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