not required.)	4
3	Algebra: Solution of quadratic equations and of those reducible to quadratic equation. (One variable). Theory of quadratic equations. Relation between roots and co-efficient.	3
4	Algebra: Series: nth terms sum to n terms of an A. P. and G. P. nth term of an H. P. (excluding means and problems on numbers etc.). Permutation and combinations: simple problems only. (Proofs of formulae not required). Binomial theorem, statement for any index: Expansion particular term coefficient of n, summation of simple infinite series evaluation cube root etc. correct to a certain place of decimal.	7
5	Co-ordinate geometry: (1)The point-distance and section formulae area of a triangle. (2) The straight-line equation: Reduction of equation $ax+by=c$: to (a) slope x $\cos\alpha+y \sin\alpha=p$ (b) intercept form (c) perpendicular form (only method of reduction and not proof); point of intersection and, concurrence, angle of intersection of lines $y=mx+c$, $Y=m_2x+c_2$, and equations of line (a) parallel and (b) perpendicular to a given line and passing through a given point. (3)The equation of a circle when (i) centre and radius given. (ii) Passes through three points (iii) extremities of a diameter given; the equation $x^2+y^2+2gx+2fy+c = 0$ represents circle, center and radius, equations circle of the tangents and normal at any point of circle (only use formula no proof).	8

Recommended Books:

1. Algebra by D. C. Kapoor and Gurbax Singh
2. Algebra by T. N. Nagpal and K. K. Gupta.
3. Comprehensive Calculus by R. S. Dehiya.
4. New Style Calculus for T. D. C. – I.

5. New Style Co-ordinator Geometry by R. K. Sondhi
6. Trignometry by Jiwan
7. Mensuration by Pic Point.

EE-101
Engineering Drawing and Graphics

Credits: 1 + 2
Contact Hours: 14 + 56

Mid-Session Exam: 15 (10+5[#])
Practical Exam: 65
End-Semester Exam: 20

Objective: To introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

Details of course:

S. No.	Particulars	Lectures
1	First and third angle methods of projection; Preparation of working drawing from models and isometric views; Drawing of missing views.	3
2	Different methods of dimensioning; Concept of sectioning; Revolved and oblique section; Sectional drawing of simple machine parts.	3
3	Types of rivet heads and riveted joints; Processes for producing leak proof joints. Symbols for different types of welded joints; Nomenclature, thread profiles, multi-start threads, left and right-hand thread; Square headed and hexagonal nuts and bolts; Conventional representation of threads.	4
4	Different types of lock nuts, studs, machine screws, cap screws and wood screws; Foundation bolts; Design process, application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD.	4

Practicals:

S. No.	Practicals	No. of practicals
1	Introduction of drawing scales; Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines.	6
2	Projections of solids: Change of position method, alteration of ground lines; Section of solids and interpenetration of solid-surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids.	6
3	Preparation of manual drawings with dimensions from models and isometric drawings of objects and machine components; Preparation of sectional drawings of simple machine parts; Drawing of riveted joints and thread fasteners.	6
4	Demonstration on computer graphics and computer aided drafting use of standard software; Sectional drawings of engineering machines; Computer graphics for food engineering applications	5
5	Interpretation of sectional views of food equipment and components; Practice in the use of basic and drawing commands on AutoCAD; Generating simple 2-D drawings with dimensioning using AutoCAD; Small Projects using CAD/CAM.	5

Recommended Books

1. Ibrahim Zeid. 2004. Mastering CAD/CAM. McGraw-Hill Book Co., NY, USA.
2. Kunwoo Lee. 1999. Principles of CAD/CAM/CAE Systems. Prentice-Hall, USA.

3. N.D. Bhat and V.M. Panchal. 1995. Machine Drawing. Charotar Publishing House, Anand.
4. N.D. Bhat. 1995. Elementary Engineering Drawing. Charotar Publishing House, Anand.

ETE-101
Basics of Electronics Engineering

Credits: 3 + 2
Contact Hours: 42 + 56

Mid-Session Exam: 25 (20+5#)
Practical Exam: 40
End-Semester Exam: 35

Objective: To acquaint the student with the fundamental skills of electronics engineering. It will build mathematical and numerical background for design of electronics circuit & component value. Students equipped with the knowledge and training provided in the course will be able to participate in design, development and operation in the different area of electronics system.

Details of course:

S. No.	Particulars	Lectures
1	Introduction to semiconductor diode, ideal diode, Characteristics of PN junction diode, drift & diffusion currents, Fermi level in intrinsic and extrinsic semiconductor, continuity equation, Mass Action Law. Zener diode characteristics, Rectifications of Half wave and full wave rectifier, Filters, Unregulated and regulated power supplies, Tunnel diode, LED, LCD and Photo Diode.	11
2	Bipolar junction transistor: Introduction, Transistor, construction, transistor operations, BJT characteristics, load line, operating point, Bias stabilization: Need for stabilization, fixed Bias, emitter bias, self bias, bias stability with respect to variations in Ico, VBE &□ (compensation techniques), Stabilization factors, thermal stability.	10
3	Small signal amplifiers, CB, CE, CC configurations, comparison of different configurations FET (Detail construction, working and characteristics), MOSFET ((Detail construction, working and characteristics), Introduction, Classification, enhancement & Depletion type MOSFETS & enhancement only MOSFET.	10
4	Feedback Amplifiers: Feedback concept, Classification of Feedback amplifiers, Properties of negative Feedback amplifiers, Impedance considerations in different Configurations, Examples of analysis of feedback Amplifiers. UJT (Detail construction, working and characteristics), SCR (Detail construction, working and characteristics	11

Practicals

S. No.	Practicals	No. of practicals
1	To study the waveforms with CRO.	4
2	To study the characteristics of forward biased PN junction Diode, reversed biased PN junction Diode.	4
3	To study half wave and full wave rectifier and find its efficiency.	4
4	To draw input & output characteristics of common emitter transistor and common base transistor.	4
5	To study the characteristics of UJT.	4
6	To study the characteristics of SCR.	4
7	To study Zener diode as voltage regulator.	4

Recommended Books

1. J. Millman and Halkias, “Electronic devices and circuits” TMH, 1999.
2. Salivahanan, Suresh Kumar, Vallavaraj, “Electronic devices and circuits” TMH, 1999
3. Millman and Halkias, “Integrated Electronics, Analog & Digital Circuits & Systems” TMH – 2000.
4. Boylestad & Nashelsky, “Electronic Devices & Circuit Theory” PHI – VIth Edition.
5. Sedra & Smith, “Micro Electronic Circuits” Oxford University Press, 2000
6. J.B.Gupta, “Electronic Devices & Circuits” S. K. Kataria, IInd Edition.

EE-102
Workshop Technology

Credits: 1 + 2
Contact Hours: 14 + 56

Mid-Session Exam: 15 (10+5#)
Practical Exam: 65
End-Semester Exam: 20

Objective: The subject aims at imparting knowledge and skill components in the field of basic workshop technology. It deals with different hand and machine tools required for manufacturing simple metal components and articles.

Details of course:

S. No.	Particulars	Lectures
1	Introduction to basic materials: Ferrous and non-ferrous materials and important engineering materials such as timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications; Safety measures in workshop; Indian Factory Acts on safety.	2
2	Measuring and Gauging: Basic measuring instruments and gauges; Heat treatment processes: Introduction to hardening, tempering, annealing, normalizing, etc.	2
3	Welding: Introduction, types of welding, types of electrodes, types of flames, types of welding joints, edge preparation, welding techniques and equipments; Gas welding and gas cutting, arc welding; Introduction to soldering and brazing and their uses; Estimation of welding and soldering cost; Smithying and forging: Introduction to different tools and their uses; Different forging operations, defects of forging; Brief ideas about power hacksaw, etc.	3
4	Carpentry: Introduction to various carpentry tools and materials; Type of woods and their characteristics, brief ideas about band saw, wooden lathe circular saw, wood planner, etc.	2
5	Machinery: Introduction to various workshop machines (1) Lathe, (2) Milling machine, (3) Shaper and planner, (4) Drilling and boring machine, (5) Grinder and (6) CNC machines; Length of cut, feed, depth of cut, RPM, cutting speed, time, time allowances; Estimation of machining time for different lathe operations; Estimation of machining time for casting, shaping, slotting and planning operations, work holding and tool holding devices.	3
6	Sheet-metal: Introduction, different operations, sheet metal joints; Allowances for sheet metal, operations and joints, estimate of cost.	2

Practicals:

S. No.	Particulars	No. of practicals
1	Identification of different materials of manufacture; Demonstration of different measuring instruments and measurement technique.	4
2	Identification of various hand tools; Demonstration of various power tools and machine tools; Simple exercises in filing, fitting, chipping, hack sawing, chiseling, tapping, etc.	5
3	Introduction to welding machine, processes, tools, their use and precautions; Simple exercises on arc welding; Simple exercises in gas welding.	4
4	Demonstration of various casting processes and equipments, tools and their use; Exercises on mould making using one-piece pattern and two-piece	6

	pattern; Demonstration of mould making using sweep pattern and match plate pattern.	
5	Simple exercises on turning: Step turning, taper turning, drilling and threading; Introduction to shaper and planner machine and preparations of various jobs on them;	5
6	Introduction to drilling machines and preparation of related jobs; Demonstration of other important operations and preparation of additional jobs.	4

Recommended Books

1. B.S. Raghuwamsi. 1996. A Course in Workshop Technology, Vols. I and II. Dhanpet Rai & Sons, New Delhi.
2. W.A.J. Chapman. 1989. Workshop Technology, Parts I and II. Arnold Publishers (India) Pvt. Ltd., New Delhi.
3. S.K. Hazra Choudari and S.K. Bose. 1982. Elements of Workshop Technology, Vols. I and II. Media Promoters and Publishers Pvt. Ltd., Mumbai.

FT-101

Fundamentals of Food Processing

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with the importance of food processing for the preservation and value addition of food products and also the understanding of associated technologies for the same.

Details of course:

S. No.	Particulars	lectures
1	Sources, types and perishability of foods; Causes and types of food spoilage; Scope and benefit of food preservation; Methods of food preservation; Preservation by salt and sugar: Principle, method and effect on food quality.	7
2	Preservation by heat treatment: Principle and equipment for blanching, canning, pasteurization, sterilization; Preservation by use of low temperature: Principle, methods, equipment.	7
3	Preservation by drying, dehydration and concentration: Principle, methods, equipment; Preservation by irradiation: Principle, methods, equipment; Preservation by chemicals- antioxidants, mould inhibitors, antibodies, acidulants, etc.	7
4	Preservation by fermentation: Principles, methods, equipment; Non-thermal preservation processes: Principles, equipment – Pulsed electric field and pulsed intense light, ultrasound, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing, etc.; Quality tests and shelf-life of preserved foods.	7

Practicals:

S. No.	Practicals	No. of practicals
1	Demonstration of various perishable food items and degree of spoilage; Blanching of selected food items.	2
2	Preservation of food by heat treatment- pasteurization; Preservation of food by high concentration of sugar: Jam; Preservation of food by using salt: Pickle.	2
3	Preservation of food by using acidulants i.e. pickling by acid, vinegar or acetic acid; Preservation of food by using chemical preservatives.	2
4	Preservation of bread, cake using mold inhibitors; Drying of fruit slices pineapple slices, apple slices in cabinet drier; Drying of green leafy vegetables; Drying of mango/ other pulp by foam-mat drying.	2
5	Drying of semisolid foods using roller dryers; Drying of foods using freeze-drying process.	2
6	Demonstration of preserving foods under cold vs. freezing process; Processing of foods using fermentation technique, i.e. preparation of sauerkraut.	2
7	Study on effect of high pressure on microbe; Study on effect of pulse electric field on food.	2

Recommended Books

1. Stavros Yanniotis. 2008. Solving Problems in Food Engineering. Springer Science + Business Media, NY, USA.
2. Gaurav Tewari and Vijay K. Juneja. 2007. Advances in Thermal and Non-Thermal Food Preservation. Blackwell Publishing, Ames, Iowa, USA.
3. M. Shafiur Rahman. 2007. Handbook of Food Preservation, 2nd Ed. CRC Press, Boca Raton, FL, USA.
4. James G. Brennan. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany. Marcus Karel and Darvl B. Lund. 2003. Physical Principles of Food Preservation, 2nd Ed. Marcel Dekker, Inc., NY, USA.
5. Peter Zeuthen and Leif Bùgh-Sùrensen. 2003. Food Preservation Techniques. CRC Press LLC, Boca Raton, FL, USA.
6. P. Fellows. 2000. Food Processing Technology: Principles and Practice, 2nd Ed. CRC Press, Boca Raton, FL, USA. Norman N. Potter and Joseph H. Hotchkiss. 1995. Food Science, 5th Ed. Chapman & Hall, NY, USA.
7. Norman W. Desrosier and James N. Desrosier. 1977. The Technology of Food Preservation, 4th Ed. AVI Publishing Co., Connecticut, USA.
8. Girdhari Lal, G.S. Siddappa and G.L. Tandon. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.

ENV-101

Environmental Sciences & Disaster Management

Credits: 1+1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To study the basics of environmental science, types of Disasters and its profile in India. Knowledge of causes and impacts of Disasters, and Case studies of National and Global Disasters. To learn about risk reduction approaches of Disasters with safety issues in mitigating Industrial disasters.

Details of course:

S. No.	Particulars	Lectures
1	Environment, ecology and ecosystem: Definition and inter-relationships amongst and between them, components of environment, relationship between different components; Man environment relationship; Impact of technology on the environment; Environmental degradation;	2
2	Ecology and ecosystems: Introduction; Ecology: Objectives and classification, concepts of an ecosystem structure and function of ecosystem; Components of ecosystem: Producers, consumers, decomposers; Bio-geo-chemical cycles: Hydrological cycle, carbon cycle, oxygen cycle, nitrogen cycle, sulfur cycle;	2
3	Energy flow in co-system; Food chains: Grazing, detritus, food webs; Ecological pyramids; Major ecosystems: Forest ecosystem, Grassland ecosystem, desert ecosystem, aquatic ecosystem, estuarine ecosystem; Population and natural resources: Development of habitation patterns and environmental factors governing human settlement; Population and pollution, reasons for overpopulation, population growth, demographic projections and population structures, production of food;	2
4	Renewable and non-renewable resources: Renewable resources, non-renewable resources, destruction versus conservation; Water resources: Water resources, Indian scenario; Water sources: Surface and ground water sources, uses and overuses of water resources, problems due to over exploitation of water resources;	2
5	Forest resources: Indian scenario; Importance of forests-ecologically and economically, uses of forest products, forest types; Deforestations: Causes and effects, forest degradation in India; Energy resources: Indian scenario, conventional energy sources and its problems; Non-conventional energy sources: Advantages and its limitations, problems due to overexploitation of energy resources.	2
6	Environmental pollution - Water pollution: Introduction, water quality standards, sources of water pollution, classification of water pollutants, effects of water pollutants, eutrophication; Air pollution: Composition of air, structure of atmosphere, ambient air quality standards, classification of air pollutants, sources of common air pollutants like SPM, SO2, NOX, natural and anthropogenic sources, effects of common air pollutants;	2
7	Land and noise pollution: Introduction, lithosphere, land uses, causes of land degradation, sources of noise pollution, effects of noise pollution; Radioactive	2

	pollution; Food processing industry waste and its management; Management of urban waste water; Recycling of organic waste; Recycling of factory effluent; Control of environmental pollution through law; Composting of biological waste; Sewage, uses of water disposal effluent treatment; Current environmental global issues: Global warming and green houses effects, acid rain, depletion of ozone layer.	

Practicals:

S. No.	Practicals	No. of practicals
1	Environment and its analysis; Water quality parameters	3
2	Collection of samples for pollution study.	2
3	Determination of pH/acidity/alkalinity from sample; Estimation of dissolved oxygen; BOD; COD; nitrates; phosphates.	3
4	Estimation of pollutant elements; Estimation of heavy/toxic elements; Estimation of lead /mercury	3
5	Visit to industrial sewage disposal unit.	3

Recommended Books

1. Gilbert M. Masters and Wendell P. Ela. 2013. Introduction to Environmental Engineering and Science. Pearson Education Limited, NY, USA.
2. Suresh K. Dhameja. 2009. Environmental Engineering and Management. S. K. Kataria & Sons, New Delhi.
3. Bernard J. Nebel and Richard T. Wright.1993. Environmental Science: The Way the World Works. Prentice-Hall Professional, New Delhi.

PHE-101

Physical Education

Credits: 0 + 1 Mid-Session Exam: 50
Contact Hours: 0 + 28 End-Semester Exam: 50

Objective: To develop motor abilities like strength, speed, endurance, coordination, flexibility, agility and balance as they are important aspects for good performance in different games and sports.

Practicals:

S. No.	Practicals	No. of practicals
1	Introduction to physical education: Definition, scientific machine principles, objectives, scope, history, development and importance.	2
2	Physical training and health; Fartlek training and circuit training; Body mechanism and body type: Kretchmark's and Sheldon's classification; Theories of learning; Exercises for good posture; Exercises to develop physical fitness, growth, flexibility - components, speed, strength, endurance, power, flexibility, agility, coordination and balance.	3
3	Test and measurement in physical education: Physical fitness test, motor fitness test, ability test, cardiovascular efficiency test and physical fitness index; Calisthenics, weight training, aerobic and anaerobic exercises.	3
4	Circuit training, interval training, far trek training, pressure training and resistance training; Importance of Asanas, free hand exercises and yoga; Recreation: Definition, agencies promoting recreation, camping and re-recreation; Governance of sports in India.	3
5	Organization of tournaments; National and international events; Drawing of fixtures; Rules and regulations; Coaching and fundamentals of skill development of major games, coaching and tactic development of athletic events.	3

Courses offered in Semester – II			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	FT-101	Food Chemistry of Macronutrients	3 (2+1)
2	FT-102	Food Microbiology	3 (2+1)
3	FT-103	Food Thermodynamics	3 (2+1)
4	EE-103	Fluid Mechanics	4 (3+1)
5	ETE-102	Basics of Electrical Engineering	5 (3+2)
6	MATH-121	Basic Mathematics-II	2 (2+0)
7	FT-104	Post-Harvest Engineering	3 (2+1)
8	STAT-102	Statistics	2(2+0)
9	PHE-102	NCC/NSS *	1 (0+1)
Total Credit Hours			26(18+8)
*** Non-Credit Course**			

FT-101

Food Chemistry of Macronutrients

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with basic concepts of food chemistry. The chemistry of various organic molecules such as fat, protein, carbohydrates and water molecules, their role and interaction in food system.

Details of course:

S. No.	Particulars	Lectures
1	Nature Scope and development of food chemistry; Moisture in foods, role and type of water in foods, functional properties of water, water activity and sorption isotherm, molecular mobility and foods stability.	5
2	Dispersed systems of foods: Physicochemical aspects of food dispersion system (Sol, gel, foam, emulations); Rheology of diphase systems.	4
3	Carbohydrates: Changes of carbohydrates on cooking, modification of carbohydrates, dietary fibres and carbohydrates digestibility; Enzymatic and chemical reactions of carbohydrates; Proteins in foods: Processing induced, physical, chemical and nutritional changes in protein, chemical and enzymatic modification of protein.	8
4	Lipids in foods: Role and use of lipids/fat, crystallization and consistency, chemical aspects of lipids, lipolysis, auto-oxidation, thermal decomposition, chemistry of frying technology of fat and oil.	5
5	Oil processing: Refining, hydrogenations, inter esterification, safety use of oils and fats in food formulation; Enzymatic and chemical reactions of fats; Rancidity and its types, detection techniques chemical aspects of lipids, antioxidants.	6

Practicals:

S. No.	Practicals	No. of practicals
1	Determination of moisture content of foods using different methods.	2
2	Studies of sorption isotherms of different foods; Swelling and solubility characteristics of starches; Rheological properties of food systems.	3
3	Determination of crude proteins by micro-Kjeldhal method.	3
4	Determination of essential amino acids i.e. lysine, tryptophan, methionine, etc.; Isolation of egg and milk protein; Preparation of protein isolate and concentrate of proteins.	3
5	Determination of acid value, saponification value and iodine number of fat/oil; Assay of amylases, papain and lipases.	3

Recommended Books

1. John W. Brady. 2013. Introductory Food Chemistry. Comstock Publishing Associates, Cornell University Press, Ithaca, USA.
2. H.-D. Belitz, W. Grosch and P. Schieberle. 2009. Food Chemistry, 4th Ed. Springer-Verlag Berlin Heidelberg.
3. Owen R, Fennema. 1996. Food Chemistry, 3rd Ed. Marcel Dekker, Inc., New York, USA.
4. Lillian Hoagland Meyer. 1974. Food Chemistry. The AVI Publishing Co Inc., Connecticut, MA, USA.

FT-102

Food Microbiology

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: The major learning objectives of this course will be to study the scope of food microbiology and food safety; to obtain the knowledge about important genera of microorganisms associated with food and their characteristics; to learn various techniques for enumeration and control of microorganisms in food.

Details of course:

S. No.	Particulars	Lectures
1	Importance and significance of microbes in food science; Microbial spoilage of foods Factors affecting kinds, numbers, growth and survival of microorganisms in foods.	5
2	Intrinsic factors; pH, water activity, nutrients etc., Extrinsic factors: Relative humidity, temperature, gaseous atmosphere; Chemical changes caused by microorganisms: Changes in nitrogenous organic compounds, non-nitrogenous organic compounds, organic acids, other compounds, lipids, pectic substances.	5
3	Contamination of foods; Sources of contamination, Genera of bacteria, Maintenance of anaerobic conditions; Asepsis, removal of microorganisms; Intermediate moisture foods; Microbiology of milk and milk products; Microbiology of fruits and vegetables, Microbiology of cereal and cereal products, Microbiology of meat and meat products, Microbiology of fish and other sea foods.	6
4	Microbiology of poultry and eggs: Microbiology of sugar and sugar products; Microbiology of salts and spices, Microbiology of canned foods, Shelf life: Calculation of shelf life, Shelf life requirements, deteriorative reactions, accelerated testing; Simulations of product: Package environment interaction, shelf life simulation for moisture, oxygen, and light sensitive products.	6
5	Food borne intoxications and infections types of food involved, toxicity and symptoms, chemical properties, environmental conditions; Food borne viruses: Polio, hepatitis A & E, noroviruses, rota viruses, prion diseases, types of food involved, toxicity and symptoms, chemical properties, environmental conditions.	6

Practicals:

S. No.	Practicals	No. of practicals
1	Isolation of bacteria and molds from foods; Microbial examination of cereal and cereal products: Identification, isolation and confirmation.	2
2	Microbial examination of vegetable and fruits: Identification, isolation and confirmation; Microbial examination of meat and meat products: Identification, isolation and confirmation.	3
3	Microbial examination of fish and other sea foods: Identification, isolation and confirmation; Microbial examination of eggs and poultry: Identification, isolation and confirmation.	3

4	Microbial examination of milk and milk products: Identification, isolation and confirmation; Microbial examination of sugar, salts and spices: Microbial examination of canned products: Identification, isolation and confirmation.	3
5	Determination and enumeration of pathogenic and indicator organisms in foods (Coliform/Enterococcus); Thermal death time determination; Detection of Salmonella from food sample; Detection of coliforms from water by MPN method; Detection of Staphylococcus aureus from food sample.	3

Recommended Books

1. Martin R. Adams and Maurice O. Moss. 2008. Food Microbiology, 3rd Ed., The Royal Society of Chemistry, Cambridge, UK.
2. James M. Jay. 2000. Modern Food Microbiology, 6th Ed. Aspen Publishers, Inc., Gaithersburg, Maryland, USA.
3. George J. Banwart. 1989. Basic Food Microbiology, 2nd Ed. Chapman & Hall, New York, USA.
4. William C. Frazier and & Dennis C. Westfoff. 1987. Food Microbiology, 4th Ed. Tata McGraw-Hill Education, New Delhi.

FT-103

Food Thermodynamics

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with the basics concepts of thermodynamics and temperature scale, understanding the first and second law of thermodynamics and apply them to various thermal engineering devices.

Details of course:

S. No.	Particulars	Lectures
1	Basic concepts: definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat.	5
2	First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, steady and unsteady flow analysis; Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, thermodynamic temperature scale, entropy, availability and irreversibility.	6
3	Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule. Thermodynamic cycles: Carnot vapor power cycle, ideal Rankine cycle, Rankine Reheat cycle, air standard Otto cycle, air standard Diesel cycle, air-standard Brayton cycle, vapor-compression refrigeration cycle.	6
4	Psychometry: thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms.	6
5	Three stages of water, phase diagram for water, vapour pressure-temperature curve for water, heat requirement for vaporization, measurement of humidity, Properties of steam: Wet, dry saturated, superheated steam, use of steam tables.	5

Practicals:

S. No.	Practicals	No. of practicals
1	Determination of dryness fraction of steam.	2
2	Determination of state of air using psychometric chart and hygrometer.	3
3	Use of psychometric chart during drying process/ humidification process.	3
4	Demonstration of equilibrium sorption isotherms; Use of psychometric chart during drying process/ humidification process.	3
5	Visit to food plant with steam utilization.	3

Recommended Books

1. R.K. Rajput. 2007. Engineering Thermodynamics, 3rd Ed. Laxmi Publications (P) Ltd., Bangalore.
2. J.M. Smith, H.C. Van Ness and M.M. Abbott. 2005. Introduction to Chemical Engineering Thermodynamics, 7th Ed. McGraw-Hill, Inc., NY, USA.
3. Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.
4. Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
5. Donald B. Brooker, Fred W. Bakker-Arkema and Carl W. Hall. 1976. Drying Cereal Grains. The AVI Publishing Company, Inc., Connecticut, MA, USA.

EE-103
Fluid Mechanics

Credits: 3 + 1
Contact hours: 42 + 28

Mid-session exam: 30 (25+5#)
Practical exam: 25
End-semester exam: 45

Objective: To introduce and explain fundamentals of Fluid Mechanics, which is used in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics etc. To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows.

Details of course:

S. No.	Particulars	Lectures
1	Units and dimensions; Properties of fluids; Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid; Pressure on vertical rectangular surfaces; Flow behavior of viscous foods; Compressible and non-compressible fluids; Surface tension, capillarity; Pressure measuring devices: Simple, differential, micro-, inclined manometer, mechanical gauges, piezometer.	6
2	Floating bodies: Archimedis principle, stability of floating bodies; Equilibrium of floating bodies, metacentric height; Fluid flow: Classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation; Bernoulli's theorem and its applications; Navier- Stokes equations in cylindrical co-ordinates, boundary conditions; Simple application of Navier- Stokes equation: Laminar flow between two straight parallel boundaries; Flow past through the immersed solids, packed and fluidized beds.	8
3	Flow through pipes: Loss of head, determination of pipe diameter; Determination of discharge, friction factor, critical velocity; Flow through orifices, mouthpieces, notches and weirs; Vena contracta, hydraulic coefficients, discharge losses; Time for emptying a tank; Loss of head due to contraction, enlargement at entrance and exit of pipe; External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs; Venturimeters, pitot tube, rotameter; Water level point gauge, hook gauge.	8
4	Dimensional analysis: Buckingham's theorem application to fluid flow phenomena, Froude Number, Reynolds number, Weber number and hydraulic similitude; Turbines and pumps: classification, centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump; Centrifugal pumps: Pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometer efficiency, operating characteristics of centrifugal pumps, Submersible pumps.	10
5	Reciprocating pumps: Working of reciprocating pump, double acting pump, instantaneous rate of discharge, acceleration of piston and water, gear pump; Pressure variation, work efficiency; Pressure requirements for viscous foods to lift them to different heights and selection of pumps; Open channel hydraulics: Classification of open channel and definitions, most economical sections of regular cross-sections; Specific energy concept-critical depth, energy diagrams; Velocity and pressure profiles in open channels; Hydraulic jumps-types.	10

Practicals:

S. No.	Practicals	No. of practicals
1	Study of different tools and fittings; Study on flow rate versus pressure drop with U-tube Manometer.	2
2	Verification of Bernoulli's theorem; Determination of discharge co-efficient for venturi, orifice, V-notch; Verification of emptying time formula for a tank.	3
3	Determination of critical Reynold's number by Reynold apparatus; Study of reciprocating, centrifugal and gear pump;	3
4	Calibration of rotameter, Study of different types of valves.	3
5	Study of pumps for viscous fluid; Floating bodies, liquid flow, venturi meter, orifice, weir, flow through pipes.	3

Recommended Books

1. Frank M. White. 2010. Fluid Mechanics, 7th Ed. McGraw-Hill Book Co., Inc., Boston, USA.
2. Yunus A. Çengel and John M. Cimbala. 2006. Fluid Mechanics: Fundamentals and Applications. McGraw-Hill, Inc., New York, USA.
3. Bruce R. Munson, Donald F. Young and Theodore H. Okiishi. 2002. Fundamentals of Fluid Mechanics, 4th Ed. John Wiley & Sons, Inc., New York, USA.
4. E. John Finnemore and Joseph B. Franzini. 2002. Fluid Mechanics with Engineering Applications, 10th Ed. McGraw-Hill, Inc., New York, USA.
5. R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot. 2002. Transport Phenomena, 2nd Ed. John Wiley & Sons, Inc., New York, USA.
6. Noel de Nevers. 1991. Fluid Mechanics for Chemical Engineers. McGraw-Hill, Inc., New York, USA.
7. Victor L. Streeter. 1962. Fluid Mechanics, 3rd Ed. McGraw-Hill Book Co., Inc., Boston, USA.

ETE-102
Basics of Electronics Engineering

Credits: 3 + 2
Contact Hours: 42 + 56

Mid-Session Exam: 25 (20+5#)
Practical Exam: 40
End-Semester Exam: 35

Objective: Students will gain knowledge regarding the various laws, principles associated with electrical systems, electrical machines, semiconductors, and apply them for designing aspects and other practical problems.

Details of course:

S. No.	Particulars	Lectures
1	**Circuit Analysis:** Ohm's Law, KCL, KVL Mesh and Nodal Analysis, Circuit parameters, energy storage aspects, Superposition, Thevenin's, Norton's, Reciprocity, Maximum Power Transfer Theorem, Millman's Theorem, Star-Delta Transformation. Application of theorem to the Analysis of dc circuits.	10
2	**A.C. Circuits:** R-L, R-C, R-L-C circuits (series and parallel), Time Constant, Phasor representation, Response of R-L, R-C and R-L-C circuit to sinusoidal input Resonance-series and parallel R-L-C Circuits, Q-factor, Bandwidth.	10
3	**Measuring Instruments:** Principles, Construction and application of moving coil, moving iron, dynamometer type, induction type instruments, extension of range of ammeter, voltmeter (shunt and multiplier), Two-wattmeter method, for the measurement of power, Cathode-ray-oscilloscope and Applications.	10
4	**Transformers:** Construction and Working principles and phasor diagrams of Single-phase Transformer, Emf equation, Equivalent circuit, Regulation and efficiency, and Auto transformer. **Three Phase Circuits:** Phase and line voltages and currents, balanced star and delta circuits, power equations, Importance of power factor and earthing, types and construction of storage battery, capacity and efficiency.	12

Practicals:

S. No.	Practicals	No. of practicals
1	Verification of Thevenin's theorem, Superposition theorem, Norton theorem.	3
2	Verification of Max. power transfer theorem, Reciprocity theorem.	2
3	Phasor Diagram and Power factor of LCR circuit.	2
4	Measurement of Power and Power factor in single phase Load using three ammeters/voltmeters.	3
5	Calibration of Energy Meter/Wattmeter/Voltmeter/Ammeter.	3
6	Two wattmeter method of measuring power in three phase circuit (resistive load only)	3
7	Load test on Single Phase Transformer, Regulation and Efficiency of Transformer.	3
8	Short Circuit/Open Circuit tests on Single Phase transformer.	3
9	To find out resonance and quality factor of a series and parallel circuit.	3
10	Verification of KCL and KVL.	3

Recommended Books

1. P.C. Sen “Principles of Electric Machines and Power Electronics”, Wiley Eastern 2003.
2. Vincent DEL TORO “Electrical Engineering Fundamental’s Prentice Hall India”, Ed 2002.

MATH-121
Basic Mathematics-II

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To acquaint the students with the basic and necessary knowledge of integration and their application in daily life, formation of basic differential equations and elementary concept of Probability. After completion of this course student will be able to find the area of region enclosed by the curves by the method of integration, solve any first order differential equation and solve the basic problems of probabilities

Details of course:

S. No.	Particulars	Lectures
1	Trigonometry: Sexagensimal, centesimal and circular measure of an angle. Definitions of T-ratio's and the relations connecting them. T-ratios of 0, 6, 45, 60, 90 (no proofs). Evaluation of T-ratios of allied angles and 2A, 3A (no proofs) and easy identities based on them and identities based on the formulae for sin P + sin Q and cos P – cos Q and their converse conditional identities, relations between the sides and the angles of a triangle i.e. sine cosine, and projections formulae, logarithm and their applications (based on the use of tables only) to simplification of fractions solution of right-angled triangles. Solution of oblique angled triangles when (i) three sides are given (ii) two angles and a side are given (iii) two sides and an angle are given, graphs of sin x and cos x and reading from graphs.	9
2	Elementary calculus: Idea of function and limit, evaluation of the limit algebraic, functions, Lt and Lt sin c.	4
3	Differentiation of simple algebraic trigonometric, inverse trigonometric, exponential functions	4
4	Theorems on differentiation of the sum, difference, the product and the quotient of functions. The further differentiation of a simple function of function, differentiation of parametric functions and of one function with regard to another function (use of transformation excluded).	5
5	Integration of the standard forms as inverse of differentiation. Elements of matrices and determinants. Kinds, properties of determinants, adjoint of matrix, inverse of matrix, solution of simultaneous equations; Cramer's rule, matrix method.	6

Recommended Books

1. Algebra by D. C. Kapoor and Gurbax Singh
2. Algebra by T. N. Nagpal and K. K. Gupta.
3. Comprehensive Calculus by R. S. Dehiya.
4. New Style Calculus for T. D. C. – I.
5. New Style Co-ordinator Geometry by R. K. Sondhi
6. Trignometry by Jiwan

FT-104

Post-Harvest Engineering

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: The course is designed to acquaint the students to develop an in-depth understanding of the way fresh horticultural produce must be handled, processed, transported and stored to maintain quality from grower to consumer.

Details of course:

S. No.	Particulars	lectures
1	Overview of post harvest technology: Concept and science, production and post harvest losses, reasons for losses, importance of loss reduction; Water activity, water binding and its effect on enzymatic and non-enzymatic reactions and food texture, control of water activity and moisture.	5
2	Post Harvest Handling operations; Cleaning: Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Sorting and grading: Sorting, grading, methods of grading; Grading- Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance.	5
3	Separation: Magnetic separator, destoners, electrostatic separators, pneumatic separator; Decorticating and shelling: Principles of working, design and constructional details, operating parameters, maintenance, etc. of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.; Grain drying theory, grain dryers; Liquid dryers; Parboiling: process, changes during parboiling, parboiling methods, advantages and disadvantages of parboiling with respect to milling, nutritional and cooking quality of grain, significance of glass transition temperature.	6
4	Milling: milling, polishing, grinding, milling equipments, dehuskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement; Materials handling: Introduction to different conveying equipments used for handling of grains, fruits and vegetables; Scope and importance of material handling devices.	4
5	Study of different material handling systems: Classification, principles of operation, conveyor system selection/design; Belt conveyor: Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain; Screw conveyor: Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors; Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types; Pneumatic conveying system: Capacity and	8

	power requirement, types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.	

Practicals:

S. No.	Practicals	No. of practicals
1	Study of cleaners for grains; washers for fruits and vegetables, graders for grains and graders for fruits and vegetables.	2
2	Study of decorticators; Study of a maize/ sunflower sheller; Study of crop dryers; Study of a RF/MW/tray dryer; Study of hot air dryer and modelling drying kinetics.	3
3	Study of vacuum dryer and modelling drying kinetics; Study of working principle of spray dryer and spray drying process.	2
4	Study of drum dryer and liquid food dehydration using drum drying; Study of fluidized bed dryer and drying process.	3
5	Study of freeze dryer and freeze-drying process; Study of rice milling machines; Study of pulse milling machines.	2
6	Study of different components of flour mill; Study of different materials handling equipment.	2

Recommended Books

1. Amalendu Chakraverty and R. Paul Singh. 2014. Post-Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
2. Chakraverty. 2008. Post-Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
4. James G. Brennan. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.
5. K.M. Sahay and K.K. singh. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.
6. G. Boumans. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
7. R.L. Earle. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
8. Carl W. Hall and Denny C. Davis. 1979. Processing Equipment for Agricultural Products. The AVI Publishing Company, Inc., Connecticut, MA, USA.
9. S.M. Henderson and R.L. Perry. 1966. Agricultural Process Engineering, 2nd Ed. The AVI Publishing Company, Inc., Connecticut, MA, USA.

STAT-102
Statistics

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To acquaint the students with the basic theoretical and applied principles of statistics needed to enter the job force. Students will be able to communicate key statistical concepts to non-statisticians. Students will gain proficiency in using statistical software for data analysis.

Details of course:

S. No.	Particulars	Lectures
1	Introduction: Definition of statistics and its use and limitations, frequency distribution and frequency curves; Measures of central tendency: Characteristics of ideal average, arithmetic mean; median, mode, merits and demerits of arithmetic mean; Measures of dispersion: standard deviation, variance and coefficient of variation.	7
2	Probability: Definition and concept of probability; Normal distribution and its properties; Introduction to sampling: random sampling; the concept of standard error; tests of significance- types of errors, null hypothesis, level of significance and degrees of freedom, steps involved in testing of hypothesis; Large sample test, SND test for means, single sample and two samples (all types).	7
3	Small sample test for means, student's t-test for single sample, two samples and paired t test. F test; Chi-Square test in 2 x 2 contingency table, yates' correction for continuity; Correlation: types of correlation and identification through scatter diagram, computation of correlation coefficient 'r' and its testing.	6
4	Linear regression: of Yon X and X on Y. Inter-relation between 'r' and the regression coefficients, fitting of regression equations. Experimental designs basic designs, completely randomized design (CRD) Experimental designs, layout and analysis with equal and unequal number of observations, randomized block design (RBD), Latin square design (LSD), layout and analysis.	8

Recommended Books

1. Algebra by D. C. Kapoor and Gurbax Singh
2. Algebra by T. N. Nagpal and K. K. Gupta.
3. Comprehensive Calculus by R. S. Dehiya.
4. New Style Calculus for T. D. C. – I.
5. New Style Co-ordinator Geometry by R. K. Sondhi
6. Trignometry by Jiwan

PHE-102

NCC/NSS *

Credits: 0 + 1 Mid-Session Exam: 50
Contact Hours: 0 + 28 End-Semester Exam: 50

Objective: To develop qualities of character courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and ideas of self-less service among the youth to make them useful citizen. To create human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of Nation.

Details of Course:

S. No.	Practicals
1	NSS: Orientation of students towards national problems; Study of the philosophy of N.S.S., fundamental rights, directive principles of state policy, socio-economic structure of Indian society, population and five-year plans; Functional literacy: Non-formal education of rural youth, eradication of social evil, awareness programmes, consumer awareness, highlights of the Consumer Act, environment enrichment and conservation, health, family welfare and nutrition; Right to information act.

Courses offered in Semester – III			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	FT-201	Crop Production Technology	3 (2+1)
2	FT-202	Processing Technology of Liquid Milk	3 (2+1)
3	FT-203	Processing Technology of Cereals	3 (2+1)
4	FT-204	Industrial Microbiology	3 (2+1)
5	FT-205	Food Chemistry of Micronutrients	3 (2+1)
6	FT-206	Heat and Mass Transfer in Food Processing	4 (3+1)
7	FT-207	Unit Operations in Food Processing-I	3 (2+1)
8	CSE-221	Computer Programming and Data Structures	3 (2+1)
Total Credit Hours			25 (17+8)

FT-201

Crop Production Technology

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To make student learn about different techniques associated with production of crops.

Details of course:

S. No.	Particulars	Lectures
1	Classification of crops; Effect of different weather parameters on crop growth and development; Principles of tillage; Soil-water-plant relationship, crop rotation, cropping systems, relay cropping and mixed cropping; Crop production technology for major cereal crops viz., paddy, wheat, maize, pearl millet, sorghum, etc.; Major varieties, sowing time, method of sowing, spacing, inter culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.	7
2	Crop production technology for major oilseed crops viz., groundnut, sesame, rapeseed, mustard, castor, etc.: Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.	4
3	Crop production technology for major pulse crops viz., pigeon pea, cowpea, gram, green gram, black gram, etc.: Major varieties, of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.; Crop production technology for major spices and cash crops viz., cumin, coriander, funnel, ginger, garlic, sugarcane, etc.: Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.	6
4	Horticulture: Scope of horticultural crops. Soil and climatic requirements for fruits and vegetables, nursery raising and management; Crop production technology for major fruit crops viz., mango, banana, sapota, aonla, pomegranate, guava, etc.: Major varieties, time of transplanting, spacing, inter-culturing, fertilizer and water requirement, time and method of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.	6
5	Crop production technology for major vegetable crops viz., potato, onion, tomato, chili and other green and leafy vegetables: Major varieties, sowing time, method of sowing, spacing, inter culturing, fertilizer and water requirement, time of harvest, maturity index, yield potential, cost of cultivation, income from production, etc.	5

Practicals:

S. No.	Practicals	No. of practicals
1	Examination of soil profile in the field; Introduction to different equipments utilized in a weather observatory.	2
2	Identification of seed of different agricultural crops and their varieties; Study of seed viability and germination test; Identification of different weeds and methods of their control.	3
3	Use of different inter-culturing equipments; Study of water requirement of different crops.	3
4	Fertilizer application methods and equipments; Judging maturity time for harvesting of crop; Identification and description of important fruit and vegetable crops.	3
5	Preparation of nursery; Study of different garden tools; Practices of pruning and training in some important fruit crops.	3

Recommended Books

1. S. Prasad and U. Kumar. 2010. Principles of Horticulture. Agrobios, New Delhi.
2. T. Yellamanda Reddy and G.H. Shankar Reddy. 1995. Principles of Agronomy. Kalyani Publishers, Ludhiana.
3. S.S. Singh. Principles and Practices of Agronomy. 1985. Kalyani Publishers, Ludhiana.

FT-202

Processing Technology of Liquid Milk

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To introduce the students to dairy industry, properties and processing of milk, manufacture of dairy products, sanitation and effluent treatment in dairy industry

Details of course:

S. No.	Particulars	Lectures
1	Historical development of dairy in India; Production and utilization of milk; Composition and properties of milk; Liquid milk collection, preservation, processing, packaging and storage - standardized milk, skim milk, sterilized milk, reconstituted/rehydrated milk, recombined milk, flavoured milk, fermented milk, acidophilous milk, etc.	8
2	Cream: definition, classification, manufacture of different types of cream, processing of cream; Fermented milk products: Processing, manufacture, storage and packaging of acidophilus milk, cultured buttermilk and other fermented milk; Bio-chemical changes occurring during manufacture of fermented milks; Factors affecting these changes and effects of these changes on the quality of finished products.	9
3	Adulterations in milk and its detection; Quality defects in milk-causes and prevention, liquid milk collection, processing, packaging and storage systems and equipment - bulk milk coolers, milk chilling units.	5
4	Milk reception equipment, milk tanks/silos, pasteurizers, sterilizers, centrifuges, clarifiers, filtration units, homogenizers, packaging and filling machines, CIP units, etc.; Hygienic design concepts, sanitary pipes and fittings, corrosion process and their control.	6

Practicals:

S. No.	Practicals	No. of practicals
1	Platform tests of raw milk (clot on boiling (COB) test, alcohol test).	2
2	Determination of physical properties of milk; Determination of proximate composition and biochemical properties of milk; Determination of microbiological properties of milk.	3
3	Detection of adulterants in milk; Identification and demonstration of liquid milk processing equipment, pipes and fittings.	3
4	Preparing standardized milk as per requirement; Separation of fat from milk; Pasteurization and homogenization of milk.	3
5	Packaging of liquid milk; Preparation of curd and yogurt, Visit to chilling centre and dairy plant.	3

Recommended Books

1. Kanekanian. 2014. Milk and Dairy Products as Functional Foods. John Wiley & Sons, Ltd., UK.
2. Adnan Y. Tamime. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.
3. Pieter Walstra, Jan T.M. Wouters, Tom J. Geurts. 2006. Dairy Science and Technology, 2nd Ed. CRC Press, Boca Raton, FL, USA.
4. Sukumar De. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
5. H.G. Kessler. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising (F.R. Germany).
6. Y.H. Hui. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.

FT-203

Processing Technology of Cereals

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: The course aims to develop the knowledge of students in the area of cereal processing and technology. This is necessary for effective understanding specific aspects of food processing related to these foods. This course will enable students to appreciate the application of scientific principles in the processing of these materials.

Details of course:

S. No.	Particulars	lectures
1	Present status and future prospects of cereals and millets; Morphology, physico-chemical properties of cereals, major and minor millets; Chemical composition and nutritive value; Paddy processing and rice milling: Conventional milling, modern milling, milling operations, milling machines, milling efficiency; Quality characteristics influencing final milled product.	9
2	Parboiling; Rice bran stabilization and its methods; Wheat milling: Break system, purification system and reduction system; extraction rate and its effect on flour composition; quality characteristics of flour and their suitability for baking.	5
3	Corn milling: Dry and wet milling of corn, starch and gluten separation, milling fractions and modified starches; Barley: Malting and milling; Oat/Rye: Processing, milling; Sorghum: Milling, malting, pearling.	5
4	Millets (Pearl millets, finger millets): Processing of millets for food uses; Secondary and tertiary products processing of cereals and millets; By-products processing of cereals and millets.	5
5	Processing of infant foods from cereals and millets; Breakfast cereal foods: Flaked, puffed, expanded, extruded and shredded.	4

Practicals:

S. No.	Practicals	No. of practicals
1	Morphological characteristics of cereals; Physical properties of cereals; Chemical properties of cereals.	2
2	Parboiling of paddy; Cooking quality of rice; Milling of rice; Conditioning and milling of wheat.	3
3	Production of sorghum flakes; Production of popcorns, flaked rice, puffed rice, noodles.	3
4	Preparation of sorghum malt; Determination of gelatinization temperature by amylograph.	3
5	Processing of value-added products from millets; Visit to Cereal processing unit.	3

Recommended Books

1. Amalendu Chakraverty and R. Paul Singh. 2014. Post-Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
2. Khalil Khan and Peter R. Shewry. 2009. Wheat: Chemistry and Technology, 4th Ed., AACC International, Inc., St. Paul, MN, USA.
3. Colin Wrigley. 2004. Encyclopedia of Grain Science. Academic Press, London, UK.
4. Elaine T. Champagne. 2004. Rice: Chemistry and Technology, 3rd Ed., AACC International, Inc., St. Paul, MN, USA.
5. Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
6. Pamela J. White and Lawrence A. Johnson. 2003. Corn: Chemistry and Technology, 2nd Ed.,
7. AACC International, Inc., St. Paul, MN, USA.
8. David A.V. Dendy and Bogdan J. Dobraszczyk. 2001. Cereal and Cereal Products: Technology and Chemistry. Springer-Verlag, US.
9. N.L. Kent and A.D. Evers. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th Ed. Elsevier Science Ltd., Oxford, UK.
10. Samuel A. Matz. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd Ed. Springer Science + Business Media, NY, USA.
11. E.V. Araullo, D.B. De Padna and Graham. 1976. Rice Post Harvest Technology. IDRC, Canada.

FT-204

Industrial Microbiology

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact Hours: 28 + 28 Practical Exam: 35
End-Semester Exam: 40

Objective: To introduce students to the principles of Microbiology to emphasize structure and biochemical aspects of various microbes and to solve the problems in microbial infection and their control.

Details of course:

S. No.	Particulars	lectures
1	History of industrial microbiology; Primary and secondary metabolites produced by the microorganisms; Screening of microorganisms; Preservation of microorganisms.	4
2	Organizations involved in microbiological work; Fermentation media, Industrial sterilization; Definition, thermal death time, media heat sterilization, advantages of continuous sterilization, design of sterilization, deterministic and probabilistic approach in designing of sterilizing equipments, sterilization charts.	7
3	Fermentor: Components of a fermentor, parts of fermentors, peripheral parts and accessories, additional accessories and peripherals. Types of fermentors: Types of fermentations; Industrially important secondary metabolites; and microorganisms involved.	6
4	Probiotics: Importance, role in fermented foods, organisms involved, beneficial effects; Bacteriocins; Nisin: Production of microbial enzymes; Downstream processing.	5
5	Cell disruption methods: Mechanical disruption methods and non-mechanical disruption methods; Extraction; Purification; Concentration; Product recovery.	6

Practicals:

S. No.	Practicals	No. of practicals
1	Isolation and screening of citric acid/ amylase/ protease /antibiotic producing microbes.	2
2	Production of citric acid/Lactic acid/ Acetic acid, Purification of citric acid/Lactic acid/ Acetic acid and Estimation of citric acid/Lactic acid/ Acetic acid.	3
3	Standardization of physical factors for higher yields of citric acid; Isolation, identification of cultures producing bio-colours; Production, purification and estimation of beer/ ethanol.	3
4	Production, purification and assay of fungal amylases/proteases/Lipase; Production and assay of nisin from lactic acid bacteria.	3
5	Single cell protein production; Starter activity of Baker's yeast Mushroom production.	3

Recommended Books

1. Nduka Okafor. 2007. Modern Industrial Microbiology and Biotechnology. Science Publishers, Enfield, New Hampshire, USA.
2. Dennis E. Briggs, Chris A. Boulton, Peter A, Brookes and Roger Stevens. 2004. Brewing Science and Practice. Woodhead Publishing Ltd. Cambridge, England.
3. G. Reed. 2004. Prescott & Dunn's Industrial Microbiology, 4th Ed. AVI Publishers, Connecticut, USA.
4. Peter F. Stanbury, Allan Whitakar and Stephen J. Hall. 1995. Principles of Fermentation Technology, 2nd Ed. Elsevier Science Ltd., Burlington, MA, USA.
5. L.E. Casida Jr. 1968. Industrial Microbiology. New Age International Publishers, New Delhi.

FT-205

Food Chemistry of Micronutrients

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: The course aims to develop the knowledge of students in the basic area of Food Chemistry. This is necessary for effective understanding of food processing and technology subjects. This course will enable students to appreciate the similarities and complexities of the chemical components in foods.

Details of course:

S. No.	Particulars	Lectures
1	Chemistry of food flavour; Philosophy and definitions of flavour, flavor matics/flavouring compounds, sensory assessment of flavour, technology for flavour retention.	4
2	Pigments in animal and plants kingdoms: Heme pigments, chlorophyll, carotenoids, phenolic and flavonoids, betalins, effect of processing on pigment behavior.	5
3	Technology for retention of natural colours of food stuffs; Food colorants; Regulatory use of regulatory dyes; Colour losses during thermal processing.	6
4	Vitamins and minerals: Requirements, allowances, enrichment, restorations, fortifications, losses of vitamins and minerals, optimization and retention of vitamins and minerals.	6
5	Chemistry of anti-nutritional factors. Enzymes in food industry: Carbohydrases, proteasase, lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, enzymes use as processing aid and ingredients.	7

S. No.	Practicals	No. of practicals
1	Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidations).	2
2	Estimation of calcium, phosphorus, iron and magnesium.	2
3	Estimation of tannins and phytic acid from food.	2
4	Determination of vitamin A (Total carotenoids) and ascorbic acid by dye method.	3
5	Determination of thiamin and riboflavin; Determination of food colors.	2
6	Assessment of hydrocolloids as food additives; Assessment of various pectinases from fruits and vegetables	3

Recommended Books

1. H.-D. Belitz, W. Grosch and P. Schieberle. 2009. Food Chemisry, 4th Ed. Springer-Verlag Berlin Heidelberg.
2. Owen R, Fennema. 1996. Food Chemistry, 3rd Ed. Marcel Dekker, Inc., New York, USA.

FT-206

Heat and Mass Transfer in Food Processing

Credits: 3 + 1 | Mid-session exam: 30 (25+5#)
Contact hours: 42 + 28 | Practical exam: 25
End-semester exam: 45

Objective: To understand the principles and applications of heat and mass transfer operations such as steady state and unsteady state heat conduction, heat transfer to flowing fluids and detailed knowledge of heat exchangers

Details of Course:

S. No.	Particulars	Lectures
1	Basic heat transfer processes, heat transfer coefficients, properties related to heat transfer; One-dimensional steady state conduction: Theory of heat conduction, Fourier's law and its derivation, Concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines.	7
2	One-dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform/non-uniform heat generation, development of equations of temperature distribution with different boundary conditions; Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (fins) of uniform area of cross-section and with Equation of temperature distribution with different boundary conditions; Effectiveness and efficiency of the fins.	10
3	Introduction to unsteady state heat conduction: System with negligible internal resistance and in various geometries; Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer; Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient.	9
4	Heat transfer to flowing fluids; Radiation: Heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors; Introduction to condensing and boiling heat transfer: Film- and drop-wise condensation, effect of non-condensable gases, boiling heat transfer.	7
5	Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube and plate heat exchangers, heat exchanger design; Application of different types of heat exchangers in dairy and food industry; Mass transfer: Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.	9

Practicals:

S. No.	Practicals	No. of practicals
1	Heat transfer analysis during conduction and convection; Study on various types of heat exchangers used in food industry.	3
2	Preparation and calibration of thermocouples; Determination of thermal conductivity of different food products.	2
3	Study of working principle and constructional details of plate heat exchanger; Study of working principle and constructional details of shell and tube heat exchanger.	3
4	Determination of overall heat transfer coefficient of shell and tube, plate heat exchangers, jacketed kettle used in food industry.	3
5	Studies on heat transfer through extended surfaces; Studies on temperature distribution and heat transfer in HTST pasteurizer.	3

Recommended Books

1. Eduardo Cao. 2010. Heat Transfer in Process Engineering. The McGraw-Hill Companies, Inc., New York, USA.
2. J.P. Holman. 2010. Heat Transfer, 10th Ed. McGraw-Hill Book Co., Boston, USA.
3. Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
4. John H. Lienhard IV and John H. Lienhard V. 2008. A Heat Transfer Textbook. Phlogiston Press, Cambrige, MA, USA.
5. Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.
6. Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
7. J, M. Coulson, J. F. Richardson, J. R. Backhurst and J. H. Harker. 1999. Coulson & Richardson's Chemical Engineering, Vol. 1, Fluid Flow, Heat Transfer and Mass Transfer, 6th Ed. Butterworth–Heinemann, Oxford, UK.
8. M. Necati Özişik. 1993. Heat Conduction, 2nd Ed. John Wiley & Sons, NY, USA.
9. Robert E. Treybal. 1980. Mass Transfer Operations, 3rd Ed. McGraw-Hill Book Company, Auckland, USA.

FT-207

Unit Operations in Food Processing-I

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To develop knowledge in handling basic unit operation such as size reduction, mixing, mechanical separation and membrane separation techniques

Details of course:

S. No.	Particulars	Lectures
1	Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization.	4
2	Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra-fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping).	4
3	Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.	7
4	Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machines; Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids.	7
5	Membrane separation: General considerations, materials for membrane construction, ultra-filtration, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and micro filtration.	6

Practicals:

S. No.	Practicals	No. of practicals
1	Determination of fineness modulus and uniformity index; Determination of mixing index of a feed mixer.	3
2	Power requirement in size reduction of grain using Rittinger's law, Kick's law and Bond's law. Performance evaluation of hammer mill.	3
3	Performance evaluation of attrition mill, Study of centrifugal separator.	2
4	Study of freeze dryer and freeze-drying process; Study on osmosis in fruits.	3

5	Determination of solid gain and moisture loss during osmosis; Study of reverse osmosis process; Study of ultra-filtration/membrane separation process.	3

Recommended Books

1. Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.
2. Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
3. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
4. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed. Butterworth–Heinemann, Oxford, UK.

CSE-221

Computer Programming and Data Structures

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To provide the knowledge of basic data structures and their implementations, understanding importance of data structures in context of writing efficient programs and to develop skills to apply appropriate data structures in problem solving.

Details of course:

S. No.	Particulars	Lectures
1	Introduction and historical background: Review of computer technology; Processor, memory, secondary storage, display devices and other peripheral devices; Basic computer organization, future trends; Brief review of present-day applications, programming; Introduction to systems software, applications software and programming language.	7
2	Algorithms and flow-charts: Input processing-output model of a computer program; Role of the compiler and the integrated development environment; Introduction to C: Structure of a C program, simple data types, declarations, operators and expressions; The assignment statement; Library functions.	5
3	Control Structures: Conditional and iterative execution of statements; Importance of documentation; Nesting of control structures and the use of indentation to indicate nesting levels; Labels and the "go to" statement; Arrays; Single and multi-dimensional arrays: Character strings and string functions; Functions: Scope rules; Argument passing by reference and by value; Storage classes; Use of function prototypes; Structures, unions and user-defined types.	6
4	Operations on files: Concept of standard input and output files; Formatting of data on input and output; Use of include files; Introduction to high level languages; Primary data types and user defined data types, variables, typecasting, operators, building and evaluating expressions, standard library functions, managing input and output.	5
5	Decision making, branching, looping, arrays, user defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, string functions, stacks, push/pop operations, queues, insertion and deletion operations, linked lists.	5

S. No.	Practicals	No. of practicals
1	Familiarizing with Turbo C IDE; Building an executable version of C program; Debugging a C program.	2
2	Developing and executing simple programs; Creating programs using decision making statements such as if, go to and switch.	3
3	Developing program using loop statements while, do and for; Using nested control structures; Familiarizing with one and two-dimensional arrays; Using string functions.	3

4	Developing structures and union; Creating user defined functions; Using local, global and external variables; Using pointers; Implementing stacks.	3
5	Implementing push/pop functions; Creating queues; Developing linked lists in C language; Insertion/deletion in data structures.	3

Recommended Books

1. Mark Allen Weiss. 2014. Data Structures and Algorithm Analysis in C++, 4th Ed. Pearson Education, Boston, USA.
2. Svetlin Nakov & Co. 2013. Fundamentals of Computer Programming with c#. Sofia, Bulgaria.
3. F. Balagurusamy. 2008. Object Oriented Programming with C++, 4th Ed. Tata McGraw-Hill Publishing Company Limited, New Delhi.

Courses offered in Semester – IV			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	FT-209	Processing Technology of Dairy Products	3 (2+1)
2	FT-210	Processing Technology of Legumes and Oilseeds	3 (2+1)
3	FT-211	Food Biochemistry and Nutrition	4 (3+1)
4	FT-212	Unit Operations in Food Processing-II	4 (3+1)
5	FT-213	Food Biotechnology	3 (2+1)
6	FT-214	Food Refrigeration and Cold Chain	4 (3+1)
7	FT-215	Processing of Spices and Plantation Crops	3 (2+1)
8	BM-201	Business Management and Economics	2 (2+0)
			Total 26 (19+7)

FT-209

Processing Technology of Dairy Products

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To introduce the students to dairy industry, properties and processing of milk, manufacture of dairy products, sanitation and effluent treatment in dairy industry

Details of course:

S. No.	Particulars	Lectures
1	Classification of dairy products; Butter: Definition, composition; processing and production steps, overrun, butter making machines, quality testing of table butter, butter-defects, causes and their prevention, packaging and storage.	5
2	Butter oil and ghee: Definition, composition, processing, equipment, quality tests; Paneer and Cheese: Definition, composition, types, processing steps, process flow diagram, equipment, quality defects, causes and prevention, packaging and storage.	5
3	Ice cream and frozen desserts: Definition, composition, types, processing steps and flow diagram, equipment, quality testing, defects cause and prevention, packaging and storage.	5
4	Condensed and Dried milk: Definition, composition, role of milk constituents in condensed milk, manufacture of condensed milk, types of standards for dried milk, manufacture of SMP and WMP using roller and spray drying, instantization, recent developments in drying, quality testing, defects, causes and prevention, packaging and storage.	8
5	Traditional Indian Dairy Products: Definitions, compositions, processing, packaging, storage, equipment and quality testing; By- products of dairy industry and their utilization.	5

S. No.	Practicals	No. of practicals
1	Preparation of butter/ table butter, ghee and paneer.	3
2	Preparation of selected type of cheese; Preparation of ice-cream and selected frozen desserts.	3
3	Preparation of condensed milk; Preparation of milk powder; Preparation of selected Indian dairy products.	4
4	Determination of selected quality parameters of selected dairy products; Visit to dairy plant.	4

Recommended Books

1. Kanekanian. 2014. Milk and Dairy Products as Functional Foods. John Wiley & Sons, Ltd., UK.
2. Adnan Y. Tamime. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.
3. Pieter Walstra, Jan T.M. Wouters, Tom J. Geurts. 2006. Dairy Science and Technology, 2nd Ed. CRC Press, Boca Raton, FL, USA.
4. Sukumar De. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.
5. H.G. Kessler. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising (F.R. Germany).
6. Y.H. Hui. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.
7. Aneja, R. P.; Mathur, B. N.; Chandan, R. C.; Banerjee, A. K., 2002, Technology of Indian Milk Products: Handbook of Procees Technology Modernization for Professionals Entrepreneurs and Scientists, Dairy India Yearbook

FT-210

Processing Technology of Legumes and Oilseeds

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: The course aims to develop the knowledge of students in the area of pulse and oil seed processing and technology. This is necessary for effective understanding and specific aspects of food processing related to these foods. This course will enable students to appreciate the application of scientific principles in the processing of these materials.

Details of course:

S. No.	Particulars	lectures
1	Present status and future prospects of legumes and oilseeds; Morphology of legumes and oilseeds; Classification and types of legumes and oilseeds; Chemical composition, nutritional value and anti-nutritional compounds in legumes and oilseeds; Methods of removal of antinutritional compounds;	7
2	Pulse milling: Home scale, cottage scale and modern milling methods, machines, milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in dhal milling industry; Nutritional changes during soaking and sprouting of pulses; Cooking quality of dhal, methods, factors affecting cooking of dhal; Quick cooking dhal, instant dhal; Soybean milk processing and value addition; Fermented products of legumes;	8
3	Oil seed milling: Ghanis, hydraulic presses, expellers, solvent extraction methods, machines, milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in oil milling industry; Desolventization;	5
4	Refining of oils: Degumming, neutralization, bleaching, filtration, deodorization, their principles and process controls; Hydrogenation of oils; New technologies in oilseed processing;	4
5	Utilization of oil seed meals for different food uses: High protein products like protein concentrates and isolates; By-products of pulse and oil milling and their value addition.	4

S. No.	Practicals	No. of practicals
1	Determination of physical properties of legumes and oil seeds.	1
2	Determination of proximate composition of selected pulses and oilseeds.	1
3	Determination of nutritional quality of selected pulses and oilseeds; Study of mini dhal mill and mini oil mill.	2
4	Preconditioning of pulses before milling; Preconditioning of oilseeds before milling.	2
5	Removal of anti-nutritional compounds from selected pulses and oilseeds; Laboratory milling of selected pulses and its quality evaluation.	2
6	Laboratory milling of selected oilseeds and its quality evaluation.	2
7	Laboratory refining of selected oils; Laboratory hydrogenation of selected oils; Study of cooking quality of dhal.	2

8	Processing of composite legume mix and preparation of value-added products; Visit to commercial dhal mills and oil mills.	2

Recommended Books

1. Guriqbal Singh, Harbhajan Singh Sekhon, Jaspinder Singh Kolar and Masood Ali. 2005. Pulses. Agrotech Publishing Academy, Udaipur.
2. A. Chakraverty. 2008. Post-Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Frank D. Gunstone. 2008. Oils and Fats in the Food Industry. John Wiley and Sons, Ltd., West Sussex, UK.
4. Fereidoon Shahidi. 2005. Bailey's Industrial Oil & Fat Products, 6th Ed., Vols. 1 to 6. John Wiley and Sons, Inc. Hoboken, New Jersey, USA.
5. Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
6. K.M. Sahay and K.K. Singh. 2001. Unit Operations of Agricultural Processing, 2nd Ed. Vikas Publishing House Pvt. Ltd., Noida.

FT-211

Food Biochemistry and Nutrition

Credits: 3 + 1
Contact hours: 42 + 28

Mid-session exam: 30 (25+5#)
Practical exam: 25
End-semester exam: 45

Objective: To enable students learn the fundamentals of biomolecules such as lipids, nucleic acids, enzymes, proteins, vitamins, hormones and their metabolism.

Details of Course:

S. No.	Particulars	Lectures
1	Biochemistry and its scope, cellular biochemistry; Carbohydrates: Occurrence, classification and structures, physicochemical and metabolic functions, metabolism; Proteins: Occurrence, classification and structures, physicochemical and metabolic functions, metabolism.	6
2	Lipids: Occurrence, classification and structure, physicochemical and metabolic functions, metabolism; Nucleic acids: Properties, structure and metabolism; Vitamins and minerals: Chemistry and metabolic functions; Enzymes: Chemical nature and nomenclature, classification, sources and properties, mechanism of action, coenzyme and prosthetic groups.	6
3	Concepts and content of nutrition: metabolic function of nutrients; Water and energy balance, water intake and losses, basal metabolism; Formulation of diets, classification of balanced diet, preparation of balanced diet for various groups; Recommended dietary allowances for various age groups; Malnutrition; Assessment of nutritional status; Food fad and faddism; Potentially toxic substance in human food; Functions of food; Basic food groups; nutrients supplied by food.	8
4	Mechanism of enzyme action: Introduction to enzymes, coenzymes, regulation of enzymatic activity, enzyme kinetics, inhibition effects of pH, allosteric enzymes, derivation of Michaelis-Menten equation; Nucleic acids; Nutrients: Sources, functions, digestion, absorption, assimilation and transport of carbohydrates, proteins and fats in human beings; Metabolism of carbohydrates: Biological role of carbohydrates, glycolysis and respiration, production of ATP, brief description of electron transport chain, oxidative and substrate phosphorylation.	8
5	Metabolism of lipids: Biological role of lipids, breakdown of triglycerides and phospholipids, β-oxidation of long chain fatty acids, ketosis, biosynthesis of fatty acids, triglycerides and phospholipids; Metabolism of proteins: Breakdown of proteins, transamination, deamination, decarboxylation, nitrogen fixation, urea cycle; Minerals: Functions, sources, factors affecting absorption of minerals, absorption promoters, absorption inhibitors, effect of deficiency.	7
6	Vitamins and hormones: Classification, functions, sources, effects of deficiency, fat soluble vitamins, water soluble vitamin; Relationship between vitamins and hormones in terms of their biological role; Physico-chemical and nutritional changes during processing: Changes during food processing treatment of drying and dehydration, irradiation, freezing, fermentation, canning, restoration, enrichment, fortification and supplementation of foods.	7

Practicals:

S. No.	Practicals	No. of practicals
1	Preparation of various solutions and buffers; Qualitative and quantitative determination of carbohydrates, amino acids, proteins, lipids and vitamins.	2
2	Isolation of enzymes from various sources; Measurement of energy using bomb calorimeter; Determination of pka of acid; Determination of pI for casein.	3
3	Estimation of sugars by Anthrone method; Estimation of protein by Lowry method; Estimation of amino acid using Biuret reaction.	2
4	Separation of amino acids using paper chromatography; Separation of amino acids using thin layer chromatography; Separation of amino acids using electrophoresis.	3
5	Estimation of phosphorus in food sample. Estimation of iron content in foods; Determination of calcium in food samples.	2
6	Estimation of β-carotene using column chromatography; Estimation of ascorbic acid using dye method; Effects of acids and alkali on pigments.	2

Recommended Books

1. Gaile Moe, Danita Kelley, Jacqueline Berning and Carol Byrd-Bredbenner. 2013. Wardlaw's Perspectives in Nutrition: A Functional Approach. McGraw-Hill, Inc., NY, USA.
2. David L. Nelson and Michael M. Cox. 2012. Lehninger Principles of Biochemisry, 6th Ed. Macmillan Learning, NY, USA.
3. Donald Voet and Judith G. Voet. 2011. Biochemisry, 4th Ed. John Wiley and Sons, Inc., NY, USA.
4. Carolyn D. Berdanier, Elaine B. Feldman and Johanna Dwyer. 2008. Handbook of Nutrition and Food, 2nd Ed. CRC Press, Boca Raton, FL, USA.
5. Bob B. Buchanan, Wilhelm Gruissem and Russell L. Jones. 2002. Biochemistry & Molecular Biology of Plants. John Wiley and Sons, Inc., NY, USA.
6. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer and Gregory J. Gatto, Jr. 2002. Biochemisry, 7th Ed. W.H. Freeman and Company, NY, USA.

FT-212

Unit Operations in Food Processing-II

Credits: 3 + 1
Contact hours: 42 + 28

Mid-session exam: 30 (25+5#)
Practical exam: 25
End-semester exam: 45

Objective: To understand the principals involved in various processing methods like heating, evaporation, food freezing, roasting and sterilization.

Details of Course:

S. No.	Particulars	Lectures
1	Evaporation: Principles of evaporation, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot; Heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient, influence of feed liquor properties on evaporation.	6
2	Evaporation equipment: Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation; Evaporator ancillary plant, design of evaporation systems, single effect, multiple effect evaporators, feeding methods of multiple effect evaporation systems, feed preheating, vapour recompression systems; Fouling of evaporators and heat exchanges; Recompression heat and mass recovery and vacuum creating devices.	8
3	Food freezing: Introduction, freezing point curve for food and water, freezing points of common food materials, Principles of food freezing, freezing time calculation by using Plank's equation; Freezing systems; Direct contact systems, air blast immersion; Changes in foods; Frozen food properties; freezing time, factors influencing freezing time, freezing/thawing time; Freeze concentration: Principles, process, methods; Frozen food storage: Quality changes in foods during frozen storage; Freeze drying: Heat mass transfer during freeze drying, equipment and practice.	9
4	Expression and Extraction: liquid-liquid extraction processes, types of equipment and design for liquid-liquid extraction, continuous multistage counter current extraction; Leaching: process, preparation of solids, rate of leaching, types of equipment, equilibrium relations; Crystallization and dissolution: Theory and principles, kinetics, applications in food industry, equipment for crystallization; Distillation: Principles, vapour-liquid equilibrium, continuous flow distillation, batch/differential distillation, fractional distillation, steam distillation, distillation of wines and spirits; Baking: Principles, baked foods, baking equipment.	9
5	Roasting: Principles of roasting, roasting equipment; Frying: theory and principles, shallow or contact frying and deep fat frying, heat and mass transfer in frying, frying equipment; Puffing: Puffing methods, puffing equipment; Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences, methods of heating, design and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger.	5
6	Sterilization: Principles, process time, T-evaluation, design of batch and continuous sterilization, different methods and equipments; UHT sterilization, in the package sterilization, temperature and pressure patterns, equipment for	5

	sterilizing goods in the package; Aseptic processing: principles, analysis of thermal resilience, duration mathematics of conduction heating; Blanching: principle and equipment; Homogenization, Emulsification.	

Practicals:

S. No.	Practicals	No. of practicals
1	Study of working principle open pan and vacuum evaporator; Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods.	2
2	Study of multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of sterilizer.	3
3	Design problems on freezers; Numerical problem on thermo bacteriology (D, Z and F); Study of freezers; Freezing of foods by different methods; Determination of freezing time of a food material.	3
4	Effect of sample particle size and time on solvent extraction process; Effect of temperature on crystallization rate of sugar.	2
5	Study of blancher, pasteurizers, fryers, homogenizers, irradiators.	2
6	Determination of oil uptake by the food product during frying; Study on qualitative changes in the fried food product; Visit sugar processing industry.	2

Recommended Books

1. R. Paul Singh and Dennis R. Heldman. 2014. Introduction to Food Engineering, 5th Ed. Elsevier, Amsterdam, The Netherlands.
2. Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.
3. Albert Ibarz and Gustavo V. Barbosa-Cánovas. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.
4. Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
5. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
6. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed. Butterworth–Heinemann, Oxford, UK.
7. P. Fellows. 2000. Food Processing Technology: Principles and Practice, 2nd Ed. CRC Press, Boca Raton, FL, USA.
8. R. K. Sinnott. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd Ed. Butterworth-Heinemann, Oxford, UK.
9. Kenneth J. Valentas, Enrique Rotstein and R. Paul Singh. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.
10. Robert E. Treybal. 1980. Mass Transfer Operations, 3rd Ed. McGraw-Hill Book Company, Auckland, USA.

FT-213

Food Biotechnology

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To explore students about various types of biomolecules, their structure, functions and metabolism with basic concepts and techniques in plant biotechnology.

Details of course:

S. No.	Particulars	Lectures
1	Chemical nature of the genetic material, properties and functions of the genetic material, organization of the genetic material in bacteria, eukaryotes and viruses; DNA replication: Replication fork, DNA polymerases, other enzymes and proteins required for DNA replication, origin of replication, replication of circular DNA molecule.	5
2	Transcription and translation: RNA synthesis, types of RNA, genetic code; Mutation and DNA repair, mechanisms of repair of damaged DNA (photo reactivation, excision repair, recombination repair, SOS repair, mismatch repair), transposable elements, plasmids, types of plasmids, genetic recombination in bacteria, transformation, transduction, conjugation, regulation of gene expression in prokaryotes; Expression of foreign genes; Promoter enzymes.	5
3	Recombinant DNA technology: Restriction enzymes, cloning vectors, cloning procedure, cloning of specific gene and their identification (colony hybridization, C-DNA, southern blotting, polymerase chain reaction); Gene cloning: Production of identical cells, isolation and purification of insert DNA, isolation of vector DNA, construction of recombined DNA, introduction of recombined DNA into host cell, identification and selection of cells containing cloned genes.	7
4	Biosensors: Classification, application in food industry; Application of biotechnology in food: Immobilization of enzymes: Arresting of cell in insoluble matrix, immobilized cell systems, cell attachment in a surface, aggregation, entrapment, containment, physical adsorption, covalent bonding, cross linking, entrapment into polymeric films, microencapsulation, large scale cell immobilization, uses and applications in industries.	6
5	Ethical issues concerning GM foods: Testing for GMOs, current guidelines for production, release and movement of GMOs, labeling and traceability, trade related aspects, bio-safety, risk assessment, risk management, public perception of GM foods, IPR, GMO Act 2004.	5

Practicals:

S. No.	Practicals	No. of practicals
1	Study of auxotroph; Micro-propagation through tissue culture; Strain improvement through U.V. mutation for lactose utilization.	3
2	Chemical mutagenesis using chemical mutagens (Ethidium bromide); Determination of survival curves using physical and chemical mutagens; Isolation and analysis of chromosomal/genomic DNA from E. coli and Bacillus cereus.	4
3	Separation of protoplast using cellulytic enzymes; Production of biomass from fruit and vegetable waste.	3
4	Introduction of ELISA/Southern blot/DNA finger printing, etc.; Agarose gel electrophoresis of plasmid DNA; Pesticide degradation by pseudomonas spp.	4

Recommended Books

1. B.D. Singh. 2014. Biotechnology - Expanding Horizons. Kalyani Publishers, New Delhi.
2. Meenakshi Paul. 2007. Biotechnology and Food Processing Mechanics. Gene-Tech Books, New Delhi.
3. James D. Watson. 2013. Molecular Biology of the Gene, 7th Ed. Benjamin Cummings, San Francisco, USA.
4. Oliver Brandenberg, Zephaniah Dhlamini, Alessandra Sensi, Kakoli Ghosh and Andrea Sonnino 2011. Introduction to Molecular Biology and Genetic Engineering. FAO, Rome, Italy.
5. S.B. Primrose and R.M. Twyman. 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing, Victoria, Australia.
6. Ashok Agarwal and Pradeep Parihar. 2005. Industrial Microbiology: Fundamentals and Applications. Agrobios India, Jodhpur.

FT-214

Food Refrigeration and Cold Chain

Credits: 3 + 1
Contact hours: 42 + 28

Mid-session exam: 30 (25+5#)
Practical exam: 25
End-semester exam: 45

Objective: To understand the underlying principles of operation in different Refrigeration & cold storage systems and its components and to provide knowledge on design aspects of cold storage systems.

Details of Course:

S. No.	Particulars	Lectures
1	Principles of refrigeration: Definition, background with second law of thermodynamics, unit of refrigerating capacity, coefficient of performance; Production of low temperatures: Expansion of a liquid with flashing, thermoelectric cooling; Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures; Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression.	9
2	Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry Vs wet compression, throttling Vs isentropic expansion), representation of vapor compression cycle on pressure- enthalpy diagram, super heating, sub cooling; Liquid-vapour regenerative heat exchanger for vapour compression system, effect of suction vapour super heat and liquid sub cooling, actual vapour compression cycle.	8
3	Vapour-absorption refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated refrigerating machine, Common refrigerants and their properties: classification, nomenclature, desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical; Azeotropes; Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve; Ice manufacture, principles and systems of ice production, Treatment of water for making ice, freezing tanks, ice cans, air agitation, quality of ice.	9
4	Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, interior finish and fitting, evaporators, automated cold stores, security of operations; Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans, refrigerated display;	8
5	Airconditioning: Meaning, factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning, problems on sensible heat factor; Winter/summer/year round air-conditioning, unitary air-conditioning systems, central air-conditioning, air distribution and duct design methods; design of complete air-conditioning systems; humidifiers and dehumidifiers; Cooling load calculations: Load sources product cooling,	8

	conducted heat, convected heat, internal heat sources, heat of respiration, peak load; etc.	

Practicals:

S. No.	Practicals	No. of practicals
1	To study vapour compression refrigeration system	2
2	Solving problems on cooling load calculations / Refrigeration load.	2
3	To study the properties and performance characteristics of some commonly used refrigerants	2
4	To study the components of the refrigeration system	2
5	Freezing of foods by different methods	2
6	Determination of freezing time of a food material	2
7	Study of refrigerated van; Study of deep freezing and thawing of foods; Study of refrigerated display of foods and estimation of cooling load.	2

Recommended Books

1. Refrigeration & Air Conditioning- R.C. Jordan and G.B. Priester, Prentice Hall of India.
2. Refrigeration & Air Conditioning-C.P.Arora, Tata-McGraw Hill, New Delhi.
3. Raymond R.Gunther: Refrigeration, Air conditioning and Cold Storage Chilten Company, Philadelphia, USA 1957
4. A course in Refrigeration & Air Conditioning – Arora & Domukundwar, Dhanpat Rai & Sons,1989.
5. Refrigeration & Air Conditioning- W.F. Stockerand J.W. Jones, Tata-McGraw Hill,New Delhi
6. Refrigeration & Air Conditioning- Manohar Parsad Wiley Estern limited, New Delhi.
7. R.Hollowell: Cold Storage and Freezer Storage Manual AVI Publishing Co. (1980)

FT-215

Processing of Spices and Plantation Crops

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To enable the students to understand about processing techniques of spices, instant coffee, and quality grading. Different types of tea and its manufacturing techniques, instant tea, quality parameters of tea, Cocoa and its processing, chocolate manufacturing technology.

Details of course:

S. No.	Particulars	Lectures
1	Production and processing scenario of spice, flavour and plantation crops and its scope; Major spices: Post harvest technology, composition; processed products of spices: Ginger, chilli, turmeric, onion and garlic, pepper, cardamom.	7
2	Minor spices: Herbs, leaves and Spartan seasonings and their processing and utilization; All spice, Annie seed, sweet basil; Caraway seed, cassia, cinnamon; Clove, coriander, cumin, dill seed; Fennel seed, nutmeg, mace, mint marjoram. Rosemary, saffron, sage; Savory, thyme, ajowan; Asafetida, curry leaves.	8
3	Post-harvest technology for Tea, coffee, cocoa; Vanilla and annatto processing; Post harvest technology and processing of areca nut, cashew nut, oil palm; Flavours of minor spices; Flavour of major spices.	6
4	Spice oil and oleoresins: Extraction techniques; Standard specification of spices; Functional packaging of spices and spice products; By-products of plantation crops and spices.	7

S. No.	Practicals	No. of practicals
1	Identification and characterization of flavouring compounds of spices.	2
2	Valuable oil determination; Extraction of oil from clove, pepper, cardamom, chilli.	3
3	Extraction of oleoresins: Turmeric, ginger, pepper, clove; Peperine estimation in pepper oleoresin; Steam distillation of spices.	3
4	Determination of curcumin content in turmeric; Chemical analysis of spices: Moisture, valuable oil, specific gravity, refractive index, acid value.	3
5	Study of standard specification of spices; Packaging study of spices; Preparation of curry powder; Visit to spice industry.	3

Recommended Books

1. K.G. Shanmugavelu. Spices and Plantation Crops. Oxford & IBH Publishing Co., New Delhi
2. J.W. Purseglave, E.G. Brown, C.L. Green and Robins. Spices,Vol. I and II. SRJ Academic Press, New Delhi.
3. J.S. Pruthi. 2001. Spices and Condiments – Major Spices of India. National Book Trust, New Delhi.
4. Kenji Hirasa and Mitsuo Takemasa. 1998. Spice Science and Technology. Marcel Dekker, NY, USA.
5. yy H. Panda. Handbook on Spices and Condiments (Cultivation, Processing and Extraction). Asia Pacific Business Press Inc., New Delhi.
6. S. Gupta. Handbook of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.

BM-201
Business Management and Economics

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To provide knowledge regarding entrepreneurship, developing organizational skills, troubleshooting and entrepreneurship.

Details of Course:

S. No.	Particulars	Lectures
1	Definitions, management principles, scientific principles, administrative principles; Maslow's Hierarchy of needs theory; Functions of management: Planning, organizing, staffing, directing, controlling; Organizational structures, principles of organization;	6
2	Types of organization: Formal and informal, line, line and staff, matrix, hybrid; Introduction to economics: Definitions, nature, scope, difference between microeconomics and macroeconomics; Theory of demand and supply, elasticity of demand, price and income elasticity;	5
3	Markets: Types of markets and their characteristics; National income: GDP, GNP, NNP, disposable personal income, per capita income, inflation; Theory of production: Production function, factors of production. Law of variable proportions and law of returns to scale;	6
4	Cost: Short run and long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost; Break even analysis; Finance management: Definition, scope, objective; Different systems of accounting: Financial accounting, cost accounting, management accounting;	6
5	Human resource management: Definitions, objectives of manpower planning, process, sources of recruitment, process of selection; Corporate social responsibility: Importance, business ethics.	5

Recommended Books

1. L.M. Prasad. 2001. Principles and Practices of Management, 9th Ed. S. Chand & Sons, New Delhi.
2. Koontz Harold. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi.
3. P.C. Thomas. Managerial Economics, 9th Ed. Kalyani Publishers.
4. K.K. Dewett and M.H. Navalur. Modern Economic Theory. S. Chand & Sons, New Delhi.
5. P. Subba Rao. Human Resource Management. Himalaya Publications.
6. S.P. Jain. Financial Accounting. Kalyani Publications, Ludhiana.

Courses offered in Semester – V			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	FT-301	Processing Technology of Fruits and Vegetables	3 (2+1)
2	FT-302	Processing of Meat and Poultry Products	3 (2+1)
3	FT-303	Instrumental Techniques in Food Analysis	4 (3+1)
4	FT-304	ICT Applications in Food Industry	3 (2+1)
5	FT-305	Food Process Equipment Design	3 (2+1)
6	FT-306	Food Storage Engineering	3 (2+1)
7	FT-307	Bakery, Confectionery and Snack Products	3 (2+1)
8	BM-301	Marketing Management and International Trade	2 (2+0)
			Total 24 (17+7)

FT-301

Processing Technology of Fruits and Vegetables

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with the processing and preservation of fruits and vegetables and the design features of the equipment used for their processing.

Details of course:

S. No.	Particulars	Lectures
1	Production and processing scenario of fruits and vegetables in India and world; Scope of fruit and vegetable processing industry in India; Overview of principles and preservation methods of fruits and vegetables; Supply chain of fresh fruits and vegetables;	6
2	Primary processing and pack house handling of fruits and vegetables; Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables; Minimal processing of fruits and vegetables; Blanching operations and equipment;	5
3	Canning: Definition, processing steps, and equipment, cans and containers, quality assurance and defects in canned products; FSSAI specifications and preparation and preservation of juices, squashes, syrups, sherbets, nectars, cordials, etc.;	5
4	Processing and equipment for above products; FSSAI specifications; Preparation, preservation and machines for manufacture of crystallized fruits and preserves, jam, jelly and marmalades, candies,	5
5	Preparation, preservation and machines for manufacture of chutney, pickles, sauce, puree, paste, ketchup; toffee, cheese, lather, dehydrated, wafers and papads, soup powders; Production of pectin and vinegar; Commercial processing technology of selected fruits and vegetables for production of various value added processed products.	7

Practicals:

S. No.	Practicals	No. of practicals
1	Primary processing of selected fruits and vegetables; Canning of Mango/Guava/ Papaya.	2
2	Preparation of jam and jelly from selected fruits; Preparation of fruit marmalade; Preparation of RTS; Preparation of squash and syrup.	3
3	Preparation of raisins, dried fig and dried banana; Preparation of anardana; Preparation of papain.	3
4	Preparation of pickles; Preparation of dried ginger; Preparation of dried onion and garlic; Preparation of banana and potato wafers.	3
5	Preparation of dehydrated leafy vegetables; Visit to fruits and vegetables pack house, canning plant, vegetable dehydration plant.	3

Recommended Books

1. U.D. Chavan and J.V. Patil. 2013. Industrial Processing of Fruits and Vegetables. Astral International Pvt. Ltd., New Delhi.
2. S. Rajarathnam and R.S. Ramteke. 2011. Advances in Preservation and Processing Technologies of Fruits and Vegetables. New India Publishing Agency, New Delhi.
3. Y.H. Hui. 2006. Handbook of Fruits and Fruit Processing. Blackwell Publishing Ltd., Oxford, UK.
4. W.V. Cruess. 2004. Commercial Fruit and Vegetable Products. Agrobios India, Jodhpur.
5. Y. H. Hui, Sue Chazala, Dee M. Graham, K.D. Murrell and Wai-Kit Nip. 2004. Handbook of Vegetable Preservation and Processing. Marcel Dekker, Inc., NY, USA.
6. A.K. Thompson. 2003. Fruit and Vegetables: Harvest, Handling and Storage, 2nd Ed. Blackwell Publishing Ltd., Oxford, UK.
7. Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
8. R.P. Srivastava and Sanjeev Kumar. 2002. Fruit & Vegetable Preservation: Principles and Practices, 3rd Ed. International Book Distribution Co., Delhi.
9. P.H. Pandey. 1997. Post Harvest Technology of Fruits and Vegetables. Saroj Prakashan, Allahabad.
10. Mircea Enachescu Dauthy. 1995. Fruit and Vegetable Processing. FAO Agricultural Services Bulletin No.119. FAO of UN, Rome.
11. Girdhari Lal, G.S. Siddappa and G.L. Tandon. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.
12. EIRI Board of Consultants and Engineers. Manufacture of Snacks, Namkeen, Papads and Potato Products. EIRI, New Delhi.

FT-302

Processing of Meat and Poultry Products

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with processing of meat, fish and poultry and the design features of the equipment used for their processing.

Details of course:

S. No.	Particulars	Lectures
1	Sources and importance of meat and poultry; Status of Meat and poultry industry in India; Preslaughter operations and slaughtering operations for animals and poultry; Evaluation of animal carcasses; Factors affecting post-mortem changes, properties and shelf life of meat; Mechanical deboning, grading and aging; Eating and cooking quality of meat.	8
2	Preservation of meat by chilling, freezing, pickling, curing, cooking and smoking, dehydration, radiation, chemical and biological preservatives; Meat tenderization; Meat emulsions; Meat cutting and handling; Preparation, preservation and equipment for manufacture of smoked meat and its quality evaluation.	7
3	Preparation, packaging and equipment for manufacture of dehydrated meat products and their quality evaluation; Preparation, preservation and equipment for manufacture of meat sausages and their quality evaluation; Abattoir design and layout.	6
4	Eggs: Structure, composition, quality characteristics, processing, preservation of eggs; Processing and preservation of poultry meat and chicken patties; Meat plant sanitation and safety; By-products of meat, poultry and eggs and their utilization; Safety standards in meat industry: HACCP/ISO/MFPO/FSSAI/Kosher/Halal.	7

S. No.	Practicals	No. of practicals
1	Pre-slaughter operations of meat animals and poultry birds; Slaughtering and dressing of meat animals;	3
2	Study of post-mortem changes; Meat cutting and handling; Preservation of meat by freezing;	3
3	Preservation of meat by curing and pickling; Preservation of meat by dehydration;	3
4	Evaluation of quality and grading of eggs;	2
5	Preservation of shell eggs; Preparation of value-added poultry meat products; Value added egg products; Visit to abattoir.	3

Recommended Books

1. Vikas Nanda. 2014. Meat, Egg and Poultry Science & Technology. I.K. International Publishing House Pvt. Ltd., New Delhi.
2. B.D. Sharma and Kinshuki Sharma. 2011. Outlines of Meat Science and Technology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.

3. Fidel Toldrá, Y. H. Hui, Iciar Astiasarán, Wai-Kit Nip, Joseph G. Sebranek, Expedito-Tadeu F. Silveira, Louise H. Stahnke, Régine Talon. 2007. Handbook of Fermented Meat and Poultry. Blackwell Publishing Professional, Ames, Iowa, USA.
4. Joseph Kerry, John Kerry and David Ledward. 2005. Meat Processing-Improving Quality. Woodhead Publishing Ltd., Cambridge, England.
5. NIIR Board of Consultants & Engineers. 2005. Preservation of Meat and Poultry. Asia Pacific Business Press, Inc., Delhi.
6. Howard J. Swatland. 2004. Meat Cuts and Muscle Foods, 2nd Ed. Nottingham Univ. Press, Nottingham.
7. B.D. Sharma. 2003. Modern Abattoir Practices and Animal Byproducts Technology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
8. B.D. Sharma. 1999. Meat and Meat Products Technology Including Poultry Products Technology. Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi.
9. Alan H. Varnam and Jane P. Sutherland. 1995. Meat and Meat Products: Technology, Chemistry and Microbiology. Chapman & Hall, London.
10. William J. Stadelman and Owen J. Cotterill. 1995. Egg Science and Technology, 4th Ed. Food Products Press, NY, USA.
11. R.A. Lawrie. 1985. Meat Science, 4th Ed. Pergamon Press, Oxford, UK.

FT-303

Instrumental Techniques in Food Analysis

Credits: 3 + 1
Contact hours: 42 + 28

Mid-session exam: 30 (25+5#)
Practical exam: 25
End-semester exam: 45

Objective: To acquaint the students with the basic principles of analytical techniques and highlight the application of advance analytical techniques used for analysis of various food products.

Details of Course:

S. No.	Particulars	Lectures
1	Concepts of food analysis; Rules and regulations of food analysis; Principles and methodology involved in analysis of foods: Rheological analysis, textural profile analysis of foods; Methods of analysis: Proximate constituents, moisture, adulterations, minerals analysis; Principles and methodology involved in analytical techniques: ion selective electrodes, spectroscopy, ultraviolet visible, florescence, infrared spectro-, atomic absorption and emission, mass spectroscopy, nuclear magnetic resonance and electron spin resonance.	9
2	Chromatography: Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method, gas-liquid, high performance liquid chromatography; Separation techniques: Dialysis, electrophoresis, sedimentation, ultrafiltration, ultracentrifugation, iso-electric focusing, isotopic techniques, manometric techniques; Immuno assay techniques in food analysis.	7
3	Instrumentation and sensors for the food industry; Food compositional analysis using near infra-red absorption technology: Principles of measurement, instrumentation, applications in the food industry, power of process monitoring and trending, practical considerations for implementing on-line measurement, practical aspects of infra-red remote thermometry, radiation thermometers, measurement principles, practical situations, miscellaneous techniques; In-line and off-line FTIR measurements, food applications, calibration and general aspects of routine use.	10
4	Rapid microbiological methods: Overview, Conductance/impedance techniques for microbial assay; chemosensors, biosensors, immunosensors; Electronic noses and tongues: Sensors for food flavour and freshness, electronic noses, tongues and testers; Introduction to flavour assessment, modelling the human nose, electronic nose, electronic tongue, marker chemical approach.	8
5	Chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, ions, gases and volatiles, amperometric, potentiometric and thermometric biosensors; Acoustic sensors, optical immunosensors; Fluorescence sensor systems; Novel sensing receptors, sensor arrays, commercial biosensors.	8

Practicals:

S. No.	Practicals	No. of practicals
1	Sampling plan; Sample collection and preparation for analysis; Sensory evaluation of products.	2
2	Quality evaluation of raw materials: Fruits, vegetables, cereals, dairy products, meat, poultry products; Quality evaluation of food products for color and taste of marketed products.	2
3	Analysis of heavy metals using atomic absorption spectrophotometer; Estimation of physic acid using spectrophotometer.	2
4	Separation of amino acids by two-dimensional paper chromatography; Identification of sugars in fruit juice using TLC; Separation of pralines by ionexchange chromatography; Molecular weight determination using sephadox-gel.	3
5	Identification of organic acids by paper electrophoresis; Gel-electrophoresis for analytic techniques; Quantitative determination of sugars and fatty acid profile by GLE; Quantitative make-up of water and fat-soluble vitamins using HPLC.	3
6	Separation of sugars by paper chromatography; Analysis of wheat flour; Analysis of foods for pesticide and drug residues; Study of colorimetry and spectrophotometry; Spectrophotometric method of total chlorophyll (A & B).	2

Recommended Books

1. S. Suzanne Nieisen. 2010. Food Analysis Laboratory Manual, 2nd Ed. Springer, NY, USA.
2. Semih Ötles. 2009. Handbook of Food Analysis Instruments. CRC Press, Boca Raton, FL, USA.
3. Da-Wen Sun. 2008. Modern Techniques for Food Authentication. Elsevier Inc., Burlington, MA, USA.
4. S. Suzanne Nieisen. 2003. Food Analysis, 3rd Ed. Kluwer Academic, New York, USA.

FT-304

ICT Applications in Food Industry

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with fundamentals of computer, operating system, provide the knowledge about windows operations, MS-office, robotics technology and their applications in food industry.

Details of course:

S. No.	Particulars	Lectures
1	Importance of computerization in food industry, operating environments and information systems for various types of food industries, Supervisory control and data acquisition (SCADA); SCADA systems hardware, firmware, software and protocols, Spreadsheet applications: Data interpretation and solving problems, preparation of charts, use of add-ins, use of solver.	7
2	Introduction to MATLAB, Basic commands, computing with MATLAB, matrix operations, user defined functions, Plotting and model building in MATLAB, Plotting functions, toolboxes useful to food industry, image processing toolbox, statistical toolbox.	7
3	Concept of automation in Food industry, mechanization and automation, classification of automation systems. Difference between hard automation and robotic automation, Conveyer system: definition, types, and components; Introduction to robot technology- robot physical configuration and basic robot motions.	7
4	Introduction to computational fluid dynamics (CFD), governing equations of fluid dynamics; Models of flow, continuity, momentum and energy equations; Physical boundary conditions, Applications of CFD in food and beverage industry; Introduction to CFD software, LabVIEW and FLUENT software.	7

Practicals:

S. No.	Practicals	No. of practicals
1	Introduction to various features in spreadsheet; Solving problems using functions in spreadsheets; Use of Add-Ins in spread sheet and statistical data analysis using Analysis Tool pack.	3
2	Solution of problems on regression analysis using Analysis Tool pack in spreadsheet; Solution of problems on optimization using solver package in spreadsheet.	2
3	Introduction to MATLAB; Writing code using MATLAB programming; Solution of problems using Curve Fitting Toolbox in MATLAB; Solution of problems using Fuzzy Logic Toolbox in MATLAB.	3
4	Solution of problems using Neural Network Toolbox in MATLAB; Solution of problems using Image Processing Toolbox in MATLAB; Introduction to GAMBIT software.	2
5	Creation of geometry for laminar flow through pipe using GAMBIT.	2

6	Introduction to FLUENT software; Import of geometry and application of boundary conditions; Solution of problems on laminar flow using FLUENT; Introduction to LabVIEW and NI-DAQ.	2

Recommended Books

1. R. Paul Singh. 2014. Computer Applications in Food Technology: Use of Spreadsheets in Graphical, Statistical and Process Analysis. Academic Press, London.
2. William J. Palm III. 2011. Introduction to MATLAB for Engineers, 3rd Ed. McGraw-Hill Companies, Inc., NY, USA.
3. Da-Wen Sun. 2007. Computational Fluid Dynamics in Food Processing. CRC Press, Boca Raton, FL, USA.
4. Nigel Chapman and Jenny Chapman. 2006. Web Design: A Complete Introduction. John Wiley & Sons, USA.
5. National Instruments Corporation. 2005. Introduction to LabVIEW: 3-Hour Hands-On. NI, Austin, Texas.
6. David Bailey and Edwin Wright. 2003. Practical SCADA for Industry. Elsevier, Burlington, MA

FT-305
Food Process Equipment Design

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with construction requirements, process design, fabrication and installation of equipment and enhance the knowledge in the design of food processing equipment.

Details of course:

S. No.	Particulars	Lectures
1	Materials and properties: Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes; Design considerations: Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations.	6
2	Design of pressure and storage vessels: Operating conditions, design conditions and stress; Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories; Design of heat exchangers: Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, sterilizer and retort; Design of evaporators and crystallizers: Design of single effect and multiple effect evaporators and its components; Design of rising film and falling film evaporators and feeding arrangements for evaporators; Design of crystallizer and entrainment separator.	7
3	Design of agitators and separators: Design of agitators and baffles; Design of agitation system components and drive for agitation; Design of centrifuge separator; Design of equipment components, design of shafts, pulleys, bearings, belts, springs, drives, speed reduction systems; Design of freezing equipment: Design of ice-ream freezers and refrigerated display system.	5
4	Design of dryers: Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer; Design of conveyors and elevators: Design of belt, chain and screw conveyor, design of bucket elevator and pneumatic conveyor.	5
5	Design of extruders: Cold and hot extruder design, design of screw and barrel, design of twin-screw extruder; Design of fermenters: Design of fermenter vessel, design problems; Hazards and safety considerations: Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.	5

Practicals:

S. No.	Practicals	No. of practicals
1	Design of pressure vessel; Design of shell and tube heat exchangers and plate heat exchanger; Design of sterilizers and retort.	3
2	Design of single and multiple effect evaporators; Design of rising film and falling film evaporator; Design of crystallizer; Design of tray dryer.	3
3	Design of fluidized bed dryer; Design of spray dryer; Design of vacuum dryer; Design of microwave dryer.	3
4	Design of belt and chain conveyor; Design of screw conveyor; Design of bucket elevator and pneumatic conveyor.	3
5	Design of twin-screw extruder; Design of fermenter.	2

Recommended Books

1. R. Paul Singh and Dennis R. Heldman. 2014. Introduction to Food Engineering, 5th Ed. Elsevier, Amsterdam, The Netherlands.
2. Albert Ibarz and Gustavo V. Barbosa-Cánovas. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.
3. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science and Business Media, New York, USA.
4. R. K. Sinnott. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd Ed. Butterworth-Heinemann, Oxford, UK.
5. Kenneth J. Valentas, Enrique Rotstein and R. Paul Singh. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.
6. Peter F. Stanbury, Allan Whitakar and Stephen J. Hall. 1995. Principles of Fermentation Technology, 2nd Ed. Elsevier Science Ltd., Burlington, MA, USA.
7. J.F. Richarson and D.G. Peacock. 1994. Coulson & Richardsons's Chemical Engineering, Vol. 3, Chemical & Biochemical Reactors & Process Control, 3rd Ed. Elsevier Butterworth-Heinemann, Amsterdam, The Netherlands

FT-306
Food Storage Engineering

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with fundamentals of food engineering, post-harvest technology, storage of perishables food and design of warehouses for storage of food products.

Details of course:

S. No.	Particulars	Lectures
1	Storage: Importance of scientific storage systems, post-harvest physiology of semi-perishables and perishables, climacteric and non-climacteric fruits, respiration, ripening, changes during ripening, ethylene bio-synthesis; Damages: Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control.	7
2	Storage structures: Traditional storage structures, improved storage structures, modern storage structures; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos; Storage of grains: respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through ventilation.	5
3	Aeration and stored grain management: purposes of aeration, aeration theory, aeration system design, aeration system operation; Storage pests and control: Damage due to storage insects and pests, its control, seed coating, fumigations, etc.; Damage caused by rodents and its control.	5
4	Storage of perishables: cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage.	5
5	Design of storage structures: Functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, BIS specifications, functional, structural and thermal design of cold stores.	6

Practicals:

S. No.	Practicals	No. of practicals
1	Visits to traditional storage structures; Layout design, sizing, capacity and drawing of traditional storage structures.	2
2	Measurement of respiration of fruits/grains in the laboratory; Study on fumigation; Visits to FCI godowns; Design of grain godowns for particular capacity and commodity.	3
3	Drawing and layout of grain godown for particular commodity and capacity; Visits to cold storage; Design of cold storage for particular capacity and commodity.	3

4	Drawing and layout of cold storage for particular commodity and capacity; Visits to CA storage; Design of CA storage for particular capacity and commodity.	3
5	Drawing and layout of CA storage for particular commodity and capacity; Visits to evaporative cooling system for storage; Storage study in the MAP.	3

Recommended Books

1. P.H. Pandey. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana.
2. Myer Kutz. 2007. Handbook of Farm, Dairy, and Food Machinery. William Andrew, Inc., Norwich, NY, USA.
3. A.M. Michael and T.P. Ojha. 2004. Principal of Agricultural Engineering, Vol. I. Jain Brothers, New Delhi.
4. L.W. Newbaver and H.B. Walker. 2003. Farm Buildings Design. Prentice-Hall Inc., New Jersey, USA.
5. J. Whitaker. 2002. Agricultural Buildings and Structures. Reston Publishing Home, Reston, Virgenia, USA.
6. G. Boumans. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
7. C.W. Hall. 1980. Drying and Storage of Agricultural Crops. The AVI Publishing Company, Inc., Westport, Connecticut, USA.
8. Donald B. Brooker, F.W. Bakker-Arkema, Carl W. Hall. 1974. Drying and Storage of Grains and Oilseeds. The AVI Publishing Company, Inc., Westport, Connecticut, USA.

FT-307
Bakery, Confectionery and Snack Products

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with preparation and preservation of bakery, confectionary and snacks products, sensory, microbiological aspects and quality analysis of the products.

Details of course:

S. No.	Particulars	Lectures
1	Bakery products: Types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing;	7
2	Confectionery and chocolate products: Types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing; Product quality characteristics, defects, causes and corrective measures;	7
3	Snack foods: Types, specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing; Snack food seasonings;	7
4	Breakfast cereals, macaroni products and malts: Specifications, compositions, ingredients, formulations, processing, equipment, packaging, storage and quality testing.	7

Practicals:

S. No.	Practicals	No. of practicals
1	Identifications and composition of various ingredients for snacks, bakery and confectionery products.	3
2	Flours, their classifications and characterization; preparation, packaging and quality evaluation of selected snack items.	3
3	Preparation, packaging and quality evaluation of selected bakery items; preparation, packaging and quality evaluation of selected confectionery items.	3
4	Preparation, packaging and quality evaluation of selected chocolates.	2
5	Preparation of traditional Indian confection. Visit to bakery, confectionary and snack units (industry).	3

Recommended Books

1. NIIR Board of Consultants & Engineers. 2014. The Complete Technology Book on Bakery Products (Baking Science with Formulation & Production), 3rd Ed. NIIR, New Delhi.
2. Peter P. Grewling. 2013. Chocolates & Confections, 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
3. E.J. Pyler and L.A. Gorton. 2009. Baking Science & Technology, Vol. II: Formulation & Production, 4th Ed. Sosland Publishing Company, Kansas City, MO, USA.
4. E.J. Pyler and L.A. Gorton. 2008. Baking Science & Technology, Vol. I: Fundamentals & Ingredients, 4th Ed. Sosland Publishing Company, Kansas City, MO, USA.

5. Y.H. Hui. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
6. John J. Kingslee. 2006. A Professional Text to Bakery and Confectionery. New Age International, New Delhi.
7. Harold Corke, Ingrid De Leyn, Nanna A. Cross, Wai-Kit Nip, Y.H. Hui. 2006. Bakery Products: Science and Technology. Blackwell Publishing Ltd., Oxford, UK.
8. Joseph Amendola and Nicole Rees. 2003. Understanding Baking: The Art and Science of Baking, 3rd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
9. Duncan Manley. 2000. Technology of Biscuits, Crackers and Cookies, 3rd Ed. Woodhead Publishing Limited, Cambridge, England.
10. N.L. Kent and A.D. Evers. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th Ed. Elsevier Science Ltd., Oxford, UK.
11. E.B. Jackson. 1995. Sugar Confectionery Manufacture, 2nd Ed. Springer-Verlag, US.
12. Samuel A. Matz. 1976. Snack Food Technology, 2nd Ed. AVI Publishing Co., Inc., Westport, Connecticut, USA.
13. US Wheat Associates. Baker's Handbook on Practical Baking.

BM-301
Marketing Management and International Trade

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To acquaint the students with the concept of marketing, planning, branding, national and international license for import and export of food products.

Details of Course:

S. No.	Particulars	Lectures
1	Marketing: Concept, functions, scope and marketing management; Process: Concepts of marketing-mix, elements of marketing-mix; Market structure and consumer buying behaviour: micro- and macro-environments; Marketing research and marketing information systems; Market measurement, market forecasting, market segmentation, targeting and positioning; Allocation and marketing resources; Marketing planning process.	7
2	Product policy and planning: Product-mix, product line, product life cycle; New product development process; Product brand, packaging, services decisions; Marketing channel decisions; Retailing, wholesaling and distribution; Pricing decisions; Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry;	6
3	Promotion-mix decisions; Advertising: Objectives, budget and advertising message, media planning, personal selling, publicity, sales promotion; World consumption of food: Patterns and types of food consumption across the globe; Salient features of international marketing, composition and direction of Indian exports, international marketing environment, deciding which and how to enter international market;	8
4	Direct exports, indirect exports, licensing, joint ventures, direct investment and internationalization process, distribution channels; WTO and world trade agreements related to food business, export trends and prospects of food products in India; Government institutions related to international food trade: APEDA, Tea Board, Spice Board, MOFPI, etc.	7

Recommended Books

1. Philip Kotler, Kevin Lane Keller, Abraham Koshy, Mithileshwar Jha. 2013. Marketing Management: A South Asian Perspective, 14th Ed. Pearson Education.
2. Willium J. Stanton. 1984. Fundamentals of Marketing. Tata McGraw-Hill Publication, New Delhi.
3. C.N. Sontakki. Marketing Management. Kalyani Publishers, New Delhi.
4. John Daniels, Lee Radebaugh, Brigham, Daniel Sullivan. International Business, 15th Ed., Pearson Education.
5. Aswathappa. International Business. Tata McGraw-Hill Education, New Delhi.
6. Fransis Cherunilam. International Business: Text and Cases, 5th Ed. PHI Learning, New Delhi.

Courses offered in Semester – VI			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	FT-308	Processing Technology of Beverages	3 (2+1)
2	FT-309	Food Plant Sanitation	4 (3+1)
3	FT-310	Food Packaging Technology and Equipment	3 (2+1)
4	FT-311	Processing of Fish and Marine Products	3 (2+1)
5	FT-312	Sensory Evaluation of Food Products	3 (2+1)
6	FT-313	Food Additives and Preservatives	2 (1+1)
7	FT-314	Food Quality, Safety Standards and Certification	3 (3+0)
8	FT-315	Instrumentation and Process Control in Food Industry	3 (2+1)
9	BM-302	Project Preparation and Management	2 (2+0)
			Total 26 (19+7)

FT-308
Processing Technology of Beverages

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact Hours: 28 + 28 Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with different types of beverages, their preparation and advances in processing of beverages.

Details of course:

S. No.	Particulars	Lectures
1	History and importance of beverages and status of beverage industry; Processing of beverages: Packaged drinking water, juice-based beverages, synthetic beverages, still, carbonated,	7
2	Low-calorie and dry beverages, isotonic and sports drinks, dairy based beverages, alcoholic beverages, fruit beverages, specialty beverages, tea, coffee, cocoa, spices, plant extracts, etc.;	5
3	FSSAI specifications for beverages; Ingredients, manufacturing and packaging processes and equipment for different beverages; Water treatment and quality of process water;	6
4	Sweeteners, colorants, acidulants, clouding and clarifying and flavoring agents for beverages; Carbon dioxide and carbonation; Quality tests and control in beverages;	5
5	Miscellaneous beverages: Coconut water, sweet toddy, sugar cane juice, coconut milk, flavoured syrups.	5

Practicals:

S. No.	Practicals	No. of practicals
1	Quality analysis of raw water; Determination of density and viscosity of caramel.	2
2	Determination of colours in soft drinks by wool technique; Preparation of iced and flavored tea.	3
3	Preparation of carbonated and non-carbonated beverages; Determination of caffeine in beverages.	3
4	Determination of brix value, gas content, pH and acidity of beverages; Quality analysis of tea and coffee.	3
5	Preparation of miscellaneous beverages; Visit to carbonation unit; Visit to mineral water plant.	3

Recommended Books

1. Hans Michael Eblinger. 2009. Handbook of Brewing: Processes, Technology, Markets. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim. Germany.
2. Y.H. Hui. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
3. Philip R. Ashurst. 2005. Chemistry and Technology of Soft Drinks and Fruit Juices, 2nd Ed. Blackwell Publishing Ltd., Oxford, UK.

4. Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
5. V.K. Joshi and Ashok Pandey. 1999. Biotechnology: Food Fermentation – Microbiology, Biochemistry and Technology, Vol. II. Educational Publishers & Distributors, New Delhi.
6. Alan H. Varnam and Jane P. Sutherland. 1994. Beverages: Technology, Chemistry and Microbiology. Chapman, London, UK.

FT-309

Food Plant Sanitation

Credits: 3 + 1
Contact hours: 42 + 28

Mid-session exam: 30 (25+5#)
Practical exam: 25
End-semester exam: 45

Objective: To acquaint the students with various concepts of personal hygiene, sanitary food handling, design consideration and sanitization of food processing plants.

Details of Course:

S. No.	Particulars	Lectures
1	Good manufacturing practices, current good manufacturing practices; Standard operating procedures, good laboratory practices, sanitation; Sanitation and the food industry: Sanitation, sanitation laws and regulations and guidelines, establishment of sanitary, potential risks of food borne bioterrorism, bioterrorism protection measures, role of pest management in bio-security; Relationship of microorganisms to sanitation,allergens, allergen control; Food contamination, protection against contamination;	9
2	Personal hygiene and sanitary food handling: Role of HACCP in sanitation, quality assurance for sanitation cleaning compounds, handling and storage precautions; Sanitizers,sanitizing methods, sanitation equipment, waste product handling,solid waste disposal, liquid waste disposal;	6
3	Pest control: Insect infestation, cockroaches, insect destruction, rodents, birds, use of pesticides, integrated pest management; Sanitary design and construction for food processing:Site selection, site preparation, building construction considerations, processing and design considerations, pest control design; Low-moisture food manufacturing and storage sanitation: Sanitary construction considerations, receipt and storage of raw materials, cleaning of low-moisture food manufacturing plants;	9
4	Dairy processing plant sanitation: Role of pathogens, sanitary construction considerations, soil characteristics in dairy plants, sanitation principles, cleaning equipment; Meat and poultry plant sanitation: Role of sanitation, sanitation principles, cleaning compounds for meat and poultry plants, sanitizers for meat and poultry plants, sanitation practices, sanitation procedures;	6
5	Sea food plant sanitation: Sanitary construction considerations, contamination sources, sanitation principles, recovery of by-products; Fruit and vegetable processing plant sanitation: Contamination sources, sanitary construction considerations, cleaning considerations, cleaning of processing plants, cleaners and sanitizers, cleaning procedures, evaluation of sanitation effectiveness;	7
6	Beverage plant sanitation: Mycology of beverage manufacture, sanitation principles, non-alcoholic beverage plant sanitation, brewery sanitation, winery sanitation, distillery sanitation;	5

Practicals:

S. No.	Practicals	No. of practicals
1	Estimation of BOD (Biological Oxygen Demand); Estimation of COD (Chemical Oxygen Demand).	2
2	Determination of hardness of water; Good Manufacturing Practices (GMPs) and personal hygiene.	2
3	Sewage treatment: Primary, secondary, tertiary and quaternary; Aerobic and anaerobic sludge treatment; Lab demonstration on state of water; Study of CIP plant.	3
4	Isolation and identification of Actinomycetes; Enrichment and isolation of cellulose degrading bacteria.	2
5	Biodegradation of phenol compounds; Bacteriological examination of water: Coliform MPN test.	2
6	Sampling of airborne microorganisms; Sampling of surfaces - equipment and physical plant; Aerosol sampling and measurement guidelines.	3

Recommended Books

1. Michael M. Cramer. 2013. Food Plant Sanitation: Design, Maintenance, and Good Manufacturing Practices. CRC Press, Boca Raton, FL, USA.
2. Ralph Mitchell and Ji-Dong Gu. 2010. Environmental Microbiology, 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
3. Norman G. Marriott and Robert B. Gravani. 2006. Principles of Food Sanitation, 5th Ed. Springer Science+Business Media, Inc., NY, USA.
4. I.L. Pepper and C.P. Gerba. 2005. Environmental Microbiology: Laboratory Manual, 2nd Ed. Elsevier Academic Press, Amsterdam.
5. Y. H. Hui, Bernard L. Bruinsma, J. Richard Gorham, Wai-Kit Nip, Phillip S. Tong and Phil Ventresca. 2003. Food Plant Sanitation. Marcel Dekker, Inc., NY, USA.

FT-310
Food Packaging Technology and Equipment

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with different food packaging method, packaging materials, packaging machineries, modern packaging techniques, and use of various tests to check quality of packaging materials

Details of course:

S. No.	Particulars	Lectures
1	Backaging situations in World, India; Need of packaging; Package requirements, package functions; Package materials: Classification of packages, paper as package material, its manufacture, types, advantages of corrugated and paper board boxes, etc.; Glass as package material, manufacture, advantages and disadvantages.	7
2	Metal (Aluminium/ tin/ SS) as package material-manufacture, advantages, disadvantages, plastic as package material, classification of polymers, properties of each plastics, uses of each plastic.	7
3	Lamination: Moulding-Injection, blow, extrusion; Coating on paper and films; Aseptic packaging: Need, advantages, process, comparison of conventional and aseptic packaging, system of aseptic packaging and materials used in aseptic packaging.	7
4	Permeability: Theoretical considerations, permeability of gases and vapours; Permeability of multilayer materials; Permeability in relation to packaging requirement of foods; Transport properties of barriers; Simulations of product: Package environment interaction; Packaging of specific foods, mechanical and functional tests on package.	7

Practicals:

S. No.	Practicals	No. of practicals
1	Classification of various packages based on material and rigidity; Measurement of thickness of paper, paper boards; Measurement of basic weight and grammage of paper and paper boards.	3
2	Measurement of water absorption of paper, paper boards; Measurement of bursting strength of paper, paper boards; Measurement of tear resistance of papers.	2
3	Measurement of puncture resistance of paper and paperboard; Measurement of tensile strength of paper, paper boards; Measurement of grease resistance of papers.	2
4	Determination of gas and water transmission rate of package films; Determination of laquer integrity test; Drop test, Box compression test; Identification of plastic films.	3
5	Determination of seal integrity, ink adhesion; packaging practices followed for packing fruits and vegetables.	2

6	Shelf life calculations for food products; Head space analysis of packaged food; Study of vacuum packaging machine, bottle filling machine and form-fill-seal machine.	2

Recommended Books

1. Gordon L. Robertson. 2014. Food Packaging: Principles and Practice, 3rd Ed. CRC Press, Boca Raton, FL, USA.
2. Gordon L. Robertson. 2010. Food Packaging and Shelf Life – A Practical Guide. CRC Press, Boca Raton, FL, USA.
3. Jung H. Han. 2007. Packaging for Nonthermal Processing of Food. Blackwell Publishing Ltd., Oxford, UK.
4. Jung H. Han. 2005. Innovations in Food Packaging. Elsevier Science & Technology Books, UK.
5. Richard Coles, Berek McDowell and Mark J. Kirwan. 2003. Food Packaging Technology. Blackwell Publishing Ltd., Oxford, UK

FT-311
Processing of Fish and Marine Products

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with processing of fish and marine products, byproducts utilization and approaches used for packaging of their products.

Details of course:

S. No.	Particulars	Lectures
1	Fisheries resources, global and Indian scenario; Types of fish and other marine products; Classification of fish (fresh water and marine), composition of fish, characteristics of fresh fish, spoilage of fish- microbiological, physiological, biochemical; Relationship between chilling and storage life, MAP, general aspects of fish freezing, changes in quality during chilled and frozen storage.	7
2	Principles of canning, effect of heat processing on fish, storage of canned fish, preprocess operations, post-process operations, cannery operations for specific canned products; Fish products: Introduction, fish muscle proteins, surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish mince products;	7
3	Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysates (FPH); Preparation protocols of indigenous products: Fish sauce and paste. Novel methods; Low dose irradiation; High pressure treatment, MAP, vacuum packaging, gas packaging;	7
4	Oxygen absorbents and CO2 generators, ethanol vapour generation, hurdle barrier concept, value added fish products, packaging; Sea food quality assurance, HACCP, EU hygienic regulations and ISO 9000 standards; New kinds of quality and safety problems emerging in sea food processing and preservation.	7

Practicals:

S. No.	Practicals	No. of practicals
1	Study of anatomy and dressing of fish; Study of anatomy and dressing of prawn and other marine products.	2
2	Identification of different types of fish - Selection and grading; Identification of different types of prawn and other marine products - Selection and grading; Quality evaluation of fish.	3
3	Preparation of sun dried and salt cured fish, fish sauce; Chilling and freezing of fish; Preparations of fish protein concentrate; Preparation of fish meal; Preparation of marine fish oils and various fish products.	3
4	Utilization of fish by-products; Preparation of marine algal products; Preservation of fish: Drying, pickling; Preservation of marine products using fermentation process.	2
5	Preparation of value added sea products: Cutlets, bullets, wafers; Processing of fish oils; Canning methods for marine fishery products; Estimation of TVB and TMA.	2

6	Determination of iodine value; Protein estimation by Folin-Lowrey's method; Visit to fish and prawn processing industry.	2

Recommended Books

1. D.P. Sen. 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd., Delhi.
2. Brigitte Maas-van Berkel, Brigiet van den Boogaard and Corlien Heijnen. 2004. Preservation of Fish and Meat. Agromisa Foundation, Wageningen.
3. FAO. 2003. Code of Practices of Canned Fishery products. FAO, UN, Rome.
4. Brend W. Rautenstrauss and Thomas Liehr. 2002. Fish Technology. Springer-Verlag, US.
5. G.M. Hall. 1997. Fish Processing Technology, 2nd Ed. Chapman & Hall, London, UK.
6. C.O. Chichester and H.D. Graham. 1973. Microbial safety of Fishery products. Academic Press, New York.
7. American Public Health Association. 1970. Recommended Procedures for the Bacteriological examination of Seawater and shell fish. APHA, USA.
8. George Borstorm. 1961. Fish as Food - Vol. I, II, III and IV. Academic Press, New York.
9. K. Gopakumar. View Larger ImageTextbook of Fish Processing Technology. ICAR, New Delhi.
10. Charles L. Cutting. Processing and Preservation of Fish. Agro Bios, New Delhi.

FT-312
Sensory Evaluation of Food Products

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students to understand food quality its physicochemical, nutritional, microbiological and sensory aspects and techniques involved in sensory analysis.

Details of course:

S. No.	Particulars	Lectures
1	Introduction, definition and importance of sensory evaluation in relation: to consumer acceptability and economic aspects; factors affecting food acceptance. Terminology related to sensory evaluation. Principles of good practice: the sensory testing environment, test protocol considerations.	7
2	Basic principles: Senses and sensory perception, Physiology of sensory organs, Classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses. Discrimination Tests, Procedure: Types of tests – difference tests (Paired comparison, due-trio, triangle) ranking, scoring, Hedonic scale and descriptive tests.	7
3	Panel selection, screening and training of judges; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements; Consumer Research – Affective Tests: Objectives. Methods, types or questionnaires, development of questionnaires, comparison of laboratory testing and Consumers studies, limitations.	7
4	Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests; Quality Evaluations Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control.	7

Practicals:

S. No.	Practicals	No. of practicals
1	Determination of threshold value for basic tastes; Odour recognition, difference (PC, Duo-trio, triangle); Determination of threshold value for various odours;	4
2	Selection of judging panel; Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests;	4
3	Descriptive analysis methodology; Sensory evaluation of various food products using different scales, score cards and tests;	3
4	Texture profile methodology; Estimation of color; Relationship between objective and subjective methods; Designing a sensory laboratory.	3

Recommended Books

1. Amerine, M.A., Pangborn, R.M. and Rossles, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, London.
2. Early, R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academic.
3. Jellinek, G. 1985. Sensory Evaluation of Food - Theory and Practice. Ellis Horwood.
4. Lawless, H.T. and Klein, B.P. 1991. Sensory Science Theory and Applicatons in Foods. Marcel Dekker.
5. Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press.
6. Maslowitz, H. 2000. Applied Sensory Analysis of Foods. Vols. I, II. CRC Press, Boca Raton, FL, USA.
7. Piggot, J.R. 1984. Sensory Evaluation of Foods. Elbview Applied Science Publ.
8. Potter, N.N. and Hotchleiss, J.H. 1997. Food Science. 5th Ed. CBS Publishers, Delhi.
9. Rai, S.C. and Bhatia, V.K. 1988. Sensory Evaluation of Agricultural Products. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.
10. Stone, H. and Sidel, J,L. 1985. Sensory Evaluation Practices. Academic Press.
11. Harry, T. Lawless, Hildegarde Heymann. 2010. Sensory Evaluation of Food: Principles and Practices. 2nd Ed., Springer, New York or Dordrecht Heidelberg, London.

FT-313
Food Additives and Preservatives

Credits: 1 + 1
Contact Hours: 14 + 28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 50
End-Semester Exam: 30

Objective: To acquaint the students with the use of different type of additives and preservative used in improve of sensory, nutritional quality and to extend the shelf life of food.

Details of Course:

S. No.	Particulars	Lectures
1	Intentional and unintentional food additives, their toxicology and safety evaluation; Naturally occurring food additives;	3
2	Food colors and dyes: Regulatory aspects of dyes, food color (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants;	3
3	Food preservatives and their chemical action. Role and mode of action of salts, chelating agents, stabilizers and thickeners;	3
4	Humectants/polyhydric alcohol, anticaking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners;	3
5	Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.	2

Practicals:

S. No.	Practicals	No. of practicals
1	Evaluation of GRAS aspect of food additives; Estimation of chemical preservatives by TLC (organic and inorganic).	2
2	Identification of food colour by TLC (organic and inorganic); Quantitative estimation of added dyes; Isolation and identification of naturally occurring food pigments by paper and TLC.	3
3	Role and mode of action of chelating agent in fruit juice; Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream).	3
4	Role and mode of clarifying agent in fruit juices; Role and mode of antioxidant in frozen fish.	3
5	Role of leaving agent in baked food product; Preservation of coconut shreds using humectants.	3

Recommended Books

1. H.-D. Belitz, W. Grosch and P. Schieberle. 2009. Food Chemistry. 4th Edition. Springer-Verlag, Berlin,Heidelberg.
2. S.N. Mahindru. 2008. Food Additives: Characteristics, Detection and Estimation. Aph Publishing Corporation, New Delhi.
3. S.S. Deshpande. 2002. Handbook of Food Toxicology. Marcel and Dekker AG, Basel, Switzerland.

FT-314
Food Quality, Safety Standards and Certification

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42 + 0 End-Semester Exam: 60

Objective: To acquaint the students to understand food quality, it's physicochemical, nutritional, microbiological and sensory aspects, techniques involved in sensory analysis, and highlights the role of regulatory and statutory bodies of India and the world in food industry.

Details of course:

S. No.	Particulars	Lectures
1	Food quality: Definition and its role in food industry; Quality attributes, classification; Color and gloss: Definition, different colors, color measurement by spectrophotometer, Muncell color system and Lovibond tintometer; role in food qualities. Role of viscosity and consistency in food quality; Physical properties: Size and shape, weight, volume, weight volume ratio, length, width, diameter, symmetry, curvature, area; Defects, classification. Genetic-physiological defects: Structural, off color, character.	7
2	Entomological defects: Holes, scars, lesions, off coloring, curled aves, pathological defects; Mechanical defects, extraneous or foreign material defects; Measurement of defects: Improving visibility by dilution, white background, color differences, standardization of conditions, reference standards, counts and measures, isolation of defects by floatation, elution, electronic sorting and internal defects; Flavour: Definition and its role in food quality; Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes.	7
3	Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odor testing, techniques, thresholds, odor intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste; Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis;	6
4	Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling, dilution procedures, descriptive sensory analysis, contour method, other procedures.	5
5	Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey; Quality of raw materials: Physical, chemical and microbial quality; Quality of products during processing and after processing: Color, taste, texture, flavour, appearance.	7

6	Factors influencing the food qualities: Soil, field practices, harvesting practices, procedures, packaging, transportation, storage, conditions, processing conditions, packaging and storage conditions of finished products. Recording and reporting of quality. Quality inspection, quality control;	4
7	Quality management and quality assurance: Total quality management, good manufacturing practices, good agricultural practices, good laboratory practices; Quality management systems, QSS; Quality circles, SQC; ISO system. HACCP: Principles, implementation; Plan documentation, types of records; Auditing: Surveillance, audit, mock audit, third party quality certifying audit, auditors and lead auditors; Certification, certification procedures, certifying bodies, accrediting bodies, international bodies.	6

Recommended Books

1. Inteaz Alli. 2004. Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, FL, USA.
2. Ronald H. Schmidt and Gary E. Rodrick. 2003. Food Safety Handbook. John Wiley & Sons, Inc., Hoboken. New Jersey, USA.
3. R.E. Hester and R.M. Harrison. 2001. Food Safety and Food Quality. Royal Society of Chemistry, Cambridge, UK.

FT-315
Instrumentation and Process Control in Food Industry

Credits: 2 + 1
Contact Hours: 28 + 28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students to understand the sound knowledge of instruments, physico-chemical measurement, transmission, transducers and impart knowledge about newer techniques such as computer-based monitoring in food industry.

Details of course:

S. No.	Particulars	Lectures
1	Introduction, definitions, characteristics of instruments, static and dynamic characteristics; Temperature and temperature scales; Various types of thermometers; thermocouples, resistance thermometers and pyrometers; Pressure and pressure scales, manometers, pressure elements differential pressure; Liquid level measurement, different methods of liquid level measurement.	6
2	Flow measurement: Kinds of flow, rate of flow, total flow differential pressure meters, variable area meters, food flow metering; Weight measurement: Mechanical scale, electronic tank scale, conveyor scale; Measurement of moisture content, specific gravity, measurement of humidity, measurement of viscosity, turbidity, color, measurement of density, brix, pH, enzyme sensors, automatic valves.	6
3	Transmission: Pneumatic and electrical; Control elements, control actions, pneumatic and electrical control systems; Process control: Definition, simple system analysis, dynamic behaviour of simple process, Laplace transform, process control hardware; Frequency response analysis, frequency response characteristics, Bode diagram and Nyquist plots and stability analysis.	6
4	Transducers: Classification, self-generating transducers, variable parameter type, digital, actuating and controlling devices; Controllers and indicators: Temperature control, electronic controllers, flow ratio control, atmosphere control, timers and indicators, food sorting and grading control, discrete controllers, adaptive and intelligent controllers.	6
5	Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer, signal interfacing, examples in food processing.	4

Practicals:

S. No.	Practicals	No. of practicals
1	Study on instrumentation symbols; Determination of relative humidity by wet and dry bulb thermometer;	3
2	Measurement of wind velocity by anemometer; Measurement of intensity of sun shine by sunshine recorders; Study of characteristics of pressure transducers,	4
3	Real-time study of pressure transducers characteristics with PC, characteristics of IC temperature sensor, characteristics of platinum RTD, temperature-controlled alarm system;	4

4	Study of water level to current conversion; Study of characteristics of capacitive transducer.	3

Recommended Books

1. Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
2. Bela G. Liptak. 2003. Instrument Engineer's Handbook, Vol. I and II, 4th Ed. CRC Press, Boca Raton, FL, USA.
3. Curtis D. Johnson. 2003. Process Control Instrumentation Technology, 7th Ed. Prentice Hall of India Pvt. Ltd., New Delhi.
4. D.V.S. Murty. 2004. Transducers and Instrumentation. Prentice-Hall of India Pvt. Ltd. New Delhi.

BM-302
Project Preparation and Management

Credits: 2 + 0 Mid-session exam: 40
Contact hours: 28+0 End-semester exam: 60

Objective: To acquaint the students with project planning, scheduling, costing, completion and application of computers in project preparation and management.

Details of Course:

S. No.	Particulars	Lectures
1	Overview of project management: Functions and viewpoints of management, evolution of project management, forms and environment of project management; Project life cycle; Project selection: Project identification and screening, project appraisal, project charter, project proposal, project scope, statement of work;	7
2	Project planning and scheduling: Work breakdown structure, planning and scheduling of activity networks, network scheduling, precedence diagrams, critical path method, program evaluation and review technique, assumptions in PERT modelling, decision CPM, GERT;	6
3	Project cost estimating: Types of estimates and estimating methods, dynamic project planning and scheduling, time-cost trade-offs, resource considerations in projects, resource profiles and levelling, limited resource allocation;	5
4	Project implementation, monitoring and control: Project management process and role of project manager, team building and leadership in projects, organizational and behavioural issues in project management, project monitoring and control, PERT/cost method, earned value analysis;	6
5	Project completion and future directions: Project completion and review; Project management: Recent trends and future directions; Computers in project management.	4

Recommended Books

1. R. Panneerselvam. 2004. Operations Research, 2nd Ed. International Book House, Mumbai. Prasanna Chandra. Projects. Tata McGraw-Hill Publication, New Delhi.
2. John M. Nicholas. Project Management for Business and Technology – Principles and Practices. Pearson Prentice Hall.
3. Harold Kerzner. Project Management – A System Approach to Planning, Scheduling, and Controlling. CBS Publishers & Distributors.
4. Prasanna Chandra. Projects – Planning, Analysis, Selection, Financing, Implementation, and Review. Tata McGraw-Hill Publishing Company Ltd.
5. P. Gopalakrishnan and V.E. Rama Moorthy. Textbook of Project Management. Macmillan

Courses offered in Semester – VII			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	ENL-401	Communication Skills and Personality Development	2 (1+1)
2	BM-403	Entrepreneurship Development	3 (2+1)
3	EXPL-401	Student READY - Experiential Learning Programme - I	14 (0+14)
4	RP-401	Student READY - Research Project	3 (0+3)
5	FT-500	Student READY - Seminar 1	(0+1)
			Total 23 (3+20)

ENL-401
Communication Skills and Personality Development

Credits: 1 + 1 Mid-Session Exam: 20 (15+5#)
Contact Hours: 14 + 28 Practical Exam: 50
End-Semester Exam: 30

Objective: To acquaint the students with the communication skills such as oral presentation, public speaking etc.

Details of Course:

S. No.	Particulars	Lectures
1	Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication; listening and note taking, writing skills,	3
2	Oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation,	4
3	Public speaking; Group discussion. Organizing seminars and conferences. Applied Grammar: Introduction to Word Classes. Structure of the Verb in English. Uses of Tenses. Study of Voice. Use of Conjunctions and Prepositions.	3
4	Sentence Patterns in English. Spoken English: Conversations of Different Situations in Everyday Life. The Concept of Stress, Stress Shift in Words and Sentences. Words with Silent Letters and their Pronunciations. The Basic Intonation Patterns.	4

S. No.	Practicals	No. of practicals
1	Listening and note taking, writing skills, oral presentation skills.	4
2	Field diary and lab record; indexing, footnote and bibliographic procedures.	4
3	Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations.	6

Recommended Books

1. Mamatha Bhatnagar and Nitin Bhatnagar. 2011. Effective Communication and Soft Skills. Person Education.
2. Meenakshi Raman, Sangeeta Sharma. Technical Communication Principles and Practice
3. Harold Wallace and Ann Masters. Personality Development. Cengage Publishers.
4. Andrea J. Rutherford. Basic Communication Skills for Technology. Pearson Education.

BM-403
Entrepreneurship Development

Credits: 2 + 1 Mid-Session Exam: 25 (20+5#)
Contact Hours: 28 + 28 Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students with the concept of entrepreneurship, SWOT analysis, project writing and various schemes and incentives of government for promotion of entrepreneurship.

Details of course:

S. No.	Particulars	Lectures
1	Entrepreneurship: Importance and growth, characteristics and qualities of entrepreneur, role of entrepreneurship, ethics and social responsibilities; Entrepreneurship development: Assessing overall business environment in the Indian economy; Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs; Globalization and the emerging business/entrepreneurial environment.	7
2	Concept of entrepreneurship, entrepreneurial and managerial characteristics, managing an enterprise, motivation and entrepreneurship development, importance of planning, monitoring, evaluation and follow up, managing competition, entrepreneurship development programs, SWOT analysis, generation, incubation and commercialization of ideas and innovations;	4
3	Women entrepreneurship: Role and importance, problems; Corporate entrepreneurship: Role, mobility of entrepreneur; Entrepreneurial motivation; Planning and evaluation of projects: Growth of firm, project identification and selection, factors inducing growth; Project feasibility study: Post planning of project, project planning and control; New venture management; Creativity.	6
4	Government schemes and incentives for promotion of entrepreneurship; Government policy on small and medium enterprises (SMEs)/SSIs; Export and import policies relevant to food processing sector; Venture capital; Contract farming and joint ventures, public-private partnerships;	6
5	Overview of food industry inputs; Characteristics of Indian food processing industries and export; Social responsibility of business.	5

Practicals:

S. No.	Practicals	No. of practicals
1	Visit to public and private enterprise; Visit to agro-processing/food business centres;	5
2	SWOT analysis of public and private enterprises;	4
3	Project proposals as entrepreneur – individual and group; Presentation of project proposals in the class.	5

Recommended Books

1. C.B. Gupta and N.P. Srinivasan. 2012. Entrepreneurship Development. S. Chand & Sons, New Delhi.
2. Anil Kumar, S., Poornima, S.C., Mini, K., Abraham and Jayashree, K. 2003. Entrepreneurship Development. New Age International Publishers, New Delhi.

3. Gupta, C.B. 2001. Management: Theory and Practice.Sultan Chand & Sons, New Delhi.
4. Vasant Desai. 2000. Dynamics of Entrepreneurial Development and Management. Himalaya Publishing House, New Delhi.

Dr. Khem Singh Gill Akal College of Agriculture
Eternal University, Baru Sahib

Course code	**Course Title**	**Lecture**	**Tutorial**	**Practical**	**Credit Hours**
EXPL-401	Student READY - Experiential Learning Programme - I	0	0	14	14
Relative Weightage	**100**				
Objective: To build practical skills and entrepreneurship attributes among the students with an aim to deal with work situations and for better employability and self-employment.					
Particulars					
Student READY (Rural Entrepreneurship Awareness Development Yojana) Experiential Learning with a credit load of 0+14 credit hours through relevant pilot plants for processing of various commodities, preferably on campus. This shall include development of Detailed Project Report on setting up of an enterprise in the selected areas of product manufacture and evaluation of the module. The Experiential Learning is intended to build practical skills and entrepreneurship attributes among the students with an aim to deal with work situations and for better employability and self-employment.					

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Course code	**Course Title**	**Lecture**	**Tutorial**	**Practical**	**Credit Hours**
RP-401	Student READY - Research Project	0	0	3	3
Relative Weightage	**100**				
Objective: To develop technically skills among the students to cater the needs of food research, industries and society.					
Particulars					
Student READY (Rural Entrepreneurship Awareness Development Yojana) –Project with a credit load of 0+3 credit hours to undertake investigation of selected problems of special interests in Food Processing Technology to individual student. The work includes library work, field or laboratory research, recording data, analyzing data and writing of report etc.					

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Course code	**Course Title**	**Lecture**	**Tutorial**	**Practical**	**Credit Hours**
FT-500	Student READY - Seminar 1	0	0	1	1
Relative Weightage	**100**				
Objective	To identify practical learning skills and concepts that will promote students' academic success.				
Particulars					

Student READY (Rural Entrepreneurship Awareness Development Yojana) — Seminar including preparation of synopsis, presentation and discussion by each student on current topics / interests in Food Processing Technology with weightage of 0+1credit hours.

Courses offered in Semester – VIII			
Sr. No.	**Course Code**	**Course Title**	**Credits L+P**
1	INDT-401	Student READY - Industrial Tour	2 (0+2)
2	INDT-402	Student READY - Internship/In-Plant Training	20 (0+20)
			Total 22 (0+22)

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Course code	**Course Title**	**Lecture**	**Tutorial**	**Practical**	**Credit Hours**
INDT-401	Student READY - Industrial Tour	0	0	2	2
Relative Weightage	**100**				
Objective	To provide the students with an opportunity to learn practically through interaction, working methods and employment practices.				
Particulars					
Student READY (Rural Entrepreneurship Awareness Development Yojana) – Educational tour of two- three weeks to various industries within and outside the state of the university and submission of report on Industrial tour carrying a weightage of 0+2 credit hours.					

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Course code	**Course Title**	**Lecture**	**Tutorial**	**Practical**	**Credit Hours**
INDT-402	Student READY - Internship/In-Plant Training	0	0	20	20
Relative Weightage	**100**				
Objective	To expose the students to an environment in which they are expected to be associated in their future career. The students will be required to have hands-on-experience in one or more commercial establishments.				
Particulars					
Student READY (Rural Entrepreneurship Awareness Development Yojana) – In-plant Training of one semester duration with a credit load of 0+20 credit hours at relevant food processing industry, machinery manufacturer, marketing or other agencies. The In-plant Training is intended to expose the students to an environment in which they are expected to be associated in their future career. The students will be required to have hands-on-experience in one or more commercial establishments.					

ETERNAL UNIVERSITY, BARU SAHIB,

RAJGARH, SIRMOUR
HIMACHAL PRADESH

Study Scheme & Syllabus

For

M. Sc. (Food Science & Technology)

(I to IV Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

Programme Structure

M. Sc. (Food Science and Technology)

DISTRIBUTION OF CREDITS

Subject	**Credit hours as per BSMA ICAR for Master's programme**
Major	20
Minor	09
Supporting	05
Seminar	01
Industrial training	01
Thesis	20
Compulsory non-credit courses	08
Total Credits	**64** (35 Course Work +01 Industrial Training+ 20 Thesis + 08 Non-credit)

M.Sc. (Food Science and Technology)

SEMESTER WISE DISTRIBUTION OF COURSES

S. No.	Course code	Course title	Credit hrs	Semester
Semester I				
Major				
1	FST 501	Food Chemistry & Nutrition	2+1	I
2	FST 502	Food Microbiology	2+1	I
3	FST 504	Principles of Food Processing	2+1	I
Minor				
4	FST 512	Technology of Fruits and Vegetable Processing	2+1	I
Non Creditable Courses				
5	FST 451	Mathematics*	3+0	I
6	FST 452	General Microbiology**	1+1	I
Total Credits		**9+3+5**	**17**	
Semester II				
Major				
1	FST 505	Food Packaging Technology	1+1	II
2	FST 506	Food Quality Systems & Management	2+1	II
3	FST 507	Techniques in Food Analysis	1+2	II
Minor				
4	FST 516	Technology of Milk and Milk Products	2+1	II
Supporting				
5	FST 531	Statistical Methods for Food Science	1+1	II
Research				
6	FST 599	Master's Research	0+2	II
Total Credits		**8+3+2+2**	**15**	

Semester III				
Major				
1	FST 503	Food Engineering	2+1	III
2	FST 591	Master's Seminar	1+0	III
Minor				
3	FST 513	Technology of Cereals, Pulses and ilseeds	2+1	III
Supporting course				
4	FST 534	Applied Nutrition	2+1	III
Non Creditable Courses				
5	FST 553	Crop Production: Concepts And Practices***	2+1	
Research				
6	FST 599	Master's Research	0+3	III
Total credits		**3+3+3+4+3**	**16**	
Semester IV				
Training				
1	FST 590	Industrial Training	0+1	IV
Research				
2	FST 599	Master's Research	0+15	IV
Total credits			**16**	

*Compulsory for graduates not having Maths at 10+2/graduate level
**Compulsory for graduates not having Microbiology at graduate level
***Compulsory for non-agricultural graduates

Training programme: The students are required to undertake compulsory four to six –weeks training (preferably during semester break) in a reputed food industry/organization after completion of major courses. On completion of the training, the students are required to submit a report. The departmental committee on the basis of certificate from host industry/organization, training report, and viva voce will assess the student's performance. They will be awarded Satisfactory/Unsatisfactory grade.

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

M.Sc. (Food Science & Technology)

Course Contents

FST 501 FOOD CHEMISTRY AND NUTRITION

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint with properties and role of various constituents in foods, interaction and changes during processing and importance of various foods and nutrients in human nutrition.

Units	Contents	Lectures
I	Definition and importance; major food constituents and their physicochemical properties; role of water in food.	5
II	Carbohydrates, proteins and lipids: classification, physical, chemical, nutritional, and functional properties and their structural correlations; auto-oxidation of lipids and rancidity.	7
III	Properties of minerals, vitamins, pigments, anti-oxidants, flavour components, allergens, toxins and anti-nutritional factors in foods; Interaction of constituents in food systems; Changes during storage and processing; Browning reactions in foods.	8
IV	Food groups and their typical composition; essential nutrients- sources, functions, deficiency diseases; requirements and recommended dietary allowances; digestion, absorption, transport and metabolism of nutrients in human system; protein quality evaluation.	8

Practical	Practical Description	
1.	Proximate analysis of foods	3
2.	Calorific value of foods	3
3.	TSS; pH and acidity of foods	2
4.	Estimation of browning intensity;	2
5.	Determination of vitamin C and beta-carotene and sugars	2
6.	Estimation of calcium, phosphorus and iron; anti-nutritional factors in foods.	2

S. No.	Reference Books
1.	Bamji MS, Rao NA & Reddy V. 2003. *Textbook of Human Nutrition*. Oxford & IBH
2.	Belitz HD.1999. *Food Chemistry*. Springer Verlag.
3.	DeMan JM. 1976. *Principles of Food Chemistry*. AVI.
4.	Fennema OR.1996. *Food Chemistry*. Marcel Dekker.
5.	Meyer LH. 1987. *Food Chemistry*. CBS.
6.	Swaminathan M. 1974. *Essentials of Foods and Nutrition*. Vol. II. Ganesh & Co.

#Assignments marks

FST 502 FOOD MICROBIOLOGY

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint with different groups of micro-organisms associated with food, their activities, destruction and detection in food.

Units	Contents	Lectures
I	Growth and survival of microorganisms in foods; spoilage organisms of milk, fruits, vegetables, grains and oilseeds, meat and poultry; Physical and chemical methods to control microorganisms.	6
II	Biochemical changes caused by microorganisms; Microbes in food fermentation, putrefaction, lipolysis; Antagonism and synergism in microorganisms; Food poisoning and food borne infections; Microbial toxins.	7
III	Food hygiene and sanitation: Contamination during handling and processing and its control; indicator organisms; Rapid methods in detection of microorganisms.	7
IV	Food Fermentations; Traditional fermented foods of India and other Asian countries; Probiotics and prebiotics; Fermented foods based on milk, meat and vegetables; Fermented beverages.	8

Practical	Practical Description	
1.	Microscopic examination of bacteria, and yeast and molds	3
2.	Standard plate count; Yeast and mould count; Spore count	3
3.	Detection and enumeration of pathogenic and indicator organisms in food; MPN of coliforms	3
4.	Enumeration of physiological groups- psychrophile, thermodurics, osmophiles and halophiles.	3
5.	Evaluation of microbiological quality of commonly consumed street foods.	2

S. No.	Reference Books
1.	Banawart GJ. 1989. *Basic Food Microbiology*. 2nd Ed. AVI Publ.
2.	Frazier J & Westhoff DC. 1988. *Food Microbiology*. 4th Ed. McGraw Hill.
3.	Garbutt J. 1997. *Essentials of Food Microbiology*. Arnold Heinemann.
4.	Jay JM, Loessner MJ & Golden DA. 2005. *Modern Food Microbiology*. 7th Ed. Springer.
5.	Ray B. 2004. *Fundamentals of Food Microbiology*.3rd Ed. CRC.
6.	Robinson RK. (Ed.). 1983. *Dairy Microbiology*. Applied Science.
7.	Steinkraus KS. 1996. *Handbook of Indigenous Fermented Foods*. Marcel Dekker.

#Assignments marks

FST 503 FOOD ENGINEERING

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint with basic principle of food engineering and its processes, with importance various foods process and their evaluation

Units	Contents	Lectures
I	Introduction to food engineering & processes: principles of thermodynamics and heat transfer applied to food engineering; fundamentals of heat and analogy to mass transfer in food processing.	5
II	Kinetics of biological reactions - kinetics of reactions occurring in processed foods, reaction velocity constant, order of reaction; quality changes during storage of foods; application of Arrhenius equation to biological reactions.	5
III	Method for thermal process evaluation - Commercial sterility, pasteurization and sterilization methods based on slowest heating region; determination of the process time based on region of greatest temperature lag; the process equivalence in terms of minutes at 121.1°C; calculation of process time for fluids on stream line flow and turbulent flow heated in heat exchangers; general introduction to aseptic canning process, hydrostatic sterilizer and aseptic packaging practices and design problems.	6
IV	Food chilling and freezing – Precooling and cold storage; CA and MA; Properties of frozen foods; freezing point depression; general introduction to enthalpy change during freezing; Plank's equation for predicting rates of product freezing; Cryogenic freezing and IQF; design of food freezing equipment such as air blast freezers, plate freezers and immersion freezers.	6
V	Process Heat Transfer - Modes of heat transfer and overall heat transfer; thermal properties of foods such as specific heat and thermal conductivity; Fourier's law, steady state and unsteady state conduction; heat exchange equipment; energy balances; rate of heat transfer; thermal boundary layer; heat transfer by forced convections; heat transfer to flat plate and in non-Newtonian fluids; heat transfer in turbulent flow; heating and cooling of fluids in forced convection outside tubes; natural convection.	6

Practical	Practical Description	
1.	Determination of viscosity of Newtonian fluid, Non Newtonian fluids	2
2.	Design of pumping systems	2
3.	Determination of thermal properties of foods such as thermal conductivity, thermal diffusivity, calorific value and specific heat;	2
4.	Calculation of freezing time for some typical foods	2
5.	Study of different types of freezers	2
6.	Calculation of thermal process time in canning of some foods	2
7.	Determination of 'U' for PHE and for SSHE; Study of blast freezer	1
8.	Visit to Food Processing Plants	1

S. No.	Reference Books
1.	Brennan JG, Butter JR, Corell ND & Lilly AVE. 1990. *Food Engineering Operations*. Elsevier.
2.	Charm SE, McCabe WL, Smith JC & Harriott P.1993. *Unit Operations of Chemical Engineering*. McGraw Hills.
3.	Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.
4.	Fellows P. 1988. *Food Processing Technology*. VCH Ellis Horwood.
5.	Heldman DR & Singh RP.1995. *Food Process Engineering*. AVI Publ.
6.	McCabe WL & and Smith JC. 1971. *Fundamental of Food Engineering*. AVI Publ.
7.	Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.
8.	Singh RP & Heldman DR. 1993. *Introduction to Food Engineering*. Academic Press.

FST 504 PRINCIPLES OF FOOD PROCESSING

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint with principles of different techniques used in processing and preservation of foods

Units	Contents	Lectures
I	Scope of food processing; historical developments; principles of food processing and preservation.	2
II	Processing and preservation by heat – blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying, etc.	4
III	Processing and preservation by low-temperature- refrigeration, freezing, CA, MA, and dehydro-freezing.	4
IV	Processing and preservation by drying, concentration and evaporation-types of dryers and their suitability for different food products; ultra- filtration, reverse osmosis.	6
V	Processing and preservation by non-thermal methods, irradiation, high pressure, pulsed electric field, hurdle technology.	5
VI	Use and application of enzymes and microorganisms in processing and preservation of foods; food fermentations, pickling, smoking etc; Food additives: definition, types and functions, permissible limits and safety aspects.	7

Practical	Practical Description	
1.	Seaming and testing of cans	2
2.	Tin coating measurement and tests for sulphide stain and crystal size of tin plates	2
3.	Determination of thermal inactivation time of enzymes	2
4.	Thermal processing and dehydration of foods	2
5.	Refrigeration and freezing of foods	2
6.	Concentration of foods and use of chemicals in preservation of foods	2
7.	Fermented food products; Extrusion cooking of foods	1

8.	Visit to a food processing plant.	1

S. No.	Reference Books
1.	Arsdel WB, Copley MJ & Morgan AI. 1973. *Food Dehydration*. 2nd Ed. Vols. I, II. AVI Publ.
2.	Desrosier NW & James N.1977. *Technology of Food Preservation*. 4th Ed. AVI. Publ.
3.	Fellows PJ. 2005. *Food Processing Technology: Principle and Practice*. 2nd Ed. CRC.
4.	Jelen P. 1985. *Introduction to Food Processing*. Prentice Hall.
5.	Potter NN & Hotchkiss 1997. *Food Science*. 5th Ed. CBS.
6.	Potty VH & Mulky MJ. 1993. *Food Processing*. Oxford & IBH.
7.	Ramaswamy H & Marcotte M. 2006. *Food Processing: Principles and Applications*. Taylor & Francis.

#Assignments marks

FST 505 FOOD PACKAGING TECHNOLOGY

Credits: 1 + 1
Contact hours: 14+28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 30
End-Semester Exam: 50

Objective: To acquaint the students with packaging methods, packaging materials, packaging machineries, modern packaging techniques etc.

Units	Contents	Lectures
I	Definitions, objectives and functions of packaging and packaging materials; Packaging requirements and selection of packaging materials; Types of packaging materials: Paper: pulping, fibrillation and beating, types of papers and their testing methods; Glass: composition, properties, types of closures, methods of bottle making; Metals: Tinplate containers, tinning process, components of tinplate, tin free steel (TFS), types of cans, aluminum containers, lacquers; Plastics: types of plastic films, laminated plastic materials, co-extrusion, edible films, biodegradable plastics.	4
II	Properties of materials such as tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength, tear strength, their methods of testing and evaluation; Barrier properties of packaging materials: Theory of permeability, factors affecting permeability, permeability coefficient, gas transmission rate (GTR) and its measurement, water vapour transmission rate (WVTR) and its measurement, prediction of shelf life of foods, selection and design of packaging material for different foods.	4
III	Food packaging systems: Different forms of packaging such as rigid, semi-rigid, flexible forms and different packaging system for (a) dehydrated foods (b) frozen foods (c) dairy products (d) fresh fruits and vegetables (e) meat, poultry and sea foods.	3
IV	Packaging equipment and machinery: Vacuum, CA and MA packaging machine; gas packaging machine; seal and shrink packaging machine; form and fill sealing machine; aseptic packaging systems; bottling machines; carton making machines.	3

Practical	Practical Description	
1.	Identification and testing of packaging materials	2
2.	Determination of wax from wax paper	1
3.	Testing of lacquered tin plate sheets	1

4.	Measurement of tin coating weight by Clarke's method	1
5.	To perform sulphide stain test	1
6.	To conduct ferricyanide paper test for porosity	1
7.	Determination of equilibrium moisture content	1
8.	Grading of glass bottles for alkalinity	1
9.	Determination of water vapour transmission rate of packaging material	1
10.	To perform vacuum packaging of food sample and carry out its storage study	1
11.	Testing the compression strength of the boxes	1
12.	Packaging the food material in seal and shrink packaging machine and study its shelf life	1
13.	Testing the strength of glass containers by thermal shock test; Testing the strength of filled pouches by drop tester	1

S. No.	**Reference Books**
1.	Crosby NT.1981. *Food Packaging: Aspects of Analysis and Migration Contaminants*. App. Sci. Publ.
2.	Kadoya T. (Ed). 1990. Food Packaging. Academic Press
3.	Mahadeviah M & Gowramma RV. 1996. *Food Packaging Materials*. Tata McGraw Hill
4.	Palling SJ. (Ed). 1980. *Developments in Food Packaging*. App. Sci. Publ.
5.	Painy FA. 1992. *A Handbook of Food Packaging*. Blackie Academic.
6.	Sacharow S & Griffin RC. 1980. *Principles of Food Packaging*. AVI Publ.
7.	Stanley S & Roger CG.1970. *Food Packaging*. AVI Publ.

FST 506 FOOD QUALITY SYSTEMS & MANAGEMENT

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint with food quality parameters and control systems, food standards, regulations, specifications

Units	Contents	Lectures
I	Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation; Sensory *vis-àvis* instrumental methods for testing quality.	6
II	Concepts of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Sampling procedures and plans; Food Safety and Standards Act, 2006; Domestic regulations; Global Food safety Initiative; Various organizations dealing with inspection, traceability and authentication, certification and quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS); Labeling issues; International scenario, International food standards.	8
III	Quality assurance, Total Quality Management; GMP/GHP; GLP, GAP; Sanitary and hygienic practices; HACCP; Quality manuals, documentation and audits.	6
IV	Indian & International quality systems and standards like ISO and Food Codex; Export import policy, export documentation; Laboratory quality procedures and assessment of laboratory performance; Applications in different food industries; Food adulteration and food safety. IPR and Patent.	8

Practical

1.	Testing and evaluation of quality attributes of raw and processed foods	2
2.	Detection and estimation of food additives and adulterants	2
3.	Quality assurance procedure, GMP, GAP documentation	2
4.	Preparation of quality policy & documentation, Application of HACCP to products, Preparation of HACCP chart	2
5.	Preparation of documentation & records, Visit to Units with ISO systems	2
6.	Visit to Units with HACCP certification	2
7.	Visit to Units implementing GMP, GAP	1
8.	Mini-project on preparation of a model laboratory manual	1

Reference Books

1.	Amerine MA, Pangborn RM & Rosslos EB. 1965. Principles of Sensory Evaluation of Food. Academic Press.
2.	Early R.1995.Guide to Quality Management Systems for Food Industries. Blackie Academic.
3.	Furia TE.1980. Regulatory status of Direct Food Additives. CRC Press.
4.	Jellinek G. 1985. Sensory Evaluation of Food - Theory and Practice. Ellis Horwoood.
5.	Krammer A & Twigg BA.1973. Quality Control in Food Industry. Vol. I, II. AVI Publ.
6.	Macrae R, Roloson R & Sadlu MJ. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XVI. Academic Press.
7.	Piggot J.R. 1984. Sensory Evaluation of Foods. Elbview Applied Science.
8.	Ranganna S. 2001. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Ed. Tata-McGraw-Hill.
9	Export/Import policy by Govt. of India.

FST 507 TECHNIQUES IN FOOD ANALYSIS

Credits: 1+2 Mid-session exam: 15 (10+5#)
Credit hours: 14+56 End-semester exam: 20
Practical exam : 65

Objective: To acquaint with food quality parameters and control systems, food standards, regulations, specifications.

Units	Contents	Lectures
I	Sampling techniques; Water activity, its measurements and significance in food quality; Calibration and standardization of different instruments.	2
II	Spectroscopic techniques using UV/Vis, fluorescence, IR, FTIR, NIR, NMR, atomic absorption, ICP, polarimetry, refractometry, microscopic techniques in food analysis (light microscopy, SEM, TEM, XRD, particle size analysis, image analysis etc.).	3
III	Chromatographic techniques: Adsorption, column, partition, affinity, ion exchange, size exclusion, GC, GLC, HPLC, HPTLC, GCMS, LCMS.	3
IV	Separation techniques: Gel filtration, dialysis, electrophoresis, sedimentation, ultrafiltration and ultracentrifugation, solid phase extraction, supercritical fluid extraction, isoelectric focusing, isotopic techniques, manometric techniques.	3
V	Special techniques: Immunoassay techniques; isotopic, non-isotopic and enzyme immunoassays; surface tension; enzymatic methods of food analysis; thermal methods in food analysis (Differential scanning colorimetry and others).	3

Practical	Practical Description	
1.	Sorption isotherms by measuring water activity in any hygroscopic food material (for instance - biscuits/potato chips/coffee powder)	2
2.	Estimation of tannin/phytic acid by spectrometric method; moisture and fat analysis by NIR spectroscopy	2
3.	Separation of amino acids/coal tar dyes by two dimensional paper hromatography;	2
4.	Separation and identification of sugars in fruit juices;	2
5.	Separation of proteins by ion-exchange chromatography;	2

6.	Separation and identification of carotenoids by column chromatography; fatty acid analysis using GC;	1
7.	Identification and determination of organic acids by HPLC;	1
8.	Analysis of dietary fibre/glucose by enzymatic method;	1
9.	Heavy metal analysis using atomic absorption spectrometry; Residue testing.	1

S. No.	Reference Books
1.	AOAC International. 2003. *Official methods of analysis of AOAC International*. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities. Kirk RS & Sawyer R. 1991. *Pearson's Chemical Analysis of Foods*. 9th Ed. Longman Scientific & Technical. Leo ML. 2004. *Handbook of Food Analysis*. 2nd Ed. Vols. I-III.
2.	Linden G. 1996. *Analytical Techniques for Foods and Agricultural Products*. VCH.
3.	Macleod AJ. 1973. *Instrumental Methods of Food Analysis*. Elek Sci. Marcel Dekker.
4.	Nielsen S. (Eds.). 1994. *Introduction to Chemical Analysis of Foods*. Jones & Bartlett.
5.	Pomrenz Y & Meloan CE. 1996. *Food Analysis - Theory and Practice*. 3rd Ed. CBS.
6.	Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw-Hill.
7.	Robinson JW. 1970. *Undergraduate Instrumental Analysis*. Marcel Dekker.

FST 512 TECHNOLOGY OF FRUITS AND VEGETABLE PROCESSING

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint with principles and methods of preservation of fruits and vegetables into various products

Units	Contents	Lectures
I	Indian and global scenario on production and processing of fruits and vegetable; Quality requirements of raw materials for processing; sourcing and receiving at processing plants; primary processing: grading, sorting, cleaning, washing, peeling, slicing and blanching.	5
II	minimal processing of tomato, guava, papaya, apple, pineapple, pomegranate, grapes etc. using aseptic packaging, canning, RTS fruit beverages, IQF and frozen fruits and vegetables; for peas, mango pulps etc.	5
III	Technology for processed products like pickles, chutneys, sauces particularly from raw mango, lime and other regional fruits and vegetables of importance.	6
IV	Processing of fruits for candies, bars, toffees, jams and jellies, squashes and syrups using locally available fruits like papaya, mango, aonla and other underutilized fruits.	6
V	Dehydration of fruits and vegetables using various drying technologies like sun drying, solar drying (natural and forced convection), osmotic, tunnel drying, fluidized fed drying, freeze drying, convectional and adiabatic drying; applications to raisins, dried figs, vegetables, intermediate moisture fruits and vegetables. Fruit powders using spray drying.	6

Practical	Practical Description	
1.	Evaluation of pectin grade; canning of mango/guava/papaya	2
2.	Preparation and quality evaluation of fruit jam: apple/ mango/ guava /papaya /aonla / strawberry and fruits of regional importance; fruit jelly, wood apple, sweet orange/mandarin/guava/tamarind	2
3.	Fruit marmalade: ginner marmalade; fruit preserve and candy; fruit RTS, squash, syrup and candy; preparation of grape raisin, dried fig and dried banana	2

4.	Processing of tomato products; preparation of *anardana*	2
5.	Preparation of papain /guava cheese; preparation of pickle, mixed pickle; preparation of dried ginger	2
6.	Preparation of *amchur*; preparation of dried onion and garlic	2
7.	Preparation of banana and potato wafers; preparation of dehydrated vegetables.	2

S. No.	**Reference Books**
1.	Barret DM, Somogyi LP &Ramaswamy H. 2005. *Processing of Fruits.CRC Press*
2.	FAO. 2007. *Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas- Technical Manual.* FAO Agr. Ser. Bull., 149.
3.	Fellows P. 2007. *Guidelines for Small-Scale Fruit and Vegetables Processors*. FAO Agr. Ser. Bull., 127.
4.	Lal G, Siddappa GS & Tandon GL. 1998. *Preservation of Fruits and Vegetables*. ICAR.
5.	Salunkhe DK & Kadam SS.1995. *Handbook of Fruit Science & Technology: Production, Composition and Processing*. Marcel Dekker.
6.	Salunkhe DK & Kadam SS. 1995. *Handbook of Vegetables Science & Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
7.	Somogyi LP. et al. 1996. *Processing Fruits - Science and Technology.* Vols I, II. Technomic Publ.
8.	Srivastava RP & Kumar S. 2003. *Fruit and Vegetable Preservation - Principles and Practices*. International Book Distributors.
9.	Verma LR & Joshi VK. 2000. *Post Harvest Technology of Fruits and Vegetables*. Indus Publ.

#Assignments marks

FST 513 TECHNOLOGY OF CEREALS, PULSES AND OILSEEDS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint with production and consumption trends, structure, composition, quality evaluation, and processing technologies for product development and value addition of various cereals, pulses and oilseeds.

Units	Contents	Lectures
I	General introduction and production and utilization trends; Structure and composition of common cereals, pulses and oilseeds.	3
II	Wheat: Types and physicochemical characteristics; wheat milling-products and byproducts; factors affecting quality parameters; physical, chemical and rheological tests on wheat flour; additives used in bakery products; flour improvers and bleaching agents; manufacture of bakery products, pasta products and various processed cereal-based foods; manufacture of whole wheat *atta*, blended flour and fortified flour.	6
III	Rice: Classification, physicochemical characteristics; cooking quality; rice milling technology; by- products of rice milling and their utilization; Parboiling of ricetechnology and effect on quality characteristics; aging of rice - quality changes; processed products based on rice.	6
IV	Corn: Types and nutritive value; dry and wet milling, manufacture of value-added products; processing of barley, oats, sorghum and millets.	6
V	Legumes and oilseeds: composition, anti-nutritional factors, processing and storage; processing for production of edible oil, meal, flour, protein concentrates and isolates; extrusion cooking technology; snack foods; development of low cost protein foods.	7

Practical	Practical Description	
1.	Physical-tests on wheat and rice	2
2.	Physicochemical and rheological properties	2
3.	Determination of gluten content in wheat flour	2
4.	Conditioning and Milling of wheat and rice by laboratory mill	1
5.	Parboiling of rice	1
6.	Quality tests of rice	1

7.	Amylose content determination in rice	1
8.	Malting of barley; puffing and popping of grains	1
9.	Experimental parboiling and assessment of degree of polishing	1
10.	Preparation of protein concentrates and isolates and their evaluation fo protein content and solubility	1
11.	Extraction of oil using expeller and solvent extraction methods; visit to relate processing industries	1

S. No.	Reference Books
1.	Chakrabarty MM. 2003. *Chemistry and Technology of Oils and Fats.* Prentice Hall. Dendy DAV & Dobraszczyk BJ. 2001. *Cereal and Cereal Products*.
2.	Hamilton RJ & Bhati A. 1980. *Fats and Oils - Chemistry and Technology*. App. Sci. Publ.
3.	Hoseney RS. 1994. *Principles of Cereal Science and Technology*. 2nd Ed. AACC.
4.	Kay DE. 1979. *Food Legumes*. Tropical Products Institute.
5.	Kent NL. 1983. *Technology of Cereals*. 4th Ed. Pergamon Press.
6.	Kulp K & Ponte GJ. 2000. *Handbook of Cereal Science and Technology*. 2nd Ed. Marcel Dekker.
7.	Lorenz KL.1991. *Handbook of Cereal Science and Technology*. Marcel Dekker.
8.	Marshall WE & Wadsworth JI. 1994. *Rice Science and Technology*. Marcel Dekker.
9.	Mathews RH. 1989. *Legumes Chemistry, Technology and Human Nutrition*. Marcel Dekker.
10.	Matz SA. 1969. *Cereal Science*. AVI Publ.
11.	Paquot C. 1979. *Standard Methods of Analysis of Oils, Fats and Derivatives*. Pergamon Press.
12.	Pomeranz Y. 1987. *Modern Cereal Science & Technology.* VCH Publ.
13.	Salunkhe DK.1992. *World Oilseeds: Chemistry, Technology and Utilization*. VNR.
14.	Swern D. 1964. *Bailey's Industrial Oil and Fat Products*. InterSci. Publ.

#Assignments marks

FST 516 TECHNOLOGY OF MILK AND MILK PRODUCTS

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint with techniques and technologies of testing and processing of milk into various products and by products

Units	Contents	Lectures
I	Present status of milk & milk products in India and Abroad; market milkComposition of milk of various species, quality evaluation and testing of milk, procurement, transportation and processing of market milk, cleaning & sanitization of dairy equipments. Special milks such as flavoured, sterilized, recombined & reconstituted toned & double toned.	5
II	Condensed milk- Definition, methods of manufacture, evaluation of condensed & evaporated milk; dried milk- Definition, methods of manufacture of skim & whole milk powder, instantiation, physiochemical properties, evaluation, defects in dried milk powder.	4
III	Cream- Definition, classification, composition, cream separation, sampling, neutralization, sterilization, pasteurization & cooling of cream, evaluation, defects in cream; Butter- Definition, composition, classification, methods of manufacture, theories of churning, evaluation, defects in butter.	5
IV	Ice cream- Definition, composition and standards, nutritive value, classification, methods of manufacture, evaluation, defects in ice cream, and technology aspects of softy manufacture.	5
V	Cheese: Definition, composition, classification, methods of manufacture, cheddar, Gouda, cottage and processed cheese, evaluation, defects in cheese.	5
VI	Indigenous milk products - Present status, method of manufacture of *yoghurt, dahi, khoa, burfi, kalakand, gulabjamun, rosogolla, srikhand, chhana, paneer, ghee, lassi* etc; probiotic milk products.	4

Practical	Practical Description	
1.	Study on basics of reception of milk at the plant; platform tests in mill estimation and fat and SNF in milk;	2
2.	Operation of LTLT & HTST Pasteurization;	2
3.	Preparation of special milks;	3
4.	Cream separation & standardization of milk;	3

5.	Preparation and evaluation of table butter, ice-cream, cheese and indigenous milk product such as *khoa, chhana, paneer, ghee, rosogolla gulab jamun, shrikhand, lassi, burfi* etc.;	2
6.	Visit to dairy plants.	2

S. No.	Reference Books
1.	Aneja RP, Mathur BN, Chandan RC & Banerjee AK. 2002. *Technology of Indian Milk Products*. Dairy India Publ.
2	De S.1980. *Outlines of Dairy Technology*. Oxford Univ. Press. Henderson JL. 1971. *Fluid Milk Industry*. AVI Publ.
3.	Rathore NS *et al.* 2008. *Fundamentals of Dairy Technology - Theory & Practices*. Himanshu Publ
4.	Spreer E. 1993. *Milk and Dairy Products*. Marcel Dekker.
5.	Walstra P. 1999. *Dairy Technology*. Marcel Dekker.
6	Walstra P. (Ed.). 2006. *Dairy Science and Technology*. 2nd Ed. Taylor & Francis.
7	Web BH, Johnson AH & Lford JA. 1987. *Fundamental of Dairy Chemistry*. 3rd Ed. AVI Publ.

FST 531 STATISTICAL METHODS FOR FOOD SCIENCE

Credits: 1 + 1
Contact hours: 14+28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 30
End-Semester Exam : 50

Objective: The students will be exposed to various statistical tools required to analyse the experimental data in food research and industry.

Units	Contents	Lectures
I	Descriptive statistics, Mean, variance, probability, conditional probability, Probability distribution.	3
II	Density functions, Mean variance.	7
III	Data and its nature; data representation; diagrams and graphs using MS Excel, Measures of Central tendency; Dispersion, Swekness and Kurtosis; Binomial and Normal Distributions.	6
IV	Confidence Interval of mean; Test of significance; Non-parametric tests; Simple, Partial and Multiple correlations.	7
V	Estimation, confidence intervals hypothesis testing, Basic principles of Experimental Designs; Analysis of Variance; Elements of Quality Control.	5

Practical	Practical Description	
1.	Exercises as per each of the Units in theory.	14

S. No.	Reference Books
1.	Aggarwal BL. 2003. *Basic Statistics*. New Age.
2.	Brookes CJ, Betteley IG & Loxston SM. 1966. *Mathematics and Statistics for Chemists*. John Wiley & Sons.
3.	Gupta SC & Kapoor VK. 2003. *Fundamentals of Mathematical Statistics*. S. Chand & Sons.
4.	Gupta SP. 2004. *Statistical Methods*. S. Chand & Sons.

#Assignments marks

FST 534 APPLIED NUTRITION

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To acquaint the students about importance of nutrition, balanced diets, therapeutic diets for health and role of food and nutraceuticals in health.

Units	Contents	Lectures
I	Importance of nutrition to health and growth; Relation of food and diseases; Nutritional requirement of human body & RDA.	3
II	Preparation of balanced diets; Deficiencies of essential nutrients; Assessment of nutritional status of population; Effect of cooking and processing on nutrients; Nutritional value of processed foods; Therapeutic nutrition.	7
III	Nutritional requirements of special group of people such as infants, pregnant and lactating mothers, patients, aged, etc.; Formulation of special dietary foods.	6
IV	Functional foods and nutraceuticals with attributes to control cardiovascular diseases, cancer, obesity, ageing etc.; Food components and nutrients affecting immune systems, behaviour and performance.	7
V	Functional aspects of dietary fibre, amino acids & peptides, lactic acid bacteria, antioxidants, vitamins, fatty acids etc. Assessment of nutritional quality of food.	5

Practical	Practical Description	
1.	Assessment of nutritional status	4
2.	Planning balanced diets for normal and therapeutic nutrition	4
3.	Formulation of nutrient rich foods	4
4.	Assessment of nutritional quality of food	2

S. No.	Reference Books
1.	Bamji MS, Rao NP & Reddy V. 2003. *Textbook of Human Nutrition*. Oxford & IBH.
2.	Joshi SA.1999. *Nutrition and Dietetics*. Tata McGraw Hill.
3.	Khanna K, Gupta S,Passi SJ, Seth R & Mahna R. 1997. *Nutrition and Dietetics*. Phoenix Publ.
4.	Swaminathan M. 1974. *Essentials of Foods and Nutrition*. Vol. II. Ganesh & Co.

#Assignments marks

FST 451 MATHEMATICS

Credits: 3 + 0 Mid-Session Exam: 40
Contact hours: 42+0 End-Semester Exam: 60

Objective: To provide basic knowledge and fundamentals of mathematics in order to provide a sound foundation for engineering related subjects.

Units	Contents	Lectures
I	**Sets, Relations and Functions** Sets and their Representations, Union, intersection and complements of sets, and their algebraic properties, Relations, equivalence relations, mappings, one-one, into and onto mappings, composition of mappings.	3
II	**Complex Numbers** Complex numbers in the form a+b and their representation in a plane. Argand diagram, Algebra of complex numbers, Modulus and Argument (or amplitude) of a complex number, square root of a complex number, Cube roots of Unity, triangle inequality.	3
III	**Matrices and Determinants:** Determinants and matrices of order two and three, properties of determinants, Evaluation of determinants. Area of triangles using determinants, Addition and multiplication of matrices, adjoint and inverse of matrix, Test of consistency and solution of simultaneous linear equations using determinants and matrices.	3
IV	**Quadratic Equations** Quadratic equations in real and complex number system and their solutions. Relation between roots and co-efficient, nature of roots, formation of quadratic equations with given roots; Symmetric functions of roots, equations reducible to quadratic equations – application to practical problems.	3
V	**Permutations and Combinations** Fundamental principle of counting; Permutation as an arrangement and combination as selection, Meaning of P(n,r) and C(n,r). Simple applications.	3
VI	Mathematical Induction and Its applications.	2
VII	**Binomial Theorem and its Applications** Binomial Theorem for a positive integral index; general term and middle term; Binomial Theorem for any index. Properties of Binomial Co-efficient, Simple applications for approximations.	4
VIII	**Sequences and Series** Arithmetic, Geometric and Harmonic progressions, Insertion of Arithmetic Geometric and Harmonic means between two given numbers, Relation between A.M., G.M. and H.M. Special series: Sn, Sn2, Sn3.Arithmetic-Geometric Series, Exponential and Logarithmic series.	4

IX	**Differential Calculus** Polynomials, rational, trigonometric, logarithmic and exponential functions, Inverse functions, Graphs of simple functions. Limits, Continuity; differentiation of the sum, difference, product and quotient of two functions, differentiation of trigonometric, inverse trigonometric, logarithmic, exponential, composite and implicit functions; derivatives of order up to two. Applications of derivatives: Rate of change of quantities, monotonic - increasing and decreasing functions, Maxima and minima of functions of one variable, tangents and normal's, Rolle's and Lagrange's Mean Value Theorems.	5
X	**Integral Calculus** Integral as an anti-derivative, Fundamental integrals involving algebraic, trigonometric, exponential and logarithmic functions, Integration by substitution, by parts and by partial fractions, Integration using trigonometric identities, Integral as limit of a sum, Properties of definite integrals, Evaluation of definite integrals; determining areas of the regions bounded by simple curves.	3
XI	**Differential Equations** Ordinary differential equations, their order and degree. Formation of differential equations, Solution of differential equations by the method of separation of variables, Solution of homogeneous and linear differential equations, and those of the type d2y dx2 = f(x).	3
XII	**Two dimensional Geometry** Recall of Cartesian system of rectangular coordinates in a plane, distance formula, area of a triangle, condition for the co-linearity of three points and section formula, centroid and in-centre of a triangle, locus and its equation, translation of axes, slope of a line, parallel and perpendicular lines, intercepts of a line on the coordinate axes.	3
XIII	**Trigonometry**-Trignometrical identities and equations, Inverse trigonometric functions and their properties, Properties of triangles, including centroid, in-centre, circum-centre and ortho-centre, solution of triangles, Heights and Distances.	3

S. No.	Reference Books
1.	Grewal BS. 2007. *Higher Engineering Mathematics*. Khanna Publ.
2.	James G. *Advanced Modern Engineering Mathematics.* Pearson Edu.
3.	Ramana BV. *Higher Engineering Mathematics*. Tata McGraw Hill.

FST 452 GENERAL MICROBIOLOGY (Prerequisite for Food Microbiology)

Credits: 1 + 1
Contact hours: 14+28

Mid-Session Exam: 20 (15+5#)
Practical Exam: 30
End-Semester Exam: 50

Objective: To provide basic knowledge about growth, reproduction, requirements of different groups of micro-organisms and techniques of isolation, identification and enumeration of microorganisms

Units	Contents	Lectures
I	Microbiology and its significance; Brief history of microbiology; Prokaryotes and Eukaryotes	7
II	Morphology; structure and function of microbial cells and their components; mode of reproduction in microorganisms.	7
III	Major groups of microorganisms: Role of bacteria, fungi and viruses in foods; Growth cycles, growth patterns; Nutrient requirements and physiology of microorganisms.	7
IV	Physical and chemical factors affecting growth and destruction of microbes- aerobes and anaerobes, psychrophiles, psychrotrophs, mesophiles, thermoduric, thermophiles, halophiles osmophiles and spore formers.	7

Practical	Practical Description	
1.	Study and use of compound microscope	3
2.	Staining techniques-simple, gram staining, capsule, spore, flagella and negative staining	3
3.	Sterilization methods	3
4.	Preparation and types of media	3
5.	Techniques for isolation, identification and enumeration of microorganisms	2

S. No.	Reference Books
1.	Black, JG. 2005. *Microbiology: Principles and Explorations*. John Wiley
2.	Frobischer M. 1968. *Fundamentals of Microbiology*.
3.	Hans G. 1986. *General Microbiology*. Cambridge Univ. Press.
4.	Pelczar JM & Reid RD. 1974. *Microbiology*. Tata McGraw Hill.
5.	Singh RP. 2005. Microbiology. Kalyani Publ
	Stanier R. 1978. *General Microbiology*. MacMillan.

#Assignments marks

FST 553 CROP PRODUCTION: CONCEPTS AND PRACTICES

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Objective: To impart theoretical and practical knowledge about crop production under different agro ecological conditions

Units	Contents	Lectures
I	Agriculture and its role in national development, food security; General features of climate - India; Crop environment, weather and significance of various weather elements; Crop production - definition and scope, crop classification based on season, life cycle, taxonomy and economic use; Growth and yield of crops, growth parameters, yield attributes and factors affecting them; Thermal and photo response of plants, thermal indices and growing degree day concept in crop phenology.	5
II	Quality of good seed, ideal condition for germination, seed treatment, hybrid and composite seeds, categories of seeds (certified, foundation and breeder seed); Importance of sowing time, seed rate, sowing methods, plant population; Tillage and intercultural operations - objectives and methods; Weeds in crop production; Irrigation - scheduling, methods and water use efficiency; Harvesting, threshing, winnowing, storage and processing.	4
III	Crop rotations, mixed cropping, inter cropping, its objectives and importance; Definitions of mono-cropping, double cropping, multiple/intensive cropping, relay cropping with example in brief; Farming system and sustainable agriculture.	4
IV	Rain fed agriculture and dry farming, soil moisture conservation; Agronomic techniques to improve crop yields and watershed management.	3
V	Soil as a three phase disperse system, its physical chemical and biological properties; Soil fertility and soil productivity, manures and fertilizers, integrated nutrient management; Soil and water testing: objectives, sampling techniques, interpretation of results and recommendations; Selection of soil, and management of water and nutrients in pot culture experiments; Problem soils and their management; Soil and water pollution.	4
VI	Classification of vegetable crops; Types of vegetable farming; Principles of vegetable production; Raising of vegetable seedlings under different environmental conditions; Important practices of cool and warm season vegetable crops.	4
VII	Concepts in Horticulture - methods of propagation, systems of planting and layout, training and pruning, fruit growth and development, fruit maturity and ripening; Post harvest management of fruits and flowers; Production technology of fruit and flower crops.	4

Practical	Practical Description	
1.	Identification of seeds of different crops, germination test and seed rate calculations	2

2.	Visit to farm for identification of different crop plants and measurement of growth	2
3.	Herbicide formulations, delivery systems; Field layout of different sowing methods	2
4.	Sampling, processing, storage and analysis of soil samples for available nutrients (N, P, K, S, Fe, Zn, Mn and Cu)	2
5.	Sampling, processing, storage and analysis of plant samples for N, P, K, S, Fe, Zn, Mn and Cu content	2
6.	Raising nursery in field and protected conditions	2
7.	Practices in methods of propagation; various methods of training system and pruning, system of planting	1
8.	Post-harvest processing.	1

Reference Books

	Authors/Name of Books/Publisher
1.	Gopal Chandra De. (1980). Fundamentals of Agronomy. Oxford and IBH Publishing Co. Ltd., Bangalore.
2.	ICAR (Indian Council of Agricultural Research). (2006). Hand Book Of Agriculture. ICAR, New Delhi.
3.	Prasad, R. (2017). Field crops production commercial crops volume II. ICAR, Krishi Anusandhan Bhavan, Pusa, New Delhi.
4.	Pihar, S.S. (2017). Irrigation of Field crops. ICAR Publishers.
5.	Gupta, O.P. (2008).Modern Weed Management. Agribios (India), Jodhpur. 540p.
6.	Reddy,SR., Nagamani,C. (2017). Principles of Crop Production. Kalyani Publishers.
7.	Agrawal, R.L. (2021). Seed Technology. CBS Publishers & Distributors Pvt Ltd.
8.	Biswas, T.D., Mukherjee, S.K. (2014). Textbook of Soil Science. McGraw Hill Education (India) Private Limited, New Delhi.
9.	Singh, J. (2017). Fundamentals of Horticulture. Kalyani Publishers.
10.	Chauhan, D.V.S. (2011). Vegetable Production in India. Ram Prasad & Sons Publisher, Bhopal.

#Assignments marks

ETERNAL UNIVERSITY, BARU SAHIB, RAJGARH, SIRMOUR HIMACHAL PRADESH

Study Scheme & Syllabus

For

M. Tech. (Food Technology) (I to IV Semester)

Syllabi Applicable for Admissions in 2021 onwards

Dr. Khem Singh Gill Akal College of Agriculture

M. Tech. Food Technology

DISTRIBUTION OF CREDITS

Subject	**Credit hours as per BSMA ICAR**
Major	20
Minor	09
Supporting	05
Seminar	01
Industrial Training	01
Thesis	20
Compulsory non-credit courses	06
Total Credits	**62** (35 Course Work + 01 Industrial Training+ 20 Thesis + 06 Non-credit)

SEMESTER WISE DISTRIBUTION OF COURSES

S. No.	Course code	Course title	Credit hrs	Semester
Semester I				
Major				
1	FST 601	Advances in Food Chemistry & Nutrition	2+1	I
2	FST 602	Modern Food Microbiology	2+1	I
3	FST 604	Food Processing	2+0	I
Minor				
4	FST 623	Juice Processing Technology	2+1	I
Non Creditable Courses				
5	PGS-501	Library and Information Services	0+1	I
6	PGS-502	Technical Writing and Communications Skills	0+1	I
Total Credits		**8+3+2**	**13**	
Semester II				
Major				
1	FST 605	Food Packaging	1+1	II
2	FST-606	Food Analysis	0+2	II
3	FST 607	Food Quality Systems & Management	2+1	II
Minor				
4	FST 630	Confectionary Technology	2+1	II
Supporting				
5	FST 531	Statistical Methods for Food Science	1+1	II
Non Creditable Courses				
6	PGS-503	Intellectual Property and Its Management in Agriculture	1+0	II
7	PGS-504	Basic Concepts in Laboratory Techniques	0+1	II
Research				
8	FST 699	Master's Research	0+2	II
Total Credits		**7+3+2+2+2**	**16**	

Semester III				
Major				
1	FST-603	Advances in Food Engineering	2+1	III
2	FST 608	Equipment Design & Process Control	1+1	III
3	FST 591	Master's seminar	1+0	III
Minor				
4	FST 612	Nutraceuticals & Health Foods	2+1	III
Supporting course				
5	FST 533	Business Management & International Trade	3+0	III
Non Creditable Courses				
6	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0	III
7	PGS 506	Disaster Management	1+0	III
Research				
8	FST 699	Master Research	0+3	III
Total credits		**5+3+3+3+3**	**17**	
Semester IV				
Research				
1	*FST 590	Industrial Training	0+1	IV
2	FST 699	Master Research	0+15	IV
Total credits		**1+15**	**16**	

***Training programme:** The students are required to undertake compulsory four to six weeks training (preferably during semester break) in a reputed food industry/organization after completion of major courses. On completion of the training, the students are required to submit a report. The departmental committee on the basis of certificate from host industry/organization, training report, and viva voce will assess the student's performance. They will be awarded Satisfactory/Unsatisfactory grade.

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

Course Contents

M. Tech. Food Technology

FST-601
ADVANCES IN FOOD CHEMISTRY AND NUTRITION

Credit hours: 2 + 1
Contact hours: 28+28

Mid-sessional exam: 25 (20+5#)
End-semester exam: 40
Practical exam: 35

Objective: To go beyond basic chemistry and nutrition in to advances with the aim of developing healthy and nutritious foods for normal and special category of population groups

Units	Contents	Lectures
I	Interactions among food components and their effect on sensory, nutritional and processing quality, Natural antioxidants, mechanisms of action and their evaluation techniques, Advanced glycation end products and their nutritional significance; Free radical chemistry, reactive oxygen, photosensitized oxidation, metal catalyzed reactions. Antioxidants: chemistry and mechanisms of action, techniques of evaluation of antioxidant activity, uses.	6
II	Water relationships in foods: water activity and its relevance to deteriorative processes in foods (chemical, enzymic, physical and microbial changes). Glass transitions and molecular mobility in foods, their relevance to quality and stability of food products, Food Carbohydrates: structural, analytical, physicochemical, nutritional and functional aspects of small mol. wt. carbohydrates and polysaccharides of plant and microbial origin.	5
III	Fragrance and flavouring compounds: essential oils, terpenoids -oleo resins biochemical pathways for the production of volatile compounds in specific plant species; Chemical structure, distribution, diurnal and seasonal fluctuations; Intraspecific differences in volatiles oil production, differentiation between geographical origins; Turpentine and terpene industry and, biological Interactions among food components and flavours, Interactions among food flavours and packaging materials, Interactions among food additives and their significance in food processing.	7
IV	Therapeutic, Parenteral and Geriatric nutrition and relevant food formulations, genetic disorders and nutritional requirements, Gene regulation in secondary metabolism, Tissue specificity (phenyl propanoids) and stress responsiveness (terpenoids indole alkaloids), Compartmentation, storage and transport.	5
V	Appetite suppressants, phytosterols, polyphenols, phytoestrogens, ω-fatty acids, glucosinolates, non-digestible oligosaccharides, Glycemic index and its role in human nutrition, Prebiotics and probiotics, Chemistry of Alkaloids, Flavonoids and other Phenolics.	

Practical	Practical Description	
1.	Study of browning reactions in model systems.	1
2.	Estimation of natural antioxidants in foods.	1
3.	Estimation of the environmental effects on auto-oxidation of processed foods, measurement of water activity and plotting of sorption isotherm of selected foods.	1
4.	Determination of physical, chemical, enzymatic and microbial changes in relation to water activity.	2
5.	Evaluation of physicochemical and functional properties of carbohydrates.	2
6.	Separation and estimation of essential oils and oleoresins.	1
7.	Study of interaction among food components, additives and flavours with food packaging.	2
8.	Formulation of therapeutic and probiotics foods.	2
9.	Determination of Glycemic index of selected foods.	2

S. No.	Reference Books
1.	Toldrá, F. 2012. Advances in Food and Nutrition Research. Elsevier Book Series.
2.	Aurand LW, Woods A & Wells MR. 1987. Food Composition and Analysis. AVI Publ.
3.	Baynes JW, Monnier VM, Ames JM & Suzanne R. 2005. The Maillard Reaction: Chemistry at the Interface of Nutrition, Aging, and Disease Thorpe. Annals of the New York Academy of Science.
4.	Birch GG & Lindley MG.1986. Interactions of Food Components. Elsevier.
5.	Fennema OR. 1996. Food Chemistry. Marcel Dekker.
6.	Kumar A & Gaonkar G. 1995. Ingredient Interaction: Effect on Food Quality. Marcel Dekker.

#Assignments marks

FST-602
MODERN FOOD MICROBIOLOGY

Credit hours: 2 + 1
Contact hours: 28+28

Mid-sessional exam: 25 (20+5#)
End-semester exam: 40
Practical exam: 35

Objective: To expose to the recent advances and applications in the area of food microbiology

Units	Contents	Lectures
I	Foods as ecological niches, Relevant microbial groups, Microbes found in raw materials and foods that are detrimental to quality, Factors that influence the development of microbes in food, newer and rapid methods for qualitative and quantitative assay demonstrating the presence and characterization of microbes, Stress, damage, adaptation, reparation, death.	8
II	Microbial growth in food: intrinsic, extrinsic and implicit factors, Microbial interactions, Inorganic, organic and antibiotic additives. Effects of enzymes and other proteins, Combination systems, Adaptation phenomena and stress phenomena, Effect of injury on growth or survival, Commercial available databases.	7
III	Microbial behavior against the newer methods of food processing, Adoption and resistance development, Microbes as test organisms, as sensors and as tools for future applications in energy production and food and non-food industrial products.	7
IV	Modern methods of cell culture: synchronous and co- cell culture, continuous cell culture in liquid and solid media, Cell immobilization and applications, Pre and probiotics cultures.	6

Practical	Practical Description	
1.	Evaluation of microorganism in raw and processed products by using various techniques.	3
2.	Study of factors influencing growth of microorganisms.	3
3.	Determination of effects of various preservatives including antibiotics on the suppression of microbial growth.	3
4.	Development of cell cultures using various techniques.	2
5.	Production of newer microbial metabolites of industrial importance and development of probiotics in lab.	3

S. No.	Reference Books
1.	Adams M. 2006. *Emerging Food-borne Pathogens*. Woodhead Publ.
2.	Adams MR & Moss MO. 2000. *Food Microbiology*. Panima.
3.	Easter MC. 2003. *Rapid Microbiological Methods in the Pharmaceutical Industry*.
4.	Harrigan W. 2003. *Laboratory Methods in Food Microbiology*. University of Reading, UK, Elsevier.
5.	James MJ, Loessner MJ & David A. 2005. *Modern Food Microbiology*. 7th Ed. Golden Food Science Text Series.
6.	Pederson CS.1979. *Microbiology of Food Fermentations*. AVI Publ.
7.	Roberts R .2002. *Practical Food Microbiology*. Blackwell Publ.
8.	Rossmore HW. 1995. *Handbook of Biocide and Preservative*. Blackie
9.	Wood JBB. 1999. *Microbiology of Fermented Foods*. Vols. I, II. Blackwell Academic.
10.	Yousef AE. 2002. *Food Microbiology: A Laboratory Manual*. AVI.

#Assignments marks

FST-603
ADVANCES IN FOOD ENGINEERING

Credit hours: 2 + 1
Contact hours: 28+28

Mid-sessional exam: 25 (20+5[#])
End-semester exam: 40
Practical exam: 35

Objective: To acquaint with recent advances of Food Engineering and its Processes

Units	Contents	ectures
I	Engineering properties of foods, their significance in equipment design, processing and handling of food and food products, steady state and unsteady state heat transfer, Numerical, graphical and analog methods in the analysis of heat transfer. Solution of unsteady state equations, solar radiation.	6
II	Mass transfer, molecular diffusion and diffusivity, equilibrium stage process, convective mass transfer co-efficient, mass transfer with laminar and turbulent flow. Design equations for convective mass transfer, simultaneous momentum, Separation by equilibrium stages, immiscible phases, distillation of binary mixtures and multi-component separations.	6
III	Aerodynamics and hydrodynamic characteristics, drag coefficient, terminal velocity and Reynold's number, application of aerodynamic properties to the separation, pneumatic handling and conveying of food products, material and energy balance.	5
IV	Thermodynamic properties of moist air, kinetics of water absorption, Evaporation and dehydration of foods, design of single and multi-effect evaporators, mechanics of movement of air through stationary bed, thin layer and thick layer bed drying, simulation models for drying systems, use of weather data for drying operations, design of dryers, New direction in freeze bed drying, cyclic pressure freeze drying. Microwave drying and vacuum drying, efficient drying systems, infrared heating, freezing of foods, freeze concentration and drying, freezing point curves, phase diagrams, methods of freeze concentration, design problems.	7
V	Theory of ultra-filtration and reverse osmosis, selection and types of membranes and properties, concentration polarization, mathematical description of flow through membrane, application and use in food industry.	4

Practical	Practical Description	
1.	Determination of engineering properties of foods.	1
2.	To design problems on evaporators; measurement of heat transfer using selected heat exchangers in model study.	2
3.	Evaluation of mass transfer and estimation of mass transfer coefficient of selected foods in evaporators and dehydrators.	2
4.	Separation of immiscible phase using appropriate centrifuge.	1

5.	Fractional distillation of multi-component mixtures, air classification and determination of particle size index of powdered food materials.	2
6.	Study of pneumatic conveyers using fluidized solids.	2
7.	Determination of drying rate and curves under various drying conditions.	2
8.	Determination of freezing curves for selected fresh fruits and vegetables, application of ultra-filtration and reverse osmosis in processing of fruit juices.	2

S. No.	Reference Books
1.	Charm SE. 1971. Fundamental of Food Engineering. AVI Publ.
2.	Cheryan M. 1998. Ultra-filtration and Micro-filtration Handbook. Technomic Publ.
3.	Duckworth R. 1975. Water Relations in Foods. Academic Press.
4.	Heldman DR & Singh RP.1984. Food Process Engineering. AVI Publ.
5.	Hendrickx and Knorr. Rockland LB & Stewart GF. 1991. UHP Treatments of Foods. KA/PP Publ.
6.	Mohsenin NN. 1986. Physical Properties of Plant and Animal Materials. Gordon & Breach Science Publ.
7.	Rao MA & Rizvi SS.1986. Engineering Properties of Foods. Marcel Dekker.
8.	Robertson GL. 1992. Food Packaging (Principles and Practices). Marcel Dekker.
9.	Watson EL & Harper JC.1989. Elements of Food Engineering. AVI Publ.

#Assignments marks

FST-604
FOOD PROCESSING

Credit hours: 2 + 0
Contact hours: 28 +0

Mid-sessional exam: 40 (30+10[#])
End-semester exam: 60

Objective: To develop an insight among the students about the existing modern techniques so as to aware them about their methodology and applications in food processing

Units	Contents	Lectures
I	Membrane technology: Introduction to pressure activated membrane processes: micro- filtration, UF, NF and RO and their industrial application. Supercritical fluid extraction: Concept, property of near critical fluids NCF and extraction methods.	7
II	Microwave and radio frequency processing: Definition, Advantages, mechanism of heat generation, application in food processing: microwave blanching, sterilization and finish drying. Hurdle technology: Types of preservation techniques and their principles, concept of hurdle technology and its application.	7
III	High Pressure processing: Concept, equipment for HPP treatment, mechanism of microbial inactivation and its application in food processing. Ultrasonic processing: Properties of ultrasonic, application of ultrasonic as processing techniques.	7
IV	Newer techniques in food processing: Application of technologies of high intensity light, pulse electric field, Ohmic heating, IR heating, inductive heating and pulsed X-rays in food processing and preservation. Nanotechnology: Principles and applications in foods.	7

S. No.	Reference Books
1.	Barbosa-Canovas 2002. *Novel Food Processing Technologies*. CRC.
2.	Dutta AK & Anantheswaran RC.1999. *Hand Book of Microwave Technology for Food Applications*.
3.	Frame ND. (Ed.). 1994. *The Technology of Extrusion Cooking*. Blackie.
4.	Gould GW. 2000. *New Methods of Food Preservation*. CRC.
5.	Shi J. (Ed) 2006. *Functional Food Ingredients and Nutraceuticals: Processing Technologies*. CRC.

#Assignments marks

FST-605
FOOD PACKAGING

Credit hours: 1 + 1
Contact hours: 14+28

Mid-sessional exam: 20 (15+5#)
End-semester exam: 30
Practical exam: 50

Objective: To provide knowledge about selected trends and development in food packaging technologies and materials aiming at assuring the safety and quality of foodstuffs in order to design an optimized package which satisfies all legislative, marketing and functional requirements sufficiently, and fulfils environmental, cost and consumer demands as well as possible modern packaging techniques etc.

Units	Contents	Lectures
I	Active and intelligent packaging, Active packaging techniques, Intelligent packaging techniques, Current use of novel packaging techniques, Oxygen, ethylene and other scavengers, Oxygen scavenging technology, Ethylene scavenging technology, Carbon dioxide and other scavengers, antimicrobial food packaging: Constructing an antimicrobial packaging system, Factors affecting the effectiveness of antimicrobial packaging.	3
II	Non-migratory bioactive polymers (NMBP) in food packaging, Advantages of NMBP, limitations, inherently bioactive synthetic polymers: types and applications, Polymers with immobilized bioactive compounds.	2
III	Time-temperature indicators (TTIs), Defining and classifying TTIs, requirements for TTIs, The development of TTIs, Current TTI systems, maximizing the effectiveness of TTIs, Using TTIs to monitor shelf-life during distribution, Using TTIs to optimize distribution and stock rotation.	2
IV	Packaging-flavour interactions, Factors affecting flavour absorption, role of the food matrix, role of differing packaging materials, Case study: packaging and lipid oxidation, Modeling flavour absorption, Packaging–flavour interactions and active packaging, Novel MAP applications for fresh-prepared produce, Novel MAP gases, Testing novel MAP applications, Applying high O2 MAP.	3
V	Modern packaging systems: Green plastics for food packaging, The problem of plastic packaging waste, The range of biopolymers, Developing novel biodegradable materials, Legislative issues, Current applications, integrating intelligent packaging , role of packaging in the supply chain, creating integrated packaging, storage and distribution: alarm systems and TTIs, Traceability: radio frequency identification, Recycling packaging materials: The recyclability of packaging plastics, Improving the recyclability of plastics packaging, Testing the safety and quality of recycled material, Using recycled plastics in packaging.	4

Practical	Practical Description	
1.	Determination of GTR and WVTR in different packaging materials.	2
2.	Use of oxygen and ethylene scavengers in packaging of fresh fruits.	2
3.	Application of anti-microbial packaging for moisture sensitive foods.	2
4.	Evaluation of pesticide residue migration from package to food, application of MAP and active packaging in selected foods.	2
5.	Determination of oxidative changes in packaged foods.	2
6.	Comparative evaluation of flexible and rigid packages for fragile foods	2
7.	Packaging of foods under inert atmosphere.	2

S. No.	Reference Books
1.	Ahvenainen R. 2001. *Novel Food Packaging Techniques*. CRC.
2.	Crosby NT. 1981. *Food Packaging Materials*. App. Sci. Publ.
3.	Mahadeviah M & Gowramma RV. 1996. *Food Packaging Materials*. Tata McGraw Hill.
4.	Painy FA. 1992. *A Handbook of Food Packaging*. Blackie.
5.	Palling SJ. 1980. *Developments in Food Packaging*. App. Sci. Publ.
6.	Rooney ML. 1988. *Active Food Packaging.* Chapman & Hall.
7.	Sacharow S & Griffin RC.1980. *Principles of Food Packaging.* AVI Publ.
8.	Stanley S & Roger CG. 1998. *Food Packaging*. AVI Publ.

#Assignments marks

FST-606
FOOD ANALYSIS

Credit hours: 0 + 2
Contact hours: 0+56

Mid-session practical exam: 50
End-semester practical exam: 50

Objective: To develop an understanding and methodologies of instrumental techniques in food analysis used for objective methods of food quality parameters

Practical	**Practical Description**	
1.	Texture analysis of foods.	2
2.	Colour measurements in raw and processed foods.	2
3.	Viscosity measurements and its significance in food quality.	2
4.	Water activity measurements and its significance in food quality.	2
5.	Techniques for dough rheology and starch characterization.	2
6.	Surface tension and its significance in food analysis.	2
7.	Enzymatic methods of food analysis.	2
8.	Microscopic techniques in food analysis (light microscopy, SEM, TEM, XRD, particle size analysis, image analysis etc.)	3
9.	Thermal methods in food analysis (Differential scanning colorimetry and others)	2
10.	Chromatographic methods in food analysis and separation	2
11.	Extraction techniques in food analysis.	2
12.	Fluorimetric and polarimetric techniques in food analysis.	2
13.	Application and operating parameters of Spectrophotometer, AAS, GC, HPLC, NMR, FTIR, GC-MS, LC-MS.	3

S. No.	**Reference Books**
1.	Clifton M & Pomeranz Y. 1988. *Food Analysis - Laboratory Experiments*. AVI Publ.
2.	Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. I. *Physical Characterization*. Marcel Dekker.
3.	Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. II. *Physicochemical Techniques.* Marcel Dekker.
4.	Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. III. *Biological Techniques.* Marcel Dekker.
5.	Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. IV. *Separation Techniques.* Marcel Dekker.
6.	Leenheer AP, Lambert WE & van Bocxlaer JF. 2000. *Modern Chromatographic Analysis of Vitamins*. 3rd Ed. Marcel Dekker.
7.	Nollet LML. 1986. *Handbook of Food Analysis*. Vol. I. Marcel Dekker.

FST-607
FOOD QUALITY SYSTEMS AND MANAGEMENT

Credit hours: 2 + 1
Contact hours: 28+28

Mid-sessional exam: 25 (20+5#)
End-semester exam: 40
Practical exam: 35

Objective: To acquaint with food quality parameters and control systems, food standards, regulations, specifications

Units	Contents	Lectures
I	Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation; Sensory vis-àvis Instrumental methods for testing quality.	8
II	Concepts of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Sampling procedures and plans; Food Safety and Standards Act, 2006; Domestic regulations; Global Food safety Initiative; Various organizations dealing with inspection, traceability and authentication, certification and quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS); Labeling issues; International scenario, International food standard.	10
III	Quality assurance, Total Quality Management; GMP/GHP; GLP, GAP; Sanitary and hygienic practices; HACCP; Quality manuals, documentation and audits; Indian & International quality systems and standards like ISO and Food Codex; Export import policy; export documentation; Laboratory qualityprocedures and assessment of laboratory performance; Applications in different food industries; Food adulteration and food safety. IPR and Patent.	10

Practical	Practical Description	
1.	Testing and evaluation of quality attributes of raw and processed foods.	1
2.	Detection and estimation of food additives and adulterants.	1
3.	Quality assurance procedure, GMP, GAP documentation.	2
4.	Preparation of quality policy & documentation.	1
5.	Application of HACCP to products.	1
6.	Preparation of HACCP chart.	1
7.	Preparation of documentation & records.	2
8.	Visit to Units with ISO systems.	1
9.	Visit to Units with HACCP certification.	2
10.	Visit to Units implementing GMP, GAP.	1
11.	Mini-project on preparation of a model laboratory manual.	1

S. No.	Reference Books
1.	Amerine MA *et al* 1965. *Principles of Sensory Evaluation of Food*. Academic Press.
2.	Early R.1995. *Guide to Quality Management Systems for Food Industries*. Blackie Academic.
3.	Furia TE.1980. *Regulatory Status of Direct Food Additives*. CRC Press.
4.	Jellinek G. 1985. *Sensory Evaluation of Food - Theory and Practice*. Ellis Horwoood.
5.	Krammer A & Twigg BA.1973. *Quality Control in Food Industry*. Vol. I, II. AVI Publ.
8.	Macrae R. *et al*.1994. *Encyclopedia of Food Science & Technology & Nutrition*. Vol. XVI. Academic Press.
9.	Piggot JR. 1984. *Sensory Evaluation of Foods*. Elbview Applied Science.
10.	Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw-Hill.
11.	Export/import Policy by Govt of India.

#Assignments marks

FST-608
EQUIPMENT DESIGN AND PROCESS CONTROL

Credit hours: 1 + 1
Contact hours: 14+28

Mid-sessional exam: 20 (15+5[#])
End-semester exam: 30
Practical exam: 50

Objective: To introduce basic equipment design and various process control mechanisms and related engineering aspects

Units	Contents	Lectures
I	Basic Scientific and Engineering principles of equipment design and process control, Properties of substances, chemical equation and stoichiometry, phases and phases rule, material and energy balances, energy balance and open system. Engineering properties of food materials and their significance in equipment design. Principles of CAD and its simple application.	3
II	Design of Vessels: Codes and regulations, Materials of construction, Design for pressures, Design pressure and temperature loadings, allowable stresses, minimum thickness after forming, corrosion mechanism, corrosion control, Design for internal and external pressure, cylindrical and spherical shell, formed heads, re-enforcement openings.	2
III	Design of food storage tank, horizontal and vertical silos, insulated and uninsulated, process plant piping: codes and regulations, testing, fabrication requirements, overall economic and safety considerations, heat exchangers: shell and tube heat exchangers, construction codes, general design considerations, clad tube sheet, plate type exchangers, air cooled heat exchangers, heat exchanger cost economics.	3
IV	Instrument terminology and performance system accuracy, flow sheet symbols, instrument evaluation, electrical, mechanical, magnetic and optical transducers for measurement of process variables like temperature, pressure, flow, level, consistency and humidity, indicating and recording devices: direct acting and servo operated systems, digital indicators, strip and circular chart recorders, electronic data loggers, principles of automatic process control.	3
V	Process characteristics, controller characteristics, closed loop system, pneumatic and electric controllers, final controlling elements, control valves, valve sizing, electronic actuators, motor drives and controls, introduction to programmable logic controllers (PLC): internal structure, inter facing with sensors and actuators, binary logic diagrams and ladder diagrams, choosing a PLC system.	3

Practical	Practical Description	
1.	Design of short, intermediate length and long cylindrical vessels.	2
2.	Design of spherical vessels.	2
3.	Design of shell and tube, double pipe, scarped surface and spiral tube heat exchangers.	1
4.	Design of jacketed vessels - insulation thickness, corrosion allowance.	1
5.	Study of various transducers for measurement of pressure, flow level, humidity and temperature	2
6.	Study of controller and recorder of pasteurizer.	2
7.	The working of controllers at constant temperature water baths, make ladder diagrams and flow sheet diagrams for control logics.	2
8.	Programme a PLC and design a computer interface of a PLC.	1
9.	Visit a food processing plant to study data acquisition and process control system.	1

S. No.	Reference Books
1.	Considine DM. 1974. *Process Instruments and Controls*. Mc-Graw-Hill.
2.	Considine DM. 1964. *Handbook of Applied Instrumentation*. Mc-Graw-Hill.
3.	Eackman DP. 1972. *Automatic Process Control*. Wiley Eastern.
4.	Evans FL. 1974. Equipment Design Hand Book. Vol. II. Gulf Publ.
5.	Foust AS et al. 1960. *Principle of Unit Operations*. John Wiley & Sons.
6.	Hesse ND, C.R. & Ruston JH. 1964. *Process Equipments Design*. Affiliated East-West Press.
7.	*Kempe's Engineers Year Book* 1996. Miller Information Services, UK.
8.	Kern DQ. 1965. *Process Heat Transfer*. McGraw-Hill.
9.	Liptak BG. 1995. *Process Measurement and Analysis*. Butterworth-Heinmann.
10.	McCabe WL, Smith JC & Harriott P. 1993. McGraw Hill.

#Assignments marks

FST-612
NUTRACEUTICALS AND HEALTH FOODS

Credit hours: 2 + 1
Contact hours: 28+28

Mid-sessional exam: 25 (20+5#)
End-semester exam: 40
Practical exam: 35

Objective: To cater to the newly emerging area of nutraceuticals with respect to the types, mechanisms of action, manufacture of selected nutraceuticals, product development, clinical testing and toxicity aspects.

Units	Contents	Lectures
I	Introduction to nutraceuticals: definitions, synonymous terms, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals including CODEX.	5
II	Concept of angiogenesis and the role of nutraceuticals/functional foods; Nutraceuticals for cardiovascular diseases, cancer, diabetes, cholesterol management, obesity, joint pain, immune enhancement, age-related macular degeneration, endurance performance and mood disorders – compounds and their mechanisms of action, dosage levels, contraindications if any etc.	9
III	Manufacturing aspects of selected nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc.; formulation of functional foods containing nutraceuticals – stability and analytical issues, labelling issues.	7
IV	Clinical testing of nutraceuticals and health foods; interactions of prescription drugsandnutraceuticals;adverse effects andtoxicity ofnutraceuticals; nutrigenomics – an introduction and its relation to nutraceuticals.	7

Practical	Practical Description	
1.	Market survey of existing health foods.	2
2.	Identification and estimation of selected nutraceuticals.	3
3.	Production and quality evaluation of foods containing nutraceuticals.	3
4.	Development of labels for health foods.	3
5.	Visit to relevant processing units.	3

S. No.	Reference Books
1.	Brigelius-Flohé, J & Joost *HG. 2006. Nutritional* Genomics: Impact on Health and Disease. Wiley VCH.
2.	Cupp J & Tracy TS. 2003. *Dietary Supplements: Toxicology and Clinical Pharmacology*. Humana Press.
3.	Gibson GR & William CM. 2000. *Functional Foods - Concept to Product*.
4.	Goldberg I. 1994. *Functional Foods: Designer Foods, Pharma Foods*.
5.	Losso JN. 2007. *Angi-angiogenic Functional and Medicinal Foods*. CRC Press.

6.	Manson P.2001. Dietary Supplements. 2nd Ed. Pharmaceutical Press.
7.	Campbell JE & Summers JL. 2004. *Dietary Supplement Labeling Compliance*.
8.	Neeser JR & German BJ. 2004. *Bioprocesses and Biotechnology for Nutraceuticals.* Chapman & Hall.
9.	Robert EC. 2006. *Handbook of Nutraceuticals and Functional Foods*. 2nd Ed. Wildman.
10.	Shi J.(Ed) 2006. *Functional Food Ingredients and Nutraceuticals: Processing technologies*. CRC.
11.	Webb GP. 2006. *Dietary Supplements and Functional Foods*. Blackwell Publ.

#Assignments marks

FST-623
JUICE PROCESSING TECHNOLOGY

Credits: 2 + 1
Contact hours: 28+28

Mid-session exam: 25 (20+5#)
End-semester exam: 40
Practical exam: 35

Objective: To understand basic fundamentals of Juice Processing Technology and to acquaint with various juice processing technology.

Units	Contents	Lectures
I	Juice Processing: Present status of juice processing in India & Abroad. Recent advances in juice processing technology. Prospects of future growth in juice processing in India.	6
II	Fruits & its processing: Harvesting and pre-processing consideration, Post harvesting processing, washing, skin removal, cutting and trimming, blanching, canning, freezing & dehydration of fruits, Fruit Processing: Freezing, blanching, ascorbic acid dip, SO2 dip, sugar syrup preservation, salt preservation, vacuum dehydration, concentration and drying, Application of membrane technology in processing of juices, Juice Processing: Orange juice, Grape fruit juice, Lemon & Lime juice, Pine apple juice, Apple juice, Mango juice.	8
III	Fruits Beverages & other processing: Fruit Beverage, Orange squash, Grape fruit squash, Lemon squash, Orange squash, Pine apple squash, Syrups, Rose, Sandal, pine apple, orange, mulberry & apple, Carbonated beverage, Lemon, lime, pine apple, Fruit juice concentrate, Tamarind Juice Concentrate and Fermented Beverages, Miscellaneous, fruit juices, tropical fruit beverages, Nectars, pulpy juices, tropic blends, Beverages- Classification, Scope, Manufacture of carbonated non-alcoholic beverages.	7
IV	Equipments & tools for juice extraction: Equipments for fruit juices, Washing equipment, sorting equipment, extraction equipment, Halving & burring machine, Roller type Press, Crusher for grape berries, Pulping equipment, Straining & screening, filtration equipment, De-areator & flash Pasteurizer.	7

Practical	Practical Description	
1.	Preparation of fruit juices- orange, pineapple, apple, lemon etc.	1
2.	Preparation of syrups.	2
3.	Preparation of fruit beverage i.e. orange squash, grape squash, lime squash, lime juice cordial.	2
4.	Preparation of fruit juice concentrates.	2
5.	Preparation of fermented beverages.	1
6.	Preparation of carbonated beverages.	2
7.	Post-harvest handling of fruits for juice extraction.	1
8.	Preparation of nectars.	1

9.	Packaging of fruit juices.	1
10.	Visit to fruit juice factory.	1

S. No.	Reference Books
1.	Nelson PE & Tressler DK. 1980. *Fruit & Vegetable Juice Processing Technology*. Vol. III. AVI Publ.
2.	Potter NN. 1978. *Food Science*. 3rd Ed. AVI Publ.
3.	Lal G, Siddappa GS & Tandon GL. 1998. *Preservation of Fruits and Vegetables*. ICAR.
4.	Desrosier NW & James N. 2004. *The Technology of Food Preservation*. 4th Ed. CBS.

#Assignments marks

FST-630
CONFECTIONERY TECHNOLOGY

Credits: 2 + 1
Contact hours: 28+28

Mid-session exam: 25 (20+5#)
End-semester exam: 40
Practical exam: 35

Objective: To provide an understanding of various classes of confectionary products, their manufacture and quality aspects

Units	Contents	Lectures
I	Raw Materials for Confectionery Manufacture, Comprehensive understanding of raw materials used in the confectionery manufacturing and processing industry, including quality control methods. cocoa, Sugar, Dried milk products, Special fats, Emulsifiers, Nut kernels, Alcoholic ingredients, The production of cocoa liqueur from the cocoa bean, Dark, milk and white chocolate, manufacturing processes.	6
II	Chocolate Processing Technology, Compound Coatings & Candy Bars, Tempering technology, Chocolate hollow figures, Chocolate shells, Enrobing technology, Manufacture of candy bars, Presentation and application of vegetable fats. Production of chocolate mass.	5
III	Sugar Confectionery manufacture, General technical aspects of industrial sugar confectionery manufacture, Manufacture of high boiled sweets Ingredients, Methods of manufacture, Types, Centre filled, lollipops, co-extruded products. Manufacture of gums and jellies–Quality aspects.	6
IV	Manufacture of Miscellaneous Products, Caramel, Toffee and fudge, Liquorices paste and aerated confectionery, Lozenges, sugar panning and Chewing gum, Count lines Quality aspects, fruit confections.	5
V	Flour confectionary Ingredients and flour specification - Types of dough – Developed dough, short dough, semi-sweet, and enzyme modified dough and batters- importance of the consistency of the dough. Indian flour confections manufacture, Flour specification, ingredients, manufacturing process, types of cheomically aerated goods.	6

Practical	Practical Description	
1.	Quality assessment of flour, batter rheology.	3
2.	Leavening agents, Different tests for leavening action of baking powder, sodium-bicarbonate and ammonium-bi-carbonate.	3
3.	Preparation of different varieties of sugar, candies, chewing gums, and chocolate.	4
4.	Flour confections, fruit confections, Indian traditional confections, chikki, etc.	4

S. No.	Reference Books
1.	Bent A, Bennion EB & Bamford GST. 1997. *The Technology of Cake Making*. 6th Ed. Blackie.
2.	Jackson EB.1999. *Sugar Confectionery Manufacture*. 2nd Ed. Aspen Publ.
3.	Junk WR & Pancost HM. 1973. *Hand Book of Sugars for Processors. Chemists and Technologists*. AVI Publ.
4.	Manley DJR.1983. *Technology of Biscuits, Crackers, and Cookies*. Ellis Horwood.
5.	Matz SA. 1992. *Bakery Technology and Engineering*. 3rd Ed. Chapman & Hall.
6.	Pomeranz Y. 1987. *Modern Cereal Science and Technology*. MVCH Publ.

#Assignments marks

FST-531
STATISTICAL METHODS FOR FOOD SCIENCE

Credit hours: 1 + 1
Contact hours: 14+28

Mid-sessional exam: 20 (15+5#)
End-semester exam: 30
Practical exam: 50

Objective: The students will be exposed to various statistical tools required to analyse the experimental data in food research and industry.

Units	Contents	Lectures
I	Descriptive statistics, Mean, variance, probability, conditional probability, Probability distribution.	3
II	Density functions, Mean variance.	3
III	Data and its nature; data representation; diagrams and graphs using MS Excel Measures of Central tendency; Dispersion, Swekness and Kurtosis; Binomial and Normal Distributions.	2
IV	Confidence Interval of mean; Test of significance; Non-parametric tests; Simple, Partial and Multiple correlations.	3
V	Estimation, confidence intervals hypothesis testing, Basic principles of Experimental Designs; Analysis of Variance; Elements of Quality Control.	3

Practical	Practical Description	
1.	Descriptive statistics, Mean, variance, probability, conditional probability, Probability distribution.	3
2.	Density functions, Mean variance.	2
3.	Data and its nature; data representation; diagrams and graphs using MS Excel, Measures of Central tendency; Dispersion, Swekness and Kurtosis; Binomial and Normal Distributions.	3
4.	Confidence Interval of mean; Test of significance; Non-parametric tests; Simple, Partial and Multiple correlations.	3
5.	Estimation, confidence intervals hypothesis testing, Basic principles of Experimental Designs; Analysis of Variance; Elements of Quality Control.	3

S. No.	Reference Books
1.	Aggarwal BL. 2003. *Basic Statistics*. New Age.
2.	Brookes CJ, Betteley IG & Loxston SM. 1966. *Mathematics and Statistics for Chemists*. John Wiley & Sons.
3.	Gupta SC & Kapoor VK. 2003. *Fundamentals of Mathematical Statistics*. S. Chand & Sons.
4.	Gupta SP. 2004. *Statistical Methods*. S. Chand & Sons.

#Assignments marks

FST-533
BUSINESS MANAGEMENT & INTERNATIONAL TRADE

Credits: 3+0 Mid-session exam: 40 (30+10#)
Contact hours: 42+0 End-semester exam: 60

Objective: To acquaint with techniques of Business Management & International Trade for food sector

Units	Contents	Lectures
I	Concept andfunctionsofmarketing;concepts and scope of marketing management; concepts and elements of marketing mix.	8
II	Concept of market structure, micro and macro environments; Consumer behaviour; consumerism; Marketing opportunities- Analysis, marketing research and marketing information systems.	9
III	Market measurement- present and future demand; Market forecasting; market segmentation, targeting and positioning, Allocation and marketing resources, Marketing Planning Process, Product policy and planning: Product-mix; product line; product life cycle, New product development process. Product brand, packaging, services decisions. Marketing channel decisions, Retailing, wholesaling and distribution, Pricing Decisions, Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry, Promotion-mix decisions	9
IV	Advertising; how advertising works? Deciding advertising objectives, advertising budget and advertising message, Media Planning, Personal Selling, Publicity; Sales Promotion, Food and Dairy Products Marketing.	8
V	International Marketing and International Trade, Salient features of International Marketing, Composition & direction of Indian exports; International marketing environment; Deciding which & how to enter international market; Exports-Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment & internationalization process, Deciding marketing Programme; Product, Promotion, Price, Distribution Channels. Deciding the Market Organization; World Trade Organization (WTO).	8

S. No.	Reference Books
1.	Chhabra T.N & Suria RK. 2001. *Management Process and Perspectives*. Kitab Mahal.
2.	Jhingan ML. 2005. *International Economics*. 5th Revised and Enlarged Ed. Virnda Publ.
3.	Kotler P. 2000. *Marketing Management*. Prentice-Hall.
4.	Reddy SS, Ram PR, Sastry TVN & Bhavani ID. 2004. *Agricultural Economics*. Oxford & IBH.

#Assignments marks

PGS 501
LIBRARY AND INFORMATION SERVICES

Credit hours: 0 + 1
Contact hours: 0+28

Mid-session practical exam: 50
End-semester practical exam: 50

Objective: To equip the library users with skills: to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical	**Practical Description**	
1.	Introduction to library and its services	1
2.	Role of libraries in education, research and technology transfer	2
3.	Classification systems and organization of library	1
4.	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources	1
5.	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.)	2
6.	Tracing information from reference sources	2
7.	Literature survey; Citation techniques/Preparation of bibliography	1
8.	Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services	2
9.	Use of Internet including search engines and its resources; e-resources access methods	2

PGS-502
TECHNICAL WRITING AND COMMUNICATIONS SKILLS

Credit hours: 0 + 1
Contact hours: 0+28

Mid-session practical exam: 50
End-semester practical exam: 50

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc.
To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical	Practical Description	
1.	***Technical writing*** Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.	8
2.	***Communication skills*** Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.	6

Sr. No.	Reference Books
1.	Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek, Chandigarh.
2.	Chicago Manual of Style. 14th Ed. 1996. Prentice-Hall of India, New Delhi.
3.	Collins' Cobuild English Dictionary. 1995. Harper Collins, New York.
4.	Gibaldi, Joseph. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press, New Delhi.
5.	Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford UP, Oxford.
6.	Krishna Mohan 2005. Speaking English Effectively. Macmillan India, New Delhi.
7.	Mills Gordon H & John A Walter. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston, New York.
8.	Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice-Hall of India, New Delhi.
9.	Shelton James H. 1994. Handbook for Technical Writing. NTC Business Books, Chicago.
10.	Smith Richard W. 1969. Technical Writing. Barnes & Noble, New York.
11.	Wren PC & Martin H.2006. High School English Grammar and Composition. S. Chand, New Delhi.

PGS-503
INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Credits: 1 + 0
Contact hours: 14+0

Mid-sessional exam: 40 (30+10[#])
End-semester exam: 60

Objective: The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR), related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Units	Contents	
I	Historical perspectives and need for the introduction of Intellectual Property Right regime.	2
II	TRIPs and various provisions in TRIPS Agreement.	1
III	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs.	1
IV	Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection.	2
V	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection.	2
VI	National Biodiversity protection initiatives.	2
VII	Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture.	2
VIII	Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	2

S. No.	Reference Books
1.	Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI, Wallingford.
2.	Ganguli, Prabudha. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill, New Delhi.
3.	India, Ministry of Agriculture. 2004. State of Indian Farmer. Vol. 5. Technology Generation and IPR Issues. Academic Foundation, New Delhi.
4.	Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies, New Delhi.
5.	Rothschild, Max & Newman, Scott (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI, Wallingford.

6.	Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya, Delhi.
7.	The Indian Acts - Patents Act, 1970 & amendments; Design Act, 2000; Trademarks Act, 1999.
8.	The Copyright Act, 1957 & amendments.
9.	Layout Design Act, 2000; PPV & FR Act 2001, and Rules 2003.
10.	National Biological Diversity Act, 2003.

#Assignments marks

PGS-504
BASIC CONCEPTS IN LABORATORY TECHNIQUES

Credit hours: 0 + 1
Contact hours: 0+28

Mid-session practical exam: 50
End-semester practical exam: 50

Objective: To acquaint the students about the basics of commonly used techniques in laboratory.

Practical	**Practical description**	
1.	Safety measures while in Lab.	1
2.	Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets.	1
3.	Washing, drying and sterilization of glassware.	1
4.	Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution.	1
5.	Handling techniques of solutions.	1
6.	Preparation of different agro-chemical doses in field and pot applications.	1
7.	Preparation of solutions of acids.	1
8.	Neutralisation of acid and bases.	1
9.	Preparation of buffers of different strengths and pH values.	1
10.	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, Water bath, oi bath	1
11.	Electric wiring and earthing. Preparation of media and methods of sterilization.	1
12.	Seed viability testing, testing of pollen viability.	1
13.	Tissue culture of crop plants; Description of flowering plants in botanical terms i relation to taxonomy.	2

S. No.	**Reference Books**
1.	**S** Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
2.	Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

#Assignments marks

PGS 505
AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (E-COURSE)

Credit hours: 1+0
Contact hours: 14+0

Mid-session exam: 40 (30+10#)
End-semester exam: 60

Objective: To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Units	Contents	Lectures
I	History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	6
II	Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.	3
III	Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, and Voluntary Agencies/Non R Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.	5

S. No.	Reference Books
1.	**Suggested Readings** Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
2.	Punia MS. 2007. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.
3.	Rao BSV. 2007. *Rural Development Strategies and Role of Institutions -Issues, Innovation and Initiatives*. Mittal Publ.
4.	Singh K. 1998. *Rural Development - Principles, Policies and Management.* Sage Publ.

#Assignments marks

PGS 506
DISASTER MANAGEMENT (E-COURSE)

Credit hours: 1+0 Mid-session exam: 40 (30+10#)
Contact hours: 14+0 End-semester exam: 60

Objective: To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building

Units	Contents	Lectures
I	Natural Disasters- Meaning and nature of natural disasters, their types and effects Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcani eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise Ozone Depletion	4
II	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.	4
III	Disaster Management- Efforts to mitigate natural disasters at national and globa levels. International Strategy for Disaster reduction. Concept of disaste management, national disaster management framework; financial arrangements role of NGOs, Community-based organizations, and media. Central, State, Distric and local Administration; Armed forces in Disaster response; Disaster response Police and other organizations.	6

S. No.	Reference Books
1.	Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.
2.	Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.
3.	Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.

#Assignments marks

Ph. D.

IN

FOOD TECHNOLOGY

SYLLABUS

DEPARTMENT OF FOOD TECHNOLOGY

Dr. KHEM SINGH GILL AKAL COLLEGE OF AGRICULTURE
ETERNAL UNIVERSITY, BARU SAHIB, HP-173101
2017

Ph.D. Programme in Food Technology at the Eternal University Baru Sahib, Himachal Pradesh

Compulsory Courses						
Semester	**Course No.**	**Course Title**	**Theory**	**Seminar**	**Practical**	**Dissertation**
Sem-I	FT-609	Research Methodology	3	0	0	0
Sem-I	FT-611	Advances in Food Analysis and Quality Control	3	0	0	0
Sem-I	FT-691	Seminar	0	1	0	0
Sem-I	FT-701	Dissertation	0	0	0	5
Optional Courses (Any two courses taking one from each option)						
Option-I						
Sem-I	FT-612	Recent Advances in Cereals, Pulses & Oilseeds Processing	3	0	0	0
Sem-I	FT-613	Recent Advances in Fruits & Vegetables Processing	3	0	0	0
Option-II						
Sem-I	FT-614	Recent advances in Food Processing and Technology	3	0	0	0
Sem-I	FT-615	Recent Advances in Dairy Science & Technology	3	0	0	0
Sem-I	FT-616	Recent Advances in Food Biotechnology	3	0	0	0
		Semester-I Total	12	1	0	5
Sem-II	FT-692	Synopsis Seminar	0	1	0	0
Sem-II	FT-701	Dissertation	0	0	0	15
Sem-III	FT-701	Dissertation	0	0	0	15
Sem-IV	FT-701	Dissertation	0	0	0	15
Sem-V	FT-701	Dissertation	0	0	0	15
Sem-VI	FT-701	Dissertation	0	0	0	15
Total			**12**	**2**	**0**	**80**

NOTE: In Semester II, there will be Comprehensive examination (will be evaluated satisfactory/unsatisfactory), each student will have to achieve 50% marks in comprehensive written examination and satisfactory performance in oral examination. There will be synopsis writing and approval of synopsis by research degree committee.

In III, IV, V and VI semesters, students will undertake his/her research work by taking 15 credit hours each semester. The major advisor will evaluate his/her work in each semester and clear the credit hours by evaluating satisfactory/unsatisfactory, depending upon the work undertaken by the student during the semester.

Examination schedule: As applicable to other post- graduate courses of eternal University

FT-609 Research Methodology

(Semester I)

Credits: 3 + 0 Mid-Session Exam: 40

Contact Hours: 42 + 0 End-Semester Exam: 60

Details of Course:

Units*	Contents	Lectures
1.	History, myths and ethnic practices; need, importance and impact of research; types of research; research process	3
2.	Synopsis writing; Selecting research problem; formulation of research projects; survey of literature; allied and critical literature; research infrastructure; experimental designs; sampling designs; recording of observations ; measurement and scaling techniques; GLPs	4
3.	Formulation and types of hypothesis; collection, maintenance, storage and analysis of data; measures of central tendencies and relationships and error analysis; tests of significance	6
4.	Compilation and presentation of results, Writing of manuscripts; research reports and thesis; organization of reference material using endnote; bibliography; plagiarism; IPR and patent application	6
5.	Financial support and various funding agencies; Multidisciplinary, multi-institutional research network initiatives; writing research proposal	3
6	Computer and informatics; introduction; word processing, excel, power point presentation; graph and figure plotting; web browsing; information resources and various databases.	6
7	Demonstration of departmental research activities and instrumentation	7
8.	Writing a review article on topic of interest or suggested by research committee.	7
Total		**42**

*Unit 1-4: common for all streams. Unit7-8: offered by concerned department.

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication
1.	Research methodology- Methods and Techniques: C R Kothari, New Age International, 2nd ed., 2004.	1985
2.	Ranjeet Kumar, Research methodology-A step by step guide for beginners, 2nd edn. Pearson Education.	2005
3.	Research Methods and Statistics, Sherri Jackson, Wadsworth Cengage Learning.	2009
4	Research methodology for biological sciences: N Gurumani, MJP Publishers.1st ed	2013
5	Research methodology in medical and biological sciences: P Laake, H benestad, B Olsen, Elsevier, 1st ed.	2007

FT-611 Advances in Food Analysis and Quality Control

(Semester I)

Credits: 3 + 0 Mid-Session Exam: 40

Contact Hours: 42 + 0 End-Semester Exam: 60

Details of Course:

S. No.	Particulars	lectures
1.	**Applications of the following in the food analysis:** Microscopic techniques in food analysis: light, phase contrast, fluorometery, confocal, Scanning Electron Microscopy (SEM), Transmission Electron microscopy (TEM), Laser particle size analysis.	7
2.	**Thermal methods in food analysis:** Differential scanning colorimetry, Differential thermal analysis.	5
3.	**Radioisotopy-** radioactive tracer techniques, radio immunological assays, safety.	5
4.	**Chromatographic methods in food analysis:** Column, size exclusion and ion exchange. TLC, adsorption, gel filtration, ion-exchange, affinity chromatography, High Performance liquid chromatography, Gas liquid chromatography, GC-MS, Visible and ultraviolet spectroscopy, FTIR spectroscopy, Flame photometry and atomic absorption spectroscopy.	7
5.	**X-ray methods:** Diffraction, Fluorescence, Electrophoresis, 2DE, capillary zone electrophoresis, pulsed-electric field, gel electrophoresis.	7
6.	**Spectroscopy-** UV-visible, Infrared spectroscopy, Nuclear magnetic resonance (NMR).	5
7.	**Rheology :** Textural properties, viscosity, Rheo-optics. **Separation techniques :** microfiltration, sedimentation, ultra-centrifugation, Reverse osmosis, ultrafiltration, nanofilteration, microfilteration.	6
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication /Reprint
1.	Clifton M & Pomeranz Y. Food Analysis - Laboratory Experiments. AVI Publication.	1988
2.	Gruenwedel, DW & Whitaker JR. Food Analysis Principles and Techniques. Vol. I, II, III & IV. Marcel Dekker	1984
3.	Leenheer AP, Lambert WE & van Bocxlaer JF. Modern Chromatographic Analysis of Vitamins. 3rd Ed. Marcel Dekker.	2000
4.	Nollet LML. Handbook of Food Analysis. Vol. I., Marcel Dekker.	1986.

5.	Pomeranz and Clifton. Food Analysis. Theory and Practice 3rd Ed. Chapmin and Hall, NewYork.	2000
6.	Rickwood, D. and Hames, B.D., "HPLC, Gel Electrophoresis, Oligonucleotide Synthesis, Soild Phase Peptide Synthesis, The Practical Approach Series", IRL Press.	1994
7.	Campbell, I.D., and Dwek, R.A., "Biological spectroscopy", Benjamin Cummins.	1984

FT-612 Recent Advances in Technology of Cereals, Pulses & Oilseeds

(Semester I)

Credits: 3 + 0 Mid-Session Exam: 40
Contact Hours: 42 + 0 End-Semester Exam: 60

Details of Course:

S. No.	Particulars	Lectures
1.	**Storage and Handling of Food Grains**: Food grain storage structure: recent trends, Problem in bag and bulk storage and their control. Protection against rodents, mould, pests and mites, fumigation processes, aeration and drying during storage, Problems of dust explosion in grain storages, Quality changes of grains during storages and remedial measures.	8
2.	**Wheat**: Present scenario of wheat processing industries. Quality testing of wheat grain and the milled product (flour, dough etc). Factors affecting yield and quality of flour. Working of milling equipments. Composite and alternate flours, air classification and their applications. Wheat starch processing, modification and utilization, development of wheat based extruded products.	7
3.	**Rice**: Present scenario of rice processing industries. Effect of different factors on milling yield and rice quality. Working of paddy driers. Modern methods of paddy parboiling. Pretreatments to paddy before milling and their advantages. Paddy milling by-products and their utilization. Recent methods of paddy processing and quality testing. Isolation, modification and utilization of rice starch. Modern, convenience and extruded products from rice.	8
4.	**Maize, coarse and pseudo cereals:** Modern dry and wet milling methods of maize, working of milling equipment. Production and utilization of corn starch derivatives. Equipments used in the milling of coarse and pseudo cereals. Nutritional products and their recovery in coarse cereals, recent utilization trends in course and pseudo cereals. Latest quality evaluation methods the coarse cereal grains.	7
5.	**Pulses**: Pretreatments given to pulses before milling. Latest quality evaluation methods for pulses. Modern pulse milling methods. Working of machinery and equipment employed in pulses processing. Losses during milling and their control. Utilization trend of pulses in India and abroad.	7
6.	**Oil Seeds:** Importance and trends of oil seed processing in India. Machinery and equipments used in the crude oil extraction and its refining. Latest production technology of shortenings, lecithin, confectionery coatings, Imitation dairy products.	5
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication
1.	Post-Harvest Technology of Cereals, Pulses and Oilseeds by Chakraverty, A	1988
2.	The Chemistry and Technology of Cereals as Food and Feed Samuel Matz	1991
3.	Maize-Recent Progress in Chemistry and Technology by George E Inglett	1982
5.	Modern Cereal Science and Technology by Y. Pomeranz	1990

6.	Storage of Cereal Grains and their Products by Cryde M. Christensen	1982
7	Hand Book Of Cereal Science and Technology by Karel Kulp and Joseph P Pante	2000
9	Technology of Cereals by N. L. Kent and A. D. Evans	1994

FT-613 Recent Advances in Fruits and Vegetables Processing

(Semester I)

Credits: 3 + 0 Mid-Session Exam: 40

Contact Hours: 42 + 0 End-Semester Exam: 60

Details of Course:

S. No.	Particulars	No. of lectures
1.	Physiology of development, ripening and senescence of fruits and vegetables, Harvesting and harvesting indices of fruits and vegetables, post harvest changes of fruits and vegetables, Technological advances in thermal processing of fruit and vegetable.	8
2.	Minimal processed technology, Fresh-cut Produce, Quality Parameters of Fresh-cut Fruit and Vegetable Products, Safety Aspects of Fresh-cut Fruits and Vegetables, Enzymatic Effects on Flavor and Texture of Fresh-cut Fruits and Vegetables, Preservative Treatments for Fresh-cut Fruits and Vegetables, Application of Packaging and Modified Atmosphere to Fresh-cut Fruits and Vegetables, storage and handling of fresh produce.	9
3.	Edible coatings for fruits, Selecting edible coatings, Gas permeation properties of edible coatings, Wettability and coating effectiveness, Determining diffusivities of fruits, Measuring internal gas composition of fruits	8
4.	Recent techniques in fruits and vegetables: Microwave and radio frequency processing, ohmic and inductive heating, high pressure processing , pulsed electric field, high voltage arc discharge, pulsed light technology, oscillating magnetic fields and ultrasonics..	9
5.	Quality attributes of fresh fruits and vegetables, Quality indices of fruit and vegetable juices, Maturity and ripeness indices of fruits and vegetables, Microbiology of fresh and processed fruits and vegetable products, Advances in by-product utilization.	8
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication
1.	Food Processing Technology by P. Fellows	2009
2.	Food microbiology by W.C. Frazier.	1958
3.	Principles of food preservation by Fennema, Kerrel	1975
4.	Preservation of Fruits and Vegetables by Lal, Siddappa & Tandon	2015
5.	F&V Juice Processing Technology. Vol. III by Nelson & Tressler	1980
6.	Handbook of Analysis of F & V Products by Ranganna	2001
7.	Chemistry and Technology of Soft Drinks and Fruit Juices by Ashurst	2016

FT-614 Recent advances in Food Processing and Technology

(Semester I)

Credits: 3 + 0 Mid-Session Exam: 40

Contact Hours: 42 + 0 End-Semester Exam: 60

Details of Course:

S. No.	Particulars	No. of Lecture
1.	**Microwave and Radio Frequency Processing:** Mechanism of Heat Generation, Applications in Food Processing: Microwave Blanching, Sterilization and Finish Drying. Electrical Resistance Heating of foods. High Voltage Pulse Techniques in Food Processing.	8
2.	**High Pressure processing:** Concept, Equipments for HPP Treatment, Mechanism of Microbial Inactivation and its Application in Food Processing.	5
3.	**Ultrasonic Processing:** Properties of Ultrasonic, Application of Ultrasonic in Processing.	5
4.	**Membrane Technology:** Micro-filtration, Ultra-filtration, Nano-filtration and Reverse Osmosis and their Application.	6
5.	Principles and Applications of Hurdle Technology. Aseptic Processing. Supercritical Fluid Extraction and its Application.	5
6.	**Nanotechnology:** Principles and Applications in Foods. Biodegradable Food Films and Coatings and Applications.	6
7.	**Newer techniques in food processing:** Application of technologies of high intensity light, pulse electric field, ohmic heating, IR heating, inductive heating and pulsed X-rays in food processing and preservation.	7
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/ Reprint
1.	Barbosa-Canovas. Novel Food Processing Technologies. CRC.	2002
2.	Dutta AK & Anantheswaran RC. Hand Book of Microwave Technology for Food Applications.	1999
3.	Frame ND. (Ed.). The Technology of Extrusion Cooking. Blackie.	1994
4.	Gould GW. New Methods of Food Preservation. CRC.	2000
5.	Shi J. (Ed.). Functional Food Ingredients and Nutraceuticals: ProcessingTechnologies. CRC.	2006
6.	Gibson GR & William CM. Functional Foods - Concept to Product.	2000
7.	Goldberg I. Functional Foods: Designer Foods, Pharma Foods.	1994
8.	Robert EC. Handbook of Nutraceuticals and Functional Foods. 2nd Ed. Wildman.	2006

FT-615 Recent advances in Dairy Science and Technology

(Semester I)

Credits: 3 + 0 Mid-Session Exam: 40

Contact Hours: 42 + 0 End-Semester Exam: 60

Details of Course:

S. No.	Particulars	No. of Lectures
1.	**Homogenization of milk:** Principle of homogenization, Effect of homogenization, Technical execution, valves and pumps, single and double stage homogenizers, care and maintenance of homogenizers, Efficiency of homogenization, design principles of homogenizers, operation and maintenance, application of homogenization in dairy industry. Recent advances in homogenization.	8
2.	**Tanks, Pumps, Stirrer mixtures and Centrifugation**:Designs and equipment of tank, types of tanks, pumps in dairy industry, Agitation and mixing, construction of agitators and patterns of flow. Separation by gravity and centrifugal force, clarifiers and separators, centrifugal separator and efficiency of separation, flow rate and power consumption.	8
3.	**Thermal processing of milk Pasteurization of milk:** Holding methods, Agitation of liquids, HTST pasteurizer and design principle and thermal death kinetics, care and maintenance, Advantages of HTST pasteurization, Vacreation, UHT processing of milk, quality changes during processing of milk. Concentration of milk Evaporator, Food properties in relation to evaporator performance, Construction and types of evaporator, heat and mass balance in single and multiple effect evaporator, performance characteristics of evaporators and their selection criteria, steam economy. Recent advances in evaporating techniques.	10
4.	**Spray and drum drying:** Theory of drying, estimation of drying rates and drying time, drying equipments, particle size calculation, design of spray and drum dryer, skim milk and whole milk powders manufacturing methods. Fluidized bed drying, Principles of fluidized bed method, Types of fluidized bed drier, Drying and cooling times in fluidized bed; Freeze drying; Agglomeration, Problems of reconstitution, Methods of Agglomeration, The effect of drying on milk products. Recent advances in drying.	9
5.	**Dairy products:** Butter; ghee; Cheese; Casein and its derivatives; Condensed and evaporated milk, Traditional products; Whey powder, protein concentrate and isolate; Lactose their composition, standards, manufacturing, process control and quality control parameters.	7
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication /Reprint
1.	Dairy products by Lampart, Lincoln M.	1975
2.	Milk and Milk Products by Eckles, Comb and Macy	1957
3.	Ice Cream by Arbuckle	2000
4.	Dairy Engineering by John T Bowen	1925

FT-616 Recent Advances in Food Biotechnology

(Semester I)

Credits: 3 + 0 Mid-Session Exam: 40

Contact Hours: 42 + 0 End-Semester Exam: 60

Details of Course:

S. No.	Particulars	Lectures
1.	**Introduction** Concept of biotechnology, historical developments, Interdisciplinary nature of biotechnology, scope and present status of biotechnology in India in relation to food technology and its general applications.	5
2.	**Fermentation and Fermenter Design** Types of fermentation-submerged, surface and solid substrate fermentation, factors affecting fermentations, Concept of fermenter and its design, scale up of fermentation, problems in scale up, Role of fermentation in food preservation, Developments in solid-state fermentation for food applications.	5
3.	**Production of Alcoholic Beverages** Introduction, classification of alcoholic beverage, Production of alcoholic beverages: raw materials, culture, fermentation technology of non-distilled beverages (beer and wine) and distilled alcoholic beverages (brandy, whiskey, vodka, rum, gin)	5
4.	**Production of Single Cell Proteins** Single cell proteins production: substrates, factors effecting SCP production, composition, uses, economic parameters and constrains including safety aspects of SCPs with special reference to RNA content.	6
5.	**Production of Organic Acids/Acidulants** Raw materials, Starters and fermentation conditions, recovery and applications, Case studies production of acetic acid (vinegar), citric acid, lactic acid and gluconic acid Biocatalysts in Food processing.	5
6.	**Sources of enzymes**, advantages of microbial enzymes, mechanism of enzyme function, Production and purification of enzymes, immobilization and applications of biocatalysts in food processing, enzyme biosensors.	5
7.	**Genetic Engineering and Genetically Modified Foods** Genetic manipulation of microorganisms, Gene cloning procedures, vectors involved: plasmids, cosmids and phagemids, transfer of recombinant molecules into host organisms, Genetically Modified (GM) foods and their safety concerns.	5
8.	**Treatment of Food Processing Wastes** Food wastes (Whey, molasses, starch substrates and others), waste treatment technologies: aerobic and anaerobic methods of treatment of food industry wastes, bioremediation, Microbial production and importance of bio-surfactants, Microorganisms for bioenergy, bio-conversation of food wastes to useful products.	6
Total		42

Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Biotechnology P.K. Gupta	2008
2.	Biotechnology: Food Fermentation by V.K. Joshi	2009
3.	Enzymes in Food Processing by P.S. Panesar	2013
4.	Food Processing : Biotechnological Applications By S.S. Marwaha	2000