Department of Physics

SYLLABUS

Four Year Undergraduate Programme (**FYUGP**) in PHYSICS
for Digboi College (Autonomous)

ESTD 1965

as per NEP-2020 Guidelines

Approved by the
Board of Studies, Department of Physics
on 17 June, 2025

Digboi College (Autonomous)
Digboi – 786171, Assam, India

Introduction

The NEP-2020 presents a unique opportunity to revolutionize the higher education system in India by shifting the focus from teachers to students. This policy promotes Outcome-Based Education, where the desired graduate attributes serve as the foundation for designing programs, courses, and supplementary activities that enable students to achieve the desired learning outcomes. The curriculum framework for the FYUGP in Physics aims to provide a strong foundation in the subject and equip students with valuable cognitive abilities and skills necessary for success in diverse professional careers in a developing and knowledge-based society. The framework adheres to globally competitive standards of knowledge and skills in Physics while emphasizing the development of scientific orientation, an enquiring spirit, problem-solving skills, and values that promote rational and critical thinking.

The FYUGP in Physics offered by Digboi College (Autonomous) is a comprehensive and challenging curriculum that aims to provide students with a strong foundation in the discipline while exposing them to cutting-edge developments in the field. The program's structure is multidisciplinary, allowing students to explore the intersections between physics and other fields of study. This approach provides students with a broader perspective and helps them understand the interconnectedness of various areas of knowledge. The program also aims to promote students' personal and professional growth by motivating them to engage in co-curricular and extracurricular activities, which will help them develop essential skills like leadership, teamwork, and communication.

The program's syllabus is designed to promote critical thinking, develop problem-solving abilities, and encourage creativity. It includes laboratory work and practical exercises that give students the opportunity to apply theoretical concepts to real-world problems and enhance their scientific skills. The program also emphasizes the importance of ethics, social responsibility, and sustainable development, instilling in students a sense of responsibility towards society and the environment.

The FYUGP program in Physics for Digboi College (Autonomous) is designed to prepare students for the challenges and opportunities of the 21st century. The program's multidisciplinary and holistic approach equips students with the skills and knowledge necessary for success in a rapidly changing world. Its commitment to social responsibility and sustainable development reflects its mission to produce not only accomplished physicists but also responsible and ethical global citizens.

The NEP 2020 promotes multidisciplinary education in the undergraduate program that integrates social sciences, arts and humanities with science, technology, engineering and mathematics. For holistic development of individuals, it requires to develop all capacities of human beings including intellectual, social, physical, emotional and moral behavior. Individuals should be acquainted with fields across the arts, humanities, languages, sciences and social sciences; professional, technical and vocational fields; soft skills, such as communication, discussion and debate etc. In order to develop such holistic and multidisciplinary education, the curriculum and credit framework for the FYUGP in Physics are designed accordingly. The FYUGP in Physics consists of six different types of courses: (i) Core Courses, (ii) Minor Courses, (iii) Generic Elective Courses (GEC), (iv) Ability Enhancement Courses (AEC), (v) Value Added Courses (VAC) and (vi) Skill Enhancement Courses (SEC). As per NEP's recommendations, the FYUGP in Physics also features multiple exit options:

1. A Certificate after completing 1 year of study.
2. A Diploma after completing 2 years of study.
3. A Bachelor's degree after completion of 3 years.
4. A 4-year Multidisciplinary Bachelor's degree.

Aims and Objectives

The objectives of the FYUGP should focus on:

1. Create an environment in educational institutions that reinforces the knowledge gained at the secondary level while inspiring students to develop a deep interest in Physics. This will help them gain a broad and well-rounded understanding of physical concepts, principles, and theories.
2. Encourage students to learn, design, and conduct experiments in laboratories that illustrate the concepts, principles, and theories covered in the classroom.
3. Foster the ability to apply classroom and laboratory knowledge to solve specific problems in both theoretical and experimental Physics.
4. Expose students to the broad scope of Physics as both a theoretical and experimental science, with applications that help solve a wide range of natural phenomena, from infrared to ultraviolet.
5. Highlight Physics as a key discipline for pursuing interdisciplinary and multidisciplinary higher education and research opportunities.
6. Emphasize the vital role of Physics in sustaining existing industries, establishing new ones, and generating job opportunities across various levels of employment.

The curriculum should be designed to gradually build students' problem-solving abilities, helping them transition from novice problem-solvers in their first year to experts by the time they graduate. By the end of the first year, students should be able to solve clearly defined problems, and by the second year, they should be able to take on more complex tasks. In the third year, students should develop the skills to address challenging, open-ended problems that require a multidisciplinary approach. By the fourth year, students should gain practical experience in solving real-world problems through internships, research, or entrepreneurial activities, preparing them for higher education or a successful career in their field.

Graduate Attributes

Graduate attributes reflect the qualities, skills, and competencies that students of Digboi College (Autonomous) will develop upon completing the FYUGP. These attributes align with the institution's commitment to academic excellence, ethical leadership, and societal impact, ensuring that graduates are prepared for professional success and lifelong learning.

1. **Knowledge and Expertise:** Graduates will demonstrate comprehensive knowledge in their chosen discipline(s) and the ability to apply theoretical and practical insights across contexts.
2. **Critical Thinking and Problem-Solving:** Graduates will analyse complex issues, synthesize information, and devise innovative solutions using evidence-based approaches.
3. **Communication and Collaboration:** Graduates will communicate effectively and work collaboratively in diverse teams, leveraging interpersonal skills to foster inclusive environments
4. **Ethical Awareness and Social Responsibility:** Graduates will uphold integrity, cultural sensitivity, and a commitment to sustainable practices, contributing positively to society.
5. **Employability and Entrepreneurial Mindset:** Graduates will possess industry-relevant skills, adaptability, and the initiative to create opportunities in diverse professional arenas.
6. **Research and Innovation:** Graduates will engage in inquiry-driven learning, contributing to knowledge creation and addressing local and global challenges.
7. **Global and Cultural Competence:** Graduates will navigate diverse cultural and global contexts with adaptability, empathy, and an appreciation for interconnectedness.
8. **Lifelong Learning and Adaptability:** Graduates will embrace continuous learning, leveraging flexibility and resilience to adapt to evolving personal and professional landscapes.

Programme Learning Outcomes

PO1: Disciplinary knowledge: Students will **develop** an adequate foundation of theoretical concepts and experimental techniques in physics.

PO2: Problem solving capacity: Students will be able to **apply** the knowledge of physics to **solve** problems using mathematical tools, experimental methods and computational techniques in relevant areas.

PO3: Communication and presentation skills: Students will be able to communicate effectively about their understanding, ideas and findings to **explain** natural phenomena.

PO4: Analytical and critical thinking: Students will be able to **evaluate** the validity of information and evidence as well as to **assess** different methodologies & tools. They will be able to critically **analyze** the existing knowledge and diverse situations.

PO5: Digital and ICT efficiency: Students will be able to **use** modern ICT tools in a variety of learning environments for knowledge gain, and work situations to broaden the capability and improve efficiency.

PO6: Teamwork and leadership: Students will be able to **develop** teamwork and leadership abilities to work effectively in a co-operative and coordinated manner within diverse teams and peer groups.

PO7: Research and inquiry: The students will **develop** the skills of observation and inquiries, and the ability to identify and articulate problems/issues.

PO8: Multidisciplinary learning: Students will be able to **analyze** a problem through a multidisciplinary approach.

PO9: Ethics and Values: Students will **comply with** ethical conduct and adhere to professional standards in learning.

PO10: Employability and entrepreneurial skills: Students will **acquire** adequate skills and knowledge to become employable and/or entrepreneur.

Teaching-Learning Process

The NEP 2020 has brought about a revolutionary change in the education system in India. One of its major focuses is on outcome-based education, which involves a shift from teacher-centric to learner- centric pedagogies and from passive to active pedagogies. This change requires a significant shift in the way teaching and learning are approached. The NEP 2020 emphasizes that each and every course has to be designed with specific objectives and outcomes in mind. To achieve these goals, appropriate teaching-learning pedagogical tools have to be adopted.

The pedagogy for FYUGP in Physics is based on the L+T+P model where L, T, and P stand for Lecture, Tutorial, and Practical respectively. This approach recognizes the importance of a well- rounded education that includes theoretical knowledge, practical experience, and personal development.

The teaching method for a theory course includes lectures that are aided with prescribed textbooks, e-learning resources, and self-study materials. The lectures are designed to provide a comprehensive understanding of the subject matter. The use of e-learning resources and self-study materials helps students to learn at their own pace and to reinforce their understanding of the material covered in the lectures.

In addition to lectures, tutorials are also an important part of the pedagogy for FYUGP in Physics. Tutorials are interactive sessions where students can ask questions, clarify their doubts, and engage in discussions with their peers and teachers. Tutorials are designed to encourage active learning and to promote critical thinking.

To understand the link between theory and experiments, laboratory courses are designed which include practical classes. This approach recognizes that practical experience is essential for a comprehensive understanding of the subject matter. The laboratory courses are designed to provide hands-on experience to students and to help them develop the necessary skills for conducting experiments.

The pedagogy for FYUGP in Physics recognizes the importance of a holistic approach to education. It is not just about acquiring knowledge, but also about developing the necessary skills and competencies to succeed in the real world. The outcome-based approach emphasizes the importance of developing critical thinking skills, problem-solving skills, communication skills, and teamwork skills. In conclusion, the NEP 2020 has brought about a significant shift in the education system in India.

The focus on outcome-based education and learner-centric pedagogies has led to a more holistic approach to education. The pedagogy for FYUGP in Physics is based on the L+T+P model and emphasizes the importance of lectures, tutorials, and practical classes. The use of appropriate teaching- learning pedagogical tools and assessment methods is an integral part of the approach. The outcome- based approach recognizes that education is not just about acquiring knowledge, but also about developing the necessary skills and competencies to succeed in the real world.

Assessment Methods

The assessment methods for the Four-Year Undergraduate Programme (FYUGP) ensure continuous evaluation aligned with the National Education Policy (NEP) 2020. The evaluation comprises In-Semester Assessments and End-Semester Examinations, with a 40:60-mark distribution per course. In-Semester Assessments (40% of total marks) include: Sessional Exam 1 (10 marks), Sessional Exam 2 (10 marks), Group Discussions (GD) or Activities (10 marks), Seminars/Assignments/Projects/Field Studies (10 marks), and Other Academic Activities (10 marks). Students must appear for both Sessional Exams and any two remaining sub-components to complete In-Semester Assessment. These components use tools like objective tests, written tests, and practical assignments for skill development, with mandatory participation; non compliance bars students from End-Semester Examinations. End-Semester Examinations (60% of total marks) have two types: courses without practicals have 60-mark exams covering the syllabus through written tests focusing on problem-solving questions; courses with practicals have 45-mark exams plus 15-mark practical evaluation by a Board of Examiners (internal course teacher and external examiner).

Assessment	**Sub-Components**	**Marks**	**Details**
In-Semester Assessment (40% of total, 40 marks)	Sessional Exam 1	10 marks (Mandatory)	First written/objective test to assess ongoing learning.
	Sessional Exam 2	10 marks (Mandatory)	Second written/objective test to evaluate progress.
	GD/Group Activities	10 marks (Choose any 2 of these)	Collaborative tasks fostering critical thinking, communication, and application skills.
	Seminars/Assignments/ Projects/ Field Studies		Collaborative/Individual tasks but individual reports/presentations
	Other Academic Activities		Flexible tasks assigned by the course teacher, e.g., quizzes, presentations, or case studies, tailored to course needs.
End-Semester Examination (60% of total)	Courses without Practicals	60 marks	Written exam covering full course, emphasizing problem-solving and application-based questions (2-hour duration for 3/4-credit courses).
	Courses with Practicals	Theory: 45 marks and Practical: 15 marks	Theory exam (45 marks) covering full course; practical exam (15 marks) assessed by internal and external examiners, to be conducted before theory exams.

Curriculum Structure

Sem.	Major (Core)	Minor	MDC	AEC	VAC	SEC	Others	Credit
I	C101 (4)	MIN101 (4)	MDC101 (3)	AEC101 (4)	VAC101 (2)	SEC101 (3)	--	20
II	C202 (4)	MIN202 (4)	MDC202 (3)	AEC202 (4)	VAC202 (2)	SEC202 (3)	--	20
III	C303 C304 (4×2)	MIN303 (4)	MDC303 (3)	--	VAC303 (2)	SEC303 (3)	--	20
IV	C405, C406, C407 C408 (4×4)	MIN404 (4)	--	--	--	--	--	20
V	C509 C510 C511 (4×3)	MIN505 (4)	--	--	--	--	IAPC500(4)	20
VI	C612 C613 C614 C615 (4×4)	MIN606 (4)	--	--	--	--	--	20
VII	C716 C717 C718 (4×3)	MIN707 (4)	--	--	--	--	RM 700(4)	20
VIII	C819 C820 (4×2)	MIN808 (4)	--	--	--	--	8 (Dissertation) / 2 DSE (4+4)	20
Total	**80**	**32**	**9**	**8**	**6**	**9**	**16**	**160**

PROGRAMME STRUCTURE

Year	Semester	Course	Title of the Course	Total Credits
Year 01	1st Semester	**C–PHY-101**	Mechanics and Properties of Matter	4
		MIN-PHY-101	Mechanics and Properties of Matter (for disciplines other than Physics)	4
		MDC-PHY-101	Evolution of Science	3
		SEC –PHY- 101	LaTeX for Beginners	3
		VAC - 1	Value Added Course	2
		AEC-1	Modern Indian Language	4
			Total of Semester 1	**20**
	2nd Semester	**C-PHY-202**	Waves and Optics	4
		MIN-PHY-202	Waves and Optics (for disciplines other than Physics)	4
		MDC-PHY-202	Introduction to Communication Technology	3
		SEC-PHY-202	Graphical Representation of Data	3
		VAC - 2	Value Added Course	2
		AEC-2	English Language and Communication Skills	4
			Total of Semester 2	**20**
	Grand Total (Semester 1 and 2)			**40**
	3rd Semester	**C-PHY-303**	Mathematical Physics – I	4
		C-PHY-304	Electricity & Magnetism	4

Year 02		**MIN-PHY-303**	Electricity & Magnetism (for disciplines other than Physics)	4
		MDC-PHY-303	Introduction to Meteorology	3
		SEC-PHY-303	Numerical Methods using Python/Scilab	3
		VAC - 3	Value Added Course	2
			Total of Semester 3	**20**
	4th Semester	**C-PHY-405**	Quantum Mechanics – I	4
		C-PHY-406	Thermal Physics	4
		C-PHY-407	Analog Electronics	4
		C-PHY-408	Atomic, Molecular and Laser Physics	4
		MIN-PHY-404	Thermal Physics (for disciplines other than Physics)	4
			Total of Semester 4	**20**
	Grand Total (Semester 1 to 4)			**80**
Year 03	**5th Semester**	**C-PHY-509**	Mathematical Physics – II	4
		C-PHY-510	Quantum Mechanics – II	4
		C-PHY-511	Statistical Mechanics	4
		MIN-PHY-505	Electronics (Analog and Digital)	4
		Internship/ Community Engagement	Internship (2) + Comm. Engmnt (2) **OR** Internship (4) / Comm. Engmnt. (4)	4
			Total of Semester 5	**20**
	6th	**C-PHY-612**	Electromagnetic Theory	4

	Semester	**C-PHY-613**	Condensed Matter Physics – I	4
		C-PHY-614	Digital Electronics	4
		C-PHY-615	Nuclear and Particle Physics	4
		MIN-PHY-606	Quantum Mechanics	4
			Total of Semester 6	**20**
	Grand Total (Semester 1 to 6)			**120**
Year 04	**7th Semester**	**C-PHY-716**	Mathematical Physics – III	4
		C-PHY-717	Quantum Mechanics – III	4
		C-PHY-718	Classical Mechanics	4
		MIN-PHY-707	Elements of Modern Physics	4
		Research	Research Methodology	4
			Total of Semester 7	**20**
	8th Semester	**C-PHY-819**	Condensed Matter Physics II	4
		C-PHY-820	Digital and Optical Electronics	4
		MIN-PHY-808	Condensed Matter Physics	4
		Research / DSE	Research Project / Dissertation (8) **OR** DSE - I (4) + DSE - II (4)	8
			Total of Semester 8	**20**
	Grand Total (Semester 1 to 8)			**160**

DETAILED SYLLABUS OF COURSES

SEMESTER - I

Paper Code	**C-PHY-101**		Total Credit	4
Paper Type	Core		Credit break-up	L - 3 T - 0 P - 1
Semester	I		Contact Hours	75 hours
Title	**Mechanics and Properties of Matter**			
Marks Distribution	In Sem – 40 + End Sem – 60			

Course Description: This course covers Newtonian mechanics, the basic laws of motion, Lagrangian-Hamiltonian mechanics, properties of matter, non-inertial systems and practical related to these topics.
The practical comprises of 8 experiments related to moment of inertia, coefficient of viscosity, Young's modulus and modulus of rigidity.

Course Objectives: The course is designed to provide a comprehensive understanding of Newtonian mechanics, Lagrangian-Hamiltonian mechanics, the properties of matter, and rotating reference frames, while exploring their applications in various areas of physics.
The aims of the practical course are to-

1. Develop experimental skills of a learner in mechanics.
2. Develop the ability of a student to expertise oneself in the field of basic physics enabling him/her to get a better knowledge of the theory.
3. To learn error propagation and its role in making conclusions.

Course Outcomes (COs): After the completion of the course, a student will be able to
CO1: Understand the basic concepts of mechanics, reference frames, and conservation laws.
- **LO1.1:** Define key terms related to mechanics.
- **LO1.2:** Explain linear dynamics and rotational dynamics.
- **LO1.3:** Interpret relative transformations and the invariance of laws of physics.

CO2: Understand and apply the concepts of Lagrangian and Hamiltonian mechanics.
- **LO2.1:** Analyze and model physical systems using both Lagrangian formulations and Hamiltonian formulation.
- **LO2.2:** Solve problems related to free particles, simple harmonic motion, central force potentials, and the motion of particles under gravity.

CO3: Correlate the consequences of non-inertial frame to our real world.
- **LO3.1:** Identify the nature of fictitious forces and their effect on the real world.
- **LO3.2:** Classify these forces arising due to non-inertial frames.
- **LO3.3:** Solve problems related to non-inertial frames and fictitious forces.

CO4: Understand the idea of different phenomena in mechanics.
- **LO4.1:** Classify between spring constant and elastic constant like Young's Modulus and modulus of rigidity.
- **LO4.2:** Develop principles of elasticity to analyze mechanical systems.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1 LO4.1	LO1.2 LO1.3	LO2.1 LO2.2	CO2		

		LO2.1 LO3.2 LO4.2 LO4.3 CO1	LO3.1			
Procedural		CO4		CO3		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S			M	M		S
CO2	S	S	S	S			M	M		S
CO3	S	S	S	S			M	M		S
CO4	S	S	S	S			M	M		S

(S:Strong, M: Medium,W: Weak)

Unit	Contents	L	T	P	Total Hours
1	**Vector Analysis: (5 Marks)** Review of vector algebra (scalar and vector product), gradient, divergence, curl and their significance.	5	0	0	5
2	**Differential Equations: (5 Marks)** First and Second Order Homogeneous Differential Equations, Solutions and Applications	5	0	0	5
3	**Newtonian Mechanics (20 Marks)** Frames of Reference, Inertial Frames, Galilean Transformations, Galilean Invariance; Dynamics of a System of Particles, Center of Mass, Conservation of Linear Momentum.	6	0	0	6
	The Work-Energy Theorem, Conservative and Non-conservative Forces, Conservation of Mechanical Energy, Work done by non-conservative forces, Force as gradient of potential energy, Energy Diagram, Stable and Unstable Equilibrium.	6	0	0	6
	Conservation of Angular Momentum, Rotation about a fixed axis, Moment of Inertia, Calculation of Moment of Inertia for rectangular, cylindrical and spherical bodies, Kinetic Energy of Rotation, Motion involving both translation and rotation.	8	0	0	8
4	**Properties of Matter (7 Marks)** Relation between Elastic constants, Twisting torque on a Cylinder or Wire.	3	0	0	3
	Kinematics of Moving Fluids, Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.	4	0	0	4
5	**Non-Inertial Systems (8 Marks)**	8	0	0	8

	Non-inertial Frames and Fictitious Forces, Uniformly Rotating Frame, Laws of Physics in rotating coordinate systems, Centrifugal Force, Coriolis Force and its applications, Foucault's pendulum, Free fall of a body on Earth's surface.				
6	**Practical (15 Marks)** (At least 60% of the experiments must be performed) 1. To determine the height of a building using a Sextant. 2. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity. 3. To determine the Moment of Inertia of a Flywheel. 4. To determine g and velocity for a freely falling body using Digital Timing Technique. 5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). 6. To determine the Young's Modulus of a Wire by Optical Lever Method. 7. To determine the Modulus of Rigidity of a Wire by Maxwell's needle. 8. To determine the elastic Constants of a wire by Searle's method.	0	0	30	30
	Total	**45**	**0**	**30**	**75**

Recommended Readings:

1. An introduction to Mechanics, *D. Kleppner, R. J. Kolenkow*, CambridgeUniversityPress.
2. Mechanics: Berkeley Physics Course Vol.1, *C.Kittel, W.Knight,et.al.*, Tata McGraw-Hill.
3. Fundamentals of Physics, *Halliday, Resnick, Walker,* John Wiley & Sons.
4. Mechanics, *D. S. Mathur*, S. Chand and Company Ltd.
5. Classical Mechanics, H. Goldstein, Pearson Education.
6. Classical Mechanics, J C Upadhyaya, Himalaya Publishing House.
7. Classical Mechanics, R. G. Takwale and P. S. Puranik,Tata McGrawHill
8. B.Sc. Practical Physics, Harnam Singh, S. Chand Publisher.
9. B.Sc. Practical Physics, C L Arora, S. Chand Publisher.

SEMESTER - I

Paper Code	**MIN-PHY-101**	Total Credit	4
Paper Type	Minor	Credit break-up	L - 3 T - 0 P - 1
Semester	I	Contact Hours	75 hours
Title	**Mechanics and Properties of Matter**		
Marks Distribution	In Sem – 40 + End Sem – 60		

Course Description: This course covers Newtonian mechanics, the basic laws of motion, Lagrangian-Hamiltonian mechanics, properties of matter, non-inertial systems and practical related to these topics.
The practical comprises of 8 experiments related to moment of inertia, coefficient of viscosity, Young's modulus and modulus of rigidity.

Course Objectives: The course is designed to provide a comprehensive understanding of Newtonian mechanics, Lagrangian-Hamiltonian mechanics, the properties of matter, and rotating reference frames, while exploring their applications in various areas of physics.
The aims of the practical course are to-

4. Develop experimental skills of a learner in mechanics.
5. Develop the ability of a student to expertise oneself in the field of basic physics enabling him/her to get a better knowledge of the theory.
6. To learn error propagation and its role in making conclusions.

Course Outcomes (COs): After the completion of the course, a student will be able to

CO1: Understand the basic concepts of mechanics, reference frames, and conservation laws.

- **LO1.1:** Define key terms related to mechanics.
- **LO1.2:** Explain linear dynamics and rotational dynamics.
- **LO1.3:** Interpret relative transformations and the invariance of laws of physics.

CO2: Understand and apply the concepts of Lagrangian and Hamiltonian mechanics.

- **LO2.1:** Analyze and model physical systems using both Lagrangian formulations and Hamiltonian formulation.
- **LO2.2:** Solve problems related to free particles, simple harmonic motion, central force potentials, and the motion of particles under gravity.

CO3: Correlate the consequences of non-inertial frame to our real world.

- **LO3.1:** Identify the nature of fictitious forces and their effect on the real world.
- **LO3.2:** Classify these forces arising due to non-inertial frames.
- **LO3.3:** Solve problems related to non-inertial frames and fictitious forces.

CO4: Understand the idea of different phenomena in mechanics.

- **LO4.1:** Classify between spring constant and elastic constant like Young's Modulus and modulus of rigidity.
- **LO4.2:** Develop principles of elasticity to analyze mechanical systems.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual	LO1.1 LO4.1	LO1.2 LO1.3	LO2.1 LO2.2	CO2		

SEMESTER - I

		LO2.1 LO3.2 LO4.2 LO4.3 CO1	LO3.1			
Procedural		CO4		CO3		
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S			M	M		S
CO2	S	S	S	S			M	M		S
CO3	S	S	S	S			M	M		S
CO4	S	S	S	S			M	M		S

(S:Strong, M: Medium,W: Weak)

Unit	**Contents**	**L**	**T**	**P**	**Total Hours**
1	**Vector Analysis: (5 Marks)** Review of vector algebra (scalar and vector product), gradient, divergence, curl and their significance.	5	0	0	5
2	**Differential Equations: (5 Marks)** First and Second Order Homogeneous Differential Equations, Solutions and Applications	5	0	0	5
3	**Newtonian Mechanics (20 Marks)** Frames of Reference, Inertial Frames, Galilean Transformations, Galilean Invariance; Dynamics of a System of Particles, Center of Mass, Conservation of Linear Momentum.	6	0	0	6
	The Work-Energy Theorem, Conservative and Non-conservative Forces, Conservation of Mechanical Energy, Work done by non-conservative forces, Force as gradient of potential energy, Energy Diagram, Stable and Unstable Equilibrium.	6	0	0	6
	Conservation of Angular Momentum, Rotation about a fixed axis, Moment of Inertia, Calculation of Moment of Inertia for rectangular, cylindrical and spherical bodies, Kinetic Energy of Rotation, Motion involving both translation and rotation.	8	0	0	8
4	**Properties of Matter (7 Marks)** Relation between Elastic constants, Twisting torque on a Cylinder or Wire.	3	0	0	3
	Kinematics of Moving Fluids, Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.	4	0	0	4
5	**Non-Inertial Systems (8 Marks)**	8	0	0	8

	Non-inertial Frames and Fictitious Forces, Uniformly Rotating Frame, Laws of Physics in rotating coordinate systems, Centrifugal Force, Coriolis Force and its applications, Foucault's pendulum, Free fall of a body on Earth's surface.				
6	**Practical (15 Marks)** (At least 60% of the experiments must be performed) 1. To determine the height of a building using a Sextant. 2. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity. 3. To determine the Moment of Inertia of a Flywheel. 4. To determine g and velocity for a freely falling body using Digital Timing Technique. 5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). 6. To determine the Young's Modulus of a Wire by Optical Lever Method. 7. To determine the Modulus of Rigidity of a Wire by Maxwell's needle. 8. To determine the elastic Constants of a wire by Searle's method.	0	0	30	30
	Total	**45**	**0**	**30**	**75**

Recommended Readings:

1. An introduction to Mechanics, *D. Kleppner, R. J. Kolenkow*, CambridgeUniversityPress.
2. Mechanics: Berkeley Physics Course Vol.1, *C.Kittel, W.Knight,et.al.*, Tata McGraw-Hill.
3. Fundamentals of Physics, *Halliday, Resnick, Walker,* John Wiley & Sons.
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9. B.Sc. Practical Physics, C L Arora, S. Chand Publisher.

SEMESTER - I

Paper Code	**MDC-PHY-101**		Total Credit	3
Paper Type	Multi Disciplinary Course		Credit break-up	L- 2 T-1 P-0
Semester	I		Contact Hours	45 hours
Title	**Evolution of Science**			
Marks Distribution	In Sem – 40 + End Sem – 60			

Course Description: This multidisciplinary course is design for general students of this program at the beginning level. It explores the evolution of science from its earliest origins to the transformative breakthroughs of the modern era. Students will know the invention of the wheel as the beginning of science. In the second unit, students will learn about the rise of modern, including the development of thermodynamics during the Industrial Revolution, and the emergence of electromagnetism through the work of Maxwell and Edison. The last part of this course covers almost all major modern developments of science, in which students will learn about the developments of special relativity, quantum mechanics to electronics and optical evolution. Ethical dilemmas in technology and gene editing will also be discussed. Through a mix of lectures and tutorials, the course encourages critical thinking about science's role in shaping human progress and societal values.

Course Objective: This course aims to provide students with a comprehensive understanding of the evolution of science, its impact on society, and the role that science will play in shaping the future. So, the course is designed with the following specific objectives:

1. To provide students with an understanding of the historical development of scientific knowledge, including key figures and their contributions.
2. To examine the interdisciplinary nature of science and its impact on various fields and industries.
3. To explore the ethical and social implications of scientific advancements, and to promote critical thinking about their consequences.
4. To foster an appreciation for the scientific method and the role of experimentation and observation in advancing scientific knowledge.

Course Outcome:
The students will able to

CO1: Understand the historical development of scientific knowledge with key figures and their contributions.

LO1.1: Explain the invention of the wheel as the beginning of science to the industrial revolution.
LO1.2: Describe the contributions of Aristotle to Darwin, Kepler etc.
LO1.3: Discuss the contributions of Sir Isaac Newton and his famous laws.
LO1.4: Illustrate nineteenth century science such as developments of thermodynamics and, electricity and magnetism with contributions of Thomas Alva Edison and Maxwell. These developments led to the beginning of modern science.
LO1.5: Outline the developments of modern science from quantum mechanics, special theory. of relativity, electronics, computer to Laser and optical evolution.
LO1.6: Explain contemporary science and India's contributions.

CO2: Describe the interdisciplinary nature of science and its impact on various fields and industries.

LO2.1: Explain the impacts of Darwin's, Newton's and Einstein's works and quantum mechanics on various branches of sciences.

LO2.2: Understand the impacts of Edison's, Maxwell's, Newton's etc. works and quantum evolutions on the industrial revolutions, technological developments and space science and technology etc. developments.

CO3: Relate the ethical and social implications of scientific advancements, and promote critical thinking about their consequences.

LO3.1: Understand the devotion, patience, ethical value and social responsibility of scientists in the development of their scientific works and achieving the goals.

CO4: Recognize the roles of scientific methods of experimentation and observation in advancing scientific knowledge.

LO4.1: Understand the necessity of dedicated experiments and observations in achieving scientific results and advancing scientific knowledge.

Factual dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
factual	LO1.1-1.6 CO1	LO2.1 LO2.2 CO2				
Conceptual		LO3.1 LO4.1 CO3 CO4				
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
C01	M	M	S	M	M		M	M	M	
C02	M	M	S	M	M		M	M	M	
C03	M	M	S	S	M		M	M	M	
C04	M	M	S	S	M		M	M	M	

Unit	**Contents**	**L**	**T**	**P**	**Total Hours**
1	**Origin and Foundation of Science** Invention of wheel and beginning of science Science in Ancient Civilizations, medieval science The Scientific Revolution: Aristotle, Galileo, Robert Hooke, Kepler etc. Contribution of Sir Issac Newton: Laws of motion, universal law of gravitation	09	5	0	15
2	**The rise of Modern Science** Rise of Modern Science in the 19th Century, Thermodynamics: heat engine and industrial revolution, Development of electricity and magnetisms, Maxwell and Edison contribution	08	5	0	15
3	**New Realities in Science** Einstein Special theory of relativity; The Paradigm shift: quantum theory, general theory of relativity. Nuclear era: space science and	13	5	0	15

	technology; Electronic age and birth of computers; Laser and optical evolution;Contemporary science and India's contribution Ethical Dilemmas in Scientific Advancements (e.g. AI, gene editing)				
	Total	**30**	**15**	**0**	**45**

Recommended Readings:

1) The Scientific Revolution, Steven Shapin, University of Chicago Press.
2) A History of Physics in its Elementary Branches: Including the Evolution of Physical Laboratories, Florian Cajori, Macmillan.
3) A Brief History of Physics, Paul F. Kisak, CreateSpace Independent Publishing Platform.

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Paper Code	**SEC-PHY-101**	Total Credit	3
Paper Type	Skill Enhancement Course	Credit break-up	L- 1 T-0 P-2
Semester	I	Contact Hour	45 hours
Title	**LaTeX for Beginners**		
Marks Distribution	In Sem – 40 End Sem – (Exam : 30 + Project : 30) = 60		

Course Objective/Description:

The course is designed to equip students with a skill that will enable them to prepare any publication grade report in future. The course is to be taught hands-on basis. The theory and practical of this course go side by side

Course Outcome:

Upon successful completion of this course, students will be able to:

1. Understand and Use Basic LaTeX Syntax
2. Create LaTeX documents from scratch with proper structure.
3. Utilize fundamental LaTeX commands for formatting text, structuring documents, and adding sections and subsections.
4. Typeset mathematical symbols, expressions, and equations in both inline and display modes.
5. Design well-structured tables and insert images with captions.
6. Use the BibTeX system to manage bibliographies and citations.
7. Modify page layout, page margins and title pages, customize document appearance.
8. Add features like footnotes, table of contents, and appendices to enhance document structure.
9. Utilize predefined LaTeX templates (e.g., research papers, reports, books).
10. Compile and troubleshoot LaTeX documents for submission or publication.

By the end of the course, students will be capable of producing clean, high-quality LaTeX documents suitable for academic, scientific, and technical writing.

Assessment: **Unit 1:** Create a basic LaTeX document with sections and simple text formatting.
Unit 2: Include a mathematical expression, a table, and reference a citation.
Unit 3: Design a document with custom layout, a table of contents, and an appendix.

Project: One Final project is to be submitted.

SEMESTER - I

Unit	Contents	L	T	P	Total Hours
1	**Introduction to LaTeX and Basic Document Structure** 1. Introduction to LaTeX: What is LaTeX, Installing LaTeX (TeXLive, MiKTeX, Overleaf) 2. Basic Structure of a LaTeX Document: Document class (\documentclass{article}); document environment (\begin{document}...\end{document}); Sections and subsections (\section{}, \subsection{}). 3. Text Formatting: Bold (\textbf{}), Italic (\textit{}); Lists: ordered and unordered (itemize, enumerate); Paragraphs and newlines 4. Compiling LaTeX Documents: Using a LaTeX editor or Overleaf; Compiling and viewing the PDF output	5	0	10	15
2	**Advanced Text Formatting and Document Customization** 1. Text Customization: Font size (\tiny, \small, \large, etc.); Changing font family (\texttt{}, \textsf{}, \textrm{}); Color and highlighting text (\textcolor{color}{text}) 2. Mathematical Typesetting: Inline and display math modes ($...$, \[...\]); Basic symbols (\alpha, \beta, \sum, etc.); Fractions, exponents, and subscripts (\frac{a}{b}, x^2, x_1). 3. Tables and Figures: Creating tables (\begin{tabular}...\end{tabular}); Including images (\includegraphics{}); Captions for tables and figures 4. Citations and Bibliography: Introduction to BibTeX; Creating a .bib file and citing references in the document; Using \cite{} and \bibliography{} commands	5	0	10	15
3	**Document Layout, Styles, and Special Features** 1. Page Layout and Document Design: Adjusting page margins (\usepackage[margin=1in]{geometry}); Title page customization (\maketitle); Headers and footers using \pagestyle{} 2. Footnotes and Endnotes: Adding footnotes (\footnote{}) 3. Creating a Table of Contents: Adding sections and auto-generating a table of contents (\tableofcontents); Modifying table of contents depth 4. Appendices and Indexing: Adding appendices (\appendix); Creating an index (\index{}) 5. LaTeX Templates: Exploring and using LaTeX templates for reports, articles, and books; Customizing template styles for specific documents (e.g., research papers)	5	0	10	15
	Total	**15**	**0**	**30**	**45**

Books and Resources:

1. The LaTeX Companion by Frank Mittelbach and Ulrike Fischer
2. LaTeX Beginner’s Guide by Stefan Kottwitz
3. The LaTeX Graphics Companion by Michel Goossens, Frank Mittelbach, Sebastian Rahtz, Denis Roegel, Herbert Voß.
4. ChatGPT
5. Overleaf Documentation

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SEMESTER - II

Paper Code	**C-PHY-202**	Total Credit	4
Paper Type	Core	Credit break-up	L - 3 T - 0 P - 1
Semester	II	Contact Hours	75 hours
Title	**Waves and Optics**		
Marks Distribution	In Sem – 40 + End Sem – 60		

Course Description: This course provides an introduction to the basic concepts of waves, oscillation, and optics. It aims to provide knowledge about superposition principles, give comprehensive ideas about simple harmonic oscillations, and introduce wave concepts, including group velocities and phase velocities. It depicts the electromagnetic nature of light and enters the domain of optics by providing in depth knowledge of optical phenomena and optical instruments based on these phenomena to undergraduate students. The last unit comprises of experiments covering Simple harmonic motion, wave and optics. Compound pendulums (bar pendulum and kater's pendulum), Melde's experiment, Prism, Michelson Interferometer, Fresnel biprism and Newton ring set up have been included to deliver hands-on knowledge on the topics included in this course.

Course Objectives: This course aims to develop theoretical knowledge as well as hands on experience on waves, oscillations, and the superposition principle. This course aims to acquaint the learner with the field of thin film interferometry and measurement techniques associated with this field and develop a strong basis for the strong basis for the working of optical devices.

Course Outcomes (COs): At the completion of the course, a student will be able to

CO1: Analyze the principle of linearity and superposition, concepts of wave motion and standing waves.
- **LO1.1:** Define superposition, plane and spherical waves, and stationary waves.
- **LO1.2:** Explain the superposition of waves, the velocity of longitudinal and transverse waves in different media, and the role of standing waves in different physical systems.
- **LO1.3:** Construct Lissajous figures and develop the differential equation of a wave.

CO2: Connect the knowledge obtained from the wave with the behavior of light.
- **LO2.1:** Explain the phenomenon of interference in thin films.
- **LO2.2:** Develop theoretical knowledge of various optical instruments.
- **LO2.3:** Illustrate key concepts of diffraction.

CO3: Understand the basic concept of holography.
- **LO3.1:** Define key terms related to holography.
- **LO3.2:** Demonstrate the construction of holography.

CO4: Apply theoretical knowledge of Oscillations and wave optics in practical applications.
- **LO4.1:** Apply the bar and Kater's pendulum for finding the value of "g" at a place.
- **LO4.2:** Interpret the working of Michelson Interferometer, Fresnel biprism and Newton rings.
- **LO4.3:** Determine the phenomenon of interference of light to find an unknown wavelength.

SEMESTER - II

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1 LO3.1	LO1.2 LO2.1 LO3.2 CO3	LO1.3 LO2.2 LO4.1	CO1 CO2 CO4 LO4.2	LO4.3	
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S			M	M		S
CO2	S	S	S	S			M	M		S
CO3	S	S	S	S			M	M		S
CO4	S	S	S	S	W	W	M	M	M	S

(S:Strong, M: Medium,W: Weak)

COURSE CONTENTS:

Unit	Contents	L	T	P	Total Hours
1	**Oscillations** Simple Harmonic Motion (SHM) and Oscillations, Differential Equation of SHM and its solution, Kinetic Energy, Potential Energy, Total energy and their time-average values, Simple pendulum, Compound Pendulum, Bar pendulum and Kater's Pendulum, Damped oscillation, Forced oscillations, Resonance, Power Dissipation and Quality Factor.	6	0	0	6
2	**Superposition of Harmonic Oscillations** Linearity and Superposition Principle. Superposition of two collinear harmonic oscillations having equal frequencies and different frequencies (Beats). Phase and Group Velocities. Lissajous Figures: Lissajous Figures with equal and unequal frequency (Graphical and Analytical Methods) and their use.	4	0	0	4
3	**Wave Motion** Plane and Spherical Waves, Longitudinal and	6	0	0	6

SEMESTER - II

	Transverse Waves, Plane Progressive (Travelling) Waves, Wave Equation, Particle and Wave Velocities, Differential Equation of a Wave. Velocity of transverse vibrations of stretched strings, Velocity of longitudinal waves in a fluid in a pipe, Newton's formula for velocity of sound, Laplace's correction, Comparison of velocity of sound in different media: air, liquid, solid. Energy, power transport and intensity of wave.				
4	**Standing Waves** Reflection of wave from the boundary of a medium, Standing (Stationary) Waves, Standing Waves in a String: Fixed and Free ends, Normal Modes of Stretched Strings, Comparison of Standing Wave with Travelling Waves, Displacement and Velocity of a Particle in a Standing Wave, Melde's Experiment, Longitudinal Standing Waves in Open and Closed Pipes, Normal Modes of Longitudinal Waves,	5	0	0	5
5	**Wave nature of light and interference** 5.1 ***Interference***: Recapitulations of Huygens' principle. Temporal and Spatial coherence. Division of amplitude and wavefront, Young's double slit experiment, Phase change on reflection: Stokes' treatment, Lloyd's Mirror and Fresnel's Biprism, Interference in parallel and wedge-shaped thin films. Newton's Rings: Measurement of wavelength and refractive index.	6	0	0	6
	5.2 ***Interferometers:*** Michelson Interferometer- (i) Idea of form of fringes (No theory required), (ii) visibility of Fringes. (iii) Applications. Introduction to Fabry-Perot interferometer.	4	0	0	4
7	**Diffraction** 7.1 ***Fresnel Diffraction***: Fresnel'sAssumptions.Fresnel'sHalf-PeriodZonesforPlaneWave.Explanation of Rectilinear Propagation of Light. Theory of a Zone, Fresnel diffraction pattern of a straight edge, a slit, wire.	6	0	0	5

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	7.2 Fraunhofer Diffraction: Single slit, Circular aperture. Resolving Power of a telescope, Double slit, Multiple slits. Diffraction grating, Resolving power of grating.	6	0	0	6
8	**Holography** Principle of Holography, Recording and Reconstruction Method, Theory of Holography as Interference between two Plane Waves.	3	0	0	3
9	1. Laboratory experiments on waves and optics: 2. To determine the value of g using Bar Pendulum. 3. To determine the value of g using Kater's Pendulum. 4. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda^2 - T$ law. 5. To determine the phase difference between two waves using Lissajous Figures. 6. To determine the (1)refractive index, (2) dispersive power (Cauchy constants of the Material of a prism using sodium source and a mercury source 7. To determine the wavelength of sodium source using Michelson's interferometer. 8. To determine wavelength of sodium light using Fresnel Biprism. 9. To determine wavelength of sodium light using Newton's Rings. 10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film. 11. To determine (1) wavelength of Na source (2) spectral lines of Hg source using plane (3) dispersive power and (4)resolving power with the help of a plane diffraction grating. 12. To determine the wavelength of given laser source using single slit diffraction method.	0	0	30	30
	Total	**45**	**0**	**30**	**75**

Recommended Readings:

SEMESTER - II

1. Waves: Berkeley Physics Course, *F.Crawford*, Tata McGraw-Hill.
2. Fundamentals of Optics, *F.A.Jenkins and H.E.White*, McGraw-Hill.
3. Principles of Optics, *M. Bornand E. Wolf,* Pergamon Press.
4. Optics, *A. Ghatak,* Tata McGraw Hill.
5. Modern Optics, *A. B. Gupta*, Books & Allied (P) Ltd.
6. The Physics of Vibrations and Waves, *H.J.Pain*, John Wiley and Sons.
7. Text book of Optics, *Dr. N. Subramanyam, Brijlal ,Dr. M. N. Avadhanulu*, S. Chand Publications
8. Fundamental of Optics, *A. Kumar, H. R. Gulati and D. R. Khanna*, R. Chand Publications
9. B.Sc. Practical Physics, *C.L. Arora*, S. Chand Publications.
10. Advanced Practical Physics for students, *B. L. Flintand H. T. Worsnop*, Asia Publishing House.
11. A Laboratory Manual of Physics for undergraduate classes, *D. P. Khandelwal,*Vani Pub

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Paper Code	**MIN-PHY-202**	Total Credit	4
Paper Type	Minor	Credit break-up	L - 3 T - 0 P - 1
Semester	II	Contact Hours	75 hours
Title	**Waves and Optics**		
Marks Distribution	In Sem – 40 + End Sem – 60		

Course Description: This course provides an introduction to the basic concepts of waves, oscillation, and optics. It aims to provide knowledge about superposition principles, give comprehensive ideas about simple harmonic oscillations, and introduce wave concepts, including group velocities and phase velocities. It depicts the electromagnetic nature of light and enters the domain of optics by providing in depth knowledge of optical phenomena and optical instruments based on these phenomena to undergraduate students. The last unit comprises of experiments covering Simple harmonic motion, wave and optics. Compound pendulums (bar pendulum and kater's pendulum), Melde's experiment, Prism, Michelson Interferometer, Fresnel biprism and Newton ring set up have been included to deliver hands-on knowledge on the topics included in this course.

Course Objectives: This course aims to develop theoretical knowledge as well as hands on experience on waves, oscillations, and the superposition principle. This course aims to acquaint the learner with the field of thin film interferometry and measurement techniques associated with this field and develop a strong basis for the strong basis for the working of optical devices.

Course Outcomes (COs): At the completion of the course, a student will be able to

SEMESTER - II

CO1: Analyze the principle of linearity and superposition, concepts of wave motion and standing waves.

LO1.1: Define superposition, plane and spherical waves, and stationary waves.

LO1.2: Explain the superposition of waves, the velocity of longitudinal and transverse waves in different media, and the role of standing waves in different physical systems.

LO1.3: Construct Lissajous figures and develop the differential equation of a wave.

CO2: Connect the knowledge obtained from the wave with the behavior of light.

LO2.1: Explain the phenomenon of interference in thin films.

LO2.2: Develop theoretical knowledge of various optical instruments.

LO2.3: Illustrate key concepts of diffraction.

CO3: Understand the basic concept of holography.

LO3.1: Define key terms related to holography.

LO3.2: Demonstrate the construction of holography.

CO4: Apply theoretical knowledge of Oscillations and wave optics in practical applications.

LO4.1: Apply the bar and Kater's pendulum for finding the value of acceleration due to gravity at a place.

LO4.2: Interpret the working of Michelson Interferometer, Fresnel biprism and Newton rings.

LO4.3: Determine the phenomenon of interference of light to find an unknown wavelength.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1 LO3.1	LO1.2 LO2.1 LO3.2 CO3	LO1.3 LO2.2 LO4.1	CO1 CO2 CO4 LO4.2	LO4.3	
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S			M	M		S
CO2	S	S	S	S			M	M		S
CO3	S	S	S	S			M	M		S
CO4	S	S	S	S	W	W	M	M	M	S

(S:Strong, M: Medium,W: Weak)

COURSE CONTENTS:

SEMESTER - II

Unit	Contents	L	T	P	Total Hours
1	**Oscillations** Simple Harmonic Motion (SHM) and Oscillations, Differential Equation of SHM and its solution, Kinetic Energy, Potential Energy, Total energy and their time-average values, Simple pendulum, Compound Pendulum, Bar pendulum and Kater's Pendulum, Damped oscillation, Forced oscillations, Resonance, Power Dissipation and Quality Factor.	6	0	0	6
2	**Superposition of Harmonic Oscillations** Linearity and Superposition Principle. Superposition of two collinear harmonic oscillations having equal frequencies and different frequencies (Beats). Phase and Group Velocities. Lissajous Figures: Lissajous Figures with equal and unequal frequency (Graphical and Analytical Methods) and their use.	4	0	0	4
3	**Wave Motion** Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Travelling) Waves, Wave Equation, Particle and Wave Velocities, Differential Equation of a Wave. Velocity of transverse vibrations of stretched strings, Velocity of longitudinal waves in a fluid in a pipe, Newton's formula for velocity of sound, Laplace's correction, Comparison of velocity of sound in different media: air, liquid, solid. Energy, power transport and intensity of wave.	6	0	0	6
4	**Standing Waves** Reflection of wave from the boundary of a medium, Standing (Stationary) Waves, Standing Waves in a String: Fixed and Free ends, Normal Modes of Stretched Strings, Comparison of Standing Wave with Travelling Waves, Displacement and Velocity of a Particle in a Standing Wave, Melde's Experiment, Longitudinal Standing Waves in Open and Closed Pipes, Normal Modes of Longitudinal Waves,	5	0	0	5

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5	**Wave nature of light and interference** 5.1 ***Interference***: Recapitulations of Huygens' principle. Temporal and Spatial coherence. Division of amplitude and wavefront, Young's double slit experiment, Phase change on reflection: Stokes' treatment, Lloyd's Mirror and Fresnel's Biprism, Interference in parallel and wedge-shaped thin films. Newton's Rings: Measurement of wavelength and refractive index.	6	0	0	6
	5.2 ***Interferometers:*** Michelson Interferometer- (i) Idea of form of fringes (No theory required), (ii) visibility of Fringes. (iii) Applications. Introduction to Fabry-Perot interferometer.	4	0	0	4
7	**Diffraction** 7.1 ***Fresnel Diffraction***: Fresnel'sAssumptions.Fresnel'sHalf-PeriodZonesforPlaneWave.Explanation of Rectilinear Propagation of Light. Theory of a Zone, Fresnel diffraction pattern of a straight edge, a slit, wire.	6	0	0	5
	7.2 Fraunhofer Diffraction: Single slit, Circular aperture. Resolving Power of a telescope, Double slit, Multiple slits. Diffraction grating, Resolving power of grating.	6	0	0	6
8	**Holography** Principle of Holography, Recording and Reconstruction Method, Theory of Holography as Interference between two Plane Waves.	3	0	0	3
9	Laboratory experiments on waves and optics: 1. To determine the value of g using Bar Pendulum. 2. To determine the value of g using Kater's Pendulum. 3. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda^2 - T$ law. 4. To determine the phase difference between two waves using Lissajous Figures. 5. To determine the (1)refractive index, (2) dispersive power (Cauchy constants of the Material of a prism using sodium source and	0	0	30	30

	a mercury source 6. To determine the wavelength of sodium source using Michelson's interferometer. 7. To determine wavelength of sodium light using Fresnel Biprism. 8. To determine wavelength of sodium light using Newton's Rings. 9. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film. 10. To determine (1) wavelength of Na source (2) spectral lines of Hg source using plane (3) dispersive power and (4)resolving power with the help of a plane diffraction grating. 11. To determine the wavelength of given laser source using single slit diffraction method.				
	Total	**45**	**0**	**30**	**75**

Recommended Readings:

1. Waves: Berkeley Physics Course, *F.Crawford*, Tata McGraw-Hill.
2. Fundamentals of Optics, *F.A.Jenkins and H.E.White*, McGraw-Hill.
3. Principles of Optics, *M. Bornand E. Wolf,* Pergamon Press.
4. Optics, *A. Ghatak,* Tata McGraw Hill.
5. Modern Optics, *A. B. Gupta*, Books & Allied (P) Ltd.
6. The Physics of Vibrations and Waves, *H.J.Pain*, John Wiley and Sons.
7. Text book of Optics, *Dr. N. Subramanyam, Brijlal ,Dr. M. N. Avadhanulu*, S. Chand Publications
8. Fundamental of Optics, *A. Kumar, H. R. Gulati and D. R. Khanna*, R. Chand Publications
9. B.Sc. Practical Physics, *C.L. Arora*, S. Chand Publications.
10. Advanced Practical Physics for students, *B. L. Flintand H. T. Worsnop*, Asia Publishing House.
11. A Laboratory Manual of Physics for undergraduate classes, *D. P. Khandelwal,*Vani Pub

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Paper Code	**PHY-MDC-202**	Total Credit	3
Paper Type	Multi Disciplinary Course	Credit break-up	L - 3 T - 0 P - 0
Semester	II	Contact Hours	45 hours
Title	**Introduction to Communication Technology**		
Marks Distribution	In Sem – 40 + End Sem – 60		

Course Description: The course on Introduction to Communication Technology begins with a discussion on what is communication, what are the techniques used in communication systems. It describes the different types of modulation and multiplexing techniques which are of utmost importance in any modern-day communication system. The course also covers the introductory idea of Antennas, RADAR, and microwave communication. A brief discussion about optical communication systems has also been included in the course.

Course Objectives:
1. To introduce the students with the technologies used in modern communication systems.
2. To make the students familiar with antennas.
3. To discuss the basic idea behind cellular communication, satellite communication etc.

Course Outcomes (COs): The students will able to

CO1: Understand the basic blocks of a communication system.

LO1.1: Define the key components of a communication system and the concept of modulation.

LO1.2: Explain the block diagram of Pulse Code Modulation.

LO1.3: Explain how antennas work.

LO1.4: Define microwave communication, cellular communication and optical fiber communication.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.4					
Conceptual	LO1.1 LO1.2 LO1.3					
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	S	M	M	S

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit	Contents	L	T	P	Total Hours
1	**Basics of Communication Systems (Marks 18)** What is a communication system, Block diagram of a communication system, Need of modulation, basic idea of Amplitude Modulation its advantages, disadvantages and application, Frequency modulation, advantages,	15	0	0	15

	disadvantages and its application, electromagnetic Spectrum. Multiplexing in communication systems, Frequency Division Multiplexing and Time division multiplexing.				
2	**Digital Communication Processes (Marks 9)** Digital communication, Block diagram of Pulse code modulation and its applications, digital modulation, advantages and disadvantages of digital modulation.	5	0	0	5
3	**Transmission Systems (Marks 9)** Basic idea of Transmission line, What is an antenna, Dipole antenna, Yagi antenna, different parameters used in antenna, Introduction to RADAR, RADAR block diagram, Pulse Repetition Frequency.	5	0	0	5
4	**Microwave and Optical Communications (Marks 24)** Introduction to microwave, Microwave communication system, advantages and disadvantages. Cellular communication, basic idea of spectrum and technologies used in cellular communication, generations of cellular communications. Introduction to satellite communication, antenna look angles, satellite communication block diagrams and frequency ranges used, Basic principle of GPS. Historical development of optical communication, general system, advantages, disadvantages, and applications of optical fiber communication, cylindrical fiber, single mode fiber, cutoff wavelength. Optical Fiber materials.	20	0	0	20
	Total	**45**	**0**	**0**	**45**

Recommended Readings:

1) Electronic Communications System: Fundamentals Through Advanced, *W. Tomasi,* Pearson Education.
2) Kennedy's Electronic Communication Systems (SIE), *I. G. Kennedy, Davis, Prasanna*, McGraw Hill Education.
3) Principles of electronic communication systems, *L. E. Frenzel*, McGraw Hill Education.
4) Optical Fiber Communications, *G. Keiser,* Tata McGraw Hill Education.

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SEMESTER - II

Paper Code	**SEC-PHY-202**	Total Credit	3
Paper Type	Skill Enhancement Course	Credit break-up	L- 2 T- 0 P-1
Semester	II	Contact Hour	45 hours
Title	**Graphical Representation of Data**		
Marks Distribution	In Sem – 40 End Sem – (Exam: 30 + Project: 30) = 60		

Course Objective/Description:
This syllabus equips students with a strong foundation in three key plotting tools and prepares them for versatile data analysis and visualization tasks across various field. Theory and practical classes has to be taken simultaneously.

Course objective:
1. Introduce students to graph plotting software.
2. Analyze data through graph.

Course Outcomes:
Upon completing this course, students will be able to:
1. Use Excel for Data Visualization: Create and customize basic charts, pivot tables, and trendlines for simple data analysis.
2. Utilize GNUplot for Command-Line Graphing: Generate advanced plots via commands and customize them for various data types and formats.
3. Learn Origin for Advanced Graphing and Data Analysis: Create publication-quality graphs, perform data fitting and statistical analysis, and export plots for academic and professional use.
4. Integrate Multiple Tools: Seamlessly combine the strengths of Excel, GNUplot, and Origin to analyze data, create visualizations, and produce professional reports.

Assessment:
Unit 1: Create basic charts and graphs in Excel with proper formatting and labeling.
Unit 2: Plot a dataset in GNUplot and customize the plot with advanced formatting.
Unit 3: Create a publication-quality graph using Origin, including advanced plot types and data analysis.
Unit 4: Complete a project that integrates Excel, GNUplot, and Origin and **submit it for final grading**.

Unit	Contents	L	T	P	Total Hours
1	**Basics of Plotting in Excel** 1. Introduction to Excel for Plotting: Overview of Excel's capabilities for data visualization, Understanding the Excel interface (Sheets, Cells, and Data Tab), Inputting and organizing data for plotting 2. Basic Plotting Techniques in Excel: Creating basic plots: Line charts, bar charts, and scatter plots; Customizing chart elements: Title, axis labels, data labels; Formatting axes: Adjusting ranges, changing scales (linear and logarithmic)	4	0	2	6

	3. Advanced Excel Chart Customization: Creating and modifying multiple chart types (Combination charts); Formatting chart style and color themes; Adding trendlines and error bars to charts				
2	**GNUplot for Command-Line Plotting** 1. Introduction to GNUplot: What is GNUplot and its role in plotting; Installing and setting up GNUplot (Windows, Linux, macOS); Understanding the command-line interface and basic syntax 2. Basic Plotting in GNUplot: Plotting basic graphs- Line plots, scatter plots, histograms; Plotting multiple datasets and configuring axes; Customizing graph appearance (line styles, colors, markers) 3. Advanced Plot Customization in GNUplot: Customizing titles, labels, and legends; Using different plot styles (points, lines, filled curves); Configuring axis properties (logarithmic, date formatting) 4. Exporting and Saving Plots in GNUplot: Saving plots to files (PNG, EPS, PDF, SVG); Setting output formats and customizing image size	8	0	4	12
3	**Origin for Graph and Data Analysis** 1. Introduction to Origin: Overview of Origin's user interface and features; Importing data from various file formats (Excel, CSV, text); Navigating the worksheet and matrix windows 2. Basic Plotting in Origin: Creating common graph types: Line, scatter, bar, and pie charts; Customizing plot axes and scale types; Adding grid lines, data points, titles, and axis labels 3. Advanced Plotting Features in Origin: Creating 3D plots (surface plots, wireframe plots); Creating multi-panel graphs and layouts; Using templates to apply consistent formatting across multiple graphs 4. Data Analysis and Fitting in Origin: Performing basic data analysis (mean, standard deviation); Curve fitting and regression analysis (linear, nonlinear fits); Using statistical tools and interpreting results 5. Exporting and Publishing Plots in Origin: Exporting high-quality plots for publications (TIFF, EPS, PDF); Creating presentation-ready graphs with detailed annotations and styling	8	0	4	12
4	Integration of Software Tools 1. Choosing the Right Tool for the Job: When to use Excel, GNUplot, and Origin: Strengths and weaknesses of each tool; Understanding the limitations and advantages in different scenarios (e.g., simple vs. complex data, interactive vs. static plots) 2. Advanced Integration Techniques: Importing and exporting data between Excel, GNUplot, and Origin; Using Excel to prepare data and exporting to Origin for advanced analysis; Using GNUplot for scripting and automating repetitive plotting	10	0	5	15

	tasks 3. Hands-on Project: Multi-Software Data Visualization - A final project involving data analysis and visualization using all three tools - Students will prepare data in Excel, analyze it in Origin, and use GNUplot for command-line plotting.				
	Total	**30**	**0**	**15**	**45**

Books and resources:

1. Gnuplot in Action: Understanding Data with Graph by Philipp K. Janert
2. gnuplot Cookbook by Lee Phillips
3. Origin Software Complete Usage Instruction and Graph Representation: A complete Guide for new users by Muhammad Arsalan and Azka Awais.
4. Origin User Guide.
5. gnuplot Documentation

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SEMESTER - III

Paper Code	**C-PHY-303**		Total Credit	4
Paper Type	Core		Credit break-up	L - 3 T - 1 P - 0
Semester	III		Contact Hours	60 hours
Title	**Mathematical Physics – I**			
Marks Distribution	In Sem – 40 + End Sem – 60			

Course Description: This course provides an account of the basic mathematical tools and methods which are instrumental in learning the theories as well as the applications of different branches in physics. This course is the first amongst the three courses dedicated to mathematical Physics in the whole four-year undergraduate program in Physics as a major. The course covers a number of elementary topics such as calculus, vector calculus, orthogonal curvilinear co-ordinates, Dirac delta function and matrices.

Course Objectives: The aim of this course is to

1. Introduce a learner to a number of mathematical tools and methods.
2. Develop a basic understanding of these mathematical tools and their physical interpretation.
3. Acquaint a learner with application of these mathematical tools and methods in physics.
4. Develop an adequate amount of mathematical skill among the learners to navigate through different areas in physics.

Course Outcomes (COs): At the completion of this course, a learner will be able to

CO1: Understand basic mathematical tools and their importance in physics.
- **LO1.1:** Define key terms and operations in calculus, vector-calculus, curvilinear-coordinates, Dirac delta function and matrices.
- **LO1.2:** Learn about the different types of differential equations and their applications
- **LO1.3:** Describe a problem in physics in terms of calculus, vector-calculus, curvilinear coordinates, Dirac delta function and matrices.

CO2: Apply the above mathematical concepts to solve problems.
- **LO2.1:** Solve advanced level mathematical problems based on the key concepts in calculus, vector calculus, curvilinear coordinates, Dirac delta function and matrices.
- **LO2.2:** Apply calculus, vector calculus, curvilinear coordinates, Dirac delta function and matrices to solve problems in elementary branches of physics like mechanics, electromagnetic theory, thermal physics.

CO3: Evaluate
- **LO3.1:** Evaluate integrals by solving differential equations
- **LO3.2:** Find the value of maxima and minima of functions using Lagranges method of undetermined multipliers.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

SEMESTER - III

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1	LO1.2 LO1.3 CO1	LO2.1 LO2.2 CO2		CO3 LO3.1 LO3.2	
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	W	M	M		S
CO2	S	S	M	S	S	W	M	M		S
CO3	S	S	M	S	S	W	S	S		S

(S:Strong, M: Medium,W: Weak)

COURSE CONTENT

Unit	Contents	L	T	P	Total Hours
1	**Calculus** 1.1 ***Recapitulation continuity of functions***: Functions and their plotting, Continuity and Differentiability of functions, Approximation methods: Taylor series, Maclaurin series.	2	0	0	2
	1.2 ***Ordinary Differential equation*** First Order Differential Equations, Integrating Factor, Second Order Differential Equations, Homogeneous and Inhomogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral.	7	3		10
	1.3 ***Calculus of functions of more than one variable***: Partial Derivatives, Exact and Inexact Differentials, Integrating Factor, Constrained Maximization using Lagrange Multipliers.	4	2	0	6
2	**Vector Calculus** 2.1 ***Recapitulation of Vector algebra:*** Dot Product, Cross Product, Scalar Triple Product, Cartesian Components of a vector, Scalar and Vector Fields.	1	1	0	2

	2.2 ***Vector Differential Calculus***: Directional Derivatives and Normal Derivative, Gradient of a Scalar Field and its geometrical interpretation, Divergence and Curl of a Vector Field, Del and Laplacian Operators, Vector identities.	7	1	0	8
	2.3 ***Vector Integral Calculus***: Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of Infinitesimal Line, Surface and Volume Elements, Line, Surface and Volume Integrals of Vector Fields, Flux of a Vector Field, Gauss' Divergence Theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).	11	3	0	14
3	**Orthogonal Curvilinear Coordinates** Co-ordinate System- Orthogonal Curvilinear, Spherical Polar, Cylindrical, Expression from Gradient, Divergence and Curl in Cartesian, Spherical and Cylindrical Coordinate Systems.	6	2	0	8
4	**Unit4: Dirac Delta Function** Definition of Dirac Delta Function, Representation as limit of a Gaussian function and rectangular function, Properties of Dirac Delta Function.	1	1		2
5	**Matrices** Definition, Operations on matrix, Transpose of a matrix, Hermitian conjugate of a matrix, Trace and Determinant, Inverse of a matrix, Special types of square matrices- Diagonal, Symmetric and Skew-symmetric, Hermitian and Skew-Hermitian, Eigen value and eigen vectors of a matrix, Diagonalization of matrix.	6	2	0	8
	Total	**45**	**15**	**0**	**60**

Recommended readings:

1. Mathematical Methods for Physicists, *G.B.Arfken,H.J.Weber,F.E.Harris*, Elsevier.
2. Mathematical Methods for Physics and Engineering,*K.F.Riley,M.P. Hobson, S. J. Bence,* Cambridge University Press.
3. An introduction to ordinary differential equations,*E.A.Coddington,*PHI learning.
4. Differential Equations, *G.F.Simmons,*McGraw Hill.
5. Mathematical Tools for Physics, *J.Nearing,*Dover Publications.
6. Mathematical methods for Scientists and Engineers, *D.A.McQuarrie,* University Science Books (USA).
7. Matrices and Tensors in Physics, *A.W. Joshi*, New Age Publishers.
8. Engineering Mathematics, *S.Pal and S.C.Bhunia,* Oxford University Press.
9. Advanced Engineering Mathematics, *ErwinKreyszig,* Wiley India.
10. Mathematical Physics, H.K.Dass, S. Chand Publications.

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SEMESTER - III

Paper Code	**C-PHY-304**	Total Credit	4
Paper Type	Core	Credit break-up	L - 3 T - 0 P - 1
Semester	III	Contact Hours	75 hours
Title	**Electricity & Magnetism**		
Marks Distribution	In Sem – 40 + End Sem – 45 + Lab – 15		

Course Description: This course provides a comprehensive introduction to the fundamental principles of electromagnetism, focusing on electrostatics and magnetostatics, as well as their potential applications in various contexts. The curriculum covers the behavior of electric fields, electric potential, and energy, exploring key concepts such as Gauss' law, Laplace's and Poisson's equations, and the method of images. It also delves into the dielectric properties of matter, the principles of magnetostatics, and the magnetic properties of materials. The course also examines electromagnetic induction, including Faraday's and Lenz's laws, and introduces Maxwell's equations. In addition, students will study electrical circuits, network theorems, and their applications to both AC and DC circuits. Through a combination of theoretical discussions and practical examples, this course aims to build a strong foundation in electromagnetism and its relevance to real-world phenomena and technological applications.

Course Objectives: The basic objective of this course is to

1. Introduce learners to the fundamental principles of electromagnetism.
2. Develop a basic understanding of electrostatics, magnetostatics, and electromagnetic induction.
3. Introduce learners to the dielectric properties of matter and the magnetic properties of materials.
4. Acquaint learners with key topics including network theorems, AC and DC circuits, and their potential applications in real-world problems.

Course Outcomes:

After successful completion of this course, students will be able to:

CO1: Understand the fundamental laws of electromagnetism and their importance in Physics.

LO1.1: Define the key concepts of electric and magnetic fields.

LO1.2: Explain the basic laws of electrostatics, magnetostatics and electromagnetic induction.

LO1.3: Describe the behavior of electric fields in matter and explain polarization phenomena.

LO1.4: Discuss magnetic properties of materials, including hysteresis, using B-H curves and magnetization concepts.

CO2: Apply fundamental laws to solve practical problems.

LO2.1: Use Gauss's law to solve problems involving symmetrical charge distributions.

LO2.2: Solve different problems based on Laplace's, Poisson's equations and method of images.

CO3: Evaluate the behavior of electrical circuits and networks using different approaches

LO3.1: Apply Thevenin's and Norton's Theorems to simplify complex circuits.

LO3.2: Analyze AC circuits using Kirchhoff's laws and solve for complex impedances and reactance.

CO4: Understand the basic concepts in hands-on mode through the basic electricity and magnetism experiments.

LO4.1: Recall the concepts of series and Parallel LCR circuits

LO4.2: Explain the characteristics of RC circuit and Network theorems.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1	LO1.2, LO1.3, LO1.4, CO1				
Procedural			LO2.1, LO2.2, LO3.1, CO2	LO3.2	CO3	
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M		M	M		M
CO2	S	S	S	S			S	S		M
CO3	S	S	S	S	S		S	S		S
CO4	S	S	M	M	M	M	S	M	M	M

(S: Strong, M: Medium, W: Weak)

Unit	Contents	L	T	P	Total Hours
1	**Electrostatics:** Electric Field, Electric Lines of Force, Electric Flux, Gauss' Law with applications to charge distributions with Spherical, Cylindrical and Planar symmetry.	5	0	0	5
	Conservative nature of Electrostatic Field, Electrostatic Potential, Laplace's and Poisson equations, The Uniqueness Theorem, Potential and Electric Field of a dipole, Force and Torque on a Dipole.	4	0	0	4
	Electrostatic Energy of System of Charges, Electrostatic Energy of a Charged Sphere, Conductors in an electrostatic field, Surface charge and force on a conductor, Capacitance of a system of charged conductors, Parallel-plate Capacitor, Capacitance of an	7	0	0	7

	isolated conductor, Method of Images and its application to (i) Plane Infinite Sheet and (ii) Sphere.				
2	**Dielectric Properties of Matter:** Electric Field in matter, Polarization, Polarization Charges, Electrical Susceptibility and Dielectric Constant; Capacitor (parallel plate, spherical, cylindrical) filled with dielectric; Displacement vector $\vec{D}$, Relations between Electric field vector $\vec{E}$, Polarization vector $\vec{P}$ and $\vec{D}$, Gauss' Law in dielectrics.	6	0	0	6
3	**Magnetostatics:** Magnetic force between current elements and definition of Magnetic Field $\vec{B}$, Biot-Savart's Law and its simple applications (straight wire and circular loop), Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole), Ampere's Circuital Law and its application to (i) Solenoid and (ii) Toroid, Properties of $\vec{B}$: curl and divergence, Vector Potential, Lorentz Force Law, Magnetic Force on (i) point charge (ii) current carrying wire (iii) between current elements, Torque on a current loop in a uniform Magnetic Field.	7	0	0	7
	Torque on a current loop, Ballistic Galvanometer, Current and Charge Sensitivity, Electromagnetic Damping, Logarithmic Damping, CDR.	2	0	0	2
4	**Magnetic Properties of Matter:** Magnetization vector ($\vec{M}$), Magnetic Intensity ($\vec{H}$), Magnetic Susceptibility and permeability. Relation between $\vec{B}$, $\vec{H}$ and $\vec{M}$. Ferromagnetism. B-H curve and hysteresis.	3	0	0	3
5	**Electromagnetic Induction:** Faraday's Law, Lenz's Law, Self-Inductance and Mutual Inductance, Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwell's Equations, Charge Conservation and Displacement current.	5	0	0	5
6	**Electrical Circuits:** AC Circuits, Kirchhoff's Laws for AC circuits, Complex Reactance and Impedance, Series LCR Circuit: (i) Resonance, (ii) Power Dissipation (iii) Quality Factor and (iv) Band Width. Parallel LCR Circuit.	3	0	0	3
7	**Network Theorems:** Ideal voltage and current Sources, Network Theorems: Thevenin Theorem, Norton Theorem, Superposition Theorem, Reciprocity Theorem, Maximum Power Transfer theorem, Applications to DC	3	0	0	3

	circuits.				
8	**Experimental Work:** (At least 60% of the experiments must be performed) a) To determine an unknown Low Resistance using Potentiometer. b) To determine an unknown Low Resistance using Carey Foster's Bridge. c) To compare capacitances using De'Sauty's bridge. d) To verify the Thevenin and Norton theorems. e) To verify the Superposition, and Maximum power transfer theorems. f) To determine self-inductance of a coil by Anderson's bridge. g) To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width. h) To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.	0	0	30	30
	Total	45	0	30	75

Recommended Readings:

1) Electricity, Magnetism & Electromagnetic Theory, *S. Mahajan and Choudhury*, Tata McGraw.
2) Electricity and Magnetism, *E. M. Purcell*, McGraw-Hill Education.
3) Electricity and Magnetism, *J. H. Fewkes & J. Yarwood*. Vol. I, Oxford University Press.
4) Introduction to Electrodynamics*, D. J. Griffiths*, Pearson Education.
5) B.Sc. Practical Physics, *C.L. Arora*, S Chand and Company Limited.
6) Advanced Practical Physics for students, *B. L. Flint and H. T. Worsnop*, Asia Publishing House.
7) A Text Book of Practical Physics, *I. Prakash & Ramakrishna,* Kitab Mahal.

SEMESTER - III

Paper Code	**MIN-PHY-303**		Total Credit	4
Paper Type	Minor		Credit break-up	L - 3 T - 0 P - 1
Semester	III		Contact Hours	75 hours
Title	**Electricity & Magnetism**			
Marks Distribution	In Sem – 40 + End Sem – 45 + Lab – 15			

Course Description: This course provides a comprehensive introduction to the fundamental principles of electromagnetism, focusing on electrostatics and magnetostatics, as well as their potential applications in various contexts. The curriculum covers the behavior of electric fields, electric potential, and energy, exploring key concepts such as Gauss' law, Laplace's and Poisson's equations, and the method of images. It also delves into the dielectric properties of matter, the principles of magnetostatics, and the magnetic properties of materials. The course also examines electromagnetic induction, including Faraday's and Lenz's laws, and introduces Maxwell's equations. In addition, students will study electrical circuits, network theorems, and their applications to both AC and DC circuits. Through a combination of theoretical discussions and practical examples, this course aims to build a strong foundation in electromagnetism and its relevance to real-world phenomena and technological applications.

Course Objectives: The basic objective of this course is to

5. Introduce learners to the fundamental principles of electromagnetism.
6. Develop a basic understanding of electrostatics, magnetostatics, and electromagnetic induction.
7. Introduce learners to the dielectric properties of matter and the magnetic properties of materials.
8. Acquaint learners with key topics including network theorems, AC and DC circuits, and their potential applications in real-world problems.

Course Outcomes:

After successful completion of this course, students will be able to:

CO1: Understand the fundamental laws of electromagnetism and their importance in Physics.

LO1.1: Define the key concepts of electric and magnetic fields.

LO1.2: Explain the basic laws of electrostatics, magnetostatics and electromagnetic induction.

LO1.3: Describe the behavior of electric fields in matter and explain polarization phenomena.

LO1.4: Discuss magnetic properties of materials, including hysteresis, using B-H curves and magnetization concepts.

CO2: Apply fundamental laws to solve practical problems.

LO2.1: Use Gauss's law to solve problems involving symmetrical charge distributions.

LO2.2: Solve different problems based on Laplace's, Poisson's equations and method of images.

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CO3: Evaluate the behavior of electrical circuits and networks using different approaches

- **LO3.1:** Apply Thevenin's and Norton's Theorems to simplify complex circuits.
- **LO3.2:** Analyze AC circuits using Kirchhoff's laws and solve for complex impedances and reactance.

CO4: Understand the basic concepts in hands-on mode through the basic electricity and magnetism experiments.

- **LO4.1:** Recall the concepts of series and Parallel LCR circuits
- **LO4.2:** Explain the characteristics of RC circuit and Network theorems.

Unit	Contents	L	T	P	Total Hours
1	**Electrostatics:** Electric Field, Electric Lines of Force, Electric Flux, Gauss' Law with applications to charge distributions with Spherical, Cylindrical and Planar symmetry.	5	0	0	5
	Conservative nature of Electrostatic Field, Electrostatic Potential, Laplace's and Poisson equations, The Uniqueness Theorem, Potential and Electric Field of a dipole, Force and Torque on a Dipole.	4	0	0	4
	Electrostatic Energy of System of Charges, Electrostatic Energy of a Charged Sphere, Conductors in an electrostatic field, Surface charge and force on a conductor, Capacitance of a system of charged conductors, Parallel-plate Capacitor, Capacitance of an isolated conductor, Method of Images and its application to (i) Plane Infinite Sheet and (ii) Sphere.	7	0	0	7
2	**Dielectric Properties of Matter:** Electric Field in matter, Polarization, Polarization Charges, Electrical Susceptibility and Dielectric Constant; Capacitor (parallel plate, spherical, cylindrical) filled with dielectric; Displacement vector $\vec{D}$, Relations between Electric field vector $\vec{E}$, Polarization vector $\vec{P}$ and $\vec{D}$, Gauss' Law in dielectrics.	6	0	0	6
3	**Magnetostatics:** Magnetic force between current elements and definition of Magnetic Field $\vec{B}$, Biot-Savart's Law and its simple applications (straight wire and circular loop), Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole), Ampere's Circuital Law and its application to (i) Solenoid and (ii) Toroid, Properties of $\vec{B}$: curl and divergence, Vector Potential, Lorentz Force Law, Magnetic Force on (i) point charge (ii) current carrying wire (iii) between current elements, Torque on a current loop in a uniform Magnetic Field.	7	0	0	7
	Torque on a current loop, Ballistic Galvanometer,	2	0	0	2

	Current and Charge Sensitivity, Electromagnetic Damping, Logarithmic Damping, CDR.				
4	**Magnetic Properties of Matter:** Magnetization vector ($\vec{M}$), Magnetic Intensity ($\vec{H}$), Magnetic Susceptibility and permeability. Relation between $\vec{B}$, $\vec{H}$ and $\vec{M}$. Ferromagnetism. B-H curve and hysteresis.	3	0	0	3
5	**Electromagnetic Induction:** Faraday's Law, Lenz's Law, Self-Inductance and Mutual Inductance, Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwell's Equations, Charge Conservation and Displacement current.	5	0	0	5
6	**Electrical Circuits:** AC Circuits, Kirchhoff's Laws for AC circuits, Complex Reactance and Impedance, Series LCR Circuit: (i) Resonance, (ii) Power Dissipation (iii) Quality Factor and (iv) Band Width. Parallel LCR Circuit.	3	0	0	3
7	**Network Theorems:** Ideal voltage and current Sources, Network Theorems: Thevenin Theorem, Norton Theorem, Superposition Theorem, Reciprocity Theorem, Maximum Power Transfer theorem, Applications to DC circuits.	3	0	0	3
8	**Experimental Work:** (At least 60% of the experiments must be performed) 1. To determine an unknown Low Resistance using Potentiometer. 2. To determine an unknown Low Resistance using Carey Foster's Bridge. 3. To compare capacitances using De'Sauty's bridge. 4. To verify the Thevenin and Norton theorems. 5. To verify the Superposition, and Maximum power transfer theorems. 6. To determine self-inductance of a coil by Anderson's bridge. 7. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width. 8. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant	0	0	30	30

	frequency and (b) Quality factor Q.				
	Total	**45**	**0**	**30**	**75**

Recommended Readings:

1) Electricity, Magnetism & Electromagnetic Theory, *S. Mahajan and Choudhury*, Tata McGraw.
2) Electricity and Magnetism, *E. M. Purcell*, McGraw-Hill Education.
3) Electricity and Magnetism, *J. H. Fewkes & J. Yarwood*. Vol. I, Oxford University Press.
4) Introduction to Electrodynamics*, D. J. Griffiths*, Pearson Education.
5) B.Sc. Practical Physics, *C.L. Arora*, S Chand and Company Limited.
6) Advanced Practical Physics for students, *B. L. Flint and H. T. Worsnop*, Asia Publishing House.
7) A Text Book of Practical Physics, *I. Prakash & Ramakrishna,* Kitab Mahal.

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Paper Code	**MDC-PHY-303**	Total Credit	3
Paper Type	Multidisciplinary Course	Credit break-up	L - 2 T - 1 P - 0
Semester	III	Contact Hours	45 hours
Title	**Introduction to Meteorology**		
Marks Distribution	In Sem – 40 + End Sem – 60		

Course Description: This Course provides a holistic understanding of the field of meteorology, emphasizing the relevance and implications of human activities on weather and climate. As this course is meant for learners across all disciplines, quantitative treatment as well as rigorous theories has been avoided to the extent possible. The course content are arranged in such a way that the learners get a overview of idea about the basic terminologies of meteorology, basic meteorology phenomena and the factors behind them.. The very relevant issue weather forecasting as well as effect of human activities on weather has been dealt with in the last two units.

Course Objectives: The aim of this course is to

i. Grasp the fundamental principles of meteorology and atmospheric science.
ii. Understand the historical development of meteorological thought and its cultural implications.
iii. Analyze the impact of weather and climate on human societies and vice versa.
iv. Develop critical thinking skills to assess contemporary meteorological issues and their societal relevance

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Course Outcomes (COs): At the completion of this course, a learner will be able to

- Understand the basic physical principles governing atmospheric processes.
- Recognize the significance of atmospheric composition and structure.
- Comprehend the processes leading to various weather phenomena

CO1: Understand the basic physical principles governing atmospheric processes.
LO1.1: Define key meteorological parameters.
LO1.2: Learn about the instruments measuring the meteorological parameters
LO1.3: Identify the layers of the atmosphere based on temperature.
CO2: Recognize the significance of atmospheric composition and structure in determining whether at a place.
LO2.1: Identify the trace gases and their role.
LO2.2: Learn the effect of constituents in global warming.
LO2.3 Understand the antroprogenic processes which affecting weather and climate adversely.
CO3: Comprehend the processes of weather forecasting
LO3.1: Learn the terminology used in weather forecasting
LO3.2: Understand the techniques used in modern weather forecasting

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual	LO1.1 LO3.1	CO1 CO2 LO1.2 LO1.3 LO2.3 LO3.2	LO2.1 LO2.2	CO3	LO3.1 LO3.2	
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	W	M	M		S
CO2	S	S	M	S	S	W	M	M		S
CO3	S	S	M	S	S	W	S	S		S

(S: Strong, M: Medium,W: Weak)

SEMESTER - III

Course Content

Unit	Contents	L	T	P	Total Hours
1	**Foundations of Meteorology** Introduction to meteorology: Definition and scope, basic parameters and their measurement. The spheres of the earth-the earth system, , Vertical structure of the atmosphere, Composition of the atmosphere, Role of trace gases, vertical variations in composition	7	4	0	14
2	**Role of temperature, pressure and moisture in the atmosphere** Solar radiation and Earth's heat balance, Controls of temperature, Atmospheric pressure, factors influencing wind, Global and local wind systems, Global circulations, Forms of Precipitations and condensations processes and types, Types of Cloud and formation	6	3	0	12
3	**Some Weather Phenomena**: Cyclones, Thunderstorms, Tornadoes, Hurricane, Typhoon, El nino-La-nina,	5	2	0	10
4	**Climate Systems and Human Impact** Green House effect, Global warming, ozone depletion and ozone hole, efforts to control global warming, Montreal protocol, Natural causes of Climate change: Plate tectonics, volcanic activity, Variations in earth's orbit, Solar variability. Human impact on global climate.	6	3	0	12
5	**Weather forecasting**: Weather map, persistent forecasting, climatological forecasting, analog methods and trend forecasting. Weather forecasting using computers: Numerical weather forecasting, ensemble forecasting, Satellites in weather forecasting	6	3	0	12
	Total	**30**	**15**	**0**	**45**

Recommended Readings:

1) Lutgens, F.K., & Tarbuck, E.J. (2001). *The Atmosphere: An Introduction to Meteorology*. Prentice Hall.
2) Critchfield, H.J. (1987). *General Climatology*. Prentice-Hall of India.
3) Trewartha, G.T., & Horne, L.H. (1980). *An Introduction to Climate*. McGraw-Hill.

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SEMESTER - III

Paper Code	**SEC-PHY-303**	Total Credit	3
Paper Type	Skill Enhancement Course	Credit break-up	L- 2 T- 0 P-1
Semester	II	Contact Hour	45 hours
Title	**Numerical Methods using Python/Scilab**		
Marks Distribution	In Sem – 40 End Sem – (Final Exam: 30 + Project: 30) = 60		

Course Objective/Description:

This syllabus is designed to introduce students to the core concepts of numerical methods with practical coding exercises in Python/Scilab. The focus is on simple methods and easy-to-understand implementations that will build confidence in handling computational problems. The practical and theory classes have to be taken simultaneously. Weakly assignments, regular practice and experimenting with the methods outside class will be key to mastering the concepts.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Solve Linear Systems: Use Gaussian elimination and matrix inversion to solve 2x2 linear systems using Python (NumPy)/Scilab.
2. Find Roots of Equations: Implement the Bisection and Newton-Raphson methods to find roots of non-linear equations.
3. Perform Interpolation: Apply linear and polynomial (Lagrange) interpolation techniques to estimate missing data points.
4. Approximate Derivatives and Integrals: Use numerical differentiation (forward, backward, central differences) and the Trapezoidal rule to approximate derivatives and integrals of functions.
5. Solve ODEs: Solve first-order ordinary differential equations (ODEs) using Euler's method and visualize results.
6. Assess Method Accuracy: Evaluate errors and convergence in numerical methods, and choose appropriate methods for different problems.

Final Project: Numerical Solutions to Real-World Problems

- **Topics:**
  - Review of all methods covered in the course
  - Choose a real-world problem and apply multiple numerical methods to solve it
  - Write a simple report explaining the methods used and results obtained
  - Introduction to simple optimization of numerical methods (optional)
- **Project Ideas:**
  - Use interpolation to estimate data from a set of points
  - Solve a physical problem (e.g., simple projectile motion using ODEs)
  - Use numerical integration to estimate the area under a curve
- **Deliverables:**
  - Code for the project in Python/Scilab
  - Written report summarizing your approach and results

Assessment and Grading:

- **In Sem: Weekly Assignments+ Practical (Marks- 40):** Weekly exercises to practice methods
- **Final Project (Marks- 30):** Final project demonstrating integration of multiple methods
- **End semester examination (Marks- 30):**

SEMESTER - III

Unit	Contents	L	T	P	Total Hours
1	**Introduction to Numerical Methods & Setup** Different Numerical Methods and their importance., Overview of Python and Scilab for Numerical Computation; Installing Python (Anaconda, Jupyter Notebook)/Scilab; Simple calculations and variables in Python/Scilab; Introduction to arrays and basic operations (addition, subtraction, multiplication, division) **Assignments:** o Install Python and Scilab on your computer Perform basic arithmetic operations and print results in Python/Scilab	4	0	2	6
2	**Solving Linear Equations** Introduction to solving linear equations (Ax = b); Simple 2x2 system of equations; Direct method: Solving equations using matrix operations in Python (NumPy)/Scilab; Basic error checking and validation of results **Assignment:** o Solve a 2x2 system of linear equations using Python/Scilab	4	0	3	7
3	**Root Finding Methods** Introduction to root-finding problems; Bisection method: Step-by-step implementation in Python/Scilab; Newton-Raphson method: Solving equations by approximating roots; Error analysis: Checking convergence and accuracy of solutions **Assignments:** o Implement the Bisection method to find the root of a simple function in Python/Scilab o Solve equations using the Newton-Raphson method	6	0	3	9
4	**Interpolation** Introduction to Interpolation and its use; Linear interpolation: Introduction and simple implementation; Polynomial Interpolation: Using Lagrange Interpolation in Python and Scilab; Simple practical example of interpolation (e.g., estimating temperature between given values) **Assignments:** o Implement linear interpolation to estimate missing data points (Python/Scilab) o Use polynomial interpolation to approximate a set of data points	5	0	2	7
5	**Numerical Differentiation and Integration** Introduction to Numerical Differentiation: Estimating derivatives;	6	0	2	8

	Simple methods for differentiation: Forward difference, backward difference; Introduction to Numerical Integration: Estimating areas under curves; Trapezoidal rule for integration (Python &Scilab) **Assignments:** ○ Use the forward and backward difference methods to approximate the derivative of a function (Python &Scilab) ○ Implement the trapezoidal rule to approximate the integral of a function				
6	**Introduction to Solving Differential Equations (ODEs)** Introduction to simple methods for solving ODEs: Implement Euler's method and RK4 method to solve a first-order ODE (e.g., dy/dx = y); Visualizing results using graphs (Python &Scilab) • **Assignments:** ○ Solve a simple first-order ODE using Euler's method (Python &Scilab) ○ Plot the solution and analyze results	5	0	3	8
	Total	**30**	**0**	**15**	**45**

Books and Resources:

1) NumPy Documentation
2) Matplotlib for plotting
3) SciPy for advanced numerical methods
4) Scilab Official Documentation
5) *Numerical Methods for Engineers* by Steven C. Chapra
6) *Introduction to Numerical Analysis* by J. Stoer and R. Bulirsch

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SEMESTER - IV

Paper Code	**C-PHY-405**		Total Credit	4
Paper Type	Core		Credit break-up	L - 3 T - 1 P - 0
Semester	IV		Contact Hours	60 hours
Title	**Quantum Mechanics – I**			
Marks Distribution	In Sem – 40 + End Sem – 60			

Course Description: This course offers the fundamental principles of quantum mechanics. It will explore deeper into quantum theory with investigations into the photoelectric effect, Compton scattering, and the wave-particle duality, including the De Broglie wavelength and matter waves. It covers the Schrödinger's equation for non-relativistic particles. It also introduces the momentum and energy operators. It also delves into the applications as one dimensional infinitely rigid box, Quantum dots, Quantum mechanical scattering and tunneling across step potentials.

Course Objectives:

1. Provide students with an understanding of the basic concepts of quantum mechanics, including wave-particle duality, the uncertainty principle, and quantum superposition.
2. Equip students with the necessary mathematical tools (such as wave functions, Schrödinger's equation, operators, and probability amplitudes) to describe and solve quantum systems.
3. Enable students to interpret quantum phenomena in terms of physical concepts, including quantum states, energy quantization, and the role of observation or measurement in quantum systems.
4. Provide students with the ability to apply quantum mechanics to solve problems related to one-dimensional potentials, harmonic oscillators, and simple atoms or particles, with an emphasis on practical applications and conceptual understanding.

Course Outcomes:

After successful completion of this course, students will be able to:

CO1: Understand the basic principles of Quantum Mechanics

LO1.1: Explain and apply the concept of wave-particle duality and superposition of states.

LO1.2: Use the uncertainty principle to estimate the minimum energy of confined particles

CO2: Develop problem solving skills

LO2.1: Solve problems involving quantum systems using Schrödinger's equation.

LO2.2: Analyze simple systems using the concept of operators and probability distributions.

CO3: Apply Quantum mechanics to real-world systems

LO3.1: Describe physical systems like particle-in-a-box.

LO3.2: Analyze scattering and tunneling across a potential barrier and Quantum dots.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		LO1.1, CO1	LO2.1, LO3.1, CO3	LO2.2, LO3.2, CO2	LO1.2	
Procedural						
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	M	M	M	M	M
CO2	S	M	S	S	S	M	S	M	M	S
CO3	S	S	M	M	M	M	M	S	M	S

(S: Strong, M: Medium, W: Weak)

Unit	Contents	L	T	P	Total Hours
1	**Quantum Theory and Blackbody Radiation:** Planck's quantum hypothesis, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.	13	3	0	16
2	**Uncertainty and Wave-particle Duality:** Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time	6	2	0	8

	uncertainty principle application to virtual particles and range of an interaction.				
3	**Schrödinger's Equation:** Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrödinger's equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension	13	5	0	18
4	**One-Dimensional Box and Step Barrier:** One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier.	13	5	0	18
	Total	**45**	**15**	**0**	**60**

Recommended Readings:

1) Introduction to Quantum Mechanics, *D. J. Griffith*, Pearson Education.
2) Quantum Mechanics: Theory & Applications, *A. K. Ghatak, S. Lokanathan*, Macmillan.
3) Quantum Physics, Berkeley Physics, *E. H. Wichman*, Tata McGraw-Hill.
4) A Text book of Quantum Mechanics, *P. M. Mathews and K. Venkatesan*, McGraw Hill.
5) Quantum Mechanics, *G. Aruldhas,* 2nd Edition, PHI Learning of India.

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Paper Code	**C-PHY-406**	Total Credit	4
Paper Type	Core	Credit break-up	L - 3 T - 0 P - 1
Semester	IV	Contact Hours	75 hours
Title	**Thermal Physics**		
Marks Distribution	In Sem – 40 + End Sem – 45 + Lab – 15		

Course Description: This course covers fundamental thermodynamic principles and kinetic theory of gasses. The course starts with the main laws of Thermodynamics, energy conservation, isothermal and adiabatic processes, and the relationship between specific heats. Heat engines, Carnot cycles, and entropy concepts are also explored thereafter. Thermodynamic potentials like internal energy, enthalpy, and Gibbs free energy are studied, alongside Maxwell's relations and their applications. The kinetic theory section addresses the Maxwell-Boltzmann distribution, molecular collisions, and real gas behavior. By course end, students will understand and will be able to apply thermodynamic principles to various physical systems.

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Course Objectives: Thermal physics is essential as it provides foundational knowledge of energy transformation and conservation principles crucial for various scientific and engineering disciplines. Understanding thermodynamics is crucial for designing and optimizing engineering systems like engines, refrigerators, and power plants. The course is equipped to provide students with analytical and problem-solving skills, enabling them to apply thermodynamic laws to real-world situations. Additionally, thermodynamics intersects with fields like chemistry, biology, and materials science, making it highly relevant for interdisciplinary applications. This course prepares students for advanced studies and careers in science and engineering by equipping them with essential theoretical and practical skills.

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Understand the fundamental principles of thermodynamics.

LO1.1: Define extensive and intensive thermodynamic variables and their significance.

LO1.2: Explain the Zeroth Law of Thermodynamics and its role in defining temperature.

LO1.3: Interpret the First Law of Thermodynamics to analyze processes and calculate energy changes.

CO2: Experiment with apparatus for practical thermodynamic applications.

LO2.1: Develop explanations for entropy changes in reversible and irreversible processes.

LO2.2: Illustrate the implications of entropy in the context of the Second Law of Thermodynamics.

CO3: Apply thermodynamic potentials and their applications.

LO3.1: Apply thermodynamic potentials such as internal energy, enthalpy, and Gibbs free energy to solve problems.

LO3.2: Construct equations and relations using Clausius-Clapeyron and Ehrenfest equations.

LO3.3: Summarize the performance of various thermodynamic cycles.

CO4: Analyze the behavior of gases and related phenomena.

LO4.1: Describe the Maxwell-Boltzmann distribution and its significance.

LO4.2: Analyze the behavior of real gases using the Van der Waals equation.

LO4.3: Apply the Joule-Thomson effect to analyze gas cooling processes.

LO4.4: Distinguish between reversible and irreversible processes and their implications.

LO4.5: Identify the efficiency of heat engines and refrigerators using the Second Law of Thermodynamics.

LO4.6: Explain the concept of entropy and its role in energy transformations.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	LO1.1	CO1, LO1.2	LO3.1, LO4.5	LO4.2		
Conceptual		LO1.3, LO2.2, LO3.3, LO4.1,	LO2.1, CO3, LO4.3	CO4, LO4.4		
Procedural		LO4.6	CO2, LO3.2			

Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	W	W	W	W	M	W
CO2	S	S	M	S	M	W	W	W	M	M
CO3	S	S	M	S	M	W	S	M	M	S
CO4	S	S	M	S	M	M	S	M	W	S
CO5	S	S	M	S	M	W	M	M	W	M

(S: Strong, M: Medium, W: Weak)

Unit	Contents	L	T	P	Total Hours
1	**Zeroth and First Law of Thermodynamics** Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Temperature Coefficient of Resistance, Concept of Work & Heat, Mechanical Equivalent of Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient.	6	0	0	6
2	**Second Law of Thermodynamics** Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Theorem, Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.	6	0	0	6
3	**Entropy** Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.	6	0	0	6
4	**Thermodynamic Potentials** Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with	6	0	0	6

SEMESTER - IV

	Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.				
5	**Maxwell's Thermodynamic Relations** Derivations and applications of Maxwell's Relations, Maxwell's Relations: (i) Clausius Clapeyron equation, (ii) Values of C_p-C_v, (iii) TdS Equations, (iv) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (v) Energy equations, (vi) Change of Temperature during Adiabatic Process	5	0	0	5
6	**Distribution of Velocities** Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific Heats of Gases.	5	0	0	5
7	**Molecular Collisions** Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (i) Viscosity, (ii) Thermal Conductivity and (iii) Diffusion. Brownian Motion and its Significance.	4	0	0	4
8	**Real Gasses** Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waals Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.	7	0	0	7
9	**Practical (any three)** 1. To determine Mechanical Equivalent of Heat, J by Callender and Barne's constant flow method. 2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus/Angstrom's Method. 3. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method. 4. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT). 5. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.	0	0	30	30
	Total	**45**	**0**	**30**	**75**

Recommended Readings:

1. Heat and Thermodynamics, *M.W. Zemansky and R. Dittman,* McGraw-Hill.
2. A Treatise on Heat, *M. Saha, and B. N. Srivastava*, Indian Press.
3. Thermal Physics, *S. Garg, R. Bansal and Ghosh*, Tata McGraw-Hill.
4. Modern Thermodynamics with Statistical Mechanics, *C. S. Helrich*, Springer.

5. Heat Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam and P. S. Hemne, S. Chand.
6. Concepts in Thermal Physics, *S. J. Blundell and K. M. Blundell*, 2012, Oxford University Press.
7. Thermal Physics, *A. Kumar and S. P. Taneja*, R. Chand Publications.
8. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, *Sears & Salinger*.

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Paper Code	**C-PHY-407**	Total Credit	4
Paper Type	Core	Credit break-up	L - 3 T - 0 P - 1
Semester	IV	Contact Hours	75 hours
Title	**Analog Electronics**		
Marks Distribution	In Sem – 40 + End Sem – 45 + Lab – 15		

Course Description: The course provides a comprehensive understanding of semiconductor devices, analog circuits, and their practical implementation in various electronic systems. It will give a basis for understanding and constructing simple systems of analog electronic circuit elements. The course also aims to provide students with hands-on experience in understanding and analyzing the characteristics of electronic components, designing and implementing amplifiers and oscillators using bipolar transistors. Students will measure and plot V-I characteristics of diodes, examine BJT characteristics, and design transistor amplifiers. They will also create and test Op-amp amplifiers using IC 741.

Course Objectives: This course aims to
1. Impart the context of electronic science in perspective of modern instruments and measurement techniques.
2. Provide the fundamental and working principles of semiconductor devices.
3. Introduce the concepts and working of analog electronics systems.
4. To allow students to apply their knowledge for designing small electronic systems.
5. To develop practical skills and foundational knowledge in electronics.
6. To enable students to design and implement various electronic circuits.

Course Outcomes (CO)s: At the completion of this course, a student will be able to

CO1: Understand the basic components of analog and digital electronics.

LO1.1: Define the basic electronic components.

LO1.2: Explain the basic principle of semiconductors and semiconductor devices.

LO1.3: Classify the different components according to their applications.

CO2: Apply the concepts of analog analysis.

LO2.1: Use of semiconductor devices like diode, transistors in building simple electronic circuits.

LO 2.2: Construct different types of analog circuits and to experiment with them.

CO3: Analyze electronic circuits to understand its functioning.

LO3.1: Distinguish between analog and digital circuit.

LO3.2: Simplify electronic circuits to its equivalent form.

CO4: Understand the characteristics of electronic components.

LO4.1: Demonstrate and plot the V-I characteristics of a PN junction diode, Light Emitting Diode, and Zener diode, including its use as a voltage regulator. **LO4.2:** Explain the characteristics of a Bipolar Junction Transistor in CE configuration.

LO4.3: Explain the characteristics of Op-Amp and its use as adder, subtractor, integrator, differentiator etc.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO 4		CO3		
Conceptual	LO1.1 LO1.2 LO1.3 CO1	LO 3.1				
Procedural	LO2.1 LO2.2 CO2	LO 3.2 LO 4.1 LO 4.2				
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	S	S	M	S	S	M
CO2	S	S	S	S	S	S	M	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S

(S: Strong, M: Medium, W: Weak)

Course Contents:

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Unit	Contents	L	T	P	Total Hours
1	**Semiconductor Devices (10 Marks)** P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. Barrier Formation in PN Junction Diode. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Application in switching, rectification (with ripple factor calculations), clipping and clamping etc. Special diodes: (1) Zener diode, (2) photodiode and photocell (3) LED.	10	0	0	10
2	**Bipolar Junction Transistor (8 Marks)** N-P-N and P-N-P Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.	8	0	0	8
3	**BJT as Amplifiers (10 Marks)** Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. *h*-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. RC coupled amplifier and frequency response.	10	0	0	10
4	**Feedback in Amplifiers and Oscillators (7 Marks)** Effect of positive and negative feedback on Input impedance, Output impedance, Gain, Stability, Distortion and noise. Four types of negative feedback and analysis, Barkhausen's Criterion for selfsustained oscillations. RC Phase shift oscillator, Wien bridge oscillator, Hartley & Colpitt's oscillators.	7	0	0	7
5	**Operational Amplifiers (10 Marks)** Differential amplifiers, Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. Applications of OPAMP: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector.	10	0	0	10
6	**Practical (15 Marks)** (At least 60% of the experiments must be performed) 1. To study V-I characteristics of PN junction diode,	0	0	30	30

	and Light emitting diode. 2. To study the V-I characteristics of a Zener diode and its use as voltage regulator. 3. To determine the ripple factor of half wave and full wave rectifier. 4. To study the characteristics of a Bipolar Junction Transistor in CE configuration. 5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias. 6. To study the frequency response of voltage gain of a RC-coupled transistor amplifier. 7. To design a phase shift oscillator of given specifications using BJT. 8. To study the Colpitt`s oscillator. 9. To design an inverting and non-inverting amplifier using Op-amp (741) for dc voltage of given gain. 10. To investigate the use of an op-amp as an Integrator. 11. To investigate the use of an op-amp as a Differentiator. 12. To design a digital to analog converter (DAC) of given specifications. 13. To study the analog to digital convertor (ADC) IC. 14. To design an inverting amplifier using Op-amp (741) for dc voltage of given gain. 15. To design inverting amplifier using Op-amp (741) and study its frequency response. 16. To design non-inverting amplifier using Op-amp (741) & study its frequency response. 17. To study the zero-crossing detector and comparator using Op-Amp (741).				
	Total	**45**	**0**	**30**	**75**

Recommended Readings:

1. Integrated Electronics, *J. Millman and C. C. Halkias*, Tata Mc-Graw Hill.
2. Electronics: Fundamentals and Applications, *J. D. Ryder*, Prentice Hall.
3. Solid State Electronic Devices, *B. G. Streetman & S. K. Banerjee*, PHI Learning.
4. Electronic Devices & circuits, *S. Salivahanan & N. S. Kumar*, Tata Mc-Graw Hill.
5. OP-Amps and Linear Integrated Circuit, *R. A. Gayakwad*, Prentice Hall.
6. Electronic circuits: Handbook of design and applications, *U. Tietze, C. Schenk*, Springer.
7. Semiconductor Devices: Physics and Technology, *S. M. Sze*, Wiley India.
8. Microelectronic Circuits, *M. H. Rashid*, Cengage Learning.
9. Electronic Devices, 7/e *Thomas L. Floyd*, Pearson India.
10. Principles of Electronics, *V.K. Mehta, Rohit Mehta*, S. Chand & Company.

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SEMESTER - IV

Paper Code	**C-PHY-408**	Total Credit	4
Paper Type	Core	Credit break-up	L - 45 T - 15 P - 0
Semester	IV	Contact Hours	60 hours
Title	**Atomic, Molecular and Laser Physics**		
Marks Distribution	In Sem – 40 + End Sem – 60		

Course Description: This course offers a comprehensive introduction to the quantum theory of atoms and molecules, along with the foundational principles and applications of laser physics. Students will explore the structure and spectra of hydrogen and hydrogen like atoms, the quantum mechanical basis of molecular bonding and spectroscopy, X-ray spectra and the interaction of electromagnetic radiation with matter including the concepts of stimulated emission, population inversion, and the design of various laser systems.

Course Objectives: The primary objective of this course is to provide undergraduate students with a deep and conceptual understanding of the structure of atoms and molecules, the interaction of electromagnetic radiation with matter, and the physical principles underlying laser operation.

By the end of the course, students will:

1. **Understand the quantum mechanical description of atoms and molecules**: Analyze atomic structure and spectra using principles of quantum mechanics, including multi-electron interactions and fine structures. Also understand the causes of Spectral line broadening and origin of X-ray spectra and their types.
2. **Explain molecular bonding and spectral transitions**: Explore the rotational, vibrational, and vibrational-rotational spectra using energy level models and selection rules.
3. **Understand the fundamental physics of light-matter interaction**: Understand absorption, spontaneous and stimulated emission processes through Einstein's coefficients and two-/three-level system models.
4. **Study the principles of laser action and types of lasers**: Learn about population inversion, optical pumping, laser gain, and resonant cavities, and examine different types of lasers and their characteristics.

Course Outcomes (CO)s: At the completion of this course, a student will be able to

CO1: Understand the quantum mechanical description of atoms and molecules**.**

LO1.1: Explain the origin of atomic spectra and fine structure.

LO1.2: Understand the selection rules and coupling schemes.

LO1.3: Explain the origin magneto optic and electro optic effects**.**

LO1.4: Understand the X-ray spectra.

CO2: Explain molecular bonding and spectral transitions**.**

LO2.1: Understand the Types of molecular spectra.

LO 2.2: Explain the origin of rotational and vibrational molecular spectra of diatomic molecules.

LO2.3: Understand molecular scattering and related phenomena.

CO3: Understand the fundamental physics of light-matter interaction and laser**.**

LO3.1: Understand absorption, spontaneous and stimulated emission processes**.**

LO3.2: Learn about population inversion and optical pumping**.**

LO3.3: Understand the operation of different types of lasers and their characteristics.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO 3		CO3		
Conceptual	LO1.1 LO1.2 LO1.3 CO1	CO 1				
Procedural	LO2.1 LO2.2 CO2	LO 3.2 LO 2.1 LO 1.2				
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	S	S	M	S	S	M
CO2	S	S	S	S	S	S	M	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S

(S: Strong, M: Medium, W: Weak)

Course Contents:

Unit	**Contents**	**L**	**T**	**P**	**Total Hours**
1	**Quantum Theory of Atoms (Marks 15)** Background of Quantum Theory: Bohr's model of the Hydrogen atom, origin of spectral lines, Hydrogen-Spectra, Bohr's correspondence principle, Sommerfeld's atom model, designation of spectral term symbol. Vector atom model, space quantization, Larmor precession, the four quantum numbers, spectral terms arising from L-S coupling and j-j coupling, selection	11	4	0	15

	rules				
2	**Fine structures of atoms (Marks 15)** Fine structure of hydrogen spectra, doublet spectra of Na-atom, Gyromagnetic ratio for orbital and spin motion, Lande's 'g' factor, strong and weak field effects, Zeeman Effect (normal and anomalous), qualitative ideas of Stark effect, Spectral line broadening and its causes.	11	4	0	15
3	**X-Ray Spectra (Marks 5)** Continuous and Characteristic X-ray Spectra, Moseley law, Fine structure of X-ray emission spectra, X-ray Absorption spectra.	4	1	0	5
4	**Molecular spectra (Marks 15)** Molecular spectra: Pure rotation spectra, theory of pure rotation spectra, selection rules, vibration spectra and selection rules, theory of rotation-vibration spectra, P and R branches, Rayleigh and Raman scattering, Raman effect, classical theory of Raman effect	11	4	0	15
5	**Basics of Lasers (Marks 10)** Introduction to Lasers: Spontaneous and stimulated emission, population inversion, Einstein's A and B coefficients, Metastable States, Optical Pumping and Population Inversion, Three-Level and Four-Level Lasers, qualitative ideas of Ammonia beam maser, Ruby laser, He-Ne laser	8	2	0	10
	Total	**45**	**15**	**0**	**60**

Suggested Readings:

1. Physics of Atoms and Molecues, B. H. Bransden and C. J. Joachain, 2rd Edition, Dorling Kindersley (India) Pvt. Ltd,. Pearson Education in South Asia.
2. Atomic Spectra, H.E. White McGraw Hill.
3. Atomic Physics, Max Born, Dover Publications, Inc., New York.
4. Molecular spectroscopy, Banwell and McCash Tata McGraw Hill.
5. Molecular Structure and Spectroscopy G. Aruldhas Prentice Hall of India.
6. Molecular Spectra and Molecular Structure G. Herzberg, McGraw Hill.
7. Lasers and Nonlinear Optics, B.B. Laud New Age International.
8. Laser Spectroscopy-Basic Concepts and Instrumentation, Wolfgang Demtröder, Springer.
9. Modern Spectroscopy, J M Hollas, John wiley& Sons.
10. Atomic and Molecular Spectra: Laser, Raj Kumar, Kedar Nath Ram Nath.

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SEMESTER - IV

Paper Code	**MIN-PHY-404**	Total Credit	4
Paper Type	Minor	Credit break-up	L - 3 T - 0 P - 1
Semester	IV	Contact Hours	75 hours
Title	**Thermal Physics**		
Marks Distribution	In Sem – 40 + End Sem – 45 + Lab – 15		

Course Description: This course covers fundamental thermodynamic principles and kinetic theory of gasses. The course starts with the main laws of Thermodynamics, energy conservation, isothermal and adiabatic processes, and the relationship between specific heats. Heat engines, Carnot cycles, and entropy concepts are also explored thereafter. Thermodynamic potentials like internal energy, enthalpy, and Gibbs free energy are studied, alongside Maxwell's relations and their applications. The kinetic theory section addresses the Maxwell-Boltzmann distribution, molecular collisions, and real gas behavior. By course end, students will understand and will be able to apply thermodynamic principles to various physical systems.

Course Objectives: Thermal physics is essential as it provides foundational knowledge of energy transformation and conservation principles crucial for various scientific and engineering disciplines. Understanding thermodynamics is crucial for designing and optimizing engineering systems like engines, refrigerators, and power plants. The course is equipped to provide students with analytical and problem-solving skills, enabling them to apply thermodynamic laws to real-world situations. Additionally, thermodynamics intersects with fields like chemistry, biology, and materials science, making it highly relevant for interdisciplinary applications. This course prepares students for advanced studies and careers in science and engineering by equipping them with essential theoretical and practical skills.

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Understand the fundamental principles of thermodynamics.
- **LO1.1:** Define extensive and intensive thermodynamic variables and their significance.
- **LO1.2:** Explain the Zeroth Law of Thermodynamics and its role in defining temperature.
- **LO1.3:** Interpret the First Law of Thermodynamics to analyze processes and calculate energy changes.

CO2: Experiment with apparatus for practical thermodynamic applications.
- **LO2.1:** Develop explanations for entropy changes in reversible and irreversible processes.
- **LO2.2:** Illustrate the implications of entropy in the context of the Second Law of Thermodynamics.

CO3: Apply thermodynamic potentials and their applications.
- **LO3.1:** Apply thermodynamic potentials such as internal energy, enthalpy, and Gibbs free energy to solve problems.
- **LO3.2:** Construct equations and relations using Clausius-Clapeyron and Ehrenfest equations.
- **LO3.3:** Summarize the performance of various thermodynamic cycles.

CO4: Analyze the behavior of gases and related phenomena.
- **LO4.1:** Describe the Maxwell-Boltzmann distribution and its significance.
- **LO4.2:** Analyze the behavior of real gases using the Van der Waals equation.

LO4.3: Apply the Joule-Thomson effect to analyze gas cooling processes.
LO4.4: Distinguish between reversible and irreversible processes and their implications.
LO4.5: Identify the efficiency of heat engines and refrigerators using the Second Law of Thermodynamics.
LO4.6: Explain the concept of entropy and its role in energy transformations.

Correlations of Learning Outcomes and Course Outcomes with Level of Learning:

Factual Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	LO1.1	CO1, LO1.2	LO3.1, LO4.5	LO4.2		
Conceptual		LO1.3, LO2.2, LO3.3, LO4.1,	LO2.1, CO3, LO4.3	CO4, LO4.4		
Procedural		LO4.6	CO2, LO3.2			
Metacognitive						

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	W	W	W	W	M	W
CO2	S	S	M	S	M	W	W	W	M	M
CO3	S	S	M	S	M	W	S	M	M	S
CO4	S	S	M	S	M	M	S	M	W	S
CO5	S	S	M	S	M	W	M	M	W	M

(S: Strong, M: Medium, W: Weak)

Unit	Contents	L	T	P	Total Hours
1	**Zeroth and First Law of Thermodynamics** Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Temperature Coefficient of Resistance, Concept of Work & Heat, Mechanical Equivalent of Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient.	6	0	0	6
2	**Second Law of Thermodynamics**	6	0	0	6

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	Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Theorem, Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.				
3	**Entropy** Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.	6	0	0	6
4	**Thermodynamic Potentials** Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.	6	0	0	6
5	**Maxwell's Thermodynamic Relations** Derivations and applications of Maxwell's Relations, Maxwell's Relations: (i) Clausius Clapeyron equation, (ii) Values of C_p-C_v, (iii) TdS Equations, (iv) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (v) Energy equations, (vi) Change of Temperature during Adiabatic Process	5	0	0	5
6	**Distribution of Velocities** Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific Heats of Gases.	5	0	0	5
7	**Molecular Collisions** Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (i) Viscosity, (ii) Thermal Conductivity and (iii) Diffusion. Brownian Motion and its Significance.	4	0	0	4
8	**Real Gasses** Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waals Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.	7	0	0	7

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9	**Practical (any three)** 6. To determine Mechanical Equivalent of Heat, J by Callender and Barne’s constant flow method. 7. To determine the Coefficient of Thermal Conductivity of Cu by Searle’s Apparatus/Angstrom’s Method. 8. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton’s disc method. 9. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT). 10. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.	0	0	30	30
	Total	**45**	**0**	**30**	**75**

Recommended Readings:

1. Heat and Thermodynamics, *M.W. Zemansky and R. Dittman,*McGraw-Hill.
2. A Treatise on Heat, *M. Saha, and B. N. Srivastava*, Indian Press.
3. Thermal Physics, *S. Garg, R. Bansal and Ghosh*, Tata McGraw-Hill.
4. Modern Thermodynamics with Statistical Mechanics, *C. S. Helrich*, Springer.
5. Heat Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam and P. S. Hemne, S. Chand.
6. Concepts in Thermal Physics, *S. J. Blundell and K. M. Blundell*, 2012, Oxford University Press.
7. Thermal Physics, *A. Kumar and S. P. Taneja*, R. Chand Publications.
8. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, *Sears & Salinger*.

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