Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE AND COMMERCE, BARAMATI

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

Faculty of Science

Department of Physics

Proposed Syllabus Submitted to

BoS

For

M.Sc. in Physics

Semester-I

From Academic Year 2022-2023

Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE AND COMMERCE, BARAMATI

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Course Structure

M.Sc.-I

Semester-I

Course Structure

Course Number	Course Code	Course Name	Credit
1	PSPH 111	Mathematical Methods in Physics	4
2	PSPH 112	Classical Mechanics	4
3	PSPH 113	Quantum Mechanics-I	4
4	PSPH 114	Electronics	4
5	PSPH 115	Electronics Laboratory-I	4
6	PSPH 116	Basic Physics Laboratory-I	4
Total Credit			**24**

Programme Outcomes (POs)

PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the discipline that forms a part of a postgraduate Programme. Execute strong theoretical and practical understanding generated from the specific Programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	**Social competence:** Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise way and help reach conclusions in group settings.
PO4	**Research-related skills and Scientific temper :** Infer scientific literature, build a sense of enquiry and able to formulate, test, Analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	**Trans-disciplinary knowledge:** Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Perform independently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

M. Sc-I (Physics) Semester-I

PSPH 111: MATHEMATICAL METHODS IN PHYSICS

Credit: 04 **Total No. of Lectures: 60**

Learning outcomes:

After completion of the course, the student should be able to:

CO1: From this course, the students are expected to learn some mathematical techniques required to understand the physical phenomena at the postgraduate level.

CO2: The students are expected to be able to solve simple problems in probability, understand the concept of independent events and work with standard continuous distributions.

CO3: The students will have idea of the functions of complex variables; solve nonhomogeneous differential equations and partial differential equations using simple methods.

CO4:The students are expected to be able to solve simple problems on Fourier series and Fourier transform, Laplace transform etc.

CO5: Students are able to solve ordinary second order differential equations important in the physical sciences; solve physically relevant partial differential equations using standard methods like separation of variables, series expansion, and integral transforms.

CO6: Students have a good grasp of the basic elements of complex analysis, including the important integral theorems.

CO7: Students are able to apply variational calculus to find optimal curves and surfaces

CO8: Problem solving ability.

CO9: Critical Analysis

Unit 1: Complex Analysis **(1 Credit)**

Complex number, Complex function (polynomial, Exponential, Trigonometric complex function, Logarithm), differentiation, Analytical function, Cauchy-Riemann condition, Line integrals, Cauchy integral formula, Derivative of analytical functions, Power Series, Taylor's theorem, Laurent's theorem, Calculus of residues, Evaluation of real definite integrals

References: 1-5

Unit 2: Vector Space and Matrix Algebra **(1 Credit)**

Revision on Vector space: Vectors (dependent and independent), Vector space, Hilbert space, Dimension of vector space, Matrix representation, Similarity transformation, Eigen values and Eigen vectors, Inner product, Orthogonality, Introduction only to Gramm-Schmidt orthogonalization procedure.

Matrix: Types of matrix, Rank of matrix, Eigen values and Eigen vectors, Unitary transformation, Diagonalization

References: 6, 7

Unit 3: Special Functions **(1 Credit)**

Bessel function, Legendre, Hermite, and Laguerre functions – Generating function, Recurrence relations and their differential equations, Orthogonality properties, Bessel's function of first and second kind.

References: 4, 5, 7

Unit 4: Fourier Series and Integral Transforms **(1 Credit)**

Fourier series: Definition, Dirichlet's Condition, Fourier Integral and Fourier transform, convolution theorem, Parseval's identity, Laplace transform and its properties, Fourier transform and Laplace transform, Dirac Delta function.

References: 3, 4, 7

Reference Books:

1. Complex Variables and Application- J. W. Brown, R. V. Churchill - McGraw Hill
2. Complex Variables – Seymour Lipschutz
3. Mathematics for Physical Sciences – Mary Boas, John Wiley and Sons
4. Mathematical methods in Physics- B. D. Gupta
5. Mathematical methods in Physics- Satyaprakash
6. Linear algebra – Seymour Lipschutz, Schaum Outline Series McGraw Hill Edition
7. Mathematical Method for Physicists, Arfken and Weber, 6th Edition,Academic Press, N. Y.
8. Fourier Series - Seymour Lipschutz, Schaum Outlines Series

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes								
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**
CO 1	3								2
CO 2		3							
CO 3				3					
CO 4					1				
CO 5				2					
CO 6		3				3			
CO7				2		3			
CO8									
CO9									

Justification

PO1: Disciplinary Knowledge

CO1: The course focuses on mathematical techniques required for understanding physical phenomena at the postgraduate level. Weightage: 3

PO2: Critical Thinking and Problem Solving

CO2: Solving problems in probability and understanding independent events require critical thinking skills. Weightage: 3

CO6: Problem-solving ability directly aligns with critical thinking and problem-solving skills. Weightage: 3

PO4: Research-related Skills and Scientific Temper

CO3: Solving nonhomogeneous differential equations and partial differential equations involves scientific temper and research-related skills. Weightage: 3

CO5: Understanding complex analysis, including integral theorems, contributes to scientific temper. Weightage: 2

CO7: Critical analysis involves a scientific temper and research-related skills to analyze information. Weightage: 2

PO5: Trans-disciplinary Knowledge

CO4: While Fourier series and transforms are used in various disciplines, the specific content in this CO might not directly contribute to trans-disciplinary knowledge. Weightage: 1

PO6: Personal and Professional Competence

CO6: Problem-solving ability is a key aspect of personal and professional competence. Weightage: 3

CO7: Critical analysis contributes to personal and professional competence. Weightage: 3

PO9: Self-directed and Life-long Learning

CO1: Learning mathematical techniques contributes to the ability to learn independently and continuously. Weightage: 2

M.Sc. I (Physics) Semester-I

PSPH 112: CLASSICAL MECHANICS

Credit: 04 **No. of Lectures: 60**

Learning outcomes: After completion of the course, the student should be able to:

CO1: The students will introduce about the newton's laws of motion and knowledge about the applications of newton's laws of motion.

CO2: This paper enables the students to understand the Langrangian approach in classical mechanics.

CO3: The students should be able to understand Hamiltonian formulation with applications

CO4: The paper also enables the students to know about variational principle with applications.

CO5: The students should be able to understand central forces and types of central forces in detail, ideas regarding equations of orbit and deduction of Kepler's laws.

CO6: Students learn about motion of a particle under central force field.

CO7: Students learn about Langrangian and Hamiltonian formulation of Classical Mechanics.

CO8: Problem solving ability

CO9: Critical analysis

Unit 1: Constrained Motion and Langrangian formulation (1 Credit)

Constrained Motion, Constraints and their Classification**,** Degrees of freedom, generalized coordinates, Virtual Displacement, Principle of Virtual Work, D'Alembert Principle, Configuration space, Lagrange's equation of motion, Theorem on total energy, Cyclic coordinates, Generalized momenta.

Problems solving

Unit 2: Hamilton's formulation and Variational Principle (1 Credit)

Hamilton's function and Hamiltonian equation of motion, Phase space, Jacobi integrals and energy conservation, Langrangian and Hamiltonian of relativistic particles and light rays, Variational principle, Euler's equation, Applications of Variational principle, Concept of symmetry.

Problems solving

Unit 3: Canonical Transformations and Poisson's Bracket (1 Credit)

Introduction- Background and definition, Legendre transformations, Generating function, Conditions for canonical transformation, Poisson's bracket-definition, identities, Poisson's theorem, Jacobi identity, Invariance of Poisson Bracket under canonical transformation.

Problems solving

Unit 4: Central Forces and Non-Inertial Frames of Reference (15 L)

Introduction, definition, and properties of Central Force, two body central force problem, Stability of orbit, Orbits of artificial satellite, Kepler's problem, Inertial forces in rotating frame, Coriolis force and its effect, Foucault's pendulum.

Problems solving

Reference Books:

1. Classical mechanics by J.C. Upadhyaya, Himalaya Publishing House.

2. Classical mechanics by N.C. Rana and P.S. Jog, Tata Mc-Graw Hill Publishing Company limited, New Delhi.

3. Classical Mechanics by P.V. Panat, Narosa publishing Home, New Delhi.

4. Classical Mechanics by Kumar, Gupta, Sharma.

5. Classical Mechanics by H. Goldstein, Narosa Publishing Home, New Delhi.

6. Classical Mechanics by D. S. Mathur.

7. Introduction to Classical Mechanics by R. G. Takawale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes								
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**
CO 1	3								2
CO 2	3			3					
CO 3		3		3					
CO 4		3		3					
CO 5		3							
CO 6						3			
CO7						3			
CO8		2							
CO9		2							

Justification

PO1: Disciplinary Knowledge

CO1: 3 Introduction to Newton's laws of motion directly contributes to disciplinary knowledge in classical mechanics. Weightage: 3

CO2: 3 Understanding the Langrangian approach in classical mechanics is a core aspect of disciplinary knowledge. Weightage: 3

PO2: Critical Thinking and Problem Solving

CO3: Understanding Hamiltonian formulation and its applications involves critical thinking in classical mechanics. Weightage: 3

CO4: Knowledge about variational principles and their applications requires critical thinking and problem-solving skills. Weightage: 3

CO5: Understanding central forces, types, equations of orbit, and deduction of Kepler's laws involves critical thinking and problem-solving. Weightage: 3

CO8: Problem solving ability Weightage: 2

Calculating the correct answer requires problem-solving skills in the context of classical mechanics.

CO9: Critical analysis Weightage: 2 Understanding concepts requires critical thinking and problem-solving skills in the context of classical mechanics.

PO4: Research-related Skills and Scientific Temper

CO2: Understanding the Langrangian approach involves some level of scientific temper and research-related skills. Weightage: 2

CO3: Hamiltonian formulation with applications requires scientific temper and research-related skills. Weightage: 2

CO4: Knowledge about variational principles involves scientific temper and research-related skills. Weightage: 2

PO6: Personal and Professional Competence

CO6: Learning about the motion of a particle under a central force field contributes to personal and professional competence. Weightage: 3

CO7: Understanding Langrangian and Hamiltonian formulations in Classical Mechanics enhances personal and professional competence. Weightage: 3

PO9: Self-directed and Life-long Learning

CO1: Introduction to Newton's laws of motion provides foundational knowledge for self-directed and life-long learning. Weightage: 2

M. Sc-I (Physics) Semester-I

PSPH 113: QUANTUM MECHANICS- I

Credit: 04 **Total No. of Lectures: 60**

Course outcomes:

After completion of the course, the student should be able to:

CO1.Understand the drawbacks of Classical Mechanics and necessity of Quantum Mechanics
CO2. Understand the behaviour of particles under Classical and Quantum conditions.
CO3. Understand the Operators in Quantum Mechanics.
CO4. Learn about Approximation Methods to solve problems.
CO5. Understand scattering of particle and symmetric and antisymmetric functions.
CO6. Perform calculations using angular momentum techniques
CO7. Manipulate expressions using Dirac's notation.

Unit 1: General Formalism of Quantum mechanics (1 Credit)

Postulates of Quantum Mechanics Representation of states and dynamical variables, observables, self-adjoint operators, eigen functions and eigen values, degeneracy, Dirac delta function, Completeness and closure property, Physical interpretation of eigen values, eigen functions and expansion coefficients, eigen values and eigen functions of momentum operator.

Unit 2: Representation of States – Dirac notation (1 Credit)

Hilbert space, Dirac's bra and ket notations and its properties, dynamical variables and linear operators, projection operator, unit and unitary operator, matrix representation of an operator, change of basis, unitary transformation. Eigen values and eigen functions of simple harmonic oscillator by operator method.

Unit 3: Angular Momentum (1 Credit)

Eigen values and eigen functions of L^2 and Lz operators, ladder operators L+ and L–, Pauli theory of spins (Pauli's matrices), matrix representation of J in |jm> basis. Addition of angular momenta, Computation of Clebsch-Gordon coefficients in simple cases (J1=1/2, J2=1/2)

Unit 4: Approximation Methods **(1 Credit)**

Time-independent Perturbation theory: Nondegenerate, Stark effect, Time dependent Perturbation theory: Transition amplitude 1^{st} and 2^{nd} order, Fermi's Golden rule, Harmonic perturbation.

Reference Books:

1. A Textbook of Quantum Mechanics by P.M. Mathews and Venkatesan.
2. Quantum mechanics by A. Ghatak and S. Lokanathan
3. Quantum Mechanics by L.I. Schiff
4. Modern Quantum mechanics by J. J. Sakurai
5. Quantum Physics by R. Eisberg and R. Resnick
6. Introduction to Quantum Mechanics by David J. Griffiths
7. Introductory Quantum mechanics by Granier, Springer Publication.
8. Introductory Quantum Mechanics, Li Boff, 4^{th} Edition, Pearson Education Ltd
9. Quantum Mechanics Noureddine Zettili, A John Wiley and Sons, Ltd., Publication
10. Principles of Quantum Mechanics, Shankar R. II^{nd} Edition (Plenum, 1994)
11. Advanced Quantum Mechanics by Satyaprakash.
12. Quantum mechanics by Chatwal Anand 4^{th} edition.

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes								
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**
CO 1	3								3
CO 2	3			2					
CO 3		3							
CO 4		3							
CO 5									
CO 6		3							
CO7				3					
CO8									
CO9									

Justification

PO1: Disciplinary Knowledge

CO1: Understanding the drawbacks of Classical Mechanics and the necessity of Quantum Mechanics directly contributes to disciplinary knowledge. Weightage: 3

CO2: Understanding the behavior of particles under Classical and Quantum conditions is a fundamental aspect of disciplinary knowledge. Weightage: 3

PO2: Critical Thinking and Problem Solving

CO3: Understanding operators in Quantum Mechanics involves critical thinking and problem-solving skills. Weightage: 3

CO4: Learning approximation methods to solve problems requires critical thinking and problem-solving skills. Weightage: 3

CO6: Applying principles of Quantum Mechanics to calculate observables involves critical thinking and problem-solving. Weightage: 3

PO4: Research-related Skills and Scientific Temper

CO2: Understanding the behavior of particles under Classical and Quantum conditions involves scientific temper and research-related skills. Weightage: 2

CO7: Applying non-relativistic quantum mechanics to areas like spectroscopy, nanotechnology, and solid-state physics involves research-related skills and scientific temper. Weightage: 3

PO9: Self-directed and Life-long Learning

CO1: Understanding the drawbacks of Classical Mechanics and the necessity of Quantum Mechanics provides a foundation for self-directed and life-long learning. Weightage: 3

M. Sc-I (Physics) Semester-I

PSPH 114: ELECTRONICS

Credit: 04 **No. of Lectures: 60**

Course outcomes:

After completion of the course, the student should be able to:
CO1: Manipulate voltage, current and resistances in electronic circuits
CO2: Demonstrate familiarity with basic electronic components and use them to design simple electronic circuits
CO3: Design and analyse of electronic circuits,
CO4: Evaluate frequency response to understand behaviour of Electronics circuits
CO5: Problem solving ability
CO6: Critical analysis
CO7: Understand the fundamentals of converting from one number system to another.

Unit 1: Study and applications of Operational Amplifiers (1 Credit)

Characteristic of op-amp, Parameters of ideal op-amp, Applications of Operational Amplifiers: Inverting and Non-inverting amplifier, Adder and Subtractor, Integrator and Differentiator, Active filters: LPF, HPF, BPF, and Notch filter 1^{st} and 2^{nd} order with designing, Instrumentation Amplifier, Function Generator – Square wave, triangular, saw tooth, sine wave. Half wave and full wave precision rectifiers, Sample and hold circuits.

Unit 2: Communication Electronics (1 Credit)

Basic principle of amplitude, frequency and phase modulation, Simple circuits for amplitude modulation and demodulation, Digital modulation (PCM) and demodulation, Fundamentals of optical communication, Microwave Oscillators (reflex, klystron, magnetron and Gunn diode), Radio detector

Unit 3: Digital Logic circuits (1 Credit)

Combinational Logic: Review of Boolean identities and its use to minimize Boolean Expressions, Minimization of Boolean Expressions using Karnaugh map: SOP and POS, Multiplexer and Demultiplexer
Sequential Logic; Flip-flops (RS, JK, MS-JK, D and T),
Shift registers using IC 7495: Applications as SISO, SIPO, PISO, PIPO etc
Counters: Synchronous, asynchronous and combinational counters, Decade counter IC 7490 with applications, Up-down counter

Unit 4: Data Converters **(1 Credit)**

Digital to analog Converters: Binary weighted type, R-2R ladder, Study of IC 0808,
Analog to digital converters: Single slope, Dual slope, Flash/Simultaneous type, Counter type, Successive approximation type

Reference Books:

1. Operational Amplifiers – G.B.Clayton (5th edition) Newnes
2. Operational Amplifiers Applications – G.B.Clayton
3. Electronic Principles – A. P. Malvino (TMH Publication)
4. Op-amps and Linear Integrated circuits – Gayakwad (Prentice Hall)
5. Linear Integrated circuits – D.Roy Choudhury, Shail Jain
6. Integrated circuits – Botkar
7. Digital Principles and Applications: Leach and Malvino
8. Data Converters – B.S. Sonde.

Course Outcomes	Programme Outcomes								
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3								
CO 2	3								
CO 3		3							2
CO 4									
CO 5		3							
CO 6		3							
CO7									

Mapping of Program Outcomes with Course Outcomes

Justification

PO1: Disciplinary Knowledge

CO1: Manipulating voltage, current, and resistances in electronic circuits directly contributes to disciplinary knowledge in electronics. Weightage: 3

CO2: Demonstrating familiarity with basic electronic components and designing simple electronic circuits is a core aspect of disciplinary knowledge. Weightage: 3

PO2: Critical Thinking and Problem Solving

CO3: Designing and analyzing electronic circuits involves critical thinking and problem-solving skills. Weightage: 3

CO5: Problem-solving ability directly aligns with critical thinking and problem-solving skills. Weightage: 3

CO6: Critical analysis is essential when evaluating frequency responses and understanding the behavior of electronic circuits. Weightage: 3

PO9: Self-directed and Life-long Learning

CO3: Designing and analyzing electronic circuits contributes to self-directed and life-long learning in the field of electronics. Weightage: 2

M.Sc. I (Physics) Semester-I

PSPH-115: Electronics Laboratory-I

Credits: 04 **No of Practicals:10**

Course outcomes: After completion of the course, the student should be able to:

CO1: Understand mathematical description and representation of continuous and discrete time signals and systems.

CO2: Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.

CO3: Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in s-domain.

CO4: Understand the basic concept of probability, random variables & random signals and develop the ability to find correlation, CDF, PDF and probability of a given event.

CO5: Comply and verify parameters after exciting devices by any stated method.

CO6: Implement circuit and test the performance.

CO7: Design and analyze circuits.

(Students must perform Any 8 Experiments)

1. Voltage to Frequency Convertor using OP-AMP.
2. DAC (4-bit R-2R Ladder Type).
3. Active filter- Low pass, High pass, Band pass and Notch Filter using OP-AMP.
4. Function generator using OP-AMP.
5. Constant current source using OP-AMP.
6. Study of multiplexer and Demultiplexer.
7. Frequency modulation and demodulation.
8. Pulse code modulation and demodulation.
9. FSK modulation and demodulation.
10. Amplitude modulation and demodulation
11. Optical fibre communication.
12. Op-amp based clipper and clampers

Additional Activity (Any one Activity equivalent to two experiments)

Students must perform at least one additional activity out of two activities in addition to eight experiments mentioned above. Total Laboratory work with additional activities should be equivalent to ten experiments.

1. **Mini Projects**

2. **Industrial Visit / Study Tour / Field visit**

Course Outcomes	Programme Outcomes								
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3								2
CO 2		3							
CO 3				2					
CO 4				2		3			
CO 5									
CO 6		3				3			
CO7									

Mapping of Program Outcomes with Course Outcomes

Justification

PO1: Disciplinary Knowledge

CO1: Understanding the limitations of Fourier transform, the need for Laplace transform, and analysing systems in the s-domain directly contributes to disciplinary knowledge in signal processing and control systems. Weightage: 3

PO2: Critical Thinking and Problem Solving

CO2: Understanding the basic concept of probability, random variables, and random signals, along with the ability to find correlation, CDF, PDF, and probability of a given event, involves critical thinking and problem-solving skills. Weightage: 3

CO6: Problem-solving ability directly aligns with critical thinking and problem-solving skills. Weightage: 3

PO4: Research-related Skills and Scientific Temper

CO3: Complying and verifying parameters after exciting devices by any stated method involves scientific temper and research-related skills. Weightage: 2

CO4: Implementing circuits and testing performance requires scientific temper and research-related skills. Weightage: 2

PO6: Personal and Professional Competence

CO4: Implementing circuits and testing performance contributes to personal and professional competence. Weightage: 3

CO5: Designing and analyzing transformers enhances personal and professional competence. Weightage: 3

PO9: Self-directed and Life-long Learning

CO1: Understanding the limitations of Fourier transform and the need for Laplace transform contributes to the ability for self-directed and life-long learning. Weightage: 2

M.Sc. I (Physics) Semester-I

PSPH-116: Basic Physics Laboratory-I

Credits: 04 **No of Practicals:10**

Course outcomes: After completion of the course, the student should be able to:

CO1: The students would be able to have strong foundation knowledge and comprehend the basic concepts and principles in Physics.

CO2: The students would be able to experience a well-resourced environment for learning Physics

CO3: To motivate and inspire the students to create deep interest in Physics, to develop broad and balanced knowledge and understanding of physical concepts, principles and theories of Physics.

CO4: Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.

CO5: Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics.

CO6: Emphasize the discipline of Physics to be the most important branch of science for

(Students must perform Any 8 Experiments)

1. Young's Modulus of steel by Flexural Vibrations of a bar
2. Fabry-Parot Etalon.
3. Hall Effect.
4. Resistivity of Ge at various temperature by Four Probe method and determination of band gap.
5. Determination of wavelength of He-Ne LASER by Reflection grating
6. Michelson Interferometer.
7. Magnetic Susceptibility by Gauoy's method.
8. 'e' by Millikan oil drop method.
9. G.M. Counter – I Counting statistics
10. G.M. Counter –II End point energy and Absorption coefficient using G. M. tube.
11. Measurement of the focal length of a given convex lens using a laser.
12. Electron Diffraction.
13. Determination of wavelength of He-Ne LASER by transmission grating
14. Coherence and width of spectral lines using Michelson Interferometer.
15. Determination of Seebeck coefficient and understanding of Thermocouple working.

Additional Activity (Any one Activity equivalent to two experiments)

Students must perform at least one additional activity out of two activities in addition to eight experiments mentioned above. Total Laboratory work with additional activities should be equivalent to ten experiments.

1. **Mini Projects**
2. **Industrial Visit / Study Tour / Field visit**

Course Outcomes	Programme Outcomes								
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**
CO 1	3								2
CO 2								3	
CO 3		2							
CO 4		3		2					
CO 5				3					
CO 6		3							
CO7		3							

Mapping of Program Outcomes with Course Outcomes

Justification

PO1: Disciplinary Knowledge

CO1: Comprehending basic concepts and principles in Physics directly aligns with the goal of building a strong foundation in disciplinary knowledge. Weightage: 3

PO2: Critical Thinking and Problem Solving

CO3: Motivating and inspiring students to create deep interest in Physics involves elements of critical thinking and problem-solving. Weightage: 2

CO4: Learning, designing, and performing experiments in labs to demonstrate concepts involve critical thinking and problem-solving skills. Weightage: 3

CO6: Problem-solving ability directly aligns with critical thinking and problem-solving skills. Weightage: 3

CO7: Critical analysis involves critical thinking and aligns with problem-solving skills. Weightage: 3

PO4: Research-related Skills and Scientific Temper

CO4: Learning, designing, and performing experiments in labs to demonstrate concepts involve research-related skills. Weightage: 2

CO5: Developing the ability to apply knowledge to specific problems in theoretical and experimental Physics involves research-related skills and scientific temper. Weightage: 3

PO8: Environment and Sustainability

CO2: Experiencing a well-resourced environment for learning Physics contributes to the understanding of the environment and sustainability. Weightage: 3

PO9: Self-directed and Life-long Learning

CO1: Having a strong foundation in Physics contributes to the ability for self-directed and life-long learning. Weightage: 2