ETERNAL UNIVERSITY

(ESTABLISHED UNDER HIMACHAL PRADESH GOVERNMENT ACT NO.3 OF 2009)

BARU SAHIB
HIMACHAL PRADESH

WORLD PEACE THROUGH VALUE BASED EDUCATION

AKAL COLLEGE OF BASIC SCIENCES

B.Sc. (HONS. WITH RESEARCH) PHYSICAL SCIENCES CURRICULUM (SEMESTER I TO IV)

APPROVED VIDE ANNEXURE 4.3.1 OF 87TH ACADEMIC COUNCIL MEETING HELD ON 25TH JULY, 2025

TO BE IMPLEMENTED FROM THE ACADEMIC SESSION 2025-26

Dean
Acad. Affairs
Eternal University
Baru Sahib (H.P.) 173101

Registrar (Officiating)
Eternal University
Baru Sahib (H.P.) 173101

ETERNAL UNIVERSITY

BARU SAHIB (H. P.)

WORLD PEACE THROUGH VALUE BASED EDUCATION

AKAL COLLEGE OF BASIC SCIENCES

B.Sc. (Hons. with Research) Physical Sciences

(With Mathematics, Physics and Chemistry as Core Disciplines)

(Framed according to NEP-2020)

Applicable from Academic Year 2024-25
(With Minor Revision for Academic Year 2025-26)

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Note: The detailed syllabus for the 1st Year and 2nd Year is incorporated.

1. NATURE AND EXTENT OF THE PROGRAM

In the 21st century, science is enriched with opportunities and challenges. Through effective teaching methodologies and cutting-edge research infrastructure, graduates with Physical Sciences have their wings to fly in multiple sectors with excellent opportunities. The B.Sc. (Hons. with Research) Physical Sciences is a four-year program consisting of eight semesters with multiple entry and exit options, as per the National Education Policy-2020 (NEP-2020). The program will include the following components:

- Discipline Specific Core (DSC) Courses
- Discipline Specific Elective (DSE) Courses
- Generic Elective (GE) Courses
- Skill Enhancement Courses (SEC)
- Value Added Courses (VAC)
- Ability Enhancement Courses (AEC)
- Internship/Apprentice/Project/Community Outreach (IAPC)

After successful completion of the first year, the student will be awarded a Certificate in Physical Sciences. On successful completion of the second year, the student will be awarded a Diploma in Physical Sciences. After successful completion of the third year, the student will be awarded Degree in B.Sc. Physical Sciences, and after successful completion of the fourth year, the student will be awarded degree in B.Sc. (Hons. with Research) Physical Sciences. However, on the basis of the credits gained by the student in different disciplines the nomenclature of the degree will be as follows:

Honors Degree: To pursue B.Sc. (Hons. with Research) Physical Sciences, candidates will have to choose, in the fourth year, only one of the disciplines (either Physics or Chemistry or Mathematics). Candidates will have to study Two DSCs and Six DSEs in the chosen discipline in the VII and VIII semesters and write dissertation.

Case I: The student shall get Major in Physics, on successful completion of VIII semester, if student earns minimum 80 credits in Physics from Eight DSCs and at least Nine DSEs of Physics and writes dissertation in Physics.

Advice: Students are advised to choose the discipline in which they wish to do Major, she must study at least Three DSEs of that discipline in the first three years. Like in this example, student must decide earlier and study three DSEs of Physics in the first three years as only maximum of six DSEs are available in fourth year. Similarly, if the student wants to minor in any of the remaining two disciplines, she should study one DSE of that discipline in the first three years. Student shall get a Minor in Mathematics, if student earns minimum 28 credits from Six DSCs

and one DSE of Mathematics. Or student shall get a Minor in Chemistry, if she earns minimum 28 credits from Six DSCs and One DSE of Chemistry.

- B.Sc. (Hons. with Research) Physical Sciences, Major in Physics and Minor in Mathematics: If Physics (80 Credit) and Mathematics (28 Credit)
- B.Sc. (Hons. with Research) Physical Sciences, Major in Physics: If Physics (80 Credit), Mathematics (24 Credit), Chemistry (4 Credit)

Case II: If a student doesn't do dissertation in Physics, but in other disciplines, say Mathematics or Chemistry, or does Academic Project or Entrepreneurship, then she will not be awarded Major in Physics as she will be unable to get 80 credits. In such cases, she will be awarded B.Sc. (Hons. with Research) Physical Sciences.

The B.Sc. (Hons. with Research) Physical Sciences program offers students a rigorous and comprehensive education in the principles and applications of physical sciences, equipping them with the skills and knowledge necessary to pursue various career paths or further academic endeavours in the fields. Students will be able to examine real-world challenges thoroughly and then develop suitable mathematical models to address them effectively in the field of physical sciences.

B.Sc. (Hons. with Research) Physical Sciences program prepares candidates for a wide range of career options. After completing the program, one may pursue job roles such as research analyst, lab technician, statistical analyst, actuarial scientist, quality assurance and quality control officer, scientific content writer, etc. Further, after completing the program, students also opt to pursue higher studies and can also appear in various national and state-level competitive examinations, including CDS, UPSC, SSC, GRE, banking, railway, and defence services. Beside these, graduates with physical sciences have opportunities in the semiconductor industry, pharmaceutical industry, fertilizer and pesticide production plants, petrochemical, ceramics and polymer industries, including fields of material science, nanotechnology, and renewable energy.

2. PROGRAM EDUCATION OBJECTIVES (PEOs)

The Program Educational Objectives for B.Sc. (Hons. with Research) Physical Sciences program describe accomplishments that graduates are expected to attain.

No.	Education Objectives
PEO1	**Multidisciplinary Approach** To provide students with a comprehensive education that integrates the fundamental principles and advanced concepts of the three core disciplines of physics, chemistry, and mathematics with multiple entry and exit options.
PEO2	**Skill Enhancement** To learn practical abilities that they can use in real life, like problem-solving, communication, or technical skills for both personal growth and success in work or other areas of life.
PEO3	**Ability Enhancement** Understanding environmental importance, promoting informed action for ecosystem conservation, and enhancing sustainability, aiming to develop communication, discussion, and debate skills, giving priority to critical reading, academic writing, and cultural exploration, to achieve proficiency in modern Indian languages and English.
PEO4	**Research Orientation** To Encourage research methodology and project work, prepare students for academic and industry research, foster curiosity and critical thinking to advance knowledge and innovate in their fields, enhance problem-solving skills, and empower contributions to research activities.
PEO5	**Value Addition and Ethical Foundation** To foster personal growth, responsible citizenship, and ethical conduct, course components integrate health, wellness, and sports, emphasising holistic well-being across physical, emotional, social, and spiritual dimensions.

3. GRADUATE ATTRIBUTES

S.No.	Attributes	Description
1.	Multidisciplinary Knowledge	Graduates will have a broad understanding of multiple core disciplines.
2.	Critical Thinking	They will be equipped with the ability to think critically and solve complex problems.
3.	Communication Skill	Effective communication skills will be a key attribute, both in professional and environmental contexts.
4.	Ethical Conduct	Ethical behavior and responsibility in professional practices will be emphasized.
5.	Lifelong Learning	The program fosters a commitment to lifelong learning for personal and professional development.
6.	Leadership Qualities	Graduates will develop leadership skills that can be applied in various situations.
7.	Teamwork	Graduates will be able to collaborate effectively, boosting creativity and productivity. Success will depend on trust, communication, and acceptance of differences to overcome obstacles and achieve goals.
8.	Innovation and Creativity	Graduates will engage in reflective thinking practice, critically evaluating their own beliefs, assumptions, and professional practices, and using feedback to enhance their learning and professional development.
9.	Global Perspective	A global perspective will be cultivated, preparing graduates for international environments.
10	Entrepreneurship	Entrepreneurial skills will be nurtured to enable graduates to create and manage new ventures.

4. QUALIFICATION DESCRIPTORS:

For a B.Sc. (Hons. with Research) Physical Sciences, the qualification descriptors outline the knowledge, skills, and competencies that students are expected to gain throughout the program in the widespread domains of physics, chemistry and mathematics. The following parameters will be the qualification descriptors of this programme:

- **Foundation Knowledge:** Understanding of the core principles and theories in physics, chemistry, and mathematics.
  - ✓ Attain proficiency in fundamental mathematical concepts, including calculus, algebra, and differential equations etc.
  - ✓ Gain the basic knowledge of classical mechanics, electromagnetism, thermodynamics, quantum mechanics etc.
  - ✓ Develop the fundamental concepts of organic, inorganic, physical and analytical chemistry etc.
- **Core Competencies:** Development of competencies to solve real world problems with appropriate rationales in the domain of physics, chemistry, and mathematics.
  - ✓ Competency in laboratory skills, including experimental design, data analysis, and interpretation.
  - ✓ Understanding of chemical structures, reactions, and their underlying principles.
  - ✓ Get proficiency in mathematical modelling and computational methods for solving scientific problems.
  - ✓ Develop critical thinking and analytical skills to evaluate scientific literature and experimental results.
- **Specialization:** Specialization in one or more fields within the domains of physics, chemistry, or mathematics.
  - ✓ Get opportunity with advanced coursework tailored to the chosen specialization, covering advanced topics and current research trends.
  - ✓ Gain benefitted with optional modules or electives allowing students to explore interdisciplinary areas or complementary subjects.
- **Research Skills:** Opportunities for practical research experience through laboratory work, projects, or internships.
  - ✓ Development of scientific writing and presentation skills through reports, presentations, and seminars.
  - ✓ Encouragement to participate in scientific conferences, workshops, or symposiums to present research findings.
- **Independent Study:** Encouragement and support for independent study and exploration of topics beyond the core curriculum.
  - ✓ Provision of resources such as libraries, online databases, and research facilities to facilitate independent learning.
  - ✓ Supervision and guidance from faculty members for independent research projects or dissertations.
- **Assessment:** Assessment methods include examinations, coursework assignments, laboratory reports, presentations, and dissertations.
  - ✓ Emphasis on both formative and summative assessment to evaluate understanding, practical skills, and critical thinking abilities.
  - ✓ Feedback mechanisms to provide students with constructive feedback on their progress and areas for improvement.

5. PROGRAM OUTCOMES

On successful completion of the B.Sc. (Hons. with Research) Physical Sciences program, the students are expected to attain the following:

S.No.	Attributes	Description
PO1	Multidisciplinary knowledge	Establish the comprehensive knowledge of theoretical and experimental aspects in three core discipline of Physical sciences.
PO2	Critical thinking and problem-solving skills	Cultivate critical thinking skills to identify, analyze, and solve diverse theoretical or experimental challenges, employing a scientific approach forknowledge development.
PO3	Analytical/Scientific reasoning and Research Skills	Utilize suitable techniques and procedures to innovate and tackle complex problems by applying evidence-based, clearly defined explanations, and explore the scientific reasoning behind the outcomes achieved. Plan and learn various techniques and software's used for analysis and exploring research projects while keeping in mind the rules and regulations pertaining to different scientific research project operations.
PO4	Effective Professional Communication skills, Social interaction and Effective citizenship	Showcase expertise through technical writings and oral presentations in the scientific community and broader society. Foster science-society dialogue by sharing insights at diverse platforms like symposia, workshops, and science fairs, contributing voluntarily to societal development.
PO5	Multicultural Competency, Leadership Readiness and Entrepreneurship	Work effectively either independently or as a team leader while being adaptable to various multicultural competencies and understanding the importance and strengths of interacting with and working along side people from diverse backgrounds. Capacity for innovation and entrepreneurship in developing and implementing start-ups, production units and service programs.
PO6	Ethics, Environment and Sustainability	Acquire a thorough understanding of ethical principles within scientific endeavors, ensuring adherence to principles of integrity and honesty. Employ methodologies that prioritize safety and sustainability in scientific pursuits, thereby contributing to global betterment.
PO7	Self-directed and Life-long Learning	Develop a habit of continuous self-learning via various online/offline educational platforms, including retention of the same and nurturing critical thinking skills, further, use them to update scientific knowledge and apply them in day-to-day life and business.

6. PROGRAM SPECIFIC OUTCOMES

PSO No.	Competency
PSO1	Students will gain a strong foundation in the core subjects of Physics, Chemistry, and Mathematics, enabling them to understand and apply basic principles and concepts in daily life.
PSO2	To gain understanding and core knowledge in the physical sciences, including the major premises of algebra, calculus, differential equations, numerical techniques, statistics; analytical, inorganic, organic & physical chemistry; classical mechanics, modern physics, material science, nanotechnology and renewable energy.
PSO3	Through laboratory courses in the physical sciences, students will develop hands-on skills in conducting experiments, analysing data, and using scientific instruments and software.
PSO4	To inculcate a scientific temperament in the students and create awareness of theimpact of various courses in physical sciences on the environment and society.
PSO5	By engaging in dissertations, academic projects, or entrepreneurship, students will utilize critical thinking, systematic approaches, and scientific knowledge to design, execute, observe, and analyze results, thereby enhancing employment opportunities.

7. ASSESSMENT CRITERIA

Total Credits	L	T	P	End term Theory Exam marks	Internal Assess-ment (IA) marks	Total of theory exam and IA	Duration of theory exam	Tutorial	Practical marks				Grand Total marks
								CA	CA	End term practical/ written exam	Viva-voce	Total	
4	3	1	0	90	30	120	3 hours	40	0	0	0	0	160
4	3	0	1	90	30	120	3 hours	0	10	20	10	40	160
4	0	0	4	0	0	0	NA	0	40	80#	40	160	160
4	1	0	3	30	10	40	1 hour	0	30	60	30	120	160
4	2	0	2	60	20	80	2 hours	0	20	40	20	80	160
2	1	0	1	30	10	40	1 hour	0	10	20**	10	40	80
2	0	0	2	0	0	0	NA	0	20	40**	20	80	80
2	2	0	0	60	20	80	2 hours	0	0	0	0	0	80

CA - Continuous Assessment **IA** - Internal Assessment

#In case there is no end term Practical examination for any 4credit course which has only practical component, this mark shall be added to Continuous Assessment of the Practical and the total of the CA for Practical shall be 120.

**In case of courses of two credits which have practical component, either there shall be end term practical Examination or end term written examination.

8. METHODOLOGY OF AWARDING CODES TO NEP-2020 COURSES

College Code:

College	Code
Dr. Khem Singh Gill Akal College of Agriculture	01
Akal College of Arts & Social Sciences	02
Akal College of Basic Sciences	**03**
Akal College of Economics Commerce & Management	04
Akal College of Education	05
Akal College of Engineering & Technology	06
Akal College of Health and Allied Sciences	07

Department/Discipline Code (Alphabetically):

Name of Discipline/Department	Code
No Deptt.	0
Botany	1
Chemistry & Biochemistry	2
Mathematics	3
Microbiology	4
Physics	5
Zoology	6
And so on	

Programme of Study:

Name of Programme	Code
Common programme Courses (AEC, GE, SEC,VAC, RM etc)	00
B.Sc. (Hons. with Research) Life Sciences	**01**
B.Sc. (Hons. with Research) Microbiology	**02**
B.Sc. (Hons. with Research) Physical Sciences	**03**
And so on	

Semester Code:

Semester	Code
SEM - I	1
SEM - II	2
SEM - III	3
SEM - IV	4
SEM - V	5
SEM - VI	6
SEM - VII	7
SEM - VIII	8
SEM - IX (For integrated course)	9
SEM - X (For integrated course)	0

Code for Category of Course:

Category of Course	Code
DSC	1
DSE	2
GE (For other disciplines)	3
SEC	4
AEC	5
VAC	6
IAPC	7
Dissertation	8
RM (Research Methodology)	9

Code for Course Number:

Course Number	Code
First	01
Second	02
Third	03
Fourth	04
Fifth	05
Sixth	06
Seventh	07
……	----
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Tenth	10
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Nineteenth	19
Twentieth	20

And so on

Code for Type of Course (Theory or Practical) of Course:

Type of course	Code
Theory including Tutorial	0
Theory + Tut +Practical or Exclusive Practical	1

An Example of Mechanics Course of Physics Discipline of Akal College of Basic Sciences (ACBS):

College Code [ACBS]	Department /Discipline Code [Physics]	Programme of Study [B.Sc. (Hons. with Research) Physi-cal Sciences]	Semester Code [SEM – I]	Category of Course Code [DSC]	Course Code [First Course]	Type of Course [T/P]	**Course Code**
03	**5**	**03**	**1**	**1**	**01**	**1**	**0350311011**

9. PROGRAMME STRUCTURE

SEMESTER – I

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-1M	**0330311010**	**Algebra**	3	1	0	4
DSC-1C	**0320311011**	**Basic Concepts of Organic Chemistry**	3	0	2	4
DSC-1P	**0350311011**	**Mechanics**	3	0	2	4
GE-1		GE (One from the pool)	3	0	2	4
SEC-1		SEC (One from the pool)	1	0	2	2
AEC-1		AEC (One from the pool)	1	0	2	2
VAC-1		VAC (One from the pool)	1	0	2	2
Total			15	1	12	**22**

SEMESTER – II

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-2M	**0330321021**	**Calculus**	3	0	2	4
DSC-2C	**0320321021**	**Periodic Properties and Chemical Bonding**	3	0	2	4
DSC-2P	**0350321021**	**Electricity and Magnetism**	3	0	2	4
GE-2		GE (One from the pool)	3	0	2	4
SEC-2		SEC (One from the pool)	1	0	2	2
AEC-2		AEC (One from the pool)	1	0	2	2
VAC-2		VAC (One from the pool)	1	0	2	2
Total			15	0	14	**22**

Note- L: Lecture Hour/week, T: Tutorial Hour/week, P: Practical Hour/week, C: Credits, DSC – Discipline Specific Course, GE – Generic Electives, SEC – Skill Enhancement Course, AEC – Ability Enhancement Course, VAC – Value Addition Course.

Note: If the student wishes to exit after completing one year/ two semesters, UG Certificate will be provided to the students.

SEMESTER – III

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-3M	**0330331030**	**Real Analysis**	3	1	0	4
DSC-3C	**0320331031**	**Chemical Energetics and Equilibria**	3	0	2	4
DSC-3P	**0350331031**	**Thermal Physics and Statistical Mechanics**	3	0	2	4
*DSE-1M	0330332011	Advanced Calculus	3	0	2	4
*DSE-1C	0320332011	Chemistry of Acids and Bases	3	0	2	4
*DSE-1P	0350332011	Mathematical Physics	3	1	0	4
*GE-3		From pool of GE courses	3	1	0	4
SEC-3		From pool of SEC courses	1	0	2	2
AEC-3		From pool of AEC courses	1	0	2	2
VAC-3		From pool of VAC courses	1	0	2	2
Total			15	1/2	12/10	**22**

SEMESTER – IV

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-4M	**0330341040**	**Vector Calculus**	3	1	0	4
DSC-4C	**0320341041**	**Chemistry of Oxygen Based Functional Groups**	3	0	2	4
DSC-4P	**0350341041**	**Electromagnetic Waves and Optics**	3	0	2	4
*DSE-2M	0330342021	Linear Algebra	3	0	2	4
*DSE-2C	0320342021	Chemistry of Colloids and Adsorption	3	0	2	4
*DSE-2P	0350342021	Waves and Vibrations	3	0	2	4
*GE-4		From pool of GE courses	3	0	2	4
SEC-4		From pool of SEC courses	1	0	2	2
AEC-4		From pool of AEC courses	1	0	2	2
VAC- 4		From pool of VAC courses	1	0	2	2
Total			15	0/1	14/12	**22**

Note – L: Lecture Hour/week, T: Tutorial Hour/week, P: Practical Hour/week, C: Credits, IAE: Internal Assessment Examination, ESE: End Semester Examination, DSC – Discipline Specific Course, GE – Generic Electives, SEC – Skill Enhancement Course, AEC – Ability Enhancement Course, VAC – Value Addition Course,

*Student can opt either one of the DSE courses or any one GE course from pool of GE courses.

Note: If the student wishes to exit after completing two years/ four semesters, UG Diploma will be provided to the students.

SEMESTER – V

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-5M	**0330351051**	**Ordinary Differential Equations**	3	0	2	4
DSC-5C	**0320351051**	**Coordination Chemistry**	3	0	2	4
DSC-5P	**0350351051**	**Quantum Physics**	3	0	2	4
DSE-3		DSE (One from the pool)	3	0/1	2/0	4
GE-5		GE (One from the pool)	3	0/1	2/0	4
IAPC-3 /SEC-5		SEC (One from the pool)	1	0	2	2
Total			16	0/2	12/8	**22**

SEMESTER – VI

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-6M	**0330361061**	**Partial Differential Equations**	3	0	2	4
DSC-6C	**0320361061**	**Quantum Chemistry and Spectroscopy**	3	0	2	4
DSC-6P	**0350361061**	**Nuclear Physics**	3	0	2	4
DSE-4		Research Methodology (RM)	3	0	2	4
GE-6		GE (One from the pool)	3	0/1	2/0	4
IPAC-4 /SEC-6		SEC (One from the pool)	1	0	2	2
Total			16	0/1	12/10	**22**

Note – L: Lecture Hour/week, T: Tutorial Hour/week, P: Practical Hour/week, C: Credits, IAE: Internal Assessment Examination, ESE: End Semester Examination, DSC – Discipline Specific Course, GE – Generic Electives, SEC – Skill Enhancement Course, AEC – Ability Enhancement Course, VAC – Value Addition Course, IAPC- Internship/Apprentice/Project/Community Outreach

Note: The student who successfully complete three years or six semesters and opt to exit the programme, will be awarded Bachelor Degree in Physical Sciences. The students who secure 75% marks and above in the first six semesters and wish to undertake research at under-graduate level can choose a research stream in the fourth year. They should do a research project or dissertation or academic project under the guidance of a faculty member of the department. The research project or dissertation will be in the major or minor. The students who secure 160 credits, including 12 credits from research project or dissertation or academic project are awarded UG Degree (Honours with Research).

SEMESTER – VII

Discipline Specific: Mathematics

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-7M	**0330371071**	**Computer Oriented Numerical Methods**	3	0	2	4
DSE-5M	0330372050	Group and Ring	3	1	0	4
DSE-6M	0330372060	Real and Complex Analysis	3	1	0	4
DSE-7M	0330372070	Special function and Integral transforms	3	1	0	4
DSE-8M	0330372080	Combinatorial Mathematics	3	1	0	4
DSE-9M	0330372090	Graph Theory	3	1	0	4
IAPC		Dissertation on Major Or Dissertation on Minor Or Academic Project/Entrepreneurship	0	0	12	6
Total			12	3	14	**22**

Discipline Specific: Chemistry and Biochemistry

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-7C	**0320371071**	**Analytical Methods in Chemistry**	3	0	2	4
DSE-5C	0320372051	Chemical Kinetics	3	0	2	4
DSE-6C	0320372061	Phase Equilibria and Photochemistry	3	0	2	4
DSE-7C	0320372071	Introduction to Supramolecular Chemistry	3	0	2	4
DSE-8C	0320372081	Industrial Chemistry	3	0	2	4
DSE-9C	0320372091	Photochemistry and Pericyclic Reactions	3	0	2	4
IAPC	IAPC	Dissertation on Major Or Dissertation on Minor Or Academic Project/Entrepreneurship	0	0	12	6
Total			12	0	20	**22**

Discipline Specific: Physics

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-7P	**0350371071**	**Condensed Matter Physics**	3	0	2	4
DSE-5P	0350372051	Particle Physics	3	0	2	4
DSE-6P	0350372061	Physics of Materials	3	0	2	4
DSE-7P	0350372071	Analog Electronics	3	0	2	4
DSE-8P	0350372081	Classical Electrodynamics	3	0	2	4
DSE-9P	0350372091	Electrical Circuit Analysis	3	0	2	4
IAPC	IAPC	Dissertation on Major Or Dissertation on Minor Or Academic Project/Entrepreneurship	0	0	12	6
Total			12	0	20	**22**

Note: Student can opt either (3 DSE) OR (2 DSE & 1 GE) OR (1 DSE & 2GE). GEs can be opted from the common pool of GEs.

SEMESTER – VIII

Discipline Specific: Mathematics

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-8M	**0330381081**	**Statistics**	3	0	2	4
DSE-10M	0330382100	Linear Programming	3	1	0	4
DSE-11M	0330382111	Mathematical Modeling	3	0	2	4
DSE-12M	0330382120	Dynamics	3	1	0	4
DSE-13M	0330382130	Statics	3	1	0	4
DSE-14M	0330382141	Multivariate Calculus	3	0	2	4
IAPC	IAPC	Dissertation on Major Or Dissertation on Minor Or Academic Project/Entrepreneurship	0	0	12	6
Total			12	1 /2 /3	18 /16 /14	**22**

Discipline Specific: Chemistry and Biochemistry

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-8C	**0320381081**	**Polymers, Dyes and Natural Products**	3	0	2	4
DSE-10C	0320382101	Biophysical Chemistry	3	0	2	4
DSE-11C	0320382111	Nanoscale Materials and their Applications	3	0	2	4
DSE-12C	0320382121	Chemistry of Elimination and Nucleophilic Substitution reactions	3	0	2	4
DSE-13C	0320382131	Electrochemistry	3	0	2	4
DSE-14C	0320382141	Polynuclear Hydrocarbons and Organic Spectroscopy	3	0	2	4
IAPC	IAPC	Dissertation on Major Or Dissertation on Minor Or Academic Project/Entrepreneurship	0	0	12	6
Total			12	0	20	**22**

Discipline Specific: Physics

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-8P	**0350381081**	**Atomic and Molecular Physics**	3	0	2	4
DSE-10P	0350382101	Nano Science and Applications	3	0	2	4
DSE-11P	0350382111	Renewable Energy and Applications	3	0	2	4
DSE-12P	0350382121	Digital Electronics	3	0	2	4
DSE-13P	0350382131	Laser Physics and Optical Fibers	3	0	2	4
DSE-14P	0350382141	Radiation and its Applications	3	0	2	4
IAPC	IAPC	Dissertation on Major Or Dissertation on Minor Or Academic Project/Entrepreneurship	0	0	12	6
Total			12	0	20	**22**

Note – Student can opt either (3 DSE) OR (2 DSE & 1 GE) OR (1 DSE & 2GE). GEs can be opted from the common pool of GEs.

Note – L: Lecture Hour/week, T: Tutorial Hour/week, P: Practical Hour/week, C: Credits, IAE: Internal Assessment Examination, ESE: End Semester Examination, DSC – Discipline Specific Course, DSE – Discipline Specific Electives, GE – Generic Electives.

Multidisciplinary Generic Electives (MGE)

Multidisciplinary Generic Electives is credited and choice-based. The students make a choice from pool of MGE offered by the Faculty under the University. (Reference: University Umbrella Multidisciplinary Generic Electives).

Value Added Courses (VAC)

Value Added Courses is credited and choice-based. The students make a choice from pool of VAC offered by the Faculty under the University. (Reference: University Umbrella Value Added Courses).

Ability Enhancement Compulsory Course (AEC)

Ability Enhancement Compulsory Courses is credited and choice-based. The students make a choice from pool of AEC offered by the Faculty under the University. (Reference: University Umbrella Ability Enhancement Compulsory Course).

Skill Enhancement Courses (SEC)

Skill Enhancement Courses is credited and choice-based. The students make a choice from pool of SEC offered by the Faculty under the University.

OVERALL CREDIT DISTRIBUTION TABLE

SEMESTER	HOURS PER WEEK			Credits
	L	T	P	
SEMESTER – I	15	1	12	22
SEMESTER – II	15	0	14	22
SEMESTER – III	15	1/2	12/10	22
SEMESTER – IV	15	1/2	12/10	22
SEMESTER – V	16	0/2	12/8	22
SEMESTER – VI	16	0/1	12/10	22
SEMESTER – VII	12	0/3	20/14	22
SEMESTER – VIII	12	0/3	20/14	22
Total	**116**	**3/14**	**114/92**	**176**

Note – L: Lecture Hour, T: Tutorial Hour, P: Practical Hour, C: Credits

10. DISCIPLINE SPECIFIC ELECTIVES (DSEs)

Course Code	Semester	Course Title	Teaching Hours/Week			Credits
			L	T	P	
Mathematics						
0330332011	III	Advanced Calculus	3	0	2	4
0330342021	IV	Linear Algebra	3	0	2	4
0330352030	V	Solid Geometry	3	1	0	4
0150069011	VI	Research Methodology	3	0	2	4
0330372050	VII	Group and Ring	3	1	0	4
0330372060		Real and Complex Analysis	3	1	0	4
0330372070		Special function and Integral transforms	3	1	0	4
0330372080		Combinatorial Mathematics	3	1	0	4
0330372090		Graph Theory	3	1	0	4
0330382100	VIII	Linear Programming	3	1	0	4
0330382111		Mathematical Modeling	3	0	2	4
0330382120		Dynamics	3	1	0	4
0330382130		Statics	3	1	0	4
0330382141		Multivariate Calculus	3	0	2	4
Chemistry and Biochemistry						
0320332011	III	Chemistry of Acids and Bases	3	0	2	4
0320342021	IV	Chemistry of Colloids and Adsorption	3	0	2	4
0320352031	V	Inorganic Materials of Industrial Importance	3	0	2	4
0150069011	VI	Research Methodology	3	0	2	4
0320372051	VII	Chemical Kinetics	3	0	2	4
0320372061		Phase Equilibria and Photochemistry	3	0	2	4
0320372071		Introduction to Supramolecular Chemistry	3	0	2	4
0320372081		Industrial Chemistry	3	0	2	4
0320372091		Photochemistry and Pericyclic Reactions	3	0	2	4
0320382101	VIII	Biophysical Chemistry	3	0	2	4
0320382111		Nanoscale Materials and their Applications	3	0	2	4
0320382121		Chemistry of Elimination and Nucleophilic Substitution Reactions	3	0	2	4
0320382131		Electrochemistry	3	0	2	4
0320382141		Polynuclear Hydrocarbons and Organic Spectroscopy	3	0	2	4
Physics						
0350332010	III	Mathematical Physics	3	1	0	4
0350342021	IV	Waves and Vibrations	3	0	2	4
0350352031	V	Classical Mechanics	3	0	2	4

0150069011	VI	Research Methodology	3	0	2	4
0350372051	VII	Particle Physics	3	0	2	4
0350372061		Physics of Materials	3	0	2	4
0350372071		Analog Electronics	3	0	2	4
0350372081		Classical Electrodynamics	3	0	2	4
0350372091		Electrical Circuit Analysis	3	0	2	4
0350382101	VIII	Nano Science and Applications	3	0	2	4
0350382111		Renewable Energy and Applications	3	0	2	4
0350382121		Digital Electronics	3	0	2	4
0350382131		Laser Physics and Optical Fibers	3	0	2	4
0350382141		Radiation and its Applications	3	0	2	4

11. GENERIC ELECTIVE (GE) COURSES OFFERED BY AKAL COLLEGE OF BASIC SCIENCES

Course Code	Semester	Course Title	Teaching Hours/Week			Credits
			L	T	P	
Botany						
0310023011	II	Plant Diversity Conservation for Sustainable Development	3	0	2	4
0310033021	III	Plant and Human Welfare	3	0	2	4
0310053031	V	Plant Ecology and Environment	3	0	2	4
0310063041	VI	Economic Botany	3	0	2	4
0310073051	VII	Ecological Management	3	0	2	4
Note: All students can opt these courses except B.Sc. (Hons. with Research) Life Sciences						
Zoology						
0360013011	I	Basic Zoology	3	0	2	4
0360023021	II	Wildlife Conservation	3	0	2	4
0360043031	IV	Aquatic Biology	3	0	2	4
0360063041	VI	Insect Vector and Diseases	3	0	2	4
0360083051	VIII	Economic Zoology	3	0	2	4
Note: All students can opt these courses except B.Sc. (Hons. with Research) Life Sciences						
Chemistry and Biochemistry						
0320013011	I	Chemistry of Biomolecules	3	0	2	4
0320033021	III	Principles of Instrumental Analysis	3	0	2	4
0320053031	V	States of Matter	3	0	2	4
0320073041	VII	Basics of Polymer Chemistry	3	0	2	4
0320083051	VIII	Chemical Technology and Society	3	0	2	4
Note: All students can opt these courses except B.Sc. (Hons. with Research) Life Sciences and B.Sc. (Hons. with Research) Physical Sciences						
Microbiology						
0340043011	IV	Introduction to Microbiology	3	0	2	4
0340053021	V	Microbes in Human Welfare	3	0	2	4
0340063031	VI	Microbial Diseases and Infection Control	3	0	2	4
Note: All students can opt these courses except B.Sc. (Hons. with Research) Microbiology						
Physics						
0350023011	II	Basics of Electricity and Magnetism	3	0	2	4
0350033021	III	Fundamentals of Mechanics	3	0	2	4
0350043031	IV	Essentials of Electromagnetic Waves and Optics	3	0	2	4
0350073041	VII	Materials Science in Daily Life	3	0	2	4
0350083051	VIII	Fundamentals of Waves and Vibrations	3	0	2	4

Note: All students can opt these courses except B.Sc. (Hons. with Research) Physical Sciences **Mathematics**						
0330013010	I	Introductory Algebra	3	1	0	4
0330023021	II	Calculus and Its Applications	3	0	2	4
0330043030	IV	Mathematical Concepts and Applications	3	1	0	4
0330063040	VI	Applied Vector Calculus	3	1	0	4
0330083051	VIII	Ordinary Differential Equations and Its Applications	3	0	2	4
Note: All students can opt these courses except B.Sc. (Hons. with Research) Physical Sciences						

12. POOL OF GENERIC ELECTIVE (GE) COURSES OFFERED BY ETERNAL UNIVERSITY

SEMESTER – I

S. No.	Course Category	Course Code	Course Title	Credits L+T+P	Sem	Offering Department
1	GE	0420013010	Essentials of Economics	3+1+0	Odd (I)	Economics
2	GE	0420013020	Sectoral Issues in Indian Economy	3+1+0	Odd (I)	Economics
3	GE	0410013010	Business & Commercial Knowledge	3+1+0	Odd (I)	Commerce
4	GE	0430013010	Fundamentals of Management	3+1+0	Odd (I)	Management
5	GE	0220013010	English Fluency – I(Mastering the Art of Communication)	3+1+0	Odd (I)	English
6	GE	0280013010	ਭਾਸ਼ਾਈਯੋਗਤਾਅਤੇਪੰਜਾਬੀਸਾਹਿਤ -।	3+1+0	Odd (I)	Punjabi
7	GE	0230013010	हिन्दी गद्य उद्भव एवं विकास- क	3+1+0	Odd (I)	Hindi
8	GE	0250013011	Hindustani Music (Vocal/ Instrumental)- 1	2+0+2	Odd (I)	Music
9	GE	0320013011	Chemistry of Biomolecules	3+0+1	Odd (I)	Chemistry & Biochemistry
10	GE	0330013010	Introductory Algebra	3+1+0	Odd (I)	Mathematics
11	GE	0360013011	Basic Zoology	3+0+1	Odd (I)	Zoology

SEMESTER – II

S. No.	Course Category	Course Code	Course Title	Credits L+T+P	Sem	Offering Department
1	GE	0430023020	Agribusiness Management	3+1+0	Even (II)	Management
2	GE	0410023020	Basic of Accounting	3+1+0	Even (II)	Commerce
3	GE	0420023040	Introductory Development Economics	3+1+0	Even (II)	Economics
4	GE	0420023040	Basic Issues in Environmental Economics	3+1+0	Even (II)	Economics
5	GE	0310023011	Plant Diversity Conservation for Sustainable Development	3+0+1	Even (II)	Botany
6	GE	0360023021	Wildlife Conversation	3+0+1	Even (II)	Zoology
7	GE	0350023011	Basic of Electricity and Magnetism	3+0+1	Even (II)	Physics
8	GE	0330023021	Calculus and Its Applications	3+0+1	Even (II)	Mathematics
9	GE	0220023010	English of Fluency - I	3+1+0	Even (II)	English
10	GE	0230023010	हिन्दी गद्य साहित्य का उद्भव एवं विकास- क	3+1+0	Even (II)	Hindi
11	GE	0280023010	ਭਾਸ਼ਾਈਯੋਗਤਾਅਤੇਪੰਜਾਬੀਸਾਹਿਤ -।	3+1+0	Even (II)	Punjabi
12	GE	0250023021	Hindustani Music (Voal/Instrumental)	2+0+2	Even (II)	Music
13	GE	0610023021	Operating System	3+0+1	Even (II)	CSE
14	GE	0240023010	Indus Valley to Vedic Age	3+1+0	Even (II)	History
15	GE	0270023011	Community Psychology	3+0+1	Even (II)	Psychology

SEMESTER – III

Sl. No.	Course Category	Course Code	Course Title	Credits L+T+P	Sem.	Offering Department
1	GE	0310033021	Plant and Human Welfare	3+0+1	Odd (III)	Botany
2	GE	0350033021	Fundamentals of Mechanics	3+0+1	Odd (III)	Physics
3	GE	0320033021	Principles of Instrumental Analysis	3+0+1	Odd (III)	Chemistry and Biochemistry
4	GE	0430033030	Entrepreneurial Skills	3+1+0	Odd (III)	Management
5	GE	0420033030	Rural Development Programmes	3+1+0	Odd (III)	Economics
6	GE	0410033030	Legal Aspects of Business	3+1+0	Odd (III)	Commerce
7	GE	0280033030	ਭਾਸ਼ਾਈਯੋਗਤਾਅਤੇਪੰਜਾਬੀਸਾਹਿਤ - III	3+1+0	Odd (III)	Punjabi
8	GE	0250033031	Hindustani Music (Vocal/ Instrumental)- III	2+0+2	Odd (III)	Music
9	GE	0220033030	Phonetics and Spoken English	3+1+0	Odd (III)	English
10	GE	0270033020	Youth, Gender and Identity	3+1+0	Odd (III)	Psychology
11	GE	0230033020	काव्य एवं प्रयोजन मूलक हिन्दी	3+1+0	Odd (III)	Hindi
12	GE	0610033031	Database Management System	3+0+1	Odd (III)	CSE

SEMESTER – IV

S. No.	Course Category	Course Code	Course Title	Credits L+T+P	Sem	Offering Department
1	GE	0340043011	Introduction to Microbiology	3+0+1	Even (IV)	Microbiology
2	GE	0420043040	Indian Economy and Governance	3+1+0	Even (IV)	Economics
3	GE	0360043031	Aquatic Biology	3+0+1	Even (IV)	Zoology
4	GE	0430043040	Business Laws	3+1+0	Even (IV)	Management
5	GE	0410024040	Fundamentals of Startup Finance	3+1+0	Even (IV)	Commerce
6	GE	0330331030	Foundation of Real Analysis	3+1+0	Even (IV)	Mathematics
7	GE	0350043031	Essentials of Electromagnetic Waves and Optics	3+0+1	Even (IV)	Physics
8	GE	0220043040	Learning English Through Literature	3+1+0	Even (IV)	English
9	GE	0250043041	Hindustani Music (Vocal / Instrumental) - 4	2+0+2	Even (IV)	Music
10	GE	0280043040	ਭਾਸ਼ਾਈਯੋਗਤਾਅਤੇਪੰਜਾਬੀਸਾਹਿਤ - IV	3+1+0	Even (IV)	Punjabi
11	GE	0610043041	Computer Networks	3+0+1	Even (IV)	CSE
12	GE	0330043030	Mathematical Concepts and Applications	3+1+0	Even (IV)	Mathematics

13. POOL OF SEC, AEC AND VAC COURSES OFFERED BY ETERNAL UNIVERSITY

SEMESTER – I

S. No.	Course Category	Course Code	Course Title	Credits L+T+P	Sem	Offering Department
1	SEC	0140014011	Bakery, Confectionary and Snack Products	1+0+1	Odd (I)	DKSGACA
2	SEC	0220014011	Soft Skills	1+0+1	Odd (I)	English
3	SEC	0250014011	Introduction to Gurmat Sangeet (with Harmonium)- 1	1+0+1	Odd (I)	Music
4	SEC	0310014011	Field Botany	1+0+1	Odd (I)	Botany
5	SEC	0330014011	Advanced Excel	1+0+1	Odd (I)	Mathematics
6	SEC	0410014011	Personal Financial Planning	1+0+1	Odd (I)	Commerce
7	SEC	0430014011	Office Management	1+0+1	Odd (I)	Management
8	SEC	0610014011	Interior Design and Decor	1+0+1	Odd (I)	CSE
9	SEC	0140014021	Culinary Arts and Catering Science	1+0+1	Odd (I)	Food Tech-nology
10	AEC	0220015011	Functional English-I	1+0+1	Odd (I)	English
11	AEC	0280015011	ਪੰਜਾਬੀਮੁੱਢਲਾਗਿਆਨ-।	1+0+1	Odd (I)	Punjabi
12	AEC	0230015011	सामान्य हिंदी भाषा और भाषा विज्ञान	1+0+1	Odd (I)	Hindi
13	AEC	0310015011	Environmental Sciences-I	1+0+1	Odd (I)	Botany
14	VAC	0260016011	Constitutional Values and Funda-mental Duties	1+0+1	Odd (I)	Political Science
15	VAC	0270016011	Emotional Intelligence	1+0+1	Odd (I)	Psychology
16	VAC	0290016011	Fit India	1+0+1	Odd (I)	Sports

SEMESTER – II

S. No.	Course Category	Course Code	Course Title	Credits L+T+P	Sem	Offering Department
1	SEC	0170024011	Mushroom Cultivation	1+0+1	Even (II)	DKSGACA
2	SEC	0220024021	Personality Development	1+0+1	Even (II)	English
3	SEC	0250024021	Introduction to Gurmat Sangeet (with Harmonium)- 2	0+0+2	Even (II)	Music
4	SEC	0230024011	कार्यालयी हिन्दी	1+0+1	Even (II)	Hindi
5	SEC	0320024011	Water Technology	1+0+1	Even (II)	Chemistry
6	SEC	0330024021	Introduction to R Programming	1+0+1	Even (II)	Mathematics
7	SEC	0430024021	Event Management	1+0+1	Even (II)	Management
8	SEC	0710024011	First Aid (Basic)	1+0+1	Even (II)	Nursing
9	SEC	0710024021	Geriatric Care	1+0+1	Even (II)	Nursing
10	SEC	0610024021	Mastering Typing	1+0+1	Even (II)	Computer
11	AEC	0220025011	Functional English-I	1+0+1	Even (II)	English
12	AEC	0280025011	ਪੰਜਾਬੀਮੁੱਢਲਾਗਿਆਨ-।	1+0+1	Even (II)	Punjabi
13	AEC	0230025011	सामान्य हिंदी भाषा और भाषा विज्ञान	1+0+1	Even (II)	Hindi
14	AEC	0310025011	Environmental Sciences- I	1+0+1	Even (II)	Botany
15	VAC	0110026011	National Cadet Corps -I	1+0+1	Even (II)	NCC UNIT
16	VAC	0290026021	Yoga: Philosophy and Practice	1+0+1	Even (II)	Sports
17	VAC	0220026011	Culture and Communication	1+0+1	Even (II)	English

SEMESTER – III

S. No.	Course Category	Course Code	Course Title	Credits L+T+P	Sem	Offering Department
1	SEC	0330034031	Introduction to LaTeX	1+0+1	Odd (III)	Mathematics
2	SEC	0360034011	Bee-keeping and Its Management	1+0+1	Odd (III)	Zoology
3	SEC	0420034011	Household Planning and Budgeting	1+0+1	Odd (III)	Commerce
4	SEC	0350034011	Nanotechnology and Its Applications	1+0+1	Odd (III)	Physics
5	SEC	0340034011	Microbiological Analysis of Water, Soil and Air	1+0+1	Odd (III)	Microbiology
6	SEC	0610034031	Python for Beginners	1+0+1	Odd (III)	CSE
7	SEC	0610034031	Computer System Hardware	1+0+1	Odd (III)	CSE
8	AEC	0310035021	Environmental Sciences-II	1+0+1	Odd (III)	Botany
9	AEC	0280035031	ਪੰਜਾਬੀਮੁੱਢਲਾਗਿਆਨ- II	1+0+1	Odd (III)	Punjabi
10	AEC	0220035021	Functional English-II	1+0+1	Odd (III)	English
11	AEC	0230035021	समाचार संकलन और लेखन	1+0+1	Odd (III)	Hindi
12	VAC	0410036011	Financial Literacy	1+0+1	Odd (III)	Economics
13	VAC	0280036011	ਮੱਧਕਾਲੀਕਾਵਿਪਰੰਪਰਾਵਿਚਨੈਤਿਕਤਾਦਾਸੰਕਲਪ	1+0+1	Odd (III)	Punjabi
14	VAC	0260036021	Human Rights: Theory and Practices	1+0+1	Odd (III)	Political Science
15	SEC	0320034021	Chemistry of Cosmetics & Hygiene Products	1+0+1	Odd (III)	Chemistry & Biochemistry
16	SEC	0310034021	Solid Waste Management	1+0+1	Odd (III)	Botany
17	SEC	0280034011	ਪੰਜਾਬੀਦ੍ਰਿਸ਼ਮੀਡੀਆਅਤੇਪਟਕਥਾਲੇਖਣ	1+0+1	Odd (III)	Punjabi
18	SEC	0220034031	Creative and Critical Expression in English	1+0+1	Odd (III)	English

SEMESTER – IV

S. No.	Course Category	Course Code	Course Title	Credits L+T+P	Sem	Offering Department
1	SEC	0310044021	Plant Identification Techniques	1+0+1	Even (IV)	Botany
2	SEC	0340044021	Food Fermentation Techniques	1+0+1	Even (IV)	Microbiology
3	SEC	0420044021	Social Survey Methods	1+0+1	Even (IV)	Economics
4	SEC	0610044041	Introduction to Web Design	1+0+1	Even (IV)	CSE
5	VAC	0280046021	ਸਾਹਿਤਅਤੇਮਨੁੱਖੀਚਰਿੱਤਰਦੀਨਿਰਮਾਣਕਾਰੀ	1+0+1	Even (IV)	Punjabi
6	VAC	0320046011	Science and Society	1+0+1	Even (IV)	Chemistry & Biochemistry
7	VAC	0220046021	Digital Storytelling	1+0+1	Even (IV)	English
8	AEC	0280045041	ਪੰਜਾਬੀਮੁੱਢਲਾਗਿਆਨ - II	1+0+1	Even (IV)	Punjabi
9	AEC	0310045021	Environmental Sciences-II	1+0+1	Even (IV)	Botany
10	AEC	0220045021	Functional English - II	1+0+1	Even (IV)	English
11	AEC	0230045021	समाचारसंकलनऔरलेखन	1+0+1	Even (IV)	Hindi
12	SEC	0280044021	ਪੰਜਾਬੀਪੱਤਰਕਾਰੀਅਤੇਸਾਹਿਤਕਪੱਤਰਕਾਰੀ	1+0+1	Even (IV)	Punjabi

SEMESTER-WISE COURSE DETAILS

Semester – I

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-1M	**0330311010**	**Algebra**	3	1	0	4
DSC-1C	**0320311011**	**Basic Concepts of Organic Chemistry**	3	0	2	4
DSC-1P	**0350311011**	**Mechanics**	3	0	2	4
GE-1		GE (One from the pool)	3	0	2	4
SEC-1		SEC (One from the pool)	1	0	2	2
AEC-1		AEC (One from the pool)	1	0	2	2
VAC-1		VAC (One from the pool)	1	0	2	2
Total			**15**	**1**	**12**	**22**

DSC-1M (Algebra)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0330311010
Course Title	Algebra
Academic Year	I
Semester	I
Number of Credits	4 (3+1+0)
Course Prerequisite	Mathematics of Class 11^{th} and 12^{th}
Course Synopsis	This course covers properties and applications of matrices including symmetric, skew symmetric, Hermitian, and skew Hermitian matrices. It explores elementary operations on matrices and their use in solving systems of linear equations, along with theorems on consistency. Additionally, topics include eigenvalues, eigenvectors, characteristic equations, and their applications, as well as solutions and nature of roots of polynomial equations, including methods for solving cubic and biquadratic equations.

Course Outcomes: At the end of the course students will be able to:

CO1	Mastery of Matrix Theory: Students will gain a comprehensive understanding of matrix operations, including different types of matrices and their properties.
CO2	Applications of Matrices: Students will learn to apply matrices to systems of linear equations, solving both homogeneous and non-homogeneous equations.
CO3	Understanding of Eigenvalues and Eigenvectors: Students will be able to calculate and interpret eigenvalues and eigenvectors and use them in various mathematical contexts.
CO4	Advanced Equation Solutions: Students will acquire skills in solving polynomial equations with conditions on roots, using various transformation techniques.
CO5	Comprehension of Equation Transformations: Students will understand the transformation of equations and how to utilize rules such as Descartes' rule of signs to solve complex equations.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	1	1	2	1	3	1	2	1
CO2	3	3	3	1	2	1	2	1	3	1	1	2
CO3	3	3	3	1	2	1	2	1	3	1	2	2
CO4	2	3	3	2	1	1	2	1	2	1	1	2
CO5	2	3	2	1	2	1	1	2	2	1	1	2
Average	**2.6**	**2.8**	**2.6**	**1.2**	**1.6**	**1**	**1.8**	**1.2**	**2.6**	**1**	**1.4**	**1.8**

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content:

L (Hours/ Week)	T (Hours/ Week)	P (Hours/ Week)	CL (Hours/Week)	Total Hour/ Week
3	-	2	-	5
Unit	**Content & Competencies**			
1.	Symmetric, Skew symmetric, Hermitian and skew Hermitian matrices, Elementary			

(Lecture Hours = 12)	Operations on matrices. Inverse of a matrix, Application of matrices to a system of linear (both homogeneous and non-homogeneous) equations, Theorems on consistency of a system of linear equations.
2. **(Lecture Hours = 10)**	Eigen values, Eigen vectors and the characteristic equation of a matrix, Caley Hamilton theorem and its use in finding the inverse of a matrix, Eigen value of Symmetric, Skew-Symmetric, Hermitian, skew Hermitian, Unitary and orthogonal Matrices.
3. **(Lecture Hours= 12)**	Relations between the roots and coefficients of general polynomial equation in one variable, Solutions of polynomial equations having conditions on roots, Common roots and multiple roots, Transformation of equations.
4. **(Lecture Hours = 11)**	Nature of the roots of an equation Descarete's rule of signs, Solutions of cubic equations (Cardon's method), Biquadratic equations and their solutions.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	-
Seminar/Journal Club	-
Small Group Discussion (SGD)	1
Self-directed Learning (SDL)/Tutorial	10
Problem Based Learning (PBL)	2
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**60**

Assessment Methods:

Formative	Summative
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs:

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva-voce	-	-	-	-	-

Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	-	-	-	-	-
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**
	1. Hall, H.S., & Knight, S.R. (2009). *Higher Algebra.* AITBS Publishers. 2. Narayan, S., & Mittal, P.K. (2010). *A Textbook of Matrices.* S. Chand Publishing. 3. Prasad, C. (1985). *Textbook on Algebra and Theory of Equations (10th ed.)*. Pothishala Pvt. Ltd. 4. Lewis, D. (1991). *Matrix theory*. World Scientific Publishing Company.

DSC-1C (Basic Concepts of Organic Chemistry)

Name of the College (Department)	Akal College of Basic Sciences (Chemistry & Biochemistry)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0320311011
Course Title	Basic Concepts of Organic Chemistry
Academic Year	I
Semester	I
Number of Credits	4 (3+0+1)
Course Prerequisite	Chemistry of Class 11th and 12th
Course Synopsis	Organic chemistry finds applications in pharmaceuticals, materials science, and agriculture, among others. Its interdisciplinary nature bridges biology, physics, and engineering, shaping diverse fields and innovations. This course will build a foundation and interest for organic chemistry as subject. Student will learn about the concept and antiquity of organic chemistry. Students will also acquire knowledge about different concepts of organic chemistry. This will help to develop the understanding and skills to think like organic chemist.
Course Outcomes: At the end of the course students will be able to:	
CO1	Define organic chemistry, outline its goals, and explain the scope of organic chemistry in our daily life.
CO2	Understanding the fundamental concepts of stereochemistry.
CO3	Frame the mechanism of organic reactions by reminding and relating the fundamental properties of the reactants involved.
CO4	Learn and identify many organic reactions.
CO5	Differentiate electrophilic addition, nucleophilic addition, nucleophilic substitution, electrophilic substitution and rearrangement reactions.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	2	1	2	2	1	2	1
CO2	1	1	2	2	1	1	1	2	1	2	3	2
CO3	2	2	2	2	2	2	-	2	1	1	1	1
CO4	2	2	1	2	2	1	2	2	2	1	2	2
CO5	3	3	2	2	3	2	2	2	2	1	3	1
Average	**2.2**	**2.2**	**2**	**2.2**	**2.2**	**1.6**	**1.2**	**2**	**1.6**	**1.2**	**2.2**	**1.4**
1= Weak Correlation				2= Moderate Correlation						3= Strong Correlation		

Course Content				
L (Hours/ Week)	**T (Hours/ Week)**	**P (Hours/ Week)**	**CL (Hours/Week)**	**Total Hour/ Week**
3	0	2	0	5
Unit	**Content & Competencies**			
1. Fundamentals of Organic Chemistry (Lecture Hours = 10)	Types of Electronic displacements: Inductive effect, Resonance effect, Hyperconjugation, Electromeric Effect. Reactive intermediates and their stability: carbocations, free radicals, carbanions, benzyne, carbenes. Acidity and basicity in			

	organic compounds (comparison of carboxylic acids, alcohols, phenols, primary, secondary and tertiary aliphatic amines, aniline and its derivatives)
2. Stereochemistry (Lecture Hours = 10)	Stereoisomerism: Concept of chirality (upto two carbon atoms). Configurational isomerism: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; Cis-trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E/Z nomenclature (for upto two C=C systems). Conformational isomerism with respect to ethane, butane and cyclohexane
3. Electrophilic & Nucleophilic addition reactions (Lecture Hours = 10)	Electrophilic addition reaction (with respect to propene, propyne, 3,3-dimethyl-1-butene): Hydration, Addition of HX in the absence and presence of peroxide, Hydroboration oxidation, Addition of bromine (with stereochemistry). Nucleophilic addition reaction of carbonyl compounds: Addition of HCN, ammonia derivatives (Hydroxylamine, Hydrazine, Semicarbazide and 2,4-DNP), the addition of carbanion (Aldol condensation, Claisen Schmidt, Benzoin condensation, Perkin reaction, reactions involving Grignard reagent)
4. Nucleophilic and Elimination substitution reactions (Lecture Hours = 15)	S_N1 and S_N2 in alkyl halides, alcohols (with nucleophiles like ammonia, halides, thiols, ambident nucleophiles (cyanide and nitrite ion)), ethers (Williamson ether synthesis), Elimination reaction (E1 & E2), elimination vs substitution (*w.r.t.*potassium t-butoxide and KOH); Nucleophilic aromatic substitution in aryl halides-elimination addition reaction w.r.t. chlorobenzene, including the effect of nitro group on the reaction. relative reactivity and strength of C-X bond in alkyl, allyl, benzyl, vinyl and aryl halides towards substitution reactions. Electrophilic Aromatic substitution with mechanism (benzene)- sulphonation, nitration, halogenation, Friedel craft acylation :*o-, m-* and *p-* directive influence giving examples of toluene/nitrobenzene/ phenol/aniline/ chlorobenzene.
5. Practical Component (Lab Hours = 30)	1. Purification of an organic compound by crystallization (from water and alcohol) and distillation, Criteria of purity: Determination of M.P. 2. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100°C by distillation and capillary method) 3. Detection of extra element 4. Preparations: (Mechanism of various reactions involved to be discussed). a. Bromination of phenol/aniline. b. 2,4-Dinitrophenylhydrazone of aldehydes and ketones c. Semicarbazone of aldehydes/ ketones d. Aldol condensation reaction using green method. e. Bromination of Stilbene. 5. Acetanilide to p-Bromoacetanilide

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small Group Discussion (SGD)	1
Self-directed Learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-

Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs:

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva-voce	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**
	1. Ahluwalia, V. K., & Dhingra, S. (2024). *Advanced Experimental Inorganic Chemistry*. Taylor & Francis. 2. Allinger, N. L., & Eliel, E.L. (Eds.). (2009). *Topics in stereochemistry*. John Wiley & Sons. 3. Furniss, B.S. (Ed.). (2011). *Vogel's textbook of practical organic chemistry*. Pearson Education India. 5. Lin, S. K., & March, J. (2001). *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure.* Molecules, 6(12), 1064-1065. 6. Sykes, P. (1986). *A guidebook to mechanism in organic chemistry.* Pearson Education India.

DSC-1P (Mechanics)

Name of the College (Department)	Akal College of Basic Sciences (Physics)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0350311011
Course Title	Mechanics
Academic Year	I
Semester	I
Number of Credits	4 (3+0+1)
Course Prerequisite	Physics and Mathematics of Class 11th and 12th
Course Synopsis	This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with dynamics of a system of particles and ends with the special theory of relativity. Students will appreciate the concept of rotational motion, gravitation and oscillations. The students will be able to apply the concepts learnt to several real-world problems.
Course Outcomes: At the end of the course students will be able to:	
CO1	Understand about the vectors and ordinary differential equations in terms of operator method and their utility in mechanics
CO2	Explain the dynamics of a system of particles, centre of mass and determine of centre of mass for discrete and continuous systems having spherical symmetry. Differentiate the conservative & non-conservative forces and elastic & in-elastic collisions.
CO3	Describe rotational and oscillatory motion. Apply theorem of parallel and perpendicular axes (statements only) and calculate moment of inertia of discrete and continuous systems.
CO4	To learn morphology, anatomy, systematic position, morphology, distinctive characters, distribution ecology and economic importance of the Annelids.
CO5	Define the frame of references and explain the concept of Lorentz, Galilean transformations, Michelson-Morley experiment, length contraction, time dilation, relativistic transformation of velocity and relativistic variation of mass.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)& Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	1	1	2	3	2	2	1
CO2	2	3	1	2	2	2	1	3	3	2	1	2
CO3	3	2	2	2	2	2	2	1	2	1	1	1
CO4	3	1	2	2	1	2	2	2	2	2	2	2
CO5	3	3	2	2	2	2	2	3	2	2	2	1
Average	**2.8**	**2.4**	**2**	**2.2**	**2**	**1.8**	**1.6**	**2.2**	**2.4**	**1.8**	**1.6**	**1.4**

1= Weak Correlation 2= Moderate Correlation
3= Strong Correlation

Course Content				
L (Hours/ Week)	**T (Hours/ Week)**	**P (Hours/ Week)**	**CL (Hours/Week)**	**Total Hour/ Week**
3	0	2	0	5
Unit	**Content & Competencies**			

1. Review of vectors and ordinary differential equation (Lecture Hours = 10)	Gradient of a scalar field, divergence and curl of vectors field, polar and axial vectors Second order homogeneous ordinary differential equations with constant coefficients (Operator Method Only).
2. Fundamentals of Dynamics (Lecture Hours = 11)	Dynamics of a system of particles, centre of mass, determination of centre of mass for discrete and continuous systems having spherical symmetry. Conservation of momentum and energy, Conservative and non-Conservative forces, work – energy theorem for conservative forces, force as a gradient of potential energy. Particle collision (Elastic and in-elastic collisions)
3. Rotational and Oscillatory Motion: Law of Gravitation (Lecture Hours = 13)	Angular momentum, torque, conservation of angular momentum, Moment of inertia, Theorem of parallel and perpendicular axes (statements only). Calculation of moment of inertia of discrete and continuous objects (1-D and 2-D). Idea of simple harmonic motion, differential equation of simple harmonic motion and its solution, Motion of simple pendulum, damped harmonic oscillator. Newton's law of gravitation, motion of a particle in a central force field, Kepler's Laws (statements only)
4. Special Theory of Relativity (Lecture Hours = 11)	Frames of reference, Galilean transformations, inertial and non-inertial frames, Michelson Morley's Experiment, postulates of special theory of relativity, Lorentz transformation, length contraction, time dilation, relativistic transformation of velocity, relativistic variation of mass.
5. Practical Component (Lab Hours = 30)	The teacher is expected to provide basic idea and working of various apparatus and instruments related to different experiments. Students are supposed to known knowledge of recording and analyzing experimental data along with study error analysis in observations. Every student should perform at least 05 experiments from the following list: 1. Measurements of (length/diameter) using vernier caliper, screw gauge. 2. Determination of height of a building using a sextant. 3. Calculate (a) spring constant and, (b) acceleration due to gravity by studying the motion of the spring. 4. Determination of moment of inertia of a flywheel. 5. Determination of value of acceleration due to gravity using simple pendulum. 6. Determination of value of acceleration due to gravity using bar pendulum. 7. Determination of the center of mass of irregular-shaped 2D/3D bodies. 8. Study of elastic and inelastic collisions using air track or ball bearings on a low-friction surface. 9. Mechanics Virtual lab Experiments

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small Group Discussion (SGD)	1
Self-directed Learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-

Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs:

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva-voce	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**

1. Kittel, C., Knight, W.D., & Ruderman, M.A. (2007). *Mechanics: Berkeley physics course* (Vol. 1). Tata McGraw-Hill.
2. Halliday, D., Resnick, R., & Walker, J. (2010). *Fundamentals of physics* (9th ed.). John Wiley & Sons.
3. Sharma, S.K. & Sharma S. (2024). *A Textbook of Mechanics B.Sc. I (Major & Minor)*. DINESH.
4. Mathur D.S. & Hemne, P.S. (2000). *Mechanics*. S. Chand Publishing.
5. Bhattacharya, B. (2015). *Engineering mechanics* (2nd ed.). Oxford University Press.
6. Reese, R.L. (2003). *University physics*. Thomson Brooks/Cole.
7. Arora, C. L. (2001). *B.Sc. Practical Physics*. S. Chand & Company.
8. Amrita Vishwa Vidyapeetham. Virtual Labs. https://vlab.amrita.edu/?sub=1
9. Indian Institute of Technology Kharagpur. Virtual Labs: An Initiative of MHRD, Govt. of India. http://vlabs.iitkgp.ac.in/vlt/
10. Amrita Vishwa Vidyapeetham & CDAC. Virtual labs: Developed with Support from MeitY. https://www.olabs.edu.in/?pg=topMenu&id=40

GENERAL ELECTIVES (GE) COURSES
[Offered under B.Sc. (Hons. With Research) Physical Sciences program opted by students enrolled in other programs]

SEMESTER – I

S.No.	Course Category	Course Code	Course Title	Credits L+T+P	Semester	Offering Department
1	GE-1C	0320013011	Chemistry of Biomolecules	3+0+1	Odd (I)	Chemistry & Biochemistry
2	GE-1M	0330013010	Introductory Algebra	3+1+0	Odd (I)	Mathematics

GE-1C (Chemistry of Biomolecules)

Name of the College (Department)	Akal College of Basic Sciences (Chemistry and Biochemistry)
Name of the Program	All Programmes other than B.Sc. (Hons. with Research) Life Sciences and B.Sc. (Hons. with Research) Physical Sciences
Course Code	0320013011
Course Title	Chemistry of Biomolecules
Academic Year	I
Semester	I
Number of Credits	4 (3+0+1)
Course Prerequisite	
Course Synopsis	This course provides a comprehensive introduction to the fundamental principles underlying the chemistry of life. It explores the structure, function and importance of biomolecules, the building blocks of life. Students will gain a deep understanding of carbohydrates, proteins, lipids, nucleic acids, vitamins and coenzymes. The course emphasizes the integration of theoretical knowledge with practical applications, fostering critical thinking and problem-solving skills. Through hands-on experiments and real-world examples, students will develop a solid foundation in biochemistry, preparing them for further studies in the biological and medical sciences.

Course Outcomes: At the end of the course students will be able to:

CO1	Classify and describe the major classes of biomolecules (carbohydrates, lipids, proteins and nucleic acids) and their structural components.
CO2	Explain the role of biomolecules in various biological processes, including energy metabolism, cell structure and genetic information transfer.
CO3	Demonstrate an understanding of the interrelationships between different classes of biomolecules and their functions within living organisms.
CO4	Apply biochemical principles to analyze and interpret experimental data related to biomolecules.
CO5	Appreciate the significance of biochemistry in fields such as medicine, agriculture and biotechnology.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1												
CO2												
CO3												
CO4												
CO5												
Average												

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content:

L (Hours/Week)	T (Hours/Week)	P (Hours/Week)	CL (Hours/Week)	Total Hours/Week
3	-	2	-	5

Unit	Content & Competencies

1. **(Lecture Hours = 11)**	Definition and classification of biomolecules: Bioorganic compounds, Bioinorganic compounds, Importance of biomolecules in living systems. Structure of biomolecules:Functional groups in biomolecules, Isomerism in biomolecules. Carbohydrates: Classification of carbohydrates, Structure and properties of monosaccharides, Oligosaccharides and Polysaccharides.
2. **(Lecture Hours = 11)**	Amino Acids and Proteins: Structure and classification of amino acids, Essential and non-essential amino acids, Zwitterionic nature of amino acids, Isoelectric point, Peptide bond formation, Protein functions: Enzymes, Hormones, Antibodies, Structural proteins, Transport proteins
3. **(Lecture Hours = 12)**	Lipids: Simple lipids, complex lipids, derived lipids. Fatty acids: Structure and properties of fatty acids, Essential fatty acids. Triglycerides: Structure and properties of triglycerides, Fats and oils, Saponification. Phospholipids: Structure and properties of phospholipids, biological membranes. Steroids: Cholesterol and steroid hormones.
4. **(Lecture Hours = 11)**	Nucleic Acids: Purines and Pyrimidines, Structure and properties of nucleotides and nucleosides. Structure of DNA and RNA, Differences between DNA and RNA. Vitamins and Coenzymes: Fat-soluble and water-soluble vitamins, Vitamin A, D, E, K, B complex and vitamin C.
5. Practical Component (Lab Hours = 30)	Any 7 practical from below mentioned list: 1. Solution preparation: Dilution, mixing and concentration calculations. 2. Measurement of the pH of different solutions (acids, bases, buffers) using pH paper or a pH meter. 3. Preparing Buffer Solutions: Principles and Practical Approaches. 4. Estimation of reducing sugars in different samples. 5. Monitoring the breakdown of starch by amylase using iodine solution. 6. Determination of presence of proteins in different samples. 7. Investigation of the solubility of different lipids (fats, oils) in various solvents. 8. Preparation of soap by saponification of a fat or oil. 9. Determination of the saponification value of a fat or oil to estimate the average molecular weight of fatty acids. 10. Estimation of Vitamin C using titration method.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	**Contact Hours**
Lecture	45
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback
References:	**List of Reference Books**
	1. Nelson DL, Cox MM (2021). *Lehninger principles of biochemistry* (8th ed.). W. H. Freeman. 2. Satyanarayana U, Chakrapani U (2013). *Biochemistry* (4th ed.). Elsevier Health Sciences 3. Wilson K, Walker J (2018). *Principles and Techniques of Biochemistry and Molecular Biology*(8th ed.). Cambridge University Press.

GE-1M (Introductory Algebra)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the Program	All programmes other than B.Sc. (Hons. with Research) Physical Sciences
Course Code	0330013010
Course Title	Introductory Algebra
Academic Year	I
Semester	I
Number of Credits	4 (3+1+0)
Course Prerequisite	Undergraduate students from all disciplines expect those pursing B.Sc. (Physical Sciences)
Course Synopsis	This course introduces matrices, their types, and operations, including the adjoint method for finding inverses and solving small systems of equations. Students will explore eigenvalues, eigenvectors, and basic properties of special matrices. The course also covers fundamental concepts of polynomials, root behavior, and simple methods for solving cubic and biquadratic equations. Emphasis is on conceptual clarity and practical computation.

Course Outcomes: At the end of the course, students will:

CO1	Identify and classify different types of matrices and perform fundamental matrix operations, including finding the adjoint and inverse of matrices.
CO2	Solve small systems of linear equations (homogeneous and non-homogeneous) using matrix methods and analyze their consistency.
CO3	Compute eigenvalues and eigenvectors of 2×2 and 3×3 matrices and apply the Cayley–Hamilton theorem in simple cases.
CO4	Solve polynomial equations under specified root conditions using factorization and substitution methods.
CO5	Apply transformations of equations and use Descartes' Rule of Signs and related techniques to analyze the nature of roots.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1												
CO2												
CO3												
CO4												
CO5												
Average												

1= Weak Correlation 2 = Moderate Correlation 3 = Strong Correlation

Course Content:

L(Hours/Week)	T(Hours/Week)	P(Hours/Week)	Total Hours/Week
3	1	-	4

Unit	Content & Competencies
1. **(Lecture Hours =12)**	Introduction to matrices, Types of matrices: Row, Column, Square, Zero, Diagonal, Scalar, Identity matrices, Symmetric and Skew-symmetric matrices (only definitions with examples). Elementary row and column operations on matrices. Adjoint of a matrix, Finding the inverse of a 2×2 and 3×3 matrix. Application: Solving small systems of linear equations (2 or 3 variables). Cremer's Rule, Introduction to consistent and inconsistent systems.
2. **(Lecture Hours =11)**	Meaning and significance of eigenvalues and eigenvectors, finding eigenvalues and eigenvectors of 2×2 and 3×3 matrix. Characteristic polynomial. Statement and application of Cayley–Hamilton theorem. symmetric and orthogonal matrices and their properties.
3. **(Lecture Hours =11)**	Introduction to polynomials and their graphs. Simple factorization of polynomials up to degree 3. Relation between roots and coefficients (only for quadratic and cubic polynomials). Computation of common roots and multiple roots of a polynomial.
4. **(Lecture Hours =11)**	Understanding nature of roots using sign changes. Descartes' Rule of Signs (only for polynomials with real coefficients).Solving cubic equations by simple substitution method. Introduction to Biquadratic equations and their solutions.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours:

Learning Strategies	Contact Hours
Lecture	45
Practical	-
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	10
Problem Based Learning (PBL)	2
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**60**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	

Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with Cos

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
Viva	-	-	-	-	-
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	-	-	-	-	-
Practical Log Book/ Record Book	-	-	-	-	-
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process	Student's Feedback
References:	**List of Reference Books**
	1. Hall, H. S., & Knight, S. R. (2009). *Higher algebra.* AITBS Publishers. 2. Narayan, S., & Mittal, P. K. (2010). *A textbook of matrices*. S. Chand Publishing. 3. Prasad, C. (1985). *Textbook on Algebra and Theory of Equations.* Pothishala Pvt. Ltd., Allahabad/Prayagraj (India), 10. 4. Lewis, D. (1991). *Matrix theory.* World Scientific Publishing Company.

SEC/AEC/VAC COURSES
[Offered under B.Sc. (Hons. With Research) Physical Sciences Program]

SEMESTER-I

S.No	Course Category	Course Code	Course Title	Credits	Semester	Offering Department
1	SEC-1	0330014011	Advance Excel	1+0+1	Odd (I)	Mathematics

SEC-1 (Advance Excel)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the program	All programmes
Course Code	0330014011
Course Title	Advance Excel
Academic Year	I
Semester	I
Number of Credits	2
Course Prerequisite	--
Course Synopsis	This course aims to equip students with the essential skills needed to leverage Excel for effective data management, analysis, and presentation, preparing them for various professional tasks involving data manipulation and reporting.

Course Outcomes: At the end of the course students will be able to

CO1	Master various formatting techniques (font, number, table, conditional) and data management skills (sort/filter, hide/unhide, paste special, insert elements).
CO2	Customize Excel interface and functionalities, use shortcut keys, and apply basic functions (SUM, AVERAGE, MAX, MIN, COUNT) with different referencing methods.
CO3	Import and manage data from multiple sources, apply advanced formatting, and use conditional formatting to highlight key data trends.
CO4	Perform complex calculations using advanced mathematical and logical functions (SUMIF, COUNTIF, AVERAGEIF, nested IF, AND, OR, NOT, trigonometric and logarithmic functions).
CO5	Implement file-level, workbook, and worksheet protection to ensure data integrity and security in Excel.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	2	3	2	1	2	2	3	2	3	1
CO2	2	2	2	2	2	2	1	3	3	2	2	2
CO3	2	1	2	2	1	2	2	1	2	1	2	1
CO4	3	2	3	2	2	1	2	2	2	2	3	2
CO5	3	2	2	2	2	2	2	3	2	2	2	1
Average	**2.6**	**1.8**	**2.2**	**2.2**	**1.8**	**1.6**	**1.8**	**2.2**	**2.4**	**1.8**	**2.4**	**1.4**

1= Weak Correlation 2 = Moderate Correlation 3 = Strong Correlation

Course Content:

L (Hours/Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total Hour/Week**
1	-	2	-	3

Unit	**Content & Competencies**
1. **(Lecture Hours = 3)**	Font formatting, Number formatting, Table formatting, Conditional formatting, Hide/Unhide, Sort/filter, Paste special, Find and select, Insert, Illustrations, Charts, Tex, Page Layout
2. **(Lecture Hours =4)**	Introduction of Excel: An overview of the screen, navigation and basic spreadsheet concepts, Various selection techniques, Shortcut Keys, Customizing Excel: Customizing the Ribbon, Using and Customizing Auto Correct, Changing Excel's Default Options, Using Basic Function, Using Functions Sum, Average, Max, Min, Count, Abso-

	lute, Mixed and Relative Referencing
3. **(Lecture Hours = 4)**	Currency Format, Format Painter, Formatting Dates, Custom and Special Formats, Formatting Cells with Number formats, Font formats, Alignment, Borders, etc, Basic conditional formatting. Data: Import from web, import from text, Text to columns, remove duplicates, Grouping and ungrouping, Hyper linking data, within sheet/workbook, Linking & Updating links between workbooks & application
4. **(Lecture Hours = 4)**	Formulae that Add/Subtract/Multiply/Divide, BODMAS/Formula Error Checking, The Sum Function, Sum If, Sum Ifs Count If, Count Ifs Average If, Average Ifs, Nested IF, IFERROR Statement, AND, OR, NOT. Trigonometric functions and their plots Math & Trigonometry Functions, Using SUMPRODUCT Functions, Using FLOOR/CEILING/ MROUND/MOD/QUOTIENT Functions, Logarithmic function and their plot. Protecting Excel: File Level Protection, Workbook, Worksheet Protection.

Learning Strategies and Contact Hours

Learning Strategies	**Contact Hours**
Lecture	15
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**45**

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	
Problem Based Learning (PBL)	
Journal Club	
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓

Viva	-	-	-	-	-
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Clinical/Practical Log Book/ Record Book	-	-	-	-	-
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process	Student's Feedback
References:	**List of Reference Books**
	1. Goldmeier, J. (2014). *Advanced Excel Essentials.* Apress. 2. Korol, J. (2022). *Excel 2021/Microsoft 365 Programming By Example.* Mercury Learning and Information. 3. Narayana, D., Ranjan, S., &Tyagi, N. (2023). *Basic Computational Techniques for Data Analysis: An Exploration in MS Excel.* Routledge India.

Semester – II

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-2M	**0330321021**	**Calculus**	3	0	2	4
DSC-2C	**0320321021**	**Periodic Properties and Chemical Bonding**	3	0	2	4
DSC-2P	**0350321021**	**Electricity and Magnetism**	3	0	2	4
GE-2		GE (One from the pool)	3	0	2	4
SEC-2		SEC (One from the pool)	1	0	2	2
AEC-2		AEC (One from the pool)	1	0	2	2
VAC-2		VAC (One from the pool)	1	0	2	2
Total			**15**	**0**	**14**	**22**

DSC-2M (Calculus)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0330321021
Course Title	Calculus
Academic Year	I
Semester	II
Number of Credits	4 (3+0+1)
Course Prerequisite	Mathematics of Class 11th and 12th
Course Synopsis	This course focuses on learning differential calculus by visualizing functions. We'll cover limits, continuity, derivatives, finding areas, volumes of shapes, force, and work. You'll also learn important formulas and methods for integrating different functions with one or more variables.

Course Outcomes: At the end of the course students will be able to:	
CO1	Students will be able to apply limit and continuity concepts to examine the behavior of different functions, calculate differentiability of functions, and approximate functions using series expansions.
CO2	Students will be able to know the behavior of curves, identify asymptotes, compute curvature, of different curves in Cartesian, parametric and polar coordinates.
CO3	Students will understand the geometric properties of various types of curves in Cartesian and polar coordinate.
CO4	Students will be able to trace curves accurately in Cartesian, parametric, and polar coordinates, apply reduction formulae to simplify integrals, calculate arc lengths using rectification techniques, and understand the concept of intrinsic equations and their applications in curve analysis.
CO5	Students will calculate curve-bounded areas, volumes, and surface areas using integration techniques.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	1	1	2	3	2	2	1
CO2	2	3	1	2	2	2	1	3	3	2	1	2
CO3	3	2	2	2	2	2	2	1	2	1	1	1
CO4	3	1	2	2	1	2	2	2	2	2	2	2
CO5	3	3	2	2	2	2	2	3	2	2	2	1
Average	**2.8**	**2.4**	**2**	**2.2**	**2**	**1.8**	**1.6**	**2.2**	**2.4**	**1.8**	**1.6**	**1.4**

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content				
L (Hours/ Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total Hours/Week**
3	-	2	-	5
Unit	**Content & Competencies**			
1. (Lecture Hours = 13)	Definition of the limit of a function, basic properties of limits, continuous functions and classification of discontinuities, Differentiability, successive differentiation, Leibnitz's theorem, Maclaurin's and Taylor's series expansions.			

2. **(Lecture Hours = 10)**	Asymptotes in Cartesian coordinates, intersection of curve and its asymptotes, asymptotes in polar coordinates, Curvature, radius of curvature for Cartesian curves, parametric curves, polar curves, Newton's method, Radius of curvature for pedal curves, Tangential polar equations, Centre of curvature, Circle of curvature, Chord of curvature, Evolutes.
3. **(Lecture Hours = 10)**	Tests for concavity and convexity, Point of inflexion, Multiple points, Cusps, nodes and conjugate points, Types of cusps. Tracing of curves in Cartesian, parametric and polar coordinates, Reduction formulae, Rectification, intrinsic equations of curve.
4. **(Lecture Hours = 12)**	Quadrature (area) sectorial area, area bounded by closed curves, volumes and surfaces of solids of revolution, Theorems of Pappu's and Guldin.
5. **Practical Component** **(Lab Hours = 30)**	**List of Practicals (using any software)** 1. Plotting of graphs of function e^{ax+b}, log(ax + b) and to illustrate the effect of a and b on the graph. 2. Plotting of graphs of function sin(ax + b), cos(ax + b), and to illustrate the effect of a and b on the graph. 3. Computing successive differentiation. 4. Plotting of graphs of function 1/(ax + b), |ax + b| and to illustrate the effect of a and b on the graph. 5. Plotting a tangent to a curve. 6. Create surface of revolution. 7. Plotting of polar curves. 8. Plotting of asymptotes.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small Group Discussion (SGD)	1
Self-directed Learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)

Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs:

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva-voce	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**
	1. Frank Ayres, Jr., Elliot Mendelson, (2009). *Calculus Schamus outline series (5th ed.).* Schaum Publishing Co., McGraw-Hill. 2. Piskunov, N. (1997). *Differential and Integral Calculus*, Peace Publishers, Moscow. 3. Prasad, G. (1994). *Differential Calculus*, Pothishala Private Ltd., Allahabad. 4. Courant, R., and John, F. (1999). *Introduction to Calculus and Analysis*, Springer-Verlag.

DSC-2C (Periodic Properties and Chemical Bonding)

Name of the College (Department)	Akal College of Basic Sciences (Chemistry & Biochemistry)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0320321021
Course Title	Periodic Properties and Chemical Bonding
Academic Year	I
Semester	II
Number of Credits	4 (3+0+1)
Course Prerequisite	Chemistry of Class 11th and 12th
Course Synopsis	The course would provide the basic information about the periodicity in properties with reference to the s, p and d block, which is necessary in understanding their group chemistry. It provides basic understanding about ionic, covalent and metallic bonding underlining the fact that chemical bonding is best regarded as a continuum between the three cases. The course provides an overview of hydrogen bonding and van der Waal's forces which influence the melting points, boiling points, solubility and energetics of dissolution of compounds.

Course Outcomes: At the end of the course students will be able to:	
CO1	Understand the trends in periodic table for ionization enthalpy, electron gain enthalpy, electronegativity and enthalpy of atomization.
CO2	Understand different oxidation state, colour, metallic character, magnetic and catalytic properties and ability to form complexes.
CO3	Comprehend the concept of lattice energy using Born-Landé expression.
CO4	Draw the structures of molecules using VSEPR theory.
CO5	Understand Molecular orbitals diagrams.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)& Program Specific Outcomes:												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	2	1	2	2	1	2	1
CO2	1	1	2	2	1	1	2	2	1	2	3	2
CO3	2	2	2	2	2	2	-	2	1	1	1	1
CO4	2	2	1	2	2	1	1	2	2	1	2	2
CO5	3	3	2	2	3	2	2	2	2	1	3	1
Average	**2.2**	**2.2**	**2**	**2.2**	**2.2**	**1.6**	**1.2**	**2**	**1.6**	**1.2**	**2.2**	**1.4**
1= Weak Correlation				2= Moderate Correlation						3= Strong Correlation		

Course Content				
L (Hours/ Week)	**T (Hours/ Week)**	**P (Hours/ Week)**	**CL (Hours/Week)**	**Total Hour/ Week**
3	-	2	-	5
Unit	**Content & Competencies**			
1. Periodic Properties (Lecture Hours = 10)	Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy, inert pair effect. General group trends of s, p			

	and d block elements with special reference to Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, oxidation state, colour, metallic character, magnetic and catalytic properties, ability to form complexes.
2. Ionic Bonding (Lecture Hours = 10)	Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.
3. Covalent Bonding (Lecture Hours = 10)	Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds.
4. Molecular Orbital Theory (Lecture Hours = 15)	Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1^{st} and 2^{nd} periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.
5. Practical Component (Lab Hours = 30)	1. Preparation of standard solutions. 2. Estimation of Sodium carbonate using HCl by acid base titration. 3. Estimation of carbonate and hydroxide present together in a mixture. 4. Estimation of carbonate and bicarbonate present together in a mixture. 5. Estimation of free alkali present in different soaps/detergents. 6. Estimation of oxalic acid using $KMnO_4$ by redox titration. 7. Estimation of Mohr's salt using $KMnO_4$ by redox titration. 8. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators. 9. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small Group Discussion (SGD)	1
Self-directed Learning (SDL)/Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination

Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs:

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva-voce	✓	✓	✓	✓	✓
Assignment/ Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**
	1. Atkins, P. (2010). *Shriver and Atkins' inorganic chemistry*. Oxford University Press, USA. 2. Crichton, R.R. (2012). *Biological inorganic chemistry: a new introduction to molecular structure and function*. Elsevier. 3. Douglas, B.E., Mc Daniel, D.H., & Alexander, J.J. (1994). *Concepts and models of inorganic chemistry*, John Wiley & Sons. 4. Huheey, J.E., Keiter, E.A., Keiter, R.L., & Medhi, O.K. (2006). *Inorganic chemistry: principles of structure and reactivity*. Pearson Education India. 5. Kaim, W., Schwederski, B., & Klein, A. (2013). *Bioinorganic Chemistry - Inorganic Elements in the Chemistry of Life: An Introduction and Guide*. John Wiley & Sons. 6. Lee, J.D. (2008). *Concise inorganic chemistry*. John Wiley & Sons. 7. Vogel, A.I., & Jeffery, G.H. (1989). *Vogel's textbook of quantitative chemical analysis*, John Wiley and Sons.

DSC-2P (Electricity and Magnetism)

Name of the College (Department)	Akal College of Basic Sciences (Physics)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0350321021
Course Title	Electricity and Magnetism
Academic Year	I
Semester	II
Number of Credits	4 (3+0+1)
Course Prerequisite	Physics and Mathematics of Class 11th and 12th
Course Synopsis	This course reviews the concepts of electromagnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields due to continuous charge and current distributions respectively.
Course Outcomes: At the end of the course students will be able to:	
CO1	Apply Coulomb's law to line, surface, and volume distributions of charges; and Apply Gauss's law of electrostatics to distribution of charges
CO2	Solve boundary value problems using method of images
CO3	Comprehend the genesis of multipole effects in arbitrary distribution of charges
CO4	Understand the effects of electric polarization and concepts of bound charges in dielectric materials.
CO5	Calculate the vector potential and magnetic field of arbitrary current Distribution. Understand the impact of time-varying magnetic and electric fields in order to comprehend the formulation of Maxwell's equations.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	1	1	2	3	2	2	1
CO2	2	3	1	2	2	2	1	3	3	2	1	2
CO3	3	2	2	2	2	2	2	1	2	1	1	1
CO4	3	1	2	2	1	2	2	2	2	2	2	2
CO5	3	3	2	2	2	2	2	3	2	2	2	1
Average	**2.8**	**2.4**	**2**	**2.2**	**2**	**1.8**	**1.6**	**2.2**	**2.4**	**1.8**	**1.6**	**1.4**
1= Weak Correlation				2= Moderate Correlation						3= Strong Correlation		

Course Content				
L (Hours/ Week)	**T (Hours/ Week)**	**P (Hours/ Week)**	**CL (Hours/Week)**	**Total Hour/ Week**
3	-	2	-	5
Unit	**Content & Competencies**			
1. Electric Field and Electric Potential; Boundary Value Problems in Electrostatics (Lecture	Electric field due to charge Distributions. Divergence and Curl of electric field, Differential and integral forms of Gauss's Law and its applications to various charge distributions with spherical, cylindrical and planar symmetries. Formulation of Laplace's and Poisson equations and their Solutions using Cartesian coordinates applying separable variable technique.			

Hours = 11)	
2: Special techniques for the calculation of Potential and Field; Multipole Expansion (Lecture Hours = 11)	The Method of Images in the presence of (i) a Plane infinite sheet maintained at constant potential, and (ii) a Sphere maintained at constant potential. Monopole, dipole and quadrupole potentials at large distances due to an arbitrary charge distribution expressed in terms of Legendre polynomials, negative Gradient of Dipole potential in spherical coordinates.
3: Electric Field in Matter (Lecture Hours = 11)	Polarization, Bound charges and their interpretation. Field inside a dielectric, Displacement vector D, Gauss' Law in the presence of dielectrics, Boundary conditions for D, Linear dielectrics, Electric Susceptibility and Dielectric Constant, idea of complex dielectric constant due to varying electric field. Boundary value problems with linear dielectrics
4: Magnetic Field and Magnetic Properties of Matter and Electromagnetism (Lecture Hours = 12)	Divergence and curl of magnetic field B, Biot-Savart law, Ampere's law, Integral and differential forms of Ampere's Law, Vector potential and its ambiguities, Coulomb gauge and possibility of making vector potential divergence less, Vector potential due to line, surface and volume currents using Poisson equations for components of vector potential. Magnetization vector. Bound currents, Magnetic intensity. Magnetic susceptibility and permeability . Ferromagnetism (Hund's rule). Faraday's Law, Lenz's Law, inductance, electromotive force, Ohm's law ($\vec{J} = \sigma \vec{E}$), energy stored in a magnetic Field.
5. Practical Component (Lab Hours = 30)	The teacher is expected to provide basic idea and working of various apparatus and instruments related to different experiments. Students are supposed to known knowledge of recording and analyzing experimental data along with study error analysis in observations. Every student should perform at least 05 experiments from the following list: 1. To find the resistance of a given wire using meter bridge and hence calculate the resistivity. 2. To study the variation of magnetic field with distance along the axis of a circular coil carrying current. 3. B-H curves for soft and hard ferromagnetic materials and comparison of their coercivity, retentivity and saturation magnetization for same applied magnetic field. 4. To calculate the capacitance of a capacitor, observe its charging and discharging characteristics. 5. To measure the value of an unknown capacitance using he flashing and quenching experiment. 6. To verify the laws of combination (series) of resistances using a metre bridge. 7. To determine the value of an air capacitance by de-Sauty Method and to find permittivity of air. 8. To find the frequency of AC mains with a sonometer 9. (a) To study Photoelectric effect using Photocell (b) inverse-square law (concept of solid angle). 10. Five Electricity and magnetism Experiments activity

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small Group Discussion (SGD)	1

Self-directed Learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs:

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva-voce	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓
Feedback Process:	Student's Feedback				
References:	**List of Reference Books**				

	1. Griffiths, D.J. (2023). *Introduction to Electrodynamics* (5th ed.). Benjamin Cummings. 2. Edminister, J.A., & Nahvi, M. (2019). *Schaum's Outline of Electromagnetics* (5th ed.). Mc Graw-Hill Education. 3. Kip, A.F. (1981). *Fundamentals of Electricity and Magnetism* (2nd ed.). McGraw-Hill. 4. Purcell, E.M. (1986). *Electricity and Magnetism*. McGraw-Hill Education. 5. Fewkes, J.H., & Yarwood, J. (1991). *Electricity and Magnetism* (Vol. I). Oxford University Press. 6. Franklin, J. (2005). *Classical Electromagnetism*. Pearson Education. 7. Arora, C. L. (2001). *B.Sc. Practical Physics*. S. Chand & Company. 8. Amrita Vishwa Vidyapeetham. *Virtual Labs*. https://vlab.amrita.edu/?sub=1 9. Indian Institute of Technology Kharagpur. *Virtual Labs: An Initiative of MHRD, Govt. of India*. http://vlabs.iitkgp.ac.in/vlt/ 10. Amrita Vishwa Vidyapeetham & CDAC. *Virtual labs: Developed with Support from MeitY*. https://www.olabs.edu.in/?pg=topMenu&id=40

GENERAL ELECTIVES (GE) COURSES
[Offered under B.Sc. (Hons. With Research) Physical Sciences program opted by students enrolled in other programs]

SEMESTER – II

S.No.	Course Category	Course Code	Course Title	Credits	Semester	Offering Department
1	GE-2C	0350023011	Basic of Electricity and Magnetism	3+0+1	Even (II)	Physics
2	GE-2M	0330023021	Calculus and Its Applications	3+0+1	Even (II)	Mathematics

GE-2C (Basic of Electricity and Magnetism)

Name of the College (Department)	Akal College of Basic Sciences (Physics)
Name of the Program	All Programs other than B.Sc. (Hons. with Research) Physical Sciences
Course Code	0350023011
Course Title	Basics of Electricity and Magnetism
Academic Year	I
Semester	II
Number of Credits	4 (3+0+1)
Course Prerequisite	Physics and Mathematics of Class 11^{th} and 12^{th}
Course Synopsis	This course reviews the concepts of electromagnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields due to continuous charge and current distributions respectively.

Course Outcomes: At the end of the course students will be able to:

CO1	Gain knowledge of historical contributions to electricity and magnetism, including those of Maxwell and Thomas A. Addison, and explore their applications in communication, medicine, and industry.
CO2	Understand basic magnetic concepts such as magnetic dipoles, magnetization, magnetic susceptibility, permeability, hysteresis, and types of magnetic materials, and their applications in fields like electronics, data storage, and medical imaging.
CO3	Understand the effects of electric polarization and concepts of bound charges in dielectric materials.
CO4	Apply the theoretical concepts of electric field in matter and dielectric properties of materials in practical applications.
CO5	Calculate the resistance of any wire, capacitance of a given capacitor along with verifies the photoelectric effect, and other core concepts, alongside proficiency in data analysis and error handling in laboratory work.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	1	2	3	3	3	2	2
CO2	2	3	2	1	2	2	1	3	3	3	2	2
CO3	3	2	2	3	2	3	2	2	2	2	3	2
CO4	3	2	3	2	3	2	3	2	2	2	1	2
CO5	3	3	2	2	2	2	3	2	2	2	2	3
Average	**2.8**	**2.6**	**2.4**	**2.2**	**2.4**	**2**	**2.2**	**2.4**	**2.4**	**2.4**	**2**	**2.2**

1= Weak Correlation 2= Moderate Correlation 3=Strong Correlation

Course Content:				
L (Hours/Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total Hours/Week**
3	-	2	-	5
Unit	**Content & Competencies**			
1. Introduction and History of Electricity and Magnetism (Contact Hours=11)	Recent developments of electricity and magnetism, Maxwell's contributions, Contributions of Thomas A. Addison. Applications of Electricity and Magnetism in communication, medicine, and industry, the principles of electromagnetism underpin much of our contemporary world.			
2. Magnetic Properties of Matter (Contact Hours=12)	Basic Concepts (Magnetic Dipoles, Magnetic Moment, Magnetization (M)), Types of Magnetic Materials (Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism etc.), Magnetic Susceptibility and Permeability, Hysteresis and Magnetic Domains, Environmental and Biological Magnetism, Magnetic Materials and Applications in fields such as electronics, data storage, medical imaging, and materials science			
3. Electric Field in Matter (Contact Hours=11)	Polarization, Bound charges and their interpretation. Field inside a dielectric, Displacement vector D, Gauss' Law in the presence of dielectrics, electric fields interact with various materials, leading to applications in electronics, optics, and materials science.			
4. Dielectric Properties of Materials (Contact Hours=11)	Fundamentals of Dielectrics, Types of Dielectrics, Dielectric Constant (Relative Permittivity), Dielectric Loss, Polarization Mechanisms (Electronic Polarization, Ionic Polarization, Dipolar (Orientational) Polarization, Interfacial (Space Charge) Polarization), Dielectric Strength, Dielectric Materials and Applications, PE Hysteresis loop			
5. Practical Component (Lab Hours = 30)	The teacher is expected to provide basic idea and working of various apparatus and instruments related to different experiments. Students are supposed to known knowledge of recording and analyzing experimental data along with study error analysis in observations. Every student should perform at least 05 experiments from the following list: 1. To calculate the capacitance of a capacitor, observe its charging and discharging characteristics. 2. To measure the value of an unknown capacitance using he flashing and quenching experiment. 3. To study the variation of magnetic field with distance along the axis of a circular coil carrying current. 4. B-H curves for soft and hard ferromagnetic materials and comparison of their coercivity, retentivity and saturation magnetization for same applied magnetic field. 5. To find the resistance of a given wire using meter bridge and hence calculate the resistivity 6. To verify the laws of combination (series) of resistances using a metre bridge. 7. To determine the value of an air capacitance by de-Sauty Method and to find permittivity of air. 8. To find the frequency of AC mains with a sonometer 9. (a) To study Photoelectric effect using Photocell (b) inverse-square law (concept of solid angle). 10. 05 Electricity and magnetism Experiments activity			

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
VIVA	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Clinical assessment	✓	✓	✓	✓	✓
Clinical/Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓
Feedback Process:	Student's Feedback				

References:	**List of Reference Books**
	1. Griffiths, D.J. (2023). *Introduction to Electrodynamics* (5th ed.). Benjamin Cummings. 2. Edminister, J.A., & Nahvi, M. (2019). *Schaum's Outline of Electromagnetics* (5th ed.). Mc Graw-Hill Education. 3. Kip, A.F. (1981). *Fundamentals of Electricity and Magnetism* (2nd ed.). McGraw-Hill. 4. Purcell, E.M. (1986). *Electricity and Magnetism*. McGraw-Hill Education. 5. Fewkes, J.H., & Yarwood, J. (1991). *Electricity and Magnetism* (Vol. I). Oxford University Press. 6. Franklin, J. (2005). *Classical Electromagnetism*. Pearson Education. 7. Arora, C. L. (2001). *B.Sc. Practical Physics*. S. Chand & Company. 8. Amrita Vishwa Vidyapeetham. *Virtual Labs*. https://vlab.amrita.edu/?sub=1 9. Indian Institute of Technology Kharagpur. *Virtual Labs: An Initiative of MHRD, Govt. of India*. http://vlabs.iitkgp.ac.in/vlt/ 10. Amrita Vishwa Vidyapeetham & CDAC. *Virtual labs: Developed with Support from MeitY*. https://www.olabs.edu.in/?pg=topMenu&id=40

GE-2M (Calculus and Its Applications)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the Program	All Programs other than B.Sc. (Hons. with Research) Physical Sciences
Course Code	0330023021
Course Title	Calculus and Its Applications
Academic Year	I
Semester	II
Number of Credits	4
Course Prerequisite	Undergraduate students from all disciplines expect those pursing B.Sc. (Physical Sciences)
Course Synopsis	This course introduces the fundamental concepts of calculus, including limits, continuity, and differentiation of elementary functions. Students will explore curve behavior through first and second derivatives, sketch graphs, and understand curvature. Integral calculus is introduced with applications to area, volume, and surface area. The course emphasizes intuitive understanding, graphical interpretation, and real-life applications in geometry and physical sciences.

Course Outcomes: At the end of the course students will be:

CO1	Define limits and continuity and evaluate standard limits of functions graphically and algebraically.
CO2	Apply rules of differentiation to find derivatives of basic functions and interpret them in terms of tangents and normals.
CO3	Analyze function behavior using first and second derivatives to identify turning points, sketch curves, and understand asymptotes and curvature.
CO4	Classify critical points using concavity and identify special features like inflection points, cusps, and nodes.
CO5	Use definite integrals to calculate areas, volumes, and surface areas.

Mapping of Course Outcomes (COs) to Program Outcomes(POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1												
CO2												
CO3												
CO4												
CO5												
Average												

1= Weak Correlation 2 = Moderate Correlation 3 = Strong Correlation

Course Content:

L(Hours/Week)	T (Hours/Week)	P (Hours/Week)	Total Hour/Week
3	-	2	5

Unit	Content & Competencies
1. **(Lecture Hours = 11)**	Definition of the limit of a function, Basic limit properties and evaluation of standard limits, Continuity at a point and over intervals (graphical perspective), Introduction to differentiability, Basic rules of differentiation (sum, product, quotient, chain rule), Derivatives of elementary functions (polynomial, trigonometric, exponential, logarithmic), Applications: finding tangents and normal.
2. **(Lecture Hours = 10)**	Basic idea of increasing/decreasing functions and turning points, Introduction to asymptotes in Cartesian coordinates (horizontal and vertical only), Graph sketching using first and second derivatives, Concept of curvature and radius of curvature for basic Cartesian curves.
3. **(Lecture Hours = 11)**	Understanding concavity and convexity, Types of critical points: local maxima, minima, and points of inflexion, Introduction to cusps and nodes, Curve tracing for simple functions in Cartesian and parametric forms.
4. **(Lecture Hours = 13)**	Introduction of definite and indefinite integrals. Area under a curve using definite integrals, Finding areas bounded by simple curves (parabola, circle, lines), Introduction to volumes of solids of revolution, Surface area of revolution, Sectorial area, and area in polar coordinates.
5. **(Practical Hours =30)**	**List of Practical (using any software)** 1. Plotting of graphs of function e^{ax+b}, log(ax + b). and to illustrate the effect of a and b on the graph. 2. Plotting of graphs of function sin(ax + b), cos(ax + b), and to illustrate the effect of a and b on the graph. 3. Plotting of graphs of function 1/(ax + b), |ax + b| and to illustrate the effect of a and b on the graph. 4. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them. 5. Sketching parametric curves. 6. Tracing of conics in Cartesian coordinates. 7. Computation of area. 8. Obtaining surface of revolution of curves.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Teaching-Learning Strategies and Contact Hours:

Teaching-Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small group discussion(SGD)	1
Self-directed learning(SDL)/Tutorial	1
Problem Based Learning(PBL)	1
Case/Project Based Learning(CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/Presentation	
Problem Based Learning (PBL)	
Journal Club	Practical Examination & viva-voice
Professional Activities	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva	-	--	-	-	-
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	-	--	-	-	-
Laboratory assessment	-	--	-	-	-
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓
Feedback Process	Student's Feedback				
References:	**List of Reference Books**				
	1. Frank Ayres, Jr., Elliot Mendelson, (2009). *Calculus Schamus outline series* (5th ed.), Schaum Publishing Co., McGraw-Hill. 2. Piskunov, N. (1997). *Differential and Integral Calculus*, Peace Publishers, Moscow. 3. Prasad, G. (1994). *Differential Calculus*, Pothishala Private Ltd., Allahabad. 4. Courant, R., and John, F. (1999). *Introduction to Calculus and Analysis*, Springer-Verlag.				

SEC/AEC/VAC COURSES
[Offered under B.Sc. (Hons. With Research) Physical Sciences Program]

SEMESTER-II

S.No	Course Category	Course Code	Course Title	Credits L+T+P	Semester	Offering Department
1	SEC-3	0320024011	Water Technology	1+0+1	Even (II)	Chemistry
2	SEC-4	0330024021	Introduction to R Programmimg	1+0+1	Even (II)	Mathematics

SEC-3 (Water Technology)

Name of the College (Department)	Akal College of Basic Sciences (Chemistry and Biochemistry)
Name of the Program	All undergraduate programs following NEP
Course Code	0320024011
Course Title	Water Technology
Academic Year	II
Semester	II
Number of Credits	2
Course Prerequisite	
Course Synopsis	Water technology involves calculating various physical, chemical, and biological characteristics of water to determine its quality and suitability for specific purposes. This process typically includes testing parameters such as pH, turbidity, dissolved oxygen and conductivity. By understanding the composition and condition of water, analysts can evaluate its safety for drinking, industrial use, agricultural irrigation, and ecological health, ensuring compliance with regulatory standards.

Course Outcomes: At the end of the course students will be able to:

CO1	Define hardness of water,types of hardness, and explain the scope of water technology.
CO2	Understand water softening techniques.
CO3	Understand characteristics and roles of potable water.
CO4	Demonstrate laboratory skills in basic water technology techniques.
CO5	The various properties of water such as pH value, alkalinity and DO etc. and their determination can be understood by the students after the completion of the course.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)& Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	1	1	2	1	1	2	1	1	1
CO2	1	1	2	2	1	1	2	1	2	2	1	2
CO3	2	2	1	1	2	2	1	1	2	1	1	2
CO4	2	1	1	1	1	1	1	2	2	1	2	1
CO5	3	1	1	2	2	2	2	2	2	1	1	1
Average	**2.2**	**1.2**	**1.2**	**1.4**	**1.4**	**1.6**	**1.4**	**1.2**	**2**	**1.2**	**1.2**	**1.4**

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content:

L (Hours/Week)	T (Hours/Week)	P (Hours/Week)	CL (Hours/Week)	Total Hours/Week
1		2		3

Unit	Content & Competencies
1. Introduction to Water Technology (Lecture Hours=4)	Importance and Scope, Common impurities, Hardness of water, Units of hardness, Quality of potable water, Purification of water, sedimentation, filtration and disinfection.
2. Industrial Problems due to Hard Water (Lecture Hours=4)	Industrial problems, Boiler troubles: Scale and Sludge formation, Internal treatment methods, Priming and Foaming, Boiler corrosion and Caustic embrittlement.
3. Water Softening Techniques (Lecture Hours=4)	Lime-Soda process, Zeolite (Permutit) process and Demineralization process.
4. Water Analysis (Lecture Hours=3)	pH, Conductivity, Turbidity, Alkalinity, DO (Dissolve oxygen), BOD (Biological oxygen demand) and COD (Chemical oxygen demand).
5. Practical Component (Lab Hours = 30)	1. Determination of temporary hardness of tap water. 2. Determination of permanent hardness of tap water. 3. Determination of dissolved oxygen of water. 4. Determination of alkalinity of the water. 5. Determination of BOD of the given water sample.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	15
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	45

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)

Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
VIVA	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Clinical/Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback
References:	**List of Reference Books**
	1. Jain, P. C., & Jain, M. (2007). *Engineering chemistry.* Dhanpat Rai & Sons, Delhi. 2. Atkins, P. W., De Paula, J., & Keeler, J. (2023). *Atkins' physical chemistry*. Oxford university press. 3. Banwell, C. N. (1972). *Fundamentals of Molecular Spectroscopy:* By CN Banwell. New York, McGraw-Hill. 4. Vollhardt, K. P. C., & Schore, N. E. (2003). *Organic chemistry: structure and function.* Macmillan. 5. Mahan, B.M. (2009). *University Chemistry*. Pearson.

SEC-4 (Introduction to R Programming)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the program	All undergraduate programs following NEP
Course Code	0330024021
Course Title	Introduction to R Programming
Academic Year	II
Semester	II
Number of Credits	2 (1+0+1)
Course Prerequisite	This course is intended for students with no prior programming experience.
Course Synopsis	This course provides an introduction to the R programming language, focusing on data analysis, visualization, and statistical computing. Students will learn the fundamentals of R, including data manipulation, data visualization, and basic statistical analysis.

Course Outcomes:

CO1	Understand the basics of R programming language.
CO2	Perform data manipulation and cleaning.
CO3	Create various types of data visualizations.
CO4	Conduct basic statistical analyses.
CO5	Write efficient R scripts for data analysis.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	2	3	2	2	3	2	2	1	1
CO2	3	2	2	1	1	1	1	2	1	2	2	2
CO3	3	2	2	2	2	2	1	2	1	1	3	2
CO4	3	1	2	1	2	1	2	2	2	2	2	2
CO5	2	2	2	2	3	2	2	2	2	2	2	2
Average	**2.6**	**2**	**2.2**	**1.6**	**2.2**	**1.6**	**1.6**	**2.2**	**1.6**	**1.8**	**2**	**1.8**

1= Weak Correlation 2 = Moderate Correlation 3 = Strong Correlation

Course Content:				
L (Hours/Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total Hour/Week**
1	-	2	-	3
Unit	**Content &Competencies**			
1. **(Lecture Hours = 3)**	Introduction to R and RStudio IDE, Installing R and RStudio, Basic R commands an d syntax, Understanding the R environment, Reference: "R for Data Science" (Chapter 1)Vectors, lists, matrices, arrays, and data frames. Basic operations on data structures, Subsetting and indexing, Reference: "R for Data Science" (Chapter 2)Reading data from various sources (CSV, Excel, etc.), Writing data to files, Data import functions, Reference: "R for Data Science" (Chapter 4)			
2. **(Lecture Hours =3)**	Introduction to dplyr package, Filtering, selecting, arranging, and summarizing data, Grouping and joining data frames, Reference: "R for Data Science" (Chapter 5), Basics of ggplot2, Creating different types of plots (scatter, bar, line, etc.), Customizing plots, Reference: "R for Data Science" (Chapter 3)Understanding data distributions, Descriptive statistics, Identifying patterns and outliers, Reference: "R for Data Science" (Chapter 7)			
3. **(Lecture Hours = 3)**	Conditional statements and loops, Writing and using functions, Scope and environment, Reference: "The Art of R Programming" (Chapters 6 and 7), Summary statistics, Hypothesis testing, Correlation and regression analysis, Reference: "R in Action" (Chapters 5 and 6). Date and time classes in R, Operations on dates and times, Reference: "R for Data Science" (Chapter 16)			
4. **(Lecture Hours = 6)**	String functions in R, Regular expressions, Reference: "R for Data Science" (Chapter 14), Advanced dplyr functions, Data reshaping with tidyr, Reference: "R for Data Science" (Chapter 12), Application of learned skills in real-world data analysis projects, Group presentations and discussions, Review and Q&A,			
5. **Practical Component (Lab Hours = 30)**	List of Practical's 1. Basic commands in R 2. Basic mathematical operations in R 3. Loops in R. 4. Vectors, lists, 5. Basic Plots in R 6. Matrices, arrays, and data frames 7. Writing data to files, Data import functions 8. Filtering, selecting, arranging, and summarizing data 9. Grouping and joining data frames 10. Descriptive statistics 11. Identifying patterns and outliers 12. Correlation and regression analysis 13. Advanced dplyr functions			

Learning Strategies and Contact Hours

Learning Strategies	**Contact Hours**
Lecture	15
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1

Self-directed learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	45

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	
Problem Based Learning (PBL)	
Journal Club	
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
VIVA	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process	Student's Feedback

References:	**List of Reference Books**
	1. Grolemund, G., & Wickham, H. (2017). *R for Data Science.O'Reilly Media*. https://r4ds.hadley.nz/ 2. Matloff, N. (2009). *The art of R programming.* http://heather. cs. ucdavis. edu/~ matloff/132/NSPpart. pdf>. Acessoem, 1(03), 2018. 3. Grolemund, G. (2014). *Hands-on programming with R: Write Your Own Functions and Simulations*. O'Reilly Media, Inc.. 4. Kabacoff, R. (2022). *R in Action: Data Analysis and Graphics with R and Tidyverse.* Simon and Schuster. 5. Wickham, H. (2019). *Advanced R.* Chapman and hall/CRC.

SEMESTER – III

Course Category	Course Code	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-3M	0330331030	Real Analysis	3	1	0	4
DSC-3C	0320331031	Chemical Energetics and Equilibria	3	0	2	4
DSC-3P	0350331031	Thermal Physics and Statistical Mechanics	3	0	2	4
*DSE-1M	0330332011	Advanced Calculus	3	0	2	4
*DSE-1C	0320332011	Chemistry of Acids and Bases	3	0	2	4
*DSE-1P	0350332011	Mathematical Physics	3	1	0	4
*GE-3		From pool of GE courses	3	1	0	4
SEC-3		From pool of SEC courses	1	0	2	4
AEC-3		From pool of AEC courses	1	0	2	41
VAC-3		From pool of VAC courses	1	0	2	4
		Total	**15**	**1/2**	**12/10**	**22**

Note – L: Lecture Hour/week, T: Tutorial Hour/week, P: Practical Hour/week, CL: Clinical Hour/week, C: Credits.

*Student can opt either one of the DSE courses or any one GE course from pool of GE courses.

DSC-3M (Real Analysis)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0330331030
Course Title	Real Analysis
Academic Year	II
Semester	III
Number of Credits	4(3+1+0)
Course Prerequisite	Mathematics of Class 11^{th} and 12^{th}
Course Synopsis	This course provides a foundation in real analysis and metric spaces. It covers key topics such as the behavior of real sequences and series, various convergence tests, and the difference between pointwise and uniform convergence. Students will also learn the basics of Riemann integration and study important concepts of metric spaces like open and closed sets, completeness, and related theorems. These units prepare students for deeper studies in mathematical analysis.

Course Outcomes: At the end of the course, students will:

CO1	Analyze the structure of the real number system, including completeness, boundedness, and convergence of sequences.
CO2	Apply standard convergence tests to determine the behavior of infinite series.
CO3	Evaluate the convergence of function sequences and series using pointwise and uniform convergence criteria, and apply the Weierstrass M-test and power series analysis.
CO4	Demonstrate understanding of Riemann integration and determine the integrability of continuous and monotone functions on closed intervals.
CO5	Explore concepts of metric spaces, including open and closed sets, completeness, and Cauchy sequences.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	1	1	1	1	3	2	1	1	1
CO2	2	1	1	1	2	2	1	2	3	1	2	1
CO3	1	1	1	1	1	2	1	2	2	1	1	1
CO4	1	3	2	2	1	1	2	3	2	2	1	1
CO5	1	2	3	1	1	1	1	2	2	1	1	1
Average	**1.4**	**1.6**	**1.6**	**1.2**	**1.2**	**1.4**	**1.2**	**2.4**	**2.2**	**1.2**	**1.2**	**1**

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content:

(Hours/Week)	T(Hours/Week)	P(Hours/Week)	Total Hours/Week
3	1	-	4

Unit	Content & Competencies
1. **(Lecture Hours = 12)**	Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R. Real sequences, Convergence, Sum and product of convergent sequences, Monotone sequences, and their convergence; Proof of convergence of some simple sequences. Subsequences and the Bolzano- Weierstrass theorem; Limit superior and limit inferior of a bounded sequence; Cauchy sequences, Cauchy convergence criterion for sequences.

2. **(Lecture Hours =12)**	Introduction of Series, Definition of Convergent, Divergent, and oscillatory series, Infinite series, Cauchy convergence criterion for series, positive term series, geometric series, Limit comparison test, convergence of p-series, D'Alembert's ratio test, Cauchy's root test; alternating series, integral test, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and Conditional Convergence.
3. **(Lecture Hours = 11)**	Sequences and series of functions, Pointwise and uniform convergence, Cauchy general principle for uniform convergence of series of functions, Weierstrass M-test; Power series, Radius and interval of convergence, Riemann integration and examples, Integrability of continuous and monotone functions.
4. **(Lecture Hours = 10)**	Definition and examples of metric space, neighborhoods, limit points, interior points, open and closed sets, closure and interior, boundary points, subspaces of a metric space, equivalent metrices, Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours:

Learning Strategies	**Contact Hours**
Lecture	45
Practical	-
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	10
Problem Based Learning (PBL)	2
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**60**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem-Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
Viva	-	-	-	-	-

Assignment/ Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	-	-	-	-	-
Practical Log Book/ Record Book	-	-	-	-	-
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process	Student's Feedback

References:	**List of Reference Books**
	1. Jain, P.K., & Ahmad, K. (2004). *Metric spaces*. Narosa Publishing House. 2. Apostol, T.M. (1985). *Mathematical analysis*. Narosa Publishing House. 3. Fischer, E. (1983). *Intermediate real analysis*. Springer-Verlag. 4. Goldberg, R.R. (1970). *Real analysis*. Oxford & IBH Publishing Co. 5. Somasundaram, D., & Choudhary, B. (1997). *A first course in mathematical analysis*. Narosa Publishing House. 6. Bartle, R.G., & Sherbert, D.R. (2000). *Introduction to real analysis* (3rd ed.). John Wiley & Sons. 7. Malik, S.C., & Arora, S. (1992). *Mathematical analysis*. New Age International.

DSC-3C (Chemical Energetics and Equilibria)

Name of the College (Department)	Akal College of Basic Sciences (Chemistry and Biochemistry)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0320331031
Course Title	Chemical Energetics and Equilibria
Academic Year	II
Semester	III
Number of Credits	4 (3+0+1)
Course Prerequisite	1st year DSC courses of Chemistry and Chemistry of Class 11th & 12th
Course Synopsis	The course would provide an integrated understanding of how energy changes and equilibrium principles govern chemical reactions, law of thermodynamics, behaviour of electrolytes and their solutions, chemical and ionic equilibrium. This will make students learn about the conditions for maximum yield in industrial processes, dissociation of electrolytes and solubility product of sparingly soluble salts with applications of solubility product principle.
Course Outcomes: At the end of the course students will be able to:	
CO1	Understand the laws of thermodynamics, thermochemistry and equilibria
CO2	Quantify and analyze energy changes, which is essential for understanding chemical systems
CO3	Use the concepts of electrolytes and electrolytic solutions
CO4	Understand important governing laws for chemical reactions
CO5	Compare weak and strong electrolytes on the basis degree of ionization for electrolytes and explain the various factors which affecting degree of dissociation of electrolytes.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	2	2	2	2	1	2	2
CO2	2	1	2	2	1	1	1	2	1	2	3	2
CO3	3	2	2	2	2	2	1	2	1	3	1	2
CO4	2	2	1	2	2	1	2	3	2	2	2	2
CO5	3	3	2	2	3	2	2	2	2	2	3	1
Average	**2.6**	**2.2**	**2**	**2.2**	**2.2**	**1.6**	**1.6**	**2.2**	**1.6**	**2**	**2.2**	**1.8**

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content

L (Hours/ Week)	T (Hours/ Week)	P (Hours/ Week)	CL (Hours/Week)	Total Hour/ Week
3	-	2	-	5

Unit	Content & Competencies

1. Basic concepts and first law of thermodynamics (Lecture Hours = 10)	Scope of thermodynamics, thermodynamic terms and basic concepts, types of thermodynamic systems, recapitulation of intensive and extensive variables, state and path functions. First law of thermodynamics: Concept of heat (Q), work(W), internal energy (U), and statement of first law, enthalpy (H), relation between heat capacities for ideal gas, Joule's experiment, calculations of Q, W, ΔU and ΔH for reversible expansion of ideal gases under isothermal conditions.
2. Thermochemistry, second and third law (Lecture Hours = 10)	Enthalpy of a system, Enthalpy of reaction and types, Hess's law, bond energy, Born Haber's cycle (NaCl/ KCl). Concept of spontaneity, entropy, statement of the second law of thermodynamics (Kelvin and Clausius), Calculation of entropy change for reversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy (Non-PV work and the work function); Free energy change. Statement of third law, qualitative treatment of absolute entropy of molecules (examples of NO, CO), concept of residual entropy.
3. Chemical Equilibrium (Lecture Hours = 10)	Chemical equilibrium and its characteristics, law of mass action, thermodynamic derivation of the law of chemical equilibrium, equilibrium constant, Free energy change in a chemical reaction and relationship between Kp, Kc and Kx for reactions involving ideal gases, Le-Chatelier's principle, conditions for maximum yield in industrial processes (Haber's and contact processes).
4. Ionic Equilibria (Lecture Hours = 15)	Weak, strong and moderate electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald's dilution law, theory of strong electrolytes: Debye-Huckel theory, Degree of dissociation, common-ion effect, factors affecting degree of dissociation, Buffer solutions, Henderson-Hasselbach equation, Conductometric titrations, Solubility and solubility product of sparingly soluble salts –applications of solubility product principle.
5. Practical Component (Lab Hours = 30)	1. Preparation of buffer solutions: (i) Sodium acetate-acetic acid or (ii) Ammonium chloride-ammonium acetate. Measurement of the pH of buffer solutions and comparison of the values with theoretical values. 2. Study the effect of addition of HCl/NaOH on pH of the buffer solutions (acetic acid, and sodium acetate). 3. pH metric titration of strong acid with strong base. 4. pH metric titration of weak acid with strong base 5. Estimation of free alkali present in different soaps/detergents. 6. Study of the solubility of benzoic acid in water and determination of ΔH 7. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 8. Determination of the enthalpy of ionization of acetic acid.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small Group Discussion (SGD)	1
Self-directed Learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2

Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
Viva-voce	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of reference books**
	1. Castellan, G.W. (2004). *Physical Chemistry*. Narosa. 2. Kapoor, K.L. (2015). *A Textbook of Physical Chemistry*. McGraw Hill Education. 3. Puri, B.R., Sharma, L.R. and Pathania M.S. (2020). *Principles of Physical Chemistry.* Vishal Publishing Co. 4. Khosla, B.D., Garg, V.C., Gulati, A.(2015). *Senior Practical Physical Chemistry*. R.Chand&Co. 5. Kapoor, K.L. (2019). *A Textbook of Physical Chemistry*. Vol 7, 1st Edition, McGraw Hill Education. 6. Batra, S.K., Kapoor, V and Gulati, S. (2017). 1st Edition, *Experiments in Physical Chemistry*. Book Age series.

DSC-3P (Thermal Physics and Statistical Mechanics)

Name of the College (Department)	Akal College of Basic Sciences (Physics)
Name of the Program	B.Sc. (Hons. with Research) Physical Science
Course Code	0350331031
Course Title	Thermal Physics and Statistical Mechanics
Academic Year	II
Semester	III
Number of Credits	4 (3+0+1)
Course Prerequisite	Physics, Chemistry and Mathematics of Class 11^{th} & 12^{th}
Course Synopsis	This course covers basic thermodynamics, kinetic theory of gases, and introduces statistical mechanics. It aims to help students understand how fundamental thermodynamic laws apply to various systems and connect macroscopic observations with microscopic particle behavior. The lab component reinforces these concepts through experiments, including black body radiation and related laws like Planck's and Stefan-Boltzmann's.

Course Outcomes: At the end of the course students will be able to:

CO1	Understand and apply the laws of thermodynamics, including concepts like internal energy, entropy, thermodynamic processes, and heat engines.
CO2	Analyze transport phenomena (viscosity, thermal conductivity, diffusion) and apply kinetic theory using Maxwell-Boltzmann distribution.
CO3	Interpret thermodynamic potentials, derive Maxwell's relations, and apply them to real processes like the Joule-Thomson effect and phase transitions.
CO4	Distinguish between different statistical distributions (M-B, B-E, F-D) and apply them to systems like ideal gases, blackbody radiation, and electron gases.
CO5	Develop experimental skills in thermodynamics and statistical physics through laboratory work, data analysis, and understanding the functioning of related instruments.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	1	1	3	3	2	2	1
CO2	2	3	2	2	2	2	1	3	3	1	1	2
CO3	3	2	2	2	2	2	2	2	2	1	1	2
CO4	3	1	3	2	2	2	2	2	2	1	2	2
CO5	3	3	1	2	2	2	2	2	2	2	2	1
Average	**2.8**	**2.4**	**2.2**	**2.2**	**2.2**	**1.8**	**1.6**	**2.4**	**2.4**	**1.4**	**1.6**	**1.6**

1=Weak Correlation 2=Moderate Correlation 3=Strong Correlation

Course Content:				
L (Hours/Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total (Hour/Week)**
3	-	2	-	5
Unit	**Content & Competencies**			
1. Introduction to Thermodynamics (Lecture Hours = 12)	Zeroth Law of Thermodynamics: Concept of temperature and thermal equilibrium. First Law of Thermodynamics: Internal energy, work, heat, and applications to different thermodynamic processes (isentropic, isothermal, adiabatic). Second Law of Thermodynamics: Entropy, reversible and irreversible processes, heat engine, and the Carnot's engine, Carnot cycle. Third Law of Thermodynamics: Concept of absolute zero temperature and the unattainability of absolute zero, heat death of universe.			
2. Kinetic Theory of Gases (Lecture Hours = 11)	Concept of mean free path, transport phenomena like viscosity, thermal conductivity, and diffusion; Maxwell-Boltzmann Law of Distribution of Velocities in an ideal gas and its experimental verification, Mean, Root Mean Square and Most Probable Speeds.			
3. Thermodynamic Potentials (Lecture Hours = 10)	Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, and Gibb's Free Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius Clapeyron Equation, Expression for ($C_P - C_V$), C_P/C_V, TdS equations.			
4. Statistical Mechanics (Lecture Hours = 12)	Concept of macro-states, micro-states, Entropy and thermodynamic probability, Three kinds of statistics (M-B, B-E, F-D) and their basic approach, Maxwell-Boltzmann Statistics: Phase space and its division into cells. Maxwell-Boltzmann Statistics for an ideal gas. Bose Einstein Statistics: Blackbody radiation, Derivation of Planck's law of radiation, deduction of Wien's distribution law and Stefan's law from Plank's law. Fermi-Dirac statistics: Applications to free electrons gas (Fermi level and Fermi Energy).			
5. Practical Component (Lecture Hours =30)	The teacher is expected to provide basic idea and working of various apparatus and instruments related to different experiments. Students are supposed to known knowledge of recording and analyzing experimental data along with study error analysis in observations. Every student should perform at least 05 experiments from the following list: 1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method. 2. To study temperature coefficient of resistance of Copper (Cu). 3. Measurement of Planck's constant using black body radiation. 4. To determine the temperature coefficient of resistance by Platinum Resistance Thermometer using Carey Foster's bridge. 5. To calculate the specific heat capacity of a solid by mixing it with water and measuring the temperature change. 6. To determine Stefan's constant by measuring the radiation from a black body. 7. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method using steam or electrical heating. 8. To study the variation of thermo-e.m.f. across two junctions of a thermocouple with temperature			

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25

Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL)/Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
Viva	✓	✓	✓	✓	✓
Assignment/Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory Assessment	✓	✓	✓	✓	✓
Practical Log Book/Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback
References:	**List of reference books**

	1. Kumar, A., & Taneja, S. P. (2014). *Thermal Physics*. R. Chand Publications. 2. Reese, R.L. (2003). *University Physics*. Thomson Brooks/Cole. 3. Fitzpatrick, R. (2020). *Thermodynamics and Statistical Mechanics*. Create Space Independent Publishing Platform. 4. Sharma S.K. & Sharma S. (2021). *Statistical & Thermal Physics* (7th ed.). DINESH. 5. Singhal, S.S., Agarwal, J.P., Prakash S. (2017). *Thermodynamics & Statistical Physics*. Pragati Prakashan. 6. Kestin, J. (2012). *Thermodynamics and Statistical Mechanics*. Elsevier. 7. Sanon, G. (2007). *B.Sc. Practical Physics* (1st ed.). R. Chand & Company. 8. Prakash, I., & Ramakrishna. (2011). A textbook of practical physics (11th ed.). Kitab Mahal. 9. Arora, C. L. (2001). B.Sc. Practical Physics. S. Chand & Company. 10. Amrita Vishwa Vidyapeetham. Virtual Labs. https://vlab.amrita.edu/?sub=1

DSE-1M (Advanced Calculus)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0330332011
Course Title	Advanced Calculus
Academic Year	II
Semester	III
Number of Credits	4(3+0+1)
Course Prerequisite	1st year DSC courses of Mathematics and Mathematics of Class 11th & 12th
Course Synopsis	The continuity and differentiability of functions of one and two variables are the main subjects of this course, which provides a thorough examination of advanced calculus concepts.It covers fundamental theorems, Taylor expansions, and optimization techniques, including the Lagrange multiplier method. Students will also study the differential geometry of curves and surfaces, gaining both analytical and visual understanding through practical implementation using any software.

Course Outcomes: At the end of the course, students will:

CO1	Students will have a comprehensive understanding of differentiability, continuity, and the behavior of real-valued functions of one and two variables.
CO2	Study analytical and graphical explanations of essential theorems, including Taylor's Theorem, Lagrange's Mean Value Theorem, Darboux's Theorem, and Rolle's Theorem.
CO3	To introduce techniques of partial differentiation, total differentials, and the use of composite and implicit functions.
CO4	Identification of maxima, minima, and saddle points using the second derivative test and the method of Lagrange multipliers.
CO5	Understanding of the differential geometry of curves and surfacesand the study of envelopes and surface properties.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	1	1	1	2	3	2	1	2
CO2	2	2	1	1	1	1	1	2	3	2	2	2
CO3	2	3	2	1	1	1	2	2	3	3	2	2
CO4	3	3	2	1	1	1	2	3	2	3	1	2
CO5	3	3	2	1	2	1	2	3	2	3	1	3
Average	**2.4**	**2.6**	**1.6**	**1.2**	**1.2**	**1**	**1.6**	**2.4**	**2.6**	**2.6**	**1.4**	**2.2**

1= Weak Correlation 2 = Moderate Correlation 3 = Strong Correlation

Course Content:

L(Hours/Week)	T(Hours/Week)	P(Hours/Week)	Total Hour/Week

3	-	2	5

Unit	Content & Competencies
1. **(Lecture Hours = 14)**	Continuity, Sequential continuity, properties of continuous functions, uniform continuity, chain rule of differentiability, Mean value theorems: Rolle's theorem and Lagrange's mean value theorem and their geometrical interpretations, Taylor's theorem with various form of remainders, Darboux intermediate value theorem for derivatives, Indeterminate forms.
2. **(Lecture Hours =12)**	Limit and continuity of real valued functions of two variables, Partial differentiation, Total differentials, Composite functions and implicit functions, change of variables, Homogeneous functions and Euler's theorem on homogeneous functions, Taylor's theorem for functions of two variables
3. **(Lecture Hours = 10)**	Differentiability of real valued functions of two variables, Young's theorem, Implicit function theorem, Maxima, Minima, and saddle points of two variables, Lagrange's method of multipliers
4. **(Lecture Hours = 9)**	Curves, Tangents, Principal Normals, Binormals, Serret-Frenet formulas, Locus of the centre of curvature, Spherical curvature, Locus of centre of spherical curvature, Involutes, Evolutes, Bertrand curves, Surfaces, Tangent planes, one parameter family of surfaces, Envelopes
5. **(Practical Hours = 30)**	**List of Practicals (using any software)** 1. Visualization of point wise and uniform continuity using plots and symbolic limits. 2. Illustration of Rolle's Theorem and Lagrange's Mean Value Theorem through graphs and symbolic differentiation. 3. Expansion of functions using Taylor series and visualization of approximation accuracy. 4. Computation of first-order partial derivatives and total differential of real-valued functions of two variables. 5. Classification of homogeneous functions and verification of Euler's identity. 6. Determination of local extrema and constrained optimization using Lagrange's method. 7. Calculation of tangent, normal, binormal vectors. 8. Calculation of curvature and torsion for 3D curves. 9. Finding and plotting the tangent plane to a surface at a given point using partial derivatives. 10. Finding critical points and classifying them using the second derivative test for local maxima, minima, or saddle points.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours:

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2

Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with Cos

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	-	-	-	-	-
Viva	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	-	-	-	-	-
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**
	1. Narayan, S., & Mittal, P.K. (2005). *Integral calculus*. S. Chand Publishing. 2. Narayan, S., & Mittal, P.K. (1942). *Differential calculus*. Shyamlal Charitable Trust. 3. Prasad, G. (1982). *Differential calculus*. Pothishala Pvt. Ltd. 4. Piskunov, N.S. (1965). *Differential and integral calculus*. P. Noordhoff. 5. Spiegel, M.R. (1981). *Theory and problems of advanced calculus*. Schaum's Outline Series. 6. Malik, S.C., & Arora, S. (1992). *Mathematical analysis*. New Age International.

DSE-1C (Chemistry of Acids and Bases)

Name of the College (Department)	Akal College of Basic Sciences (Chemistry and Biochemistry)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0320332011
Course Title	Chemistry of Acids and Bases
Academic Year	II
Semester	III
Number of Credits	4 (3+0+1)
Course Prerequisite	1st year DSC courses of Chemistry and Chemistry of Class 11th & 12th
Course Synopsis	The course would provide fundamental concepts and applications of acids and bases. Moreover, understands the concept of buffers, pH, complex formations, hardness and softness in acids and bases.

Course Outcomes: At the end of the course students will be able to:	
CO1	Understand concepts of acids and bases with their applications
CO2	Use the concepts of acidity parameters, buffers and indicators
CO3	Understand redox reactions, electrochemical series and various potential diagrams
CO4	Understand complex behaviour of metal ions and their applications in biological processes
CO5	Understand the precipitation reactions and their application in metal ions analysis

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	2	2	2	2	1	2	2
CO2	2	2	2	2	1	3	2	2	2	2	3	2
CO3	3	2	2	2	2	2	1	2	1	3	1	2
CO4	2	2	1	2	2	2	2	3	2	1	2	2
CO5	3	3	2	2	3	2	2	2	3	2	3	1
Average	**2.6**	**2.4**	**2**	**2.2**	**2.2**	**2.2**	**1.8**	**2.2**	**2**	**1.8**	**2.2**	**1.8**

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content:

L (Hours/ Week)	T (Hours/ Week)	P (Hours/ Week)	CL (Hours/Week)	Total Hours/Week
3	-	2	-	5

Unit	**Content & Competencies**
1. Concepts of acids and bases (Lecture Hours = 10)	Concepts: Arrhenius, Bronsted-Lowry and strength of Bronsted acids and bases, Lewis's acids and bases, Hard and soft acids and bases, HSAB principle, Drago-wayland equation Relative strengths of acids and bases, factors affecting relative strengths of acids and bases, solvent levelling, superacids and superbases.
2. Acidity, buffers and	Thermodynamic acidity parameters, gas phase acidity and proton affinity, acid-base

indicators (Lecture Hours = 10)	equilibria in aqueous solution(proton transfer equilibria in water),Buffers (NH_4OH/NH_4Cl, NaOAc/HOAc, boric acid and borate, Phosphate buffers, Universal Buffer), buffer capacity, calculation of pH of buffer solutions, pH calculation using Handerson-Hasselbalch equation, Applications of Acids & Bases and buffers in biological processes, acid-base neutralisation curve, indicator, choice of indicators.
3. Redox reactions (Lecture Hours = 10)	Elementary idea on standard redox potentials with sign conventions, Nernst equation,standard potentials and spontaneity, trends in standard potentials, electrochemical series, Redox stability of species in aqueous solutions (influence of pH, effect of solvation, redox reaction with water, disproportionation), Latimer diagrams, Frost diagrams and Pourbaix diagrams their significance, Applications of redox reactions in quantitative analysis: permanganate, dichromate & iodine titrations, Examples of Redox reactions in biological processes
4. Complex ions and precipitation reactions (Lecture Hours = 15)	Complexation behaviour of metal ions: Lewis acid – base type (d block), electrostatic interactions based (s block elements with crown ethers and cryptates), stabilisation of oxidation states by complexation (Cu(I), Mn(III)). Applications of complexes in biological systems with special mention of metalloenzymes Precipitation: Insoluble salts with anions like S^{2-}, SO_4^{2-}, PO_4^{3-}, halides, OH-, $C_2O_4^{2-}$, CO_3^{2-} and their application in metal ions analysis.
5. Practical Component (Lab Hours = 30)	1. Preparation of acetylacetonato complexes of (a) Cu(II) (b) Fe(III). 2. Preparation of Potassium trioxalatochromate (III). 3. Preparation of Potassium trisoxalatomanganate (III). 4. Determination of available chlorine in bleaching powder iodometrically. 5. Determination of strength of oxalate ions and oxalic acid in a mixture titrimetrically. 6. Preparation of a phosphate buffer solution and measurement of its pH using pH meter. 7. Determination of buffer capacity of phosphate buffer. 8. pH metric titration of a strong acid with a strong base.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	**Contact Hours**
Lecture	45
Practical	25
Seminar/Journal Club	-
Small Group Discussion (SGD)	1
Self-directed Learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
Viva-voce	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓
Assignment					
Feedback Process:	Student's Feedback				
References:	**List of Reference Books**				
	1. Shriver, D.D., Atkins, P., Langford, C.H. (1994). *Inorganic Chemistry* 2nd Ed. Oxford University Press. 2. Atkins, P.W., Overton, T.L., Rourke, J.P., Weller, M.T., Armstrong, F.A. (2010). *Inorganic Chemistry*, 5th Edition, W. H. Freeman and Company. 3. Lee, J.D. (2010). *Concise Inorganic Chemistry*. Wiley India. 4. Miessler, G. L. (2008). *Inorganic chemistry*. Pearson Education India. 5. Sharpe, A. G. (1992). *Inorganic chemistry*. Longman Publishing Group. *6.* Lehninger, A. L., Nelson, D. L., Cox, M. M., Cox, M. M. (2005). *Lehninger principles of biochemistry*. Macmillan India. 7. Svehla, G. (2008). *Vogel qualitative inorganic analysis*. Pearson Education India. 8. Jeffery, G.H., Bassett, J., Mendham, J., Denney, R.C. (1989). *Vogel's Textbook of Quantitative Chemical Analysis*. John Wiley and Sons.				

DSE-1P (Mathematical Physics)

Name of the College (Department)	Akal College of Basic Sciences (Physics)
Name of the Program	B.Sc. (Hons. with Research) Physical Science
Course Code	0350332011
Course Title	Mathematical Physics
Academic Year	II
Semester	III
Number of Credits	4 (3+1+0)
Course Prerequisite	1st year DSC courses of Mathematics and Mathematics of Class 11th & 12th
Course Synopsis	This course covers complex functions, analyticity, and contour integration, including Cauchy-Riemann equations, singularities, Taylor and Laurent series, and residue calculus for evaluating real integrals. It introduces Fourier Integral Theorem, sine and cosine transforms, and key properties of Fourier Transforms with applications to solving differential equations. The course also explores Beta and Gamma functions, their interrelation, and introduces special functions like Dirac delta, Bessel, and Legendre functions with applications.

Course Outcomes: At the end of the course students will be able to:

CO1	Understand and analyze the properties of complex functions, including limits, continuity, differentiability, and the application of Cauchy-Riemann equations.
CO2	Evaluate complex integrals using contour integration techniques and apply Cauchy's theorems, residue calculus, and classification of singularities.
CO3	Apply Taylor and Laurent series expansions to study the behavior of analytic functions near singular points.
CO4	Utilize Fourier Integral Theorem and various Fourier Transform properties to solve first and second-order ordinary differential equations.
CO5	Demonstrate knowledge of Beta, Gamma, and special functions, and express complex integrals in terms of these functions for applications in mathematical and physical problems.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	2	2	2	1	2	3	2	2	2
CO2	3	2	3	2	3	2	1	3	3	2	2	1
CO3	2	2	3	2	2	2	2	2	2	1	1	2
CO4	3	2	2	3	1	1	2	2	2	3	2	2
CO5	3	3	1	2	2	2	2	2	2	2	2	3
Average	**2.6**	**2.4**	**2.2**	**2.2**	**2**	**1.8**	**1.6**	**2.2**	**2.4**	**2**	**1.8**	**2**

1=Weak Correlation 2=Moderate Correlation 3=Strong Correlation

Course Content:				
L (Hours/Week)	**T(Hours/Week)**	**P(Hours/Week)**	**CL(Hours/Week)**	**Total Hours/Week**
3	1	-	-	4
Unit	**Content& Competencies**			
1: Complex functions and analysis (Lecture Hours = 11)	Complex functions and mappings. Limits of complex functions. Continuity and differentiability of a complex function, Cauchy-Riemann equations, sufficient conditions for differentiability. Analytic functions, singular points. Elementary functions.			
2: Integration in complex plane (Lecture Hours = 12)	Integration in complex plane: contours and contour integrals, Cauchy-Goursat Theorem (No proof) for simply and multiply connected domains. Cauchy's Inequality. Cauchy's Integral formula. Taylor's and Laurent's theorems (statements only), types of singularities (removable, poles and essential), residues and Cauchy's residue theorem. Evaluation of real integrals by contour integration (excluding integrands with branch points).			
3: Fourier Transforms (FTs) (Lecture Hours = 12)	Fourier Integral Theorem. Sine and Cosine Transforms. Properties of FTs: (1) FTs of Derivatives of Functions, (2) Change of Scale Theorem, (3) FTs of Complex Conjugates of Functions, (4) Shifting Theorem, (5) Modulation Theorem, (6) Convolution Theorems, and (7) Parseval's Identity. Solution of First and Second Order ODEs by using FTs.			
4: Some Special Integrals and Functions (Lecture Hours = 10)	Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Elementary idea of some special functions and their applications (Dirac delta function, Bessel functions, Legendre function).			

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	-
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL)/Tutorial	10
Problem Based Learning (PBL)	2
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**60**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	-

Viva-voce	-
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	-
Assignment	-

Mapping of Assessment with COs

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
Viva-voce	-	-	-	-	-
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	-	-	-	-	-
Practical Log Book/ Record Book	-	-	-	-	-
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback
References:	**List of Reference Books**

1. Boas, M.L. (2007). *Mathematical Methods in the Physical Sciences* (3rd ed.). Wiley India.
2. Kreyszig, E. (2008). *Advanced Engineering Mathematics* (10th ed.). Wiley India.
3. Lipschutz, S. (1987). *Theory and Problems of Linear Algebra*. McGraw-Hill Inc.
4. Weber, H.J., & Arfken, G.B. (2010). *Mathematical Methods for Physicists* (7th ed.). Elsevier.
5. Finkbeiner, D.T. (1978). *Introduction to Matrices and Linear Transformations* (2nd ed.). Dover Publications.
6. Joshi, A.W. (2017). *Matrices and Tensors in Physics*. New Age International Pvt.
7. Das, H.K., Verma R. (2011) *Mathematical Physics* (6th ed.). S. Chand Higher Academics.

GENERAL ELECTIVES (GE) COURSES
[Offered under B.Sc. (Hons. With Research) Physical Sciences program opted by students enrolled in other programs]

SEMESTER – III

S.No.	Course Category	Course Code	Course Title	Credits L+T+P	Semester	Offering Department
2	GE-2P	0350033021	Fundamentals of Mechanics	3+0+1	III (Odd)	Physics
3	GE-2C	0320033021	Principles of Instrumental Analysis	3+0+1	III (Odd)	Chemistry & Biochemistry

GE-2P (Fundamentals of Mechanics)

Name of the College (Department)	Akal College of Basic Sciences (Physics)
Name of the Program	All Programs other than B.Sc. (Hons. With Research) Physical Sciences
Course Code	0350033021
Course Title	Fundamentals of Mechanics
Academic Year	II
Semester	III
Number of Credits	4 (3+0+1)
Course Prerequisite	Mathematics and Physics of Class 11^{th} /or 12^{th}
Course Synopsis	This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with dynamics of a system of particles and ends with the special theory of relativity. Students will realize the concept of rotational motion, gravitation and oscillations. The course includes hands-on experiments focusing on measurements, motion analysis, and error estimations using basic physics instruments.

Course Outcomes: At the end of the course students will be able to:

CO1	Understand the vector calculus concepts and ordinary differential equations in terms of operator method and their utility in mechanics.
CO2	Understand and apply the principles of particle dynamics, including center of mass, conservation laws, work-energy theorem, and analyze elastic and inelastic collisions in physical systems.
CO3	Analyze rotational dynamics and oscillatory motion by applying concepts of angular momentum, moment of inertia, simple harmonic motion, and gravitational laws, including motion under central forces and Kepler's laws.
CO4	Understand and apply the principles of special relativity to analyze motion in different reference frames, including the effects of time dilation, length contraction, and relativistic velocity and mass transformations.
CO5	Develop practical skills in performing fundamental Mechanics experiments, including precise measurement, motion analysis, and data interpretation with error estimation.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1												
CO2												
CO3												
CO4												
CO5												
Average												

1=Weak Correlation 2=Moderate Correlation 3=Strong Correlation

Course Content:				
L (Hours/Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total (Hour/Week)**
3	-	2	-	5
Unit	**Content& Competencies**			
1. Review of vectors and ordinary differential equation (Lecture Hours: 10)	Gradient of a scalar field, divergence and curl of vectors field, polar and axial vectors Second order homogeneous ordinary differential equations with constant coefficients (Operator Method Only).			
2. Fundamentals of Dynamics (Lecture Hours: 11)	Dynamics of a system of particles centre of mass, determination of centre of mass for discrete and continuous systems having spherical symmetry. Conservation of momentum and energy, Conservative and non-Conservative forces, work – energy theorem for conservative forces, force as a gradient of Potential energy. Particle collision (Elastic and in-elastic collisions)			
3. Rotational and Oscillatory Motion: Law of Gravitation (Lecture Hours: 13)	Angular momentum, torque, conservation of angular momentum, Moment of inertia, Theorem of parallel and perpendicular axes (statements only). Calculation of moment of inertia of discrete and continuous objects (1-D and 2-D). Idea of simple harmonic motion, differential equation of simple harmonic motion and its solution, Motion of simple pendulum, damped harmonic oscillator. Newton's law of gravitation, motion of a particle in a central force field, Kepler's Laws (statements only)			
4. Special Theory of Relativity (Lecture Hours: 11)	Frames of reference, Galilean transformations, inertial and non-inertial frames, Michelson Morley's Experiment, postulates of special theory of relativity, Lorentz transformation, length contraction, time dilation, relativistic transformation of velocity, relativistic variation of mass.			
5. Practical Component (Lab Hours = 30)	The teacher is expected to provide basic idea and working of various apparatus and instruments related to different experiments. Students are supposed to known knowledge of recording and analyzing experimental data along with study error analysis in observations. Every student should perform at least 05 experiments from the following list: 1. Measurements of (length/diameter) using vernier caliper, screw gauge. 2. Determination of height of a building using a sextant. 3. Calculate (a) spring constant and, (b) acceleration due to gravity by studying the motion of the spring. 4. Determination of moment of inertia of a flywheel. 5. Determination of value of acceleration due to gravity using simple pendulum. 6. Determine the value of acceleration due to gravity using compound pendulum. 7. Determination of the center of mass of irregular-shaped 2D/3D bodies. 8. Study of elastic and inelastic collisions using air track or ball bearings on a low-friction surface. 9. Mechanics Virtual lab Experiments			

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25

Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL)/Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva	✓	✓	✓	✓	✓
Assignment/Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory Assessment	✓	✓	✓	✓	✓
Practical Log Book/Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓
Feedback Process:	Student's Feedback				

References:	List of Reference Books:
	1. Kittel C. et.al. (2017). *Mechanics, Berkeley Physics Course, Vol. 1*, McGraw-Hill. 2. Halliday, D., Resnick, R. & Walker, J. (2021). *Fundamentals of Physics,* (12th ed.), John Wiley & Sons. 3. Reese R.L. (2003). *University Physics,* Thomson Brooks/Cole. 4. Bhattacharya B. (2015). *Engineering Mechanics*, (2nd ed.), Oxford University Press. 5. Upadhyaya, J.C. (2024). *Classical Mechanics.* Himalaya Publishing House. 6. Sharma, S.K. & Sharma S. (2024). *A Textbook of Mechanics B.Sc. I (Major & Minor)*. DINESH. 7. Mathur D.S. & Hemne, P.S. (2000). *Mechanics.* S. Chand Publishing. 8. Arora, C.L. (2001). *B.Sc. Practical Physics*. S. Chand & Company. 9. Amrita Vishwa Vidyapeetham. Virtual Labs. https://vlab.amrita.edu/?sub=1 10. Indian Institute of Technology Kharagpur. Virtual Labs: An Initiative of MHRD, Govt. of India. http://vlabs.iitkgp.ac.in/vlt/ 11. Amrita Vishwa Vidyapeetham & CDAC. Virtual labs: Developed with Support from MeitY. https://www.olabs.edu.in/?pg=topMenu&id=40

GE-2C (Principles of Instrumental Analysis)

Name of the College (Department)	Akal College of Basic Sciences (Chemistry and Biochemistry)
Name of the Program	All Programs other than B.Sc. (Hons. With Research) Physical Sciences
Course Code	0320033021
Course Title	Principles of Instrumental Analysis
Academic Year	II
Semester	III
Number of Credits	4 (3+0+1)
Course Prerequisite	Students should have basic understanding and interest in subject of Life or Chemical Sciences.
Course Synopsis	This course provides a comprehensive introduction to essential biophysical techniques used in modern biological research. Students will gain a solid understanding of the underlying principles, instrumentation and applications of chromatography, electrophoresis, centrifugation, spectroscopy and radio isotopic methods. Through a combination of theoretical lectures and hands-on laboratory experiments, students will develop critical thinking, problem-solving and experimental skills. The course emphasizes the application of these techniques to address biological questions and challenges.

Course Outcomes: At the end of the course students will be able to:

CO1	Understand basic concepts, applications, merits and limitations of various bio separation techniques like chromatography, electrophoresis, and centrifugation.
CO2	Understand the main components, working principles and applications of spectroscopy and radio isotopic techniques
CO3	Apply biophysical techniques to separate, purify and characterize biological molecules such as proteins, nucleic acids and lipids.
CO4	Design and conduct experiments using biophysical techniques to address specific biological questions.
CO5	Evaluate the suitability of different techniques for specific research problems and justify the choice of methodology.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1												
CO2												
CO3												
CO4												
CO5												
Average												

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content				
L (Hours/Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total Hour/Week**
3	-	2	-	5
Unit	**Content & Competencies**			
1. Chromatographic techniques (Lecture Hours = 12)	General principles, distribution coefficient. Types of chromatography: Planar chromatography (paper & thin-layer chromatography) and Column chromatography (liquid & gas chromatography). Specialized chromatographic techniques: Ion exchange, Affinity and Size exclusion chromatography.			
2. Electrophoresis (Lecture Hours = 11)	Basic principles, Electrophoresis of Proteins: Native and SDS-PAGE, Isoelectric focusing, 2D-PAGE and molecular weight determination. Electrophoresis of nucleic acid: Agarose gel electrophoresis of DNA and RNA.			
3. Centrifugation techniques (Lecture Hours = 12)	Basic principles of sedimentation and sedimentation coefficient. Types of centrifuges and Rotors. Differential centrifugation and Density gradient centrifugation, Applications of centrifugation. Radio isotopic techniques: Isotopes and nature of radioactivity, Radioactivity units. Types and rate of radioactive decay, half-life, Radioactive counters. Radioisotopes in biology: Applications and precautions.			
4. Spectroscopy (Lecture Hours = 10)	Basic Principles, Electromagnetic radiation, Absorption, emission and scattering. UV-Visible Spectroscopy, Infrared Spectroscopy, Optical rotatory dispersion and circular dichroism. Nuclear magnetic resonance (NMR) and Electron spin resonance (ESR). Atomic spectrometry, mass spectroscopy.			
5. Practical Component **(Lab Hours = 30)**	Any 5 practical from below mentioned list: 1. Separation of plant pigment by paper chromatography 2. Separation of compounds by thin layer chromatography 3. Separation of proteins by Native PAGE 4. Separation of proteins by SDS PAGE 5. Determination of molecular weight of a protein by SDS PAGE 6. Agarose gel electrophoresis of DNA 7. Use of benchtop centrifuge for sample separations 8. Determination of the concentration of a substance in a solution using spectrophotometer. 9. Determination of absorption maxima in a sample.			

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2

Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with Cos

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback
References:	**List of Reference Books:**

1. Wilson K, Walker J (2018). *Principles and Techniques of Biochemistry and Molecular Biology* (8th ed.). Cambridge University Press.
2. Upadhyay A, Upadhyay K & Nath N (2000). *Biophysical Chemistry* (1st ed.). Himalaya Publishing.
3. Sawhney SK & Singh R (2005). *Introductory Practical Biochemistry* (2nd). Narosa Publishers.

SEC/AEC/VAC COURSES
[Offered under B.Sc. (Hons. With Research) Physical Sciences Program]

SEMESTER-III

S.No	Course Category	Course Code	Course Title	Credits L+T+P	Semester	Offering Department
1	SEC-1	0330034031	Introduction to Latex	1+0+1	Odd (III)	Mathematics
2	SEC-3	0350034011	Nanotechnology and Its Applications	1+0+1	Odd (III)	Physics
3	SEC-6	0320034021	Chemistry of Cosmetics & Hygiene Products	1+0+1	Odd (III)	Chemistry & Biochemistry

SEC-1 (Introduction to LaTeX)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0330034031
Course Title	Introduction to LaTeX
Academic Year	II
Semester	III
Number of Credits	2 (1+0+1)
Course Prerequisite	--
Course Synopsis	This course provides a comprehensive introduction to LaTeX, a high-quality typesetting system used for producing scientific and technical documents. Students will learn the fundamental concepts of LaTeX, document structuring, mathematical typesetting, and creating various types of documents.

Course Outcomes: At the end of the course students will be able to

CO1	Create well-structured LaTeX documents using appropriate document classes and packages
CO2	Typeset complex mathematical expressions and equations.
CO3	Produce professional-quality tables and figures.
CO4	Customize document formatting, including page layout, headers, footers, and bibliographies
CO5	Compile and troubleshoot LaTeX documents using various LaTeX editors and tools.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	2	3	2	2	2	1	3	2	2	2	2
CO2	3	3	2	2	2	2	2	3	3	1	1	1
CO3	3	3	3	2	2	2	2	2	3	1	1	2
CO4	3	1	2	3	2	2	2	2	2	1	2	2
CO5	3	3	1	2	3	1	1	2	2	2	2	1
Average	**2.8**	**2.4**	**2.2**	**2.2**	**2.2**	**1.8**	**1.6**	**2.4**	**2.4**	**1.4**	**1.6**	**1.6**

1= Weak Correlation 2 = Moderate Correlation 3 = Strong Correlation

Course Content:

L (Hours/Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total Hours/Week**
1	-	2	-	3

Unit	Content & Competencies
1. **(Lecture Hours = 4)**	Overview of LaTeX: History, features, and applications Installing LaTeX and selecting an editor (TeXShop, TeXworks, Overleaf, etc.), Basic document structure: Document classes, preamble, and sections, Compiling LaTeX documents: PDF, DVI, and Post Script outputs
2. **(Lecture Hours =3)**	Text formatting: Fonts, styles, and sizes, Lists: Itemize, enumerate, and description environments. Document structuring: Sections, subsections, paragraphs, and labels, including comments and handling special characters
3. **(Lecture Hours = 3)**	Inline and display math modes, Basic mathematical expressions: Fractions, roots, superscripts, and subscripts, Complex equations: Arrays, matrices, and align environments, Symbols and operators: Greek letters, integrals, sums, and limits
4. **(Lecture Hours = 5)**	Creating tables: Tabular environment, table formatting, and multirow/multicolumn cells, including graphics: Importing images with graphicx package, Positioning figures and tables: Float environments, captions, and labels, Creating and customizing plots: Using pgfplots package. Customizing the layout: Page dimensions, headers, footers, and footnotes, Bibliographies and citations: Using bibtex and biber, creating presentations: Using beamer class, writing large documents: Splitting projects into multiple files, using input, and include, troubleshooting common errors and debugging LaTeX code

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	15
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**45**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)

Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
VIVA	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process	1. Student's Feedback

References:	**List of Reference Book**
	1. Kopka, H., & Daly, P. W. (2003). *Guide to LATEX*. Pearson Education.

SEC-3 (Nanotechnology and Its Applications)

Name of the College (Department)	Akal College of Basic Sciences (Physics)
Name of the Program	
Course Code	0350034011
Course Title	Nanotechnology and Its Applications
Academic Year	II
Semester	III
Number of Credits	2 (1+0+1)
Course Prerequisite	Physics syllabus of class XII
Course Synopsis	This course offers a foundational understanding of nanoscience and nanotechnology, covering atomic structure, size effects, carbon nanomaterials, and nano–micro/macro interactions. It includes synthesis methods for nanostructured materials, their characterization using advanced techniques like XRD, SEM, TEM, and AFM, and explores diverse applications in energy, environment, electronics, and biology. Hands-on lab sessions enable students to synthesize nanoparticles, operate key instruments, and analyze experimental data.

Course Outcomes: At the end of the course students will be able to:

CO1	Understand the fundamentals of nanoscience and nanotechnology, including the definition of nano, atomic structure, and the impact of size effects on material properties at the nanoscale.
CO2	Develop skills to synthesizeand characterize nanomaterials using various methods for exploring their structural, morphological, and functional properties.
CO3	Understand the classification, composition, and unique properties of nanostructured materials, including quantum dots, metal oxides, semiconductors, and composites.
CO4	Explore nanomaterials applications in electronics, energy, environment, agriculture, and healthcare, focusing on sustainable technologies and nano-enabled devices.
CO5	Develop practical skills in nanoparticle synthesis, equipment handling, and data analysis using XRD, SEM, TEM, and other spectroscopic techniques.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	1	1	1	3	3	2	2	1
CO2	2	2	2	3	2	2	1	3	3	1	1	2
CO3	3	2	2	2	2	2	2	2	2	2	1	2
CO4	3	3	3	1	2	2	2	2	2	1	1	2
CO5	3	1	1	3	2	2	2	2	2	2	2	1
Average	**2.8**	**2.2**	**2.2**	**2.4**	**1.8**	**1.8**	**1.6**	**2.4**	**2.4**	**1.6**	**1.4**	**1.6**

1=Weak Correlation 2=Moderate Correlation 3=Strong Correlation

Course Content:				
L(Hours/Week)	**T(Hours/Week)**	**P(Hours/Week)**	**CL(Hours/Week)**	**Total(Hours/Week)**
1		2	-	3
Unit	**Content& Competencies**			
1.Background to Nanoscience (Lecture Hours: 4)	Definition of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties.			
2.Synthesis and characterization of Nanomaterials (Lecture Hours: 4)	Synthesis of bulk nanostructured materials –Sol Gel processing- bulk and nano composite materials - Grinding - high energy ball milling – injection moulding - extrusion - melt quenching and annealing. Characterization Techniques: XRD, Raman Spectroscopy, SEM, TEM, IR, UV-Vis, Dielectric Spectroscopy, VSM, AFM.			
3. Types and properties of nanomaterials (Lecture Hours: 3)	One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties.			
4.Application of Nanomaterials (Lecture Hours: 4)	Ferroelectric materials and nanoelectronics; biological, environmental andmembrane based application, solar cells, Fuel Cells, Nano devices and Sensors, Nanotechnology for sustainable energy, Nanotechnology in agriculture and food processing and Environmental applications of nanomaterials.			
5. Practical Component (Lab Hours = 30)	The teacher is expected to provide basic idea and working of various apparatus and instruments related to different experiments. Students are supposed to known knowledge of recording and analyzing experimental data along with study error analysis in observations. Every student should perform at least 05 experiments from the following list: 1. To operate and calibrate some basic materials science and nanotechnology lab equipments 2. To synthesize nanoparticles using sol-gel method 3. To synthesize nanoparticles using solid state reaction method 4. To synthesize nanoparticles using green synthesis process 5. To synthesize nanoparticles using hydrothermal technique 6. To calculate crystallite size of nanoparticles using XRD data analysis 7. To calculate the particle size using SEM and TEM images with help of ImageJ software 8. To perform graph plotting and data analysis of the data obtained from any of the studied spectroscopic techniques			

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	15

Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL)/Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**45**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with Cos

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
VIVA	✓	✓	✓	✓	✓
Assignment/Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory Assessment	✓	✓	✓	✓	✓
Practical Log Book/Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	1. Chattopadhyay, K. K., & Banerjee, A. N. (2009). *Introduction to Nanoscience and Nanotechnology.* PHI Learning Pvt. Ltd. 2. Kulkarni, S. K. (2015). *Nanotechnology: Principles and Practices*. Springer. 3. Cao, G., & Wang, Y. (2011). *Nanostructures and Nanomaterials: Synthesis, Properties, and Applications.* World Scientific Publishing Company. 4. Di Ventra, M., Evoy, S., & Heflin, J. R. (2004). *Introduction to Nanoscale Science and Technology.* Springer. 5. Tanaka, K., & Iijima, S. (Eds.). (2010). *Carbon Nanotubes and Graphene.* Elsevier. 6. Sharma, A., & Oza, G. (2023). *Nanochemistry: Synthesis, Characterization and Applications.* CRC Press.

SEC-6 (Chemistry of Cosmetics & Hygiene Products)

Name of the College (Department)	Akal College of Basic Sciences (Chemistry and Biochemistry)
Name of the Program	For other Colleges
Course Code	0320034021
Course Title	Chemistry of Cosmetics & Hygiene Products
Academic Year	II
Semester	III
Number of Credits	2 (1+0+1)
Course Prerequisite	XII with Science
Course Synopsis	Cosmetic chemistry helps students to understand the basics of cosmetics and applications. Students can also formulate the products like skin care products, hair care products etc. Learners would be aware of the herbs and excipient in cosmetics and hygiene product formulations.

Course Outcomes: At the end of the course students will be able to:

CO1	Define cosmetics, Scope, Classification of cosmetics.
CO2	Understand the formulation of cosmetic products.
CO3	Understand the herbs role in cosmetics.
CO4	Understand the excipients of cosmetics.
CO5	Understand the use of basic terms in cosmetics.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	1	1	3	3	2	2	1
CO2	3	3	2	2	2	2	1	3	3	1	1	2
CO3	2	2	3	2	2	2	2	2	2	1	1	2
CO4	2	1	3	2	2	2	2	2	2	1	2	2
CO5	2	3	3	2	2	2	2	2	2	2	2	1
Average	**2.4**	**2.4**	**2.8**	**2.2**	**2.2**	**1.8**	**1.6**	**2.4**	**2.4**	**1.4**	**1.6**	**1.6**

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content:

L (Hours/Week)	T (Hours/Week)	P (Hours/Week)	CL (Hours/Week)	Total Hour/Week
1	-	2	-	3

Unit	Content & Competencies
1. Basics of cosmetics (Contact Hours=3)	Definition, History and scope of cosmetics, Applications, Classifications, Limitations, Good manufacturing practices.

2. Principles and Formulation of cosmetic products (Contact Hours=4)	• Skin care products • Hair care products • Oral hygiene products • Nail care products • Advantages and Disadvantages • Common cosmetic formulation
3. Role of Herbs in cosmetics (Contact Hours=4)	Common Herbal Ingredients and their uses: skin care, hair care, fragrance and aromatherapy; cleansing and detoxification.
4. Cosmetic excipients (Contact Hours=4)	Cosmetic excipients: surfactants, rheology modifiers, preservatives, emollients, humectants. principles of cosmetic evaluation, basic terms: comedogenic, non-comedogenic, dermatitis.
5. Practical Component (Lab Hours = 30)	1. To Prepare samples of shampoo. 2. Preparation of hand wash. 3. Preparation of soaps. 4. Preparation of face cream. 5. Preparation of toothpaste. 6. Preparation of talcum powder

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	**Contact Hours**
Lecture	15
Practical	30
Seminar/Journal Club	
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	
Case/Project Based Learning (CBL)	
Revision	1
Others If any:	
Total Number of Contact Hours	**45**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce

Professional Activity	
Assignment	

Mapping of Assessment with Cos

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
VIVA	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Practical Logbook/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**
	1. Barel, A.O., Paye, M., Maibach, H.I. (2014). *Handbook of Cosmetic Science and Technology*. CRC Press. 2. Butler, H. (2000). *Poucher's Perfumes, Cosmetic and Soap*. Springer. 3. Garud, A., Sharma, P.K., Garud, N. (2012). *Textbook of Cosmetics*. Pragati Prakashan. 4. Gupta, P.K., Gupta, S.K. (2011). *Pharmaceutics and Cosmetics*. Pragati Prakashan 5. Kumari, R. *Chemistry of Cosmetics*. Prestige Publishers. 6. Moore, R. J., Wilkinson, J. B. (1982). *Harry's Cosmeticology*. Chemical Publishing company, Seventh Edition. 7. Nanda, S., & Khar, R. K. *Textbook of Cosmetiology*. Tata Publishers. 8. Romanowski, P. (2009). *Beginning Cosmetic Chemistry*. Allured Pub Corp. 9. Sharma, P. P. *Cosmetics – Formulations, Manufacturing and Quality Control.* 4th Edition, Vandana Publications Pvt. Ltd., Delhi.

SEMESTER – IV

Course Code	Course Category	Course Title	Teaching Hours/Week			Credits
			L	T	P	
DSC-4M	0330341040	Vector Calculus	3	1	0	4
DSC-4C	0320341041	Chemistry of Oxygen Based Functional Groups	3	0	2	4
DSC-4P	0350341041	Electromagnetic Waves and Optics	3	0	2	4
*DSE-2M	0330342021	Linear Algebra	3	0	2	4
*DSE-2C	0320342021	Chemistry of Colloids and Adsorption	3	0	2	4
*DSE-2P	0350342021	Waves and Vibrations	3	0	2	4
*GE-4		From pool of GE courses	3	0	2	4
SEC-4		From pool of SEC courses	1	0	2	4
AEC-4		From pool of AEC courses	1	0	2	4
VAC- 4		From pool of VAC courses	1	0	2	4
Total			**15**	**0/1**	**14/12**	**22**

Note – L: Lecture Hour/week, T: Tutorial Hour/week, P: Practical Hour/week, CL: Clinical Hour/week, C: Credits.

*Student can opt either one of the DSE courses or any one GE course from pool of GE courses.

DSC-4M (Vector Calculus)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0330341040
Course Title	Vector Calculus
Academic Year	II
Semester	IV
Number of Credits	4(3+1+0)
Course Prerequisite	1st year DSC courses of Mathematics and Mathematics of Class 11th & 12th
Course Synopsis	Vector Calculus focuses on the differential and integral calculus of vector fields. Topics include scalar and vector point functions, directional derivatives, and the computation of gradient, divergence, and curl. The course introduces coordinate transformations in cylindrical and spherical systems and applies key vector theorems to physical problems. Emphasis is placed on both theory and real-world applications, especially in physics and engineering.

Course Outcomes: At the end of the course, students will:

CO1	Students will study the concepts of scalar and vector products in three dimensions and apply them to physical and mathematical problems.
CO2	Students will learn to compute gradients, divergence, and curl of vector fields, and analyse their geometrical significance.
CO3	Utilize orthogonal curvilinear coordinate systems including cylindrical and spherical coordinates in solving vector calculus problems.
CO4	Study Green's, Stokes', and Gauss' divergence theorems and solve complex vector calculus problems in physical and engineering contexts.
CO5	Solve real-world engineering and physics problems using vector differential and integral calculus tools.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	1	1	1	3	3	1	2	2
CO2	2	2	1	1	1	1	1	2	2	1	1	2
CO3	2	3	2	1	1	1	2	2	2	1	1	2
CO4	2	2	3	1	1	1	2	3	3	2	2	3
CO5	3	3	3	1	1	1	2	3	3	3	2	3
Average	**2.4**	**2.4**	**2.2**	**1.2**	**1**	**1**	**1.6**	**2.6**	**2.6**	**1.6**	**1.6**	**2.4**

1= Weak Correlation 2 = Moderate Correlation 3 = Strong Correlation

Course Content:

L(Hours/Week)	T(Hours/Week)	P(Hours/Week)	Total Hour/Week
3	1	-	4

Unit	Content & Competencies

1. **(Lecture Hours = 10)**	Scalar and Vector Product of two vectors, Scalar and vector product of three vectors, product of four vectors, Reciprocal vectors, Vector differentiation, Scalar valued point functions, derivative along a curve, directional derivatives.
2. **(Lecture Hours =11)**	Gradient of a scalar point function, geometrical interpretation of grad, character of gradient as a point function, Divergence and Curl of vector point function, characters of Div f and Curl f as a point function, examples, Gradient, Divergence and Curl of sums and product and their related vector identities, Laplacian operator
3. **(Lecture Hours = 12)**	Orthogonal curvilinear coordinates for orthogonally, the fundamental triad of mutually orthogonal unit vectors, Gradient, Divergence, Curl, and Laplacian operators in terms of orthogonal curvilinear coordinates, Cylindrical coordinates and spherical coordinates
4. **(Lecture Hours = 12)**	Vector integration, line integral, surface integral, and volume integral, Theorems of Gauss, Stokes, and Greens, and problems based on these theorems

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours:

Learning Strategies	**Contact Hours**
Lecture	45
Practical	-
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	10
Problem Based Learning (PBL)	2
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**60**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Mid Semester Examination	University Examination
Mid Term Practical Examination	Multiple Choice Questions (MCQ)
Quiz	Short Answer Questions (SAQ)
Seminars/ Presentation	Long Answer Question (LAQ)
Problem Based Learning (PBL)	Practical Examination & Viva-voce
Journal Club	
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
VIVA	-	-	-	-	-
Assignment / Presentation	✓	✓	✓	✓	✓

Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	-	-	-	-	-
Practical Log Book/ Record Book	-	-	-	-	-
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**
	1. Spiegel, M. R. (1968). *Vector analysis.* Schaum Publishing Company. 2. Saran, N., & Nigam, S. N. (1993). *Introduction to vector analysis*. Pothishala. 3. Narayan, S. (2003). *A textbook of vector calculus.* S. Chand & Co. 4. Marsden, J., & Tromba, W. (2003). *Vector calculus.* W. H. Freeman.

DSC-4C (Chemistry of Oxygen Based Functional Groups)

Name of the College (Department)	Akal College of Basic Sciences (Chemistry and Biochemistry)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0320341041
Course Title	Chemistry of Oxygen Based Functional Groups
Academic Year	II
Semester	IV
Number of Credits	4(3+0+1)
Course Prerequisite	1st year DSC courses of Chemistry & Biochemistry and Chemistry of Class 11th & 12th
Course Synopsis	This course explores the structure, reactivity, and mechanisms of organic compounds containing oxygen-based functional groups. Emphasis is placed on alcohols, aldehydes, ketones, carboxylic acids, and related derivatives. Students will examine how electronic and steric factors influence reactivity, and how these compounds participate in key organic reactions such as nucleophilic substitution, oxidation-reduction, and condensation. Real-world applications, including pharmaceuticals, biomolecules, and industrial processes, are discussed to highlight the relevance of organic chemistry. Through lectures, problem-solving sessions, and laboratory experiments, students will gain both theoretical knowledge and practical skills essential for advanced organic chemistry and related disciplines. This course serves as a foundation for further study in medicinal, environmental, and industrial chemistry.

Course Outcomes: At the end of the course students will be able to:

CO1	Define oxygen-based compounds, outline its goals, and explain the scope of organic chemistry in our daily life.
CO2	Understanding the fundamental concepts of carbonyl compounds.
CO3	Frame the mechanism of organic reactions by reminding and relating the fundamental properties of the reactants involved.
CO4	Learn and identify many organic reactions of oxygen containing molecules.
CO5	Differentiate and etheoxygen based functional groups.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)& Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	1	1	2	3	2	2	1
CO2	2	3	1	2	2	2	1	3	3	2	1	2
CO3	3	2	2	2	2	2	2	1	2	1	1	1
CO4	3	1	2	2	1	2	2	2	2	2	2	2
CO5	3	3	2	2	2	2	2	3	2	2	2	1
Average	**2.8**	**2.4**	**2**	**2.2**	**2**	**2**	**1.6**	**2.2**	**2.4**	**1.8**	**1.6**	**1.4**

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content:				
L (Hours/Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total Hour/Week**
3	-	2	-	5
Unit	**Content & Competencies**			
1. Alcohols Compounds and their Derivatives (aliphatic and aromatic) (Lecture Hours = 10)	Alcohols: Classification and nomenclature of Monohydric alcohols – nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols. Dihydric alcohols – nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$] and HIO_4 and pinacol-pinacolone rearrangement.			
2. Carbonyl Compounds and their Derivatives (aliphatic and aromatic)(Lecture Hours = 10)	Aldehydes and Ketones: Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids. Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations.			
3. Name reaction with mechanism (Lecture Hours = 10)	Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones. An introduction to α,β-unsaturated aldehydes and ketones.			
4. Carboxylic Compounds and their Derivatives (aliphatic and aromatic) (Lecture Hours = 15)	Carboxylic Acids: Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids, Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Methods of formation and chemical reactions of unsaturated mono-carboxylic acids. Dicarboxylic acids: methods of formation and effect of heat and dehydrating agents.			
5. Practical Component (Practical Hours = 30)	1. Determination of R_f value and purity of organic compounds by use of thin layer chromatography. 2. To analyze the analgesic drug APC by thin layer chromatography. 3. Separation of mixture of *o*-nitroaniline and *p*-nitroaniline by column Chromatography 4. Synthesis of organic compounds: Acetylation/benzolyation of salicylic acid. 5. Preparation of m-dinitrobenzene from nitrobenzene. 6. Preparation of p-nitroacetanilide from acetanilide. 7. Preparation of p-bromoacetanilide from acetanilide.			

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small Group Discussion (SGD)	1
Self-directed Learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
VIVA	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**
	5. Nickon, A., & Silversmith, E.F. (2013). *Organic chemistry: the name game: modern coined terms and their origins*. Elsevier. 6. Mukerji S.M., Singh S.P. and Kapoor R.P (1985). *Organic Chemistry* Vol. I/II, Pubs: Wiley Eastern Ltd., New Delhi, 1985. 7. Solomons, T.W.G.; Fryhle, C.B. ; Snyder, S.A. (2016). *Organic Chemistry*, 12th Edition., Wiley. 8. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005). *Intermediate for Organic Synthesis*, I.K. International. 9. Carey F.A. (2003), Organic Chemistry, Pubs: McGraw-Hill, Inc. 10. Ahluwalia, V.K., & Dhingra, S. (2024). *Advanced Experimental Inorganic Chemistry*. Taylor & Francis. 11. Furniss, B.S. (Ed.). (2011). *Vogel's textbook of practical organic chemistry*. Pearson Education India.

DSC-4P (Electromagnetic Waves and Optics)

Name of the College (Department)	Akal College of Basic Sciences (Physics)
Name of the Program	B.Sc. (Hons. with Research) Physical Science
Course Code	0350341041
Course Title	Electromagnetic Waves and Optics
Academic Year	II
Semester	IV
Number of Credits	4 (3+0+1)
Course Prerequisite	Physics and Mathematics of class 11^{th} & 12^{th}
Course Synopsis	This course builds upon the foundational knowledge of optics and electromagnetism introduced at the school level and provides a deeper and more rigorous understanding of the subject. It introduces the concept of electromagnetic waves through Maxwell's equations and explores wave propagation in various media, including conducting and dielectric materials. The course further examines the behavior of light through phenomena such as polarization, interference, and diffraction, with emphasis on both theoretical principles and practical applications. Students will gain hands-on experience with key optical instruments and interferometers, enabling precise measurement and analysis of light properties. The course is essential for understanding modern optical systems and electromagnetic theory in both classical and applied physics contexts.

Course Outcomes: At the end of the course students will be able to:

CO1	Explain and apply Maxwell's equations to derive the wave equation in free space, dielectrics, and conducting media; analyze energy transport, wave impedance, and reflection/transmission of electromagnetic (EM) waves across media boundaries.
CO2	Analyze different states of polarization of plane harmonic waves (linear, circular, elliptical) and use optical devices (wave plates, Nicol prism) to produce and analyze polarized light, including applications in birefringent and scattering media..
CO3	Demonstrate the conditions for interference of light using coherent sources and thin films; apply interference principles to practical devices such as Newton's rings, interferometers, and filters for precise optical measurements.
CO4	Apply and interpret the working principles of Michelson and Fabry-Perot interferometers for precision measurements and spectral analysis; illustrate the role of coherence and interference in filter design.
CO5	Describe and distinguish between Fraunhofer and Fresnel diffraction phenomena; apply diffraction principles to analyze the resolving power of optical instruments and evaluate conditions for optimum resolution.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	1	1	3	3	2	2	1
CO2	2	3	2	2	2	2	1	3	3	1	1	2
CO3	3	2	2	2	2	2	2	2	2	1	1	2
CO4	3	1	3	2	2	2	2	2	2	1	2	2
CO5	3	3	1	2	2	2	2	2	2	2	2	1
Average	**2.8**	**2.4**	**2.2**	**2.2**	**2.2**	**1.8**	**1.6**	**2.4**	**2.4**	**1.4**	**1.6**	**1.6**

1=Weak Correlation 2=Moderate Correlation 3=Strong Correlation

Course Content:				
L (Hours/Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total Hour/Week**
3	-	2	-	5
Unit	**Content& Competencies**			
1: Electromagnetic Waves (Contact Hours: 11 Hours)	Electromagnetic Waves: Electromagnetic nature of light, Huygens' principle; coherence (spatial & temporal), Maxwell's equations, wave equation, Displacement current and plane electromagnetic waves, Poynting theorem and energy flux (Poynting vector), EM waves in a medium with finite ε and μ, EM waves in a conducting medium- skin depth and impedance of a conductor. Reflection and transmission of EM waves at the boundary of two dielectric media,			
2: Polarization (Contact Hours: 12 Hours)	Polarization: Polarization of plane harmonic waves, linear, circular and elliptical polarization, natural light, production of polarized light, Malus' law, Brewster's law and determination of refractive index, polarization by scattering, Birefringence, quarter wave and half-wave plates. Double refraction, Nicol prism, analysis of circularly and elliptically polarized light.			
3: Interference (Contact Hours: 11 Hours)	Interference: Coherence, Michelson: fringe patterns, measurements (wavelength, refractive index, visibility), Fabry–Pérot: basic concept and applications, Theory of interference. Young's double slit experiment, Fresnel's biprism, Lloyd's mirror, Thin film interference, Newton's rings: basic concept and applications, white-light fringes.			
4: Diffraction (Lecture Hours =11 Hours)	Diffraction: Introduction: Helmholtz Kirchhoff's integral, Scalar diffraction theory, Fraunhofer diffraction (single slit, circular aperture, diffraction grating), Fresnel diffraction (half-period zones, Cornu spiral, zone plate), Rayleigh's criterion for resolution, Resolving power of a diffraction grating, a telescope and a microscope.			
5. Practical Component (Practical Hours = 30)	The teacher is expected to provide basic idea and working of various apparatus and instruments related to different experiments. Students are supposed to known knowledge of recording and analyzing experimental data along with study error analysis in observations. Every student should perform at least 05 experiments from the following list: 1. To determine the refractive index of the material of a glass prism using spectrometer and sodium light. 2. To determine the wavelength of monochromatic light using interference fringes formed in Newton's rings setup. 3. To determine the wavelengths of spectral lines emitted by a source (such as mercury or sodium lamp) using diffraction grating and a spectrometer. 4. To determine the wavelength of monochromatic light by analyzing the interference fringes produced using a Fresnel biprism. 5. To determine the specific rotation of sugar solution using Polarimeter. 6. To determine the wavelength of monochromatic light and measure the refractive index of a thin transparent material using a Michelson interferometer. 7. To determine the resolving power and magnification of an optical telescope. 8. To determine the resolving power of a diffraction grating and verify its dispersive properties. 9. To observe and analyze the diffraction pattern produced by a single slit and determine the slit width using the angular position of minima.			

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45

Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL)/Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
Viva-voce	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓
Feedback Process:	Student's Feedback				

References:	List of Reference Books
	1. Subrahmanyam, N., Lal, B., & Avadhanulu, M.N. (2012). *A Textbook of Optics: For B.Sc. students as per UGC model syllabus*. S. Chand. 2. Griffiths, D. J. (2017). *Introduction to Electrodynamics* (4th ed.). Pearson. 3. Hecht, E. (2017). *Optics* (5th ed.). Pearson Education. 4. Beiser, A. (2003). *Concepts of Modern Physics* (6th ed.). McGraw-Hill. 5. Sadiku, M.N.O. (2015). *Elements of Eectromagnetics* (6th ed.). Oxford University Press. 6. Laud, B.B. (1987). *Electromagnetics* (2nd ed.). Wiley Eastern. 7. Arora, C.L. (2001) *B.Sc. Practical Physics*. S. Chand & Company. 8. Amrita Vishwa Vidyapeetham. *Virtual labs*. https://vlab.amrita.edu/?sub=1 9. Indian Institute of Technology Kharagpur. *Virtual labs: An initiative of MHRD, Govt. of India*. http://vlabs.iitkgp.ac.in/vlt/ 10. Amrita Vishwa Vidyapeetham & CDAC. *Virtual labs: Developed with support from MeitY*. https://www.olabs.edu.in/?pg=topMenu&id=40

DSE-2M (Linear Algebra)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0330342021
Course Title	Linear Algebra
Academic Year	II
Semester	IV
Number of Credits	4(3+0+1)
Course Prerequisite	1st Year DSC courses of Mathematics and Mathematics of class 11th & 12th
Course Synopsis	This course offers a comprehensive study of vector spaces and linear transformations, laying the foundation for advanced topics in linear algebra. It covers key concepts such as basis, dimension, eigenvalues, eigenvectors, canonical forms, and inner product spaces. Students will also explore special matrices and transformations, with applications in solving systems of equations and optimization problems. Practical sessions will enhance understanding through hands-on experience with computations and matrix operations.

Course Outcomes: At the end of the course, students will:

CO1	Students will develop a deep understanding of algebraic structures and vector spaces**,** including the foundational concepts of groups, rings, fields, subspaces, linear span, linear dependence and independence, basis, dimension, and quotient spaces.
CO2	To explore linear transformations and their properties including kernel, range, rank, nullity, isomorphisms, and their matrix representations, along with the study of algebraic operations on transformations and their applications in solving linear systems.
CO3	To study important forms of linear operators, such as eigenvalues and eigenvectors, diagonalization, invariant subspaces, the Cayley-Hamilton theorem, minimal polynomials, and the Jordan canonical form.
CO4	To explore inner product spaces, including orthogonal and orthonormal vectors, the Gram-Schmidt process, and how inner products help in solving equations and finding best-fit solutions.
CO5	To apply theoretical knowledge in understanding advanced matrix theory concepts, such as symmetric, Hermitian, orthogonal, unitary, and normal transformations, as well as the use of adjoint operators and how they are used in practical problems.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	2	2	1	1	2	1	3	2	2	2	2
CO2	2	3	2	1	1	1	2	2	2	2	1	2
CO3	2	3	2	1	2	1	1	2	2	2	1	2
CO4	3	3	2	2	1	2	2	3	3	3	1	2
CO5	3	3	3	2	2	2	2	3	3	3	2	3
Average	**2.4**	**2.8**	**2.2**	**1.4**	**1.4**	**1.6**	**1.6**	**2.6**	**2.4**	**2.4**	**1.4**	**2.2**

1= Weak Correlation 2 = Moderate Correlation 3 = Strong Correlation

Course Content:			
L(Hours/Week)	**T(Hours/Week)**	**P(Hours/Week)**	**Total Hour/Week**
3	-	2	5
Unit	**Content & Competencies**		
1. **(Lecture Hours = 13)**	Introduction of Group, Ring and Field, Vector space, subspaces, sum of subspaces, Linear span, Linear independent and dependent subset of vector space, Bases, and dimension, Dimension of subspaces, Quotient space, Dimensions for sum of subspaces and Quotient spaces.		
2. **(Lecture Hours =12)**	Linear transformations, Range and Null space, linear functional, Dual Spaces, Dimension theorem on Dual space, Singular and Non-Singular transformation, Rank and nullity of a linear transformation, Matrix representation of a linear transformation, Algebra of linear transformations, Invertibility and isomorphisms.		
3. **(Lecture Hours = 10)**	Annihilators, Eigenvalues, Eigenvectors, Eigenspaces, and the characteristic polynomial of a linear operator; Diagonalizability, Direct sum of subspaces, Invariant subspaces, and the Cayley-Hamilton theorem; Jordan canonical form and the minimal polynomial of a linear operator.		
4. **(Lecture Hours = 10)**	Definition of inner product between two vectors, orthogonal and orthonormal vectors, Gram-Schmidt process for orthogonalization, quadratic forms, positive definite forms, Symmetric, Hermitian, orthogonal, unitary and Normal transformations/matrices, Adjoint of a linear operator with applications to least squares approximation and minimal solutions to systems of linear equations.		
5. **(Practical Hours = 30)**	**List of Practicals (using any software)** 1. To verify whether a given set of vectors forms a subspace of a vector space using rank and linear dependence. 2. To determine the linear dependence or independence of vectors and compute the basis and dimension of the vector space. 3. To define a linear transformation and obtain its matrix representation concerning standard bases. 4. To verify the rank-nullity theorem for a given linear transformation. 5. To compute eigenvalues and eigenvectors of a matrix and check if the matrix is diagonalizable. 6. To compute the Jordan canonical form of a matrix and verify the Cayley-Hamilton theorem. 7. To apply the Gram-Schmidt process to a set of vectors and obtain an orthonormal basis. 8. To solve an overdetermined system of equations using the least squares approximation method. 9. Analyze linear functional and dual space concepts. 10. To compute quadratic form and check if the associated matrix is positive definite.		

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours:

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	1

Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Mid Semester Examination	University Examination
Mid Term Practical Examination	Multiple Choice Questions (MCQ)
Quiz	Short Answer Questions (SAQ)
Seminars/ Presentation	Long Answer Question (LAQ)
Problem Based Learning (PBL)	Practical Examination & Viva-voce
Journal Club	Practical Examination & viva-voice
Professional Activity	
Assignment	

Mapping of Assessment with Cos

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	-	-	-	-	-
VIVA	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	-	-	-	-	-
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**
	1. Herstein, I.N. (1975). *Topics in algebra*. Wiley Eastern Ltd. 2. Hoffman, K., & Kunze, R. (1971). *Linear algebra*. Englewood Cliffs, New Jersey. 3. Kumaresan, S. (2000). *Linear algebra: A geometric approach*. Prentice-Hall of India. 4. Seymour, L., & Lipschutz, M. (2004). *Schaum's outline of theory and problems of linear algebra* (3rd ed.). Erlangga. 5. Strang, G. (2016). *Linear algebra and its applications* (5th ed.). Cengage Learning.

DSE-2C (Chemistry of Colloids and Adsorption)

Name of the College (Department)	Akal College of Basic Sciences (Chemistry and Biochemistry)
Name of the Program	B.Sc. (Hons. with Research) Physical Sciences
Course Code	0320342021
Course Title	Chemistry of Colloids and Adsorption
Academic Year	II
Semester	III
Number of Credits	4 (3+0+1)
Course Prerequisite	1st Year DSC courses of Chemistry and Chemistry & Physics of class 11th & 12th
Course Synopsis	This course offers a comprehensive understanding of colloidal systems and adsorption phenomena. It covers the classification, properties, and preparation of colloids, including lyophilic, lyophobic, macromolecular, and associated colloids (micelles). Key concepts like Tyndall effect, Brownian motion, coagulation, electrophoresis, and dialysis are discussed along with the Schulze–Hardy rule. The course introduces emulsification, surfactant selection (HLB), and colloids in food and biomedical applications. Students explore the distinction between adsorption and absorption, types of adsorptions (physisorption and chemisorption), and isotherms (Freundlich and Langmuir). Emphasis is placed on real-world applications such as catalysis, drug delivery, water purification, and chromatography.

Course Outcomes: At the end of the course students will be able to:

CO1	Differentiate between true solutions, colloids, and suspensions based on particle size, visibility, filtration behavior, and stability, and classify colloidal systems based on the nature of the dispersed phase and medium.
CO2	Understand the types, formation, and stability of colloidal systems, including multimolecular, macromolecular, and associated colloids (micelles), and apply the concepts of Hydrophile–Lyophile Balance (HLB) in the context of emulsification.
CO3	Describe the methods of colloid preparation and purification (condensation, dispersion, electrophoresis, dialysis), and interpret key properties such as Tyndall effect, Brownian motion, coagulation, and the Schulze–Hardy rule.
CO4	Understand the principles of adsorption, differentiate between physisorption and chemisorption, analyze adsorption isotherms (Freundlich and Langmuir), and explain the factors influencing adsorption of gases and solutions on solid surfaces.
CO5	Identify and evaluate the real-life applications of colloids and adsorption, including their roles in food chemistry, drug delivery, catalysis, water purification, chromatography, and environmental and industrial processes.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	2	1	2	2	1	2	1
CO2	1	1	2	2	1	1	2	2	1	2	3	2
CO3	3	2	2	2	2	2	1	2	1	1	1	1
CO4	2	3	1	2	2	1	1	2	2	1	2	2
CO5	3	2	2	2	3	2	2	2	2	1	3	1

Average	**2.4**	**2.2**	**2**	**2.2**	**2.2**	**1.6**	**1.4**	**2**	**1.6**	**1.2**	**2.2**	**1.4**
1= Weak Correlation					2= Moderate Correlation						3= Strong Correlation	

Course Content				
L (Hours/ Week)	**T (Hours/ Week)**	**P (Hours/ Week)**	**CL (Hours/Week)**	**Total Hour/ Week**
3	-	2	-	5
Unit	**Content & Competencies**			
1. Colloidal State (Lecture Hours = 15)	Distinction among true Solutions, Colloids, and Suspensions: Comparative study based on particle size, visibility, filtration, and stability. Components and Classification of Colloids: Dispersed phase and dispersion medium; classification into lyophilic and lyophobic colloids. Hydrophile–Lyophile Balance (HLB): Concept and significance in emulsification and surfactant behavior.Types of Colloidal Systems: Multimolecular Colloids – formed by aggregation of atoms or molecules. Macromolecular Colloids – formed by large molecules dispersed in a medium. Associated Colloids (Micelles): Critical micelle concentration (CMC), formation, and behavior in aqueous solution.			
2. Preparation and Properties of Colloids (Lecture Hours = 10)	Methods of preparation of colloids: condensation and dispersion techniques, Stabilization of colloidal systems Tyndall effect, Brownian movement, coagulation and flocculation; electrophoresis, dialysis. Schulze–Hardy Rule: Influence of ionic charge on coagulation of colloids. Emulsification by surfactants, selection of surfactants as emulsifying agent, colloidal phenomenon in food chemistry, Protein based functional colloids.			
3. Applications of Colloids and Adsorption (Lecture Hours = 10)	Applications of colloids: Applications of Adsorption phenomenon in living systems. Industrial (paints, inks, rubber), medicinal (drug delivery), environmental (waste treatment). Applications of adsorption: Catalysis, gas masks, purification of water, chromatography, Role of colloids and adsorption in biological and technological processes.			
4. Surface Chemistry (Lecture Hours = 10)	Adsorption, Distinction between adsorption and absorption, Types of Adsorptions, Physisorption and chemisorption along with their key characteristics and comparative analysis, factors affecting adsorption of gases on solids – Freundlich and Langmuir adsorption isotherms, Adsorption from solutions.			
5. Practical Component (Lab Hours = 30)	1. Preparation of colloidal solution of Starch/Gum. 2. Preparation of colloidal solution of Ferric chloride (condensation method). 3. Verification of the Schulze–Hardy Law (study the effect of electrolyte valency on the coagulation of colloidal solutions). 4. To verify the Freundlich's Adsorption isotherms. 5. Study of adsorption of Oxalic acid on charcoal and prove the validity of Langmuir's adsorption isotherms. 6. Preparation of colloidal solution of Aluminum hydroxide. 7. To study of Adsorption of Acetic Acid (HAc) on Activated Charcoal and Verification of Langmuir's Adsorption Isotherm. 8. Study of Tyndall Effect in Different Colloidal Systems (to observe light scattering and verify colloidal dispersion through the Tyndall effect). 9. Emulsification and Demulsification of Oil-Water Emulsions (study the formation of emulsions and the role of surfactants as emulsifying agents).			

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	**Contact Hours**
Lecture	45
Practical	25
Seminar/Journal Club	-
Small Group Discussion (SGD)	1
Self-directed Learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs:

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
Viva-voce	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓
Feedback Process:	Student's Feedback				

References:	1. Puri B.R., Sharma L.R. and Pathania M.S., (2020) *Principles of Physical Chemistry*, Vishal Publishing Co. Jalandhar, Punjab, India. 2. Kapoor K.L.,(2015) *Textbook of Physical Chemistry, Vol. 4*, McGraw Hill Education (India) Private Limited, Chennai, India. 3. Evans D.F. , Wenner Ström's, (1999) *The Colloidal Domain,* (2nd ed.), John Wiley & Sons Inc. 4. Adamson A.W. and Gast A., (1967) *Physical Chemistry of Surfaces (Main text)* (6th ed.), John Wiley & Sons Inc. 5. Berg, J.C. (2010). *An Introduction to Interfaces & Colloids*, Hackensack. 6. IsraelachviliJ.N.,(2011) *Intermolecular and Surface Forces*, Elsevier Inc. 7. Singhal, A. (2009). *Physical chemistry for the IIT JEE*. Pearson Education India. 8. Giri, S; Bajpai, D.N.; Pandey, O.P. (1972) *Practical Chemistry*, S. Chand Limited. 9. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), *Senior Practical Physical Chemistry*, R. Chand & Co.

DSE-2P (Waves and Vibrations)

Name of the College (Department)	Akal College of Basic Sciences (Physics)
Name of the Program	B.Sc. (Hons. with Research) Physical Science
Course Code	0350342021
Course Title	Waves and Vibrations
Academic Year	II
Semester	IV
Number of Credits	4(3+0+1)
Course Prerequisite	1st Year DSC courses of Physics and Mathematics & Physics of class 11th & 12th
Course Synopsis	This course offers an in-depth understanding of mechanical and electrical vibrations, covering damped and forced harmonic motion, resonance, energy transfer, and wave phenomena including interference, Lissajous figures, and impedance matching. It explores coupled oscillations, normal modes, and the behavior of waves on strings, emphasizing both theoretical concepts and phasor analysis. Hands-on experiments with pendulums, LCR circuits, CRO, and ultrasonic interferometers enhance students' practical skills in data collection, waveform analysis, and error estimation.

Course Outcomes: At the end of the course students will be able to:

CO1	Understand the principles of simple harmonic motion, including damped and forced oscillations, and analyze parameters like relaxation time, logarithmic decrement, Q-factor, and phase relationships using phasor methods.
CO2	Analyze the superposition of harmonic vibrations, interpret Lissajous figures, and understand conditions for constructive and destructive interference in oscillatory systems.
CO3	Explain the behavior of coupled oscillators and wave systems, including stiffness coupling, normal modes, wave propagation, impedance matching, and energy transmission in strings and media.
CO4	Apply theoretical knowledge to operate and understand the working of scientific instruments such as the CRO, ultrasonic interferometer, and pendulum setups for experimental investigations.
CO5	Develop competence in experimental data collection, analysis, and interpretation with an emphasis on error analysis, enhancing practical skills through hands-on experiments in vibrations and wave mechanics.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	2	1	3	3	2	2	2
CO2	2	2	3	2	3	2	1	3	3	2	2	2
CO3	2	3	2	2	2	1	2	2	2	1	1	2
CO4	3	2	3	2	2	2	2	2	2	3	2	2
CO5	3	3	1	2	2	2	2	2	2	2	2	3
Average	**2.6**	**2.6**	**2.4**	**2.2**	**2.2**	**1.8**	**1.6**	**2.4**	**2.4**	**2**	**1.8**	**2.2**

1=Weak Correlation 2=Moderate Correlation 3=Strong Correlation

Course Content:				
L (Hours/Week)	**T(Hours/Week)**	**P (Hours/Week)**	**CL(Hours/Week)**	**Total Hour/Week**
3	-	2	-	5
Unit	**Content & Competencies**			
1. Superposition of Harmonic Motions and Damped Harmonic Motion (Lecture Hours = 12)	Superposition of two simple harmonic motions of the same frequency along the same line, interference, superposition of two mutually perpendicular simple harmonic vibrations of the same frequency, Lissajous figures, case of different frequencies, Damped S.H.M. Logarithmic decrement, Relaxation time. The quality factor, Q-Value of a simple harmonic oscillator.			
2. Forced Oscillator (Lecture Hours = 11)	Transient and steady behaviour of forced oscillator. Displacement and velocity variation with driving force frequency. Variation of phase with frequency. Power supplied to an oscillator and its variation with frequency Q-Value and band width. Q- Value as an amplification factor (phasor treatment to be followed)			
3. Coupled Oscillators (Lecture Hours = 10)	Stiffness coupled pendulums. Normal co-ordinates and normal modes of vibration. Inductance coupling of electrical oscillators.			
4. Wave motion (Lecture Hours = 12)	Type of waves, wave equation and its solution. Characteristics impedance of a string. Impedance matching. Reflection and transmission of energy. Reflected and transmitted energy coefficients. Standing waves on a string of fixed length. Energy of vibrating string. Wave and group velocity their measurements.			
5. Practical Component (Lecture Hours = 30)	The teacher is expected to provide basic idea and working of various apparatus and instruments related to different experiments. Students are supposed to known knowledge of recording and analyzing experimental data along with study error analysis in observations. Every student should perform at least 05 experiments from the following list: 1. To find the value of acceleration due to gravity 'g' using simple pendulum or bar Pendulum. 2. Determination of radius of gyration and acceleration due to gravity using a compound pendulum. 3. To study normal modes of oscillation of coupled pendulum. 4. To study the characteristics of series and parallel resonance of LCR Circuit and to find resonance frequency and quality factor. 5. To obtain the different waveforms using cathode ray oscilloscope (CRO). 6. To determine the spring constant by studying SHM in a spring mass system. 7. To determine the frequency and phase difference between two sinusoidal signals using Lissajous figures on a CRO. 8. To determine the velocity of ultrasonic waves in liquids using ultrasonic interferometer.			

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL)/Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva-voce	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback
References:	1. Puri, S.P. (2004). *Text Book of Vibrations and Waves*, Macmillan India. 2. Pain, H.J. (1976). *The Physics of Vibrations and Waves*: Wiley and ELBS. 3. Sharma S.K. & Sharma S. (2021). *Vibrations, Waves & E.M. Theory* (20th ed.). Dinesh. 4. French A.P. (2017). *Vibrations and Waves.* CRC Press. 5. Giurgiutiu, V. (2022). *Stress, Vibration, and Wave Analysis in Aerospace Composites*. Academic Press Inc. 6. Arora, C. L. (2001). *B.Sc. Practical Physics*. S. Chand & Company. 7. Amrita Vishwa Vidyapeetham. Virtual Labs. https://vlab.amrita.edu/?sub=1 8. Indian Institute of Technology Kharagpur. Virtual Labs: An Initiative of MHRD, Govt. of India. http://vlabs.iitkgp.ac.in/vlt/ 9. Amrita Vishwa Vidyapeetham & CDAC. Virtual labs: Developed with Support from MeitY. https://www.olabs.edu.in/?pg=topMenu&id=40

GENERAL ELECTIVES (GE) COURSES
[Offered under B.Sc. (Hons. With Research) Physical Sciences program opted by the students enrolled in other programs]

SEMESTER – IV

S.No.	Course Category	Course Code	Course Title	Credits L+T+P	Semester	Offering Department
1	GE-3M	0330043030	Mathematical Concepts and Applications	3+1+0	IV (Even)	Mathematics
2	GE-3P	0350043031	Essentials of Electromagnetic Waves and Optics	3+0+1	IV (Even)	Physics

GE-3M (Mathematical Concepts and Applications)

Name of the College (Department)	Akal College of Basic Sciences (Mathematics)
Name of the program	All Programs other than B.Sc. (Hons. with Research) Physical Sciences
Course Code	0330043030
Course Title	Mathematical Concepts and Applications
Academic Year	II
Semester	IV
Number of Credits	4 (3+1+0)
Course Prerequisite	Basic understanding and interest in Mathematics or Physical Sciences.
Course Synopsis	This course explores fundamental mathematical ideas through the lives of great mathematicians. The course aims to introduce number systems, fundamental arithmetic operations, prime numbers, and Pythagorean triplets. It also familiarizes students with the basic concepts of matrices and determinants, along with their properties.

Course Outcomes: At the end of the course, students will:

CO1	Describe the contributions of key ancient and modern mathematicians.
CO2	Explain number systems and number theory concepts, including primes and modular arithmetic.
CO3	Apply basic combinatory and explore patterns such as Latin and magic squares.
CO4	Analyze basic functions using graphs and understand principles of perspective geometry.
CO5	Identify and interpret symmetry and fractals in nature, art, and geometry.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1												
CO2												
CO3												
CO4												
CO5												
Average												

1=Weak Correlation 2=Moderate Correlation 3=Strong Correlation

Course Content:

L(Hours/Week)	T(Hours/Week)	P(Hours/Week)	Total Hour/Week
3	1	-	4

Unit	Content & Competencies

1. **(Lecture Hours = 10)**	A brief introduction to the lives and information on the works of the following mathematicians: Aryabhata, Brahmagupta, Bhaskara I & II, Sri Dharacharya, Euler, Lagrange, Gauss, Cauchy, Abel, Riemann, Hardy, Ramanujan, Bhargava. Newton, Fourier, Laplace.
2. **(Lecture Hours =13)**	An overview of number systems, Algebraic and transcendental numbers with some historical background, Fundamental arithmetic operations, Rules of divisibility, Hierarchy of operations and Modular arithmetic, Euclidean algorithm, Prime numbers, Fundamental theorem of arithmetic, Euclid's lemma, Fermat numbers, Mersenne numbers and Mersenne primes, prime testing method of Fermat, Statement and significance of the prime number theorem, Goldbach conjuctures, Twin primes, Uses of prime numbers, Perfect and amicable numbers, Pythagoreans triplets and its properties, Permutation and combinations, Latin squares and magic squares, Ramanujan Magic Square.
3. **(Lecture Hours = 12)**	Introduction of functions, Graphs of functions, Increasing and decreasing functions, Even and odd functions, Location of points of extrema, Inflection, Periodic functions – all via graphs. Perspective geometry: Lines and points in 2D and 3D, Fundamental trigonometric functions, Use of perspective in drawing, Historic background, Common tools adopted by artists for such representations, Analysis of some paintings to spot uses of perspective and projection techniques.
4. **(Lecture Hours = 10)**	Types of symmetry, Concrete examples of symmetry groups, Study of symmetry and patterns by looking at monuments/buildings/ornamental art, Fibonacci sequences in nature, Golden ratio, Golden triangle. Shapes and solids, Basic tilings, The regular polyhedron, Fractals in nature.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours:

Learning Strategies	**Contact Hours**
Lecture	45
Practical	-
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	10
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	1
Revision	2
Others If any:	-
Total Number of Contact Hours	**60**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Test	University Examination
Quiz	Multiple Choice Questions (MCQ)

Seminars/ Presentation	Short Answer Questions (SAQ)
Problem-Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Quiz	✓	✓	✓	✓	✓
Viva	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory assessment	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	✓	✓	✓	✓	✓
Class Test	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback
References:	**List of Reference Books**
	1. Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebra* (5th ed.). Elsevier India. 2. Gulberg, Jan. (1997). *Mathematics from the Birth of numbers.* W.W. Norton & Company. 3. Puttaswamy, T. K. (2012). *Mathematical Achievements of Pre-Modern Indian Mathematicians.* Elsevier Inc. USA. 4. Srinivasiengar, C. N. (1988). *The History of Ancient Indian Mathematics.* World Press Private Ltd. Calcutta. 5. Divakaran, P. P. (2018). *The Mathematics of India: Concepts, Methods, Connections*. Springer Singapore. Indian Print by Hindustan Book Agency, New Delhi.

GE-3P (Essentials of Electromagnetic Waves and Optics)

Name of the College (Department)	Akal College of Basic Sciences (Physics)
Name of the Program	All Programs other than B.Sc. (Hons. with Research) Physical Sciences
Course Code	0350043031
Course Title	Essentials of Electromagnetic Waves and Optics
Academic Year	II
Semester	IV
Number of Credits	4 (3+0+1)
Course Prerequisite	Mathematics and Physics of Class 11^{th} and/or 12^{th}
Course Synopsis	This course builds upon the foundational knowledge of optics and electromagnetism introduced at the school level and provides a deeper and more rigorous understanding of the subject. It introduces the concept of electromagnetic waves through Maxwell's equations and explores wave propagation in various media, including conducting and dielectric materials. The course provides a comprehensive study of light behavior through phenomena such as polarization, interference, and diffraction, emphasizing both foundational theory and experimental applications. Students will gain hands-on experience with key optical instruments and interferometers, enabling precise measurement and analysis of properties of light. This course is essential for understanding modern optical systems and electromagnetic theory in both classical and applied physics contexts.

Course Outcomes: At the end of the course students will be able to:

CO1	Understand and apply Maxwell's equations to derive the electromagnetic wave equation and analyze the propagation of EM waves in different media, including conductors and dielectrics.
CO2	Explain the concepts of wave impedance, energy flux, and skin depth, and apply these to problems involving reflection, transmission, and dispersion of EM waves at media boundaries.
CO3	Demonstrate an understanding of polarization phenomena, including linear, circular, and elliptical polarization, and apply concepts such as Malus's law, birefringence, and double refraction in optical systems.
CO4	Analyze interference patterns in both division of wavefront and amplitude (e.g., Young's double slit, Fresnel's biprism, Newton's rings), and utilize this understanding in the design of optical experiments.
CO5	Understand and apply the working principles of interferometers like the Michelson and Fabry-Perot for precision measurements and optical filtering.

Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1												
CO2												
CO3												

CO4												
CO5												
Average												
1=Weak Correlation					2=Moderate Correlation					3=Strong Correlation		

Course Content:				
L (Hours/Week)	**T (Hours/Week)**	**P (Hours/Week)**	**CL (Hours/Week)**	**Total (Hour/Week)**
3	-	2	-	5
Unit	**Content & Competencies**			
1. Fundamentals of Electromagnetic Waves and Applications (Lecture Hours= 8)	Maxwell's equations and the electromagnetic wave equation, Plane wave solutions in free space and media, Energy transport in EM waves (Poynting vector), Wave impedance, reflection and transmission at interfaces, Communication technologies (radio, microwave, and optical links), EM shielding and antenna design, Remote sensing and satellite communications.			
2. Polarization and Optical Devices (Lecture Hours= 9)	Types of polarization: linear, circular, elliptical, Polarization by reflection, refraction, and scattering. Birefringence and double refraction, Optical components: polarizers, wave plates, Nicol prism, LCD screens, sunglasses, stress analysis in engineering, Polarization in photography and astronomy, Fiber optics with polarization control.			
3. Interference & Michelson's Interferometer (Lecture Hours= 9)	Principle of interference and conditions for constructive/destructive interference. Young's Double Slit Experiment, Fresnel's Biprism. Thin film interference, Newton's Rings. Michelson's interferometer— principle, theory and applications, Fabry-Perot interferometer and etalon, Interference filters. Biomedical imaging (e.g., Optical Coherence Tomography).			
4. Diffraction & Fraunhoffer Diffraction (Lecture Hours= 9)	Scalar diffraction theory: Fresnel and Fraunhofer types, Single-slit, circular aperture, diffraction grating, Resolving power of optical systems: telescope, microscope, spectrometer, Zone plate and its imaging properties. Spectroscopy and grating-based spectrometers, Optical resolution in microscopes and telescopes, Laser-based sensing and diffraction-based security features.			
5. Practical Component (Lab Hours = 30)	The teacher is expected to provide basic idea and working of various apparatus and instruments related to different experiments. Students are supposed to known knowledge of recording and analyzing experimental data along with study error analysis in observations. Every student should perform at least 05 experiments from the following list: 1. To determine the wavelength of monochromatic light using Young's Double Slit Experiment. 2. To determine the radius of curvature of a plano-convex lens using Newton's Rings. 3. To determine the wavelength of monochromatic light or refractive index of thin film/gas by Michelson's Interferometer. 4. To determine the width of the slit by Diffraction through a Single Slit. 5. To determine the specific rotation of sugar solution by Polarimeter.			

	6. To determine Brewster's angle and the refractive index of a material using the phenomenon of polarization by reflection based on Brewster's Law. 7. To determine the wavelength of sodium light using Fresnel's biprism through the principle of interference. 8. To determine the dispersive power of a prism using a spectrometer by measuring the angular deviation for different wavelengths.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	Contact Hours
Lecture	45
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL)/Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**75**

Assessment Methods:

Formative	Summative
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce
Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva	✓	✓	✓	✓	✓
Assignment/Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Laboratory Assessment	✓	✓	✓	✓	✓
Practical Log Book/Record Book	✓	✓	✓	✓	✓
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process:	Student's Feedback

References:	**List of Reference Books**

1. Subrahmanyam, N., Lal, B., & Avadhanulu, M.N. (2012). *A Textbook of Optics: For B.Sc. Students as Per UGC Model Syllabus*. S. Chand Publishing.
2. Griffiths, D.J. (2023). *Introduction to Electrodynamics (5th ed.).* Cambridge University Press.
3. Hecht, E. (2016). *Optics* (5th ed.). Pearson Education.
4. Beiser, A., Mahajan, S., & Choudhury, S.R. (2024). *Concepts of Modern Physics (8th ed.)*. MedTech Science Press Publication.
5. Sadiku, M., Nelatury, S. (2021). *Elements of Electromagnetics* (7th ed.). Oxford University Press.
6. Laud, B.B. (2000). *Electromagnetics*. Wiley Eastern.
7. Arora, C. L. (2001). *B.Sc. Practical Physics*. S. Chand & Company.
8. Amrita Vishwa Vidyapeetham. Virtual Labs. https://vlab.amrita.edu/?sub=1
9. Indian Institute of Technology Kharagpur. Virtual Labs: An Initiative of MHRD, Govt. of India. http://vlabs.iitkgp.ac.in/vlt/
10. Amrita Vishwa Vidyapeetham & CDAC. Virtual labs: Developed with Support from MeitY. https://www.olabs.edu.in/?pg=topMenu&id=40

SEC/AEC/VAC COURSES
[Offered under B.Sc. (Hons. With Research) Physical Sciences Program]

SEMESTER – IV

S.No.	Course Category	Course Code	Course Title	Credits L+T+P	Semester	Offering Department
1	VAC-1	0320046011	Science and society	1+0+1	Even (IV)	Chemistry & Biochemistry

VAC-1 (Science and Society)

Name of College and (Department)	Akal College of Basic Sciences (Chemistry & Biochemistry)
Name of the Program	All Programs
Course Code	0320046011
Course Title	Science and society
Academic Year	II
Semester	IV
Number of Credits	2 (1+0+1)
Course Prerequisite	-
Course Synopsis	The main goal is to encourage students for scientific temper. The course also uses a variety of examples and case studies to raise awareness about basic scientific ideas that are significant to our everyday lives. The course will create an awareness regarding important revolutions for welfare of society.

Course Outcomes: At the end of the course students will be able to:

CO1	Students will gain a fundamental understanding of scientific methods.
CO2	Students will learn scientific advancement that has contributed significantly to the growth of human society from ancient times to the present day.
CO3	To help students to make educated decisions concerning technology advancements and their possible effects on society.
CO4	Students will also learn a close relation between science and society.
CO5	Awareness regarding important revolutions for welfare of society.

Mapping of Course Outcomes (COs) to Program Outcomes (POs)& Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	2	1	1	1	1	2	1
CO2	2	2	2	1	1	1	2	3	2	2	1	1
CO3	2	2	2	2	2	2	1	2	1	1	1	2
CO4	2	3	1	3	2	1	1	2	2	1	2	2
CO5	2	2	2	2	3	2	2	3	2	1	2	2
Average	**2.2**	**2.4**	**2**	**2.2**	**2.2**	**1.6**	**1.4**	**2.2**	**1.6**	**1.2**	**1.6**	**1.6**

1= Weak Correlation 2= Moderate Correlation 3= Strong Correlation

Course Content:

L (Hours/Week)	T (Hours/Week)	P (Hours/Week)	CL(Hours/Week)	Total Hours/Week
1	-	2	-	3

Unit	Content & Competencies
1. Sociology of Science (Lecture Hours = 3)	Scope and importance; the Nature of Science. Pure vs. Applied Science; Relationship between Science and Technology; Science as a Social System.
2. Ethos of Science (Lecture Hours = 3)	Scientific Temper; Ethics and Professionalism in Scientific Research; Social Aspects of Rise and Development of Science; Political Economy of Science & Technology.

3. Science, Technology and Traditional Practices (Lecture Hours = 4)	Water harvesting structures and Practices; Construction, architecture and design - use of natural environment-friendly designs and materials; Agriculture including domestication of plants and animals.
4. Science and Technology in Modern Times (Lecture Hours = 5)	Public Health: Nutrition, Hygiene, Physical and Mental Health, Vaccines and Antibiotics, Anti-microbial resistance; Food Security: Green Revolution, White Revolution; IT Revolution, E-Governance; Clean Energy, Renewable Energy; Space Science and Exploration; Evolution, Ecology and Environment.
5. Practical component (Lab Hours = 30)	1. Visits to science laboratories in the University or neighbouring Institute. 2. Visit to science museums or planetarium. 3. Visits to botanical gardens/apiary/mushroom production unit/ waste management unit and nature walks. 4. To estimate the acidic or basic nature of fruit juices, soap, carbonated (using pH strips or pH meter). 5. To know the science of splitting colours from white light.

Note: The course plan included as an annexure has the details of each unit with the number of hours and mode of delivery and pedagogical approach.

Learning Strategies and Contact Hours

Learning Strategies	**Contact Hours**
Lecture	15
Practical	25
Seminar/Journal Club	-
Small group discussion (SGD)	1
Self-directed learning (SDL) / Tutorial	1
Problem Based Learning (PBL)	1
Case/Project Based Learning (CBL)	-
Revision	2
Others If any:	-
Total Number of Contact Hours	**45**

Assessment Methods:

Formative	**Summative**
Multiple Choice Questions (MCQ)	
Viva-voce	
Class Tests	University Examination
Quiz	Multiple Choice Questions (MCQ)
Seminars/ Presentation	Short Answer Questions (SAQ)
Problem Based Learning (PBL)	Long Answer Question (LAQ)
Journal Club	Practical Examination & Viva-voce

Professional Activity	
Assignment	

Mapping of Assessment with COs

Nature of Assessment	CO1	CO2	CO3	CO4	CO5
Quiz	✓	✓	✓	✓	✓
Viva	✓	✓	✓	✓	✓
Assignment / Presentation	✓	✓	✓	✓	✓
Professional Activity	✓	✓	✓	✓	✓
Practical Log Book/ Record Book	-	-	-	-	-
Class Tests	✓	✓	✓	✓	✓
University Examination	✓	✓	✓	✓	✓

Feedback Process	Student's Feedback

References:	**List of Reference Books**
	1. Barber, B. (1952). *Science and the Social Order*, New York: Free Press. 2. Gaillard, J. (1991). *Scientists in the Third World,* Lexington: Kentucky University Press. 3. Gaillard, J., Krishna V.V. and Waast R. (Eds.). (1997). *Scientific Communities in the Developing World*, New Delhi: Sage. 4. William. (1962). *Scientists in Industry*, Berkley: University of California Press. 5. Mallik, S.C. (1971). *Management and Organization of Indian Universities*, Simla: Indian Institute of Advanced Study. 6. Kumar, D. (2023). *Science and society in modern India.* Cambridge University Press. 7. Chattopadhyaya, D. (1978). *Science and society in ancient India* (Vol. 22). John Benjamins Publishing.