CO-PO attainment
in
CCFUP Programme
in
Outcome Based Education

Department of Physics

Government General Degree College, Kalna-I

Program Outcome (PO)

- ❖PO1: Disciplinary knowledge
- ❖PO2: Communication Skills
- ❖PO3: Critical thinking
- ❖PO4 : Problem solving
- ❖PO5: Self directed learning
- ❖PO6: Research-related skills
- ❖PO7: Scientific reasoning
- ❖PO8: Information/digital literacy
- ❖PO9: Lifelong learning

Program Specific Outcome (PSO): UG Physics

❖PSO1: **Foundation for Theoretical Concepts of Physics:** To use theoretical methodologies to explain physical laws around us.

❖PSO2: **Foundation for Experimental/Numerical tools of Physics :** The ability to implement/visualize the theoretical knowledge through laboratory based experimental /numerical techniques.

❖PSO3: **Foundation for possible further developments** : The ability to grasp the scientific ideas behind different physical laws and connecting them to broad area of real life applications and provide new ideas and innovations towards research.

Course Content

Semester: I

Course code : Major-Physics

Course name: Mathematical Physics-I

Course Code: PHYS1011
(Credits: Theory-03, Practicals-01)

MAJOR-I: F.M.=75 (Theory-40, Practical–20, Internal Assessment–15)

COURSE OBJECTIVE: The aim of this course is to equip the students with mathematical methods that are important prerequisites for physics courses.

Theory: 45 Lectures

Calculus:

Recapitulation: Limits, Continuity, Average and instantaneous quantities, Differentiation. Plotting functions. Intuitive ideas of continuous, differentiable etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). (3 Lectures)

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of the existence and the Uniqueness theorem for Initial Value Problems. Particular Integral. (9 Lectures)

Calculus of functions of more than one variable: Partial derivatives, Exact and inexact differentials. (6 Lectures)

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. (5 Lectures)

Vector Differentiation: 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. (6 Lectures)

Vector Integration: Ordinary integrals of vectors, Multiple integrals, Jacobian. Notion of an 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). (10 Lectures)

Orthogonal Curvilinear Coordinates: Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. (6 Lectures)

Practical: 30 Lectures

Introduction and Overview: Computer architecture and organization, Memory, Input/Output devices.

Basics of scientific computing: Binary and decimal arithmetic, Floating point numbers, Algorithms, Sequence, Selection and Repetition, Single and double precision arithmetic, Underflow and overflow, Emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.

Errors and Error-Analysis: Truncation and round off errors, Absolute and relative errors, Floating point computations.

Review of C & C++ Programming Fundamentals: Introduction to Programming, Constants, Variables, Data types, Operators and expressions, I/O statements, scanf and printf, cin and cout, Manipulators for data formatting, Control statements (Decision making statements: if statement, if else Statement, Nested if structure, else if ladder statement, Ternary Operator, goto statement, switch case statement. Unconditional and conditional looping: while loop, do-while loop, for loop, break and continue statements, Nested loops). Arrays (1D & 2D), Strings, User defined functions, Structure and Union, Idea of classes and objects.

1. Write and execute a program in C/C++ to compute the factorial of a positive integer including Zero.
2. Write and execute a program in C/C++ to calculate sum of squares of n natural numbers.
3. Write and execute a program in C/C++ to find the area and the volume of a Sphere by varying the radius.
4. Write and execute a program in C/C++ to display Fibonacci series.
5. Write and execute a program in C/C++ to find the value of Sine function using power series
6. Write and execute a program in C/C++ to find the value of Cosine function using power series
7. Write and execute a program in C/C++ to find the value of ex (x will be given during execution of the program).
8. Write and execute a program in C/C++ to sort elements of an array of elements in ascending/ descending order.
9. Write and execute a program in C/C++ to separate odd and even integers in arrays.
10. Write and execute a program in C/C++ to find the largest and smallest in a given set of numbers.
11. Write and execute a program in C/C++ to calculate value of π.

Course Outcome (CO) **Paper: PHYS1011**

Sl. No.	Course Outcome (CO)	Knowledge Level	POs	PSOs
Theory				
1	**Discussion** of the fundamental concepts of calculus, graphical representation, and approximation techniques. **Identification** and classification of different types of differential equations.	**L1: Remembering**	**1,2,3,7,8,9**	**1,2,3**
2	**Computation** of the First Order and Second Order Differential Equations, and solution of Particular Integral of a non-homogeneous linear differential equation. **Demonstration** of the concept of Partial derivatives.	**L3: Applying**	**1,2,3,4,5,6,7,8,9**	**1,2,3**
3	**Discussion** of the fundamental properties of vector algebra.	**L1: Remembering**	**1,2,3,4,5,7,9**	**1,2,3**
4	**Computation** of the differentiation and integration of vector fields and application of the techniques to solve problems in electromagnetism, fluid dynamics, and other fields.	**L3: Applying**	**1,2,3,4,5,6,7,8,9**	**1,2,3**
5	**Development** of a deeper understanding of orthogonal curvilinear coordinate systems of vector calculus and its geometric underpinnings.	**L6: Creating**	**1,2,3,4,5,6,7,8,9**	**1,2,3**
Practical				
1	**Outline** of the C Programming fundamentals	**L1: Remembering**	**1,2,3,4,5,6,7,8,9**	**1,2,3**
2	**Computation** of basic mathematical operation using C prograninning	**L3: Applying**	**1,2,3,4,5,6,7,8,9**	**1,2,3**

Programme Articulation Matrix (CO-PO Matrix)

	CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3
Theory	1	3	3	2	-	-	-	2	3	3	3	2	2
	2	3	3	2	2	2	2	2	2	2	2	2	2
	3	2	2	3	3	3	-	3	-	3	3	3	3
	4	3	3	3	3	3	3	3	2	2	2	3	3
	5	3	2	3	3	2	3	3	2	2	2	3	3
Practical	1	3	3	3	3	3	3	3	3	3	3	3	3
	2	3	3	3	3	3	3	3	3	3	3	3	3
	Average	2.9	2.7	2.7	2.8	2.7	2.8	2.7	2.8	2.6	2.6	2.7	2.7

Course Content

Semester: I

Course code : SEC-1: PHYS1051

Course name: RENEWABLE ENERGY AND ENERGY HARVESTING
(Credits: Theory-03)

SEC-1: F.M.=50 (Theory-40, Internal Assessment–10)

Theory

COURSE OBJECTIVE: The aim of this course is to impart knowledge about Renewable energy and energy harvesting in context of energy crisis and provide them with exposure and hands-on learning wherever possible.

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.
(3 Lectures)

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.
(6 Lectures)

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.
(3 Lectures)

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. (3 Lectures)
Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. (2 Lectures)

Geothermal Energy: Geothermal Resources, Geothermal Technologies. (2 Lectures)

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. (2 Lectures)

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power. (4 Lectures)

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications.
(2 Lectures)

Carbon captured technologies, cell, batteries, power consumption. (2 Lectures)

Environmental issues and Renewable sources of energy, sustainability. (1 Lecture)

Course Outcome (CO) Paper: SEC-1: PHYS1051

Sl. No.	Course Outcome (CO)	Knowledge Level (Bloom's Level)	POs	PSOs
1	**Identify** renewable and non-renewable energy sources in the context of energy crisis	**L1: Remembering**	**1,2,3,5,9**	**1,2,3**
2	**Give example** of Solar, Wind, Geothermal, Ocean, Hydro energy sources	**L2: Understanding**	**1,2,3,4,5,7,9**	**1,2,3**
3	**Demonstrating** the fundamental ideas of Piezoelectric and Electromagnetic Energy harvesting	**L3: Applying**	**1,2,3,5,6,7,9**	**1,2,3**
4	**Illustrate** the basic concepts of Carbon capture technologies and Environmental issues along with sustainability of Renewable sources of energy	**L4: Analyzing**	**1,2,3,5,7,8,9**	**1,2,3**

Programme Articulation Matrix (CO-PO Matrix)

CO	**Program Outcome (PO) & Program Specific Outcome (PSO)**											
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3
1	3	3	2	-	2	-	-	-	2	3	3	2
2	3	3	2	2	2	-	2	-	2	3	3	3
3	2	2	3	-	3	2	3	-	3	2	2	3
4	3	3	3	-	3	-	3	2	3	2	3	3
Average	2.8	2.8	2.5	2.0	2.5	2.0	2.6	2.0	2.5	2.7	2.8	2.5

Course Content

Semester: I

Course code : Minor-Physics

Course name: Mathematical Physics-I

Course Code: PHYS1021
(Credits: Theory-03, Practicals-01)

MINOR-I: F.M.=75 (Theory-40, Practical–20, Internal Assessment–15)

COURSE OBJECTIVE: The aim of this course is to equip the students with mathematical methods that are important prerequisites for physics courses.

Theory: 45 Lectures

Calculus:

Recapitulation: Limits, Continuity, Average and instantaneous quantities, Differentiation. Plotting functions. Intuitive ideas of continuous, differentiable etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). (3 Lectures)

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of the existence and the Uniqueness theorem for Initial Value Problems. Particular Integral. (9 Lectures)

Calculus of functions of more than one variable: Partial derivatives, Exact and inexact differentials. (6 Lectures)

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. (5 Lectures)

Vector Differentiation: 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. (6 Lectures)

Vector Integration: Ordinary integrals of vectors, Multiple integrals, Jacobian. Notion of an 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). (10 Lectures)

Orthogonal Curvilinear Coordinates: Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. (6 Lectures)

Practical: 30 Lectures

Introduction and Overview: Computer architecture and organization, Memory, Input/Output devices.

Basics of scientific computing: Binary and decimal arithmetic, Floating point numbers, Algorithms, Sequence, Selection and Repetition, Single and double precision arithmetic, Underflow and overflow, Emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.

Errors and Error-Analysis: Truncation and round off errors, Absolute and relative errors, Floating point computations.

Review of C & C++ Programming Fundamentals: Introduction to Programming, Constants, Variables, Data types, Operators and expressions, I/O statements, scanf and printf, cin and cout, Manipulators for data formatting, Control statements (Decision making statements: if statement, if else Statement, Nested if structure, else if ladder statement, Ternary Operator, goto statement, switch case statement. Unconditional and conditional looping: while loop, do-while loop, for loop, break and continue statements, Nested loops). Arrays (1D & 2D), Strings, User defined functions, Structure and Union, Idea of classes and objects.

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8. Write and execute a program in C/C++ to sort elements of an array of elements in ascending/ descending order.
9. Write and execute a program in C/C++ to separate odd and even integers in arrays.
10. Write and execute a program in C/C++ to find the largest and smallest in a given set of numbers.
11. Write and execute a program in C/C++ to calculate value of π.

Course Outcome (CO)	Paper: PHYS1021

Sl. No.	Course Outcome (CO)	Knowledge Level	POs	PSOs
Theory				
1	**Discussion** of the fundamental concepts of calculus, graphical representation, and approximation techniques. **Identification** and classification of different types of differential equations.	**L1: Remembering**	**1,2,3,7,8,9**	**1,2,3**
2	**Computation** of the First Order and Second Order Differential Equations, and solution of Particular Integral of a non-homogeneous linear differential equation. **Demonstration** of the concept of Partial derivatives.	**L3: Applying**	**1,2,3,4,5,6,7,8,9**	**1,2,3**
3	**Discussion** of the fundamental properties of vector algebra.	**L1: Remembering**	**1,2,3,4,5,7,9**	**1,2,3**
4	**Computation** of the differentiation and integration of vector fields and application of the techniques to solve problems in electromagnetism, fluid dynamics, and other fields.	**L3: Applying**	**1,2,3,4,5,6,7,8,9**	**1,2,3**
5	**Development** of a deeper understanding of orthogonal curvilinear coordinate systems of vector calculus and its geometric underpinnings.	**L6: Creating**	**1,2,3,4,5,6,7,8,9**	**1,2,3**
Practical				
1	**Outline** of the C Programming fundamentals	**L1: Remembering**	**1,2,3,4,5,6,7,8,9**	**1,2,3**
2	**Computation** of basic mathematical operation using C programinning	**L3: Applying**	**1,2,3,4,5,6,7,8,9**	**1,2,3**

Programme Articulation Matrix (CO-PO Matrix)

	CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3
		Program Outcome (PO) & Program Specific Outcome (PSO)											
Theory	1	3	3	2	-	-	-	2	3	3	3	2	2
	2	3	3	2	2	2	2	2	2	2	2	2	2
	3	2	2	3	3	3	-	3	-	3	3	3	3
	4	3	3	3	3	3	3	3	2	2	2	3	3
	5	3	2	3	3	2	3	3	2	2	2	3	3
Practical	1	3	3	3	3	3	3	3	3	3	3	3	3
	2	3	3	3	3	3	3	3	3	3	3	3	3
	Average	2.9	2.7	2.7	2.8	2.7	2.8	2.7	2.8	2.6	2.6	2.7	2.7

Course Content

Semester: II (Major) | **Course Code: Major: PHYS2011**
Course name: Mechanics | **(Credits: Theory-04, Practicals-02)**

PHYS2011: F.M.=75 (Theory-40, Practical–20, Internal Assessment–15)

COURSE OBJECTIVE: The objectives of this course is to provide an in-depth understanding of the principles of Newtonian mechanics and apply them to solve problems involving the dynamics of classical mechanical systems.

Theory: 45 Lectures

Fundamentals of Dynamics: Reference frames; Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. (6 Lectures)

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non- conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy. (4 Lectures)

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames. (3 Lectures)

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and pherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. (8 Lectures)

Elasticity: : Elastic properties of matter, Hooke's Law, Relation between Elastic constants, Twisting torque on a cylinder or a wire, Bending of Beams: Cantilever, Beam supported near the ends on two knife edges held in the same horizontal plane and a concentrated load W is applied at the midpoint. (4 Lectures)

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. (4 Lectures)

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). (6 Lectures)

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. (6 Lectures)

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. (4 Lectures)

COURSE OUTCOME: This course in Mechanics serves as the foundation for further progress towards the study of physics at graduate or post-graduate level. Upon completion of the course, the student will be able to apply Newton's laws of motion to different force fields for a single particle and for a system of particles.

Practical Paper:

1. To study the Motion of Spring and calculate (a) Spring constant,(b)gand (c)Modulus of rigidity.
2. To determine the Moment of Inertia of a Flywheel/regular shaped body.
3. To determine g and velocity for a freely falling body using Digital Timing Technique.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle/dynamical method.
6. To determine the elastic Constants of a wire by Searle's method.
7. To determine the value of g using Bar pendulum/Kater's Pendulum.
8. To determine the value of Young's Modulus by Flexure method.

Course Outcome (CO) — Paper: PHYS2011

Sl. No.	Course Outcome (CO)	Knowledge Level	POs	PSOs
Theory				
1	**Outline** the laws of Newtonian Mechanics leading to the ideas behind inertial reference frame and free body diagram.	**L1: Remembering**	**1,2,3,4,5,6,7,9**	**1,2,3**
2	**Distinguish** between various types of conservative and non-conservative systems, and illustrate these concepts using energy diagrams.	**L4: Analyzing**	**1,2,3,4,5,6,7,9**	**1,2,3**
3	**Demonstrate** the ideas behind rotational motion and moment of inertia in this aspect.	**L3: Applying**	**1,2,3,4,5,6,7,9**	**1,2,3**
4	**Illustrate** the central force and outline Gravitational field as an example of the same.	**L4: Analyzing**	**1,2,3,4,5,6,7,9**	**1,2,3**
5	**Discuss** the Simple Harmonic Oscillator as a general framework for studying bound systems in the perturbative regime, including an analysis of free and forced oscillators. Additionally, provide an **outline** of non-inertial reference frames, with examples such as the Coriolis force and centrifugal force.	**L1: Remembering**	**1,2,3,4,5,6,7,9**	**1,2,3**
Practical				
1	**Demonstrate** experimental verifications of different Mechanical properties like Spring constant, Young's Modulus, Modulus of Rigidity etc. of material of a wire.	**L3: Applying**	**1,2,3,4,5,6,7,9**	**1,2,3**
2	**Measure** gravitational acceleration due to Earth using Kater's pendulum method.	**L5: Evaluating**	**1,2,3,4,5,6,7,9**	**1,2,3**

Programme Articulation Matrix (CO-PO Matrix)

	CO	Program Outcome (PO)								
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
Theory	1	3	3	2	3	3	2	3	-	3
	2	3	3	2	3	2	2	2	-	3
	3	3	2	2	3	2	3	2	-	3
	4	3	2	3	3	3	3	3	-	3
	5	3	2	3	3	3	3	3	-	3
Practical	1	3	3	3	3	2	2	3	-	3
	2	3	3	3	3	2	2	3	-	3
	Average	3	2.6	2.6	3	2.4	2.4	2.7	-	3

Course Content

Semester: II

Course name: **ELECTRICAL CIRCUITS AND NETWORK SKILLS**

Course Code: SEC-2: PHYS2051
(Credits: Theory-03)

SEC-2: PHYS2051: F.M.=50 (Theory-40, Internal Assessment–10)

COURSE OBJECTIVE: The aim of this course is to enable the students to understand the basics of electronic circuits. Practical design and trouble shoot of electronic instrument is also a major objective of this Couse.

Theory: 45 Lectures

COURSE OBJECTIVE: The aim of this course is to enable the students to understand the basics of electronic circuits. Practical design and trouble shoot of electronic instrument is also a major objective of this Couse.

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. (5 Lectures)

Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyse DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyse AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. (8 Lectures)

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. (5 Lectures)

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. (5 Lectures)

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. (5 Lectures)

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources. (5 Lectures)

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device). (5 Lectures)

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board. (7 Lectures)

COURSE OUTCOME: After the completion of the course the student will acquire necessary skills/ hands on experience /working knowledge on Multimeter, voltmeters, ammeters, electric circuit elements, dc power sources. With the knowledge of basic electronics a student can able to detect troubleshoot and repair some of the electronic instruments used in our daily life.

Course Outcome (CO) Paper: SEC-2: PHYS2051

Sl. No.	Course Outcome (CO)	Knowledge Level (Bloom's Level)	Pos	PSOs
1	**Identify** Basic Electricity Principles and Understanding Electrical Circuits	**L1: Remembering**	**1,2,3,5,9**	**1,2,3**
2	**Explain** the principle of operation of Electric Generator, Transformer and Electric Motors	**L2: Understanding**	**1,2,3,4,5,7,9**	**1,2,3**
3	**Demonstrating** the fundamental ideas of Solid State Devices such as Resistors, inductors and capacitors. Diode and rectifiers	**L3: Applying**	**1,2,3,4,5,6,7,9**	**1,2,3**
4	**Outline** the fundamental ideas of Electrical Protection and Electrical Wiring.	**L4: Analyzing**	**1,2,3,4,5,7,8,9**	**1,2,3**

Programme Articulation Matrix (CO-PO Matrix)

CO	Program Outcome (PO)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
1	3	3	2	-	2	-	-	-	2
2	3	3	2	2	2	-	2	-	2
3	2	2	3	3	3	2	3	-	3
4	3	3	3	3	3	-	3	2	3
Average	2.8	2.8	2.5	2.6	2.5	2.0	2.6	2.0	2.5

Course Content

Semester: II (Minor) **Course Code: Minor: PHYS2021**
Course name: Mechanics **(Credits: Theory-04, Practicals-02)**

PHYS2011: F.M.=75 (Theory-40, Practical–20, Internal Assessment–15)

COURSE OBJECTIVE: The objectives of this course is to provide an in-depth understanding of the principles of Newtonian mechanics and apply them to solve problems involving the dynamics of classical mechanical systems.

Theory: 45 Lectures

Fundamentals of Dynamics: Reference frames; Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. (6 Lectures)

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non- conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy. (4 Lectures)

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames. (3 Lectures)

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and pherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. (8 Lectures)

Elasticity: : Elastic properties of matter, Hooke's Law, Relation between Elastic constants, Twisting torque on a cylinder or a wire, Bending of Beams: Cantilever, Beam supported near the ends on two knife edges held in the same horizontal plane and a concentrated load W is applied at the midpoint. (4 Lectures)

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. (4 Lectures)

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). (6 Lectures)

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. (6 Lectures)

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. (4 Lectures)

COURSE OUTCOME: This course in Mechanics serves as the foundation for further progress towards the study of physics at graduate or post-graduate level. Upon completion of the course, the student will be able to apply Newton's laws of motion to different force fields for a single particle and for a system of particles.

Practical Paper:

1. To study the Motion of Spring and calculate (a) Spring constant,(b)gand (c)Modulus of rigidity.
2. To determine the Moment of Inertia of a Flywheel/regular shaped body.
3. To determine g and velocity for a freely falling body using Digital Timing Technique.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle/dynamical method.
6. To determine the elastic Constants of a wire by Searle's method.
7. To determine the value of g using Bar pendulum/Kater's Pendulum.
8. To determine the value of Young's Modulus by Flexure method.

Course Outcome (CO) **Paper: PHYS2021**

Sl. No.	Course Outcome (CO)	Knowledge Level	POs	PSOs
Theory				
1	**Outline** the laws of Newtonian Mechanics leading to the ideas behind inertial reference frame and free body diagram.	**L1: Remembering**	**1,2,3,4,5,6,7,9**	**1,2,3**
2	**Distinguish** between various types of conservative and non-conservative systems, and illustrate these concepts using energy diagrams**.**	**L4: Analyzing**	**1,2,3,4,5,6,7,9**	**1,2,3**
3	**Demonstrate** the ideas behind rotational motion and moment of inertia in this aspect.	**L3: Applying**	**1,2,3,4,5,6,7,9**	**1,2,3**
4	**Illustrate** the central force and outline Gravitational field as an example of the same.	**L4: Analyzing**	**1,2,3,4,5,6,7,9**	**1,2,3**
5	**Discuss** the Simple Harmonic Oscillator as a general framework for studying bound systems in the perturbative regime, including an analysis of free and forced oscillators. Additionally, provide an **outline** of non-inertial reference frames, with examples such as the Coriolis force and centrifugal force.	**L1: Remembering**	**1,2,3,4,5,6,7,9**	**1,2,3**
Practical				
1	**Demonstrate** experimental verifications of different Mechanical properties like Spring constant, Young's Modulus, Modulus of Rigidity etc. of material of a wire.	**L3: Applying**	**1,2,3,4,5,6,7,9**	**1,2,3**
2	**Measure** gravitational acceleration due to Earth using Kater's pendulum method.	**L5: Evaluating**	**1,2,3,4,5,6,7,9**	**1,2,3**

Programme Articulation Matrix (CO-PO Matrix)

	CO	Program Outcome (PO)								
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
Theory	1	3	3	2	3	3	2	3	-	3
	2	3	3	2	3	2	2	2	-	3
	3	3	2	2	3	2	3	2	-	3
	4	3	2	3	3	3	3	3	-	3
	5	3	2	3	3	3	3	3	-	3
Practical	1	3	3	3	3	2	2	3	-	3
	2	3	3	3	3	2	2	3	-	3
	Average	3	2.6	2.6	3	2.4	2.4	2.7	-	3

Course Content

Semester: III (Major)
Course Name: Electricity and Magnetism

Course Code: Major: PHYS3011
(Credits: Theory-04, Practicals-02)

PHYS2011: F.M.=75 (Theory-40, Practical–20, Internal Assessment–15)

COURSE OBJECTIVE: The objective of this paper is to give the basic concept as well as an in-depth understanding of the principles of electricity and magnetism and apply them to solve the problems related.

Theory: 60 Lectures

Electrostatics

UNIT-I: Quantization of electric charge, Coulomb's law, Principle of superposition, Electric field (Physical concept, quantitative definition and its source), Electric field of a point charge, Electric field lines and their properties, Charge density, Volume charge density, Surface charge density, Line charge density, Electric fields due to continuous charge distributions, Electric field due to a uniformly charged non-conducting rod at an axial point and at a point on the perpendicular bisector of that rod, Electric field due to a circular disc on the axial point. (5 Lectures)

UNIT-II: Electric flux, Gauss' law, Differential form of Gauss' law, Equivalence of Coulomb's law and Gauss' law, Gaussian surface, Application of Gauss' law to evaluate the electric field at a point for charge distributions with spherical (A thin spherical shell of radius R with a charge +Q evenly distributed over its surface, thick shell, and a solid sphere of radius R with uniform volume charge density), planar (Infinitely large non-conducting plane with uniform surface charge density) and cylindrical symmetry (Infinitely long non-conducting rod of uniform line charge density). (6 Lectures)

UNIT-III: Conservative nature of electrostatic field, Electric scalar potential, Relation between the electric field and the electric potential, Electric potential of a point charge and a group of point charges, Electric potential due to a continuous charge distribution, Electric potential and field due to an electric dipole, Force and torque acting on an electric dipole in a uniform electric field, Laplace's and Poisson's equations, The Uniqueness theorem (Proof required). (5 Lectures)

UNIT-IV: Electrostatic potential energy, Electrostatic potential energy of a collection of point charges, Electrostatic potential energy of a continuous charge distribution (general expression and a charged sphere as an example), Self energy, Classical electron radius, Electrostatic potential energy of an electric dipole in a non-uniform electric field. (4 Lectures)

UNIT-V: Equipotential surfaces, Electrostatic equilibrium properties (regarding electric charge, electric field and electric potential) of a conductor in a uniform electric field, Surface charge and force on a conductor, Boundary conditions on the electric field at the interface between a vacuum and a conductor, Capacitor as a charge storing device, Capacitance and the energy stored in a capacitor, Capacitance of a system of charged conductors, Parallel-plate capacitor, Capacitance of an isolated conductor, Method of Images and its application to: (1) Plane infinite sheet and (2) Sphere. (6 Lectures)

UNIT-VI: Dielectric properties of matter: Electric field inside a matter, Polarization, Polarization charges, Electrical susceptibility and dielectric Constant, Capacitor (parallel-plate, spherical, cylindrical) filled with dielectric, Displacement vector, Relations between E, P and D, Gauss' Law in dielectrics, Boundary conditions between two dielectric interfaces. (4 Lectures)

Steady Electric Current

Electric current, Current density, Continuity equation, Conductivity, Ohm's law, Electromotive force, Kirchhoff's first and second law- statement and applications, Thevenin's, Norton's and maximum power transfer theorems and their applications. (2 Lectures)

Magneto-statics

UNIT-I: Electric current as a source of magnetic field, Definition and units (SI) of: Magnetic flux Density, B, Magnetic field strength, H and Magnetization vector, M, Relation between B , B and M, Magnetic susceptibility and magnetic permeability, Boundary conditions between two magnetic media, Force (Lorentz force) on a moving charge in the simultaneous presence of both electric and magnetic fields, Trajectory of a charged particle in a crossed uniform electric and magnetic fields. (3 Lectures)

UNIT-II: Biot Savart's Law and its applications: B due to current in a long straight conductor, a circular loop, a solenoid, Current loop as a magnetic dipole and its dipole moment. (3 Lectures)

UNIT-III: Ampere's circuital law and its applications: B due to current in a long straight conductor, a solenoid and a toroid. (2 Lectures)

Course Content

Semester: III (Major) **Course Code: Major: PHYS3011**
Course Name: Electricity and Magnetism **(Credits: Theory-04, Practicals-02)**

UNIT-IV:Magnetic force on (i) a current element, (ii) a line current, Force between two current elements, Divergence and Curl of B (Gauss and Ampere's laws), Physical significance of the nature of the divergence and curl of B, Magnetic vector potential. (3 Lectures)

Transient current
Growth and decay of currents in LR, CR and LCR circuits, Time constant (2 Lectures)

Alternating Current
Source of alternating current, Mean value, Peak value and RMS value of alternating voltage and current, Inductive and capacitive reactance, Real power, Reactive power and apparent power, Power triangle, Power factor, Series LCR circuit analysis, Phasor diagrams (AC voltage from a source (V), Current through the resistor R (i_R) and the voltage across R (V_R), Current through the capacitor C (i_c) and the voltage across C (V_c), Current through the inductor L(i_L) and the voltage across L (V_L), Calculation of total impedance of a series LCR circuit using the phasor diagram of V, V_R, V_L and V_c, Parallel LCR circuit analysis, Resonance in LCR circuits (series and parallel), LC oscillations. (7 Lectures)

Electromagnetic Induction
Faraday's law, Lenz's law and conservation of energy, Motional EMF, Eddy current, Principle of power generation, Self-inductance and mutual inductance, Induction oven, Induction brake, Reciprocity theorem, Energy stored in a magnetic Field, Introduction to Maxwell's equations, Continuity equation.

Electrical equipment
Moving coil ballistic and dead beat galvanometers: Working principle, Derivation of the equation relating between the charge flowing through the coil and the ballistic throw of the galvanometer, Damping correction, Current, charge and voltage sensitivities of a moving coil galvanometer, Equation of motion of the coil, Non-oscillatory, aperiodic or dead beat motion, Critical damping, Light damping: Ballistic motion, Uses. (4 Lectures)

Course Outcome: At the end of this course, students will be able to comprehend the concept of electric field, electric flux, magnetic field and their origin. They will learn to apply the Gauss's theorem to find the electric fields for different types of charge distribution. The students will develop a sound perception about Electrostatics, Magneto-statics, Electric current and electromagnetic induction.

Practical: 30 Hour

1. To verify the Thevenin's, Norton's and Maximum Power transfer theorems
2. To determine the Self-inductance of a coil using Anderson's bridge
3. To study the response curve of a series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor and (d) Band width
4. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor
5. Measurement of Charge Sensitivity and CDR of a Ballistic Galvanometer
6. Determination of a Ballistic Galvanometer Constant by Capacitor Charging-Discharging Method
7. Construction of a One Ohm coil
8. Determination of a Ballistic Galvanometer Constant by the Solenoid method
9. Determination of Mutual Inductance of two coils by Carey-Foster's method

Sl. No.	Course Outcome (CO)	Knowledge Level	POs	PSOs
Theory				
1	**Understand** the principles of electrostatics, including quantization of charge, electric fields, Gauss's law, electric potential, electric potential energy and the behavior of charge distributions.	**L2: Understanding**	**1, 3, 5, 8, 9**	**1,2,3**
2	**Solve** problems related to electric fields and potentials in various geometrical configurations.	**L3: Applying**	**1, 2, 3, 5, 4, 6, 9**	**1,2,3**
3	**Analyze** electrostatic properties of conductors and dielectrics, including concepts of equipotential surfaces, electrostatic equilibrium, capacitors, capacitance, dielectric behavior in electric fields, and the application of boundary conditions and Gauss's Law in various scenarios.	**L4: Analyzing**	**1, 2, 3, 4, 6, 7, 9**	**1,2,3**
4	**Apply** principles of magnetostatics, including the magnetic effects of current, relationships between magnetic quantities, boundary conditions, Lorentz force, and vector potentials, through the use of laws such as Biot-Savart and Ampere's Law, in predicting magnetic fields and forces in various configurations.	**L3: Applying**	**1, 2, 3, 4, 5, 6, 9**	**1,2,3**
5	**Evaluate** the behavior of alternating current circuits, the principles of electromagnetic induction, and the functioning of key electrical equipment like galvanometers, understanding concepts such as reactance, power factor, LCR resonance, inductance, energy storage, and damping mechanisms in electrical systems.	**L5: Evaluating**	**1, 2,3, 4,5, 6,7, 8,9**	**1,2,3**
Practical				
1	**Verify** and **analyze** electrical circuit theorems, determine self-inductance using Anderson's bridge, and evaluate series and parallel LCR circuit responses to calculate resonance characteristics, quality factor, and bandwidth.	**L4: Analyzing**	**1,2,3,4,5,6,7,8, 9**	**1,2,3**
2	**Measure** and **evaluate** charge sensitivity, CDR of a ballistic galvanometer, **construct** precision resistive coils, and determine mutual inductance of coils through the CF method.	**L5: Evaluating**	**1,2,3,4,5,6,7,8,9**	**1,2,3**

	Programme Articulation Matrix (CO-PO Matrix)											
	CO	Program Outcome (PO)										
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
Theory	1	3	-	2	-	3	-	-	2	3	3	2	2
	2	3	3	2	3	2	2	-	-	3	3	3	3
	3	2	2	2	2	-	3	2	-	2	2	2	2
	4	2	2	3	3	3	3	-	-	2	2	3	3
	5	3	2	3	2	3	3	3	2	2	2	3	3
Practical	1	2	3	3	3	2	2	3	3	3	3	3	3
	2	3	3	3	2	2	2	3	3	3	3	3	3
Average		2.6	2.6	2.6	2.5	2.5	2.5	2.7	2.5	2.6	2.6	2.7	2.7

Course Content

Semester: III (Major)
Course Name: Waves and Optics

Course Code: Major: PHYS3012
(Credits: Theory-04, Practicals-02)

PHYS2011: F.M.=75 (Theory-40, Practical–20, Internal Assessment–15)

COURSE OBJECTIVE: The objective of this course is to provide an in-depth understanding of the nature of waves in general, sound wave as an example of mechanical wave and light as an electromagnetic wave. It is also intended to provide a comprehensive idea of some phenomena like interference, diffraction and polarisation and their physical explanation in terms of the wave theory of light.

Theory: 60 Lectures

Superposition of Collinear Harmonic Oscillations

Simple harmonic motion as a projection of a uniformly rotating vector on a reference axis, Linearity and superposition principle, Superposition of two collinear simple harmonic vibrations with different amplitudes, different initial phases and with: (1) same frequencies using both the analytical method and the vector method, (2) slightly different frequencies, Beats (graphical representation of beats), Superposition of a large number (N) of simple harmonic vibrations of equal amplitude and frequency but with (a) equal successive initial phase differences and (b) random phases by the vector method, Superposition of a large number (N) of simple harmonic vibrations of equal amplitude and same initial phase but with equal successive frequency differences by the analytical method.

5 Hours

Superposition of two Perpendicular Harmonic Oscillations

Superposition of two perpendicular simple harmonic oscillations having (1) equal frequencies, different amplitudes and an initial phase difference δ (graphical representation for δ varying between 0 and 2π), and (2) two different frequencies, different amplitudes and an initial phase difference δ (Lissajous Figures) using the analytical method as well as the graphical method.

2 Hours

Coupled Oscillations

Stiffness coupled oscillators: two identical pendulums (each a light rigid rod of length l supporting a mass m) coupled by a weightless spring of stiffness *s*, Normal coordinates, Degrees of freedom, Normal modes of vibration, A large number (N) of coupled oscillators *e.g.*, a light string fixed at both ends, supporting N equal masses spaced at equal distance along its length (Qualitative discussion without any mathematical details).

3 Hours

One Dimensional Waves

Unit I Transverse oscillations (in a plane) of a slightly extensible, uniform string of mass per unit length ρ under a constant tension (T) with free ends: Equation of motion - $\frac{\partial^2 y}{\partial x^2} = \frac{T}{\rho}\frac{\partial^2 y}{\partial t^2}$ ~ the one dimensional wave equation representing a travelling wave of velocity (c) equal to $\sqrt{\frac{T}{\rho}}$, $y = A\,sin\frac{2\pi}{\lambda}(ct \pm x)$ or $A\,cos\frac{2\pi}{\lambda}(ct \pm x)$ - a solution of the wave equation, $\frac{2\pi}{\lambda}(ct \pm x)$ - a dimensionless quantity for λ representing a length, Harmonic waves, Wavelength (λ), Wave or phase velocity ($c = \frac{\partial x}{\partial t}$), Frequency ($\nu = \frac{c}{\lambda}$), Oscillator or particle velocity ($\frac{\partial y}{\partial t}$).

Unit II Oscillations of a string of fixed length l under a constant tension (T) with both ends rigidly clamped: Equation of motion $\frac{\partial^2 y}{\partial x^2} = \frac{1}{c^2}\frac{\partial^2 y}{\partial t^2}$ (same) with the boundary conditions $y = 0$ at $x = 0$ and $x = l$ for all t, General solution $y = A\,sin\frac{2\pi}{\lambda}(ct - x) + B sin\frac{2\pi}{\lambda}(ct + x)$, The boundary condition $y = 0$ at $x = 0$ for all t implies $A = -B \rightarrow y = 2A\,sin\,\frac{2\pi}{\lambda}ct\,cos\,\frac{2\pi}{\lambda}x$ – superposition of a wave moving along positive or negative x-axis and the wave reflected at either fixed end (discontinuity) with a π phase change in amplitude, Nature of oscillations: (a) All particles of the string execute simple harmonic oscillation about their equilibrium positions (points on the string at rest) at the same frequency, (b) The amplitude varies along the length of the string, (c) Nodes with zero amplitude and antinodes with a peak amplitude, (d) The positions of the nodes and antinodes do not change with time, The boundary condition $y = 0$ at $x = l$ for all t gives $\frac{2\pi}{\lambda} = \frac{n\pi}{l}$ or $\nu_n = \frac{nc}{2l}$, the general solution

$$y(x,t) = \sum_{n=1}^{\infty}\left(a_n\,sin\,\frac{n\pi ct}{l}\,cos\,\frac{n\pi}{l}x\right) = \sum_{n=1}^{\infty}(a_n\,\sin\omega_n t\,cos\frac{\omega_n}{c}x)$$

Additional characteristics: $y(x,t)$ - superposition of an infinite number normal modes of different frequencies ($\nu_n = \frac{nc}{2l}$), The total energy of the vibrating string (derivation required) $\langle E\rangle = \sum E_n$,

$E_n = \frac{1}{2} m\omega_n^2 a_n^2$, Wave group with a number of components of different frequencies, dispersive medium, Group velocity $= \frac{d\omega}{dk}$, Doppler Effect.

6 Hours

Sound Waves in Gases

Longitudinal disturbances in the pressure and density causing compressions and rarefactions of small volume elements of the gases, Deduction of the wave equation $\frac{\partial^2 y}{\partial x^2} = \frac{1}{c^2}\frac{\partial^2 y}{\partial t^2}$, Velocity of sound waves $c = \sqrt{\frac{B}{\rho}} = \sqrt{\frac{\gamma P}{\rho}}$, The energy (kinetic, potential, total) distribution in space for a sound wave in a gas (qualitative idea), Intensity of sound waves and units.

3 Hours

Elastic Waves in Bulk Solids

Longitudinal and transverse modes, The wave equations for each mode, Velocity of waves in each mode.

2 Hours

Three Dimensional Waves

Wavefront-a surface of constant phase at a given instant of time, A plane wave $\psi(\vec{r}, t) = Ae^{i(\vec{k}\cdot\vec{r} - \omega t)}$ with a wavefront defined by $\vec{k}\cdot\vec{r}$ = constant, A spherical wave $\psi(r,t) = \frac{A}{r} e^{i(kr-\omega t)}$ with a wavefront defined by kr = constant, A cylindrical wave $\psi(\vec{r}, t) = \psi(r, \theta, z, t) = \frac{A}{\sqrt{r}} e^{i(kr-\omega t)}$ is θ-independent and z-independent and the wavefront is a right circular cylinder centered on the z-axis and having infinite length.

Light propagation explained as rays in geometrical optics (deals with an image formation in different optical instruments) whereas electromagnetic waves in physical optics (deals with different phenomena as interference, diffraction and polarization).

2 Hours

Superposition of Harmonic Waves

The wave equation supports the superposition principle, Superposition of electromagnetic waves treating the fields as scalar, Superposition of (a) Two harmonic plane waves of the same frequency – Idea of coherent sources and interference, (b) N harmonic waves with identical frequencies: (i) randomly phased sources of equal amplitudes, (ii) Coherent (constant phase relationship) sources of the same type) and in phase.

3 Hours

Interference

Unit 1 Conditions of interference, Spatial and temporal coherence, Realization of coherent sources by division of a wavefront: Young's double slit experiment, Fresnel's Bi-prism, Lloyd's Mirror.

Unit 2 Phase change on reflection: Stokes' treatment, Realization of coherent sources by division of amplitude, Interference in thin films: Parallel and wedge-shaped films, Fringes of equal inclination (Haidinger Fringes), Fringes of equal thickness (Fizeau Fringes), Newton's Rings: Measurement of wavelength and refractive index.

Unit 3 Michelson interferometer, Formation of the fringes, (No theory required), Applications: Determination of the (1) wavelength and (2) wavelength difference, (3) Refractive Index, Visibility of fringes.

Unit 4 Fabry-Perot interferometer, Formation of the fringes, Intensity distribution, Resolving Power, Superiority over Michelson interferometer.

10 Hours

Diffraction

The Huygens–Fresnel principle, Diffraction and interference, Fresnel diffraction and Fraunhofer diffraction.

Fraunhofer diffraction: Single slit diffraction, Double slit diffraction, N-slits diffraction or a diffraction grating, Rayleigh criterion for resolution, Resolving power of a grating, Grating spectra versus Prism spectra.

Fresnel Diffraction: Fresnel's assumptions, Fresnel's half-period zones for plane wave, Explanation of rectilinear propagation of light, Theory of a zone plate: Multiple foci of a zone plate, Fresnel's integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

10 Hours

Polarisation of Light

Types of polarized light: Plane polarized light, Circularly polarized light, Elliptically polarized light,

Production of polarized light (a) by reflection, Brewster angle, Malus law, (b) by dichroism, Pollaroids, (c) by double refraction, Doubly refracting crystals, Negative crystals, Positive crystals, Optic axis, Nicol prism, Huygen's theory of double refraction, Phase retardation plate: 1) Quarter wave plate 2) Half wave plate,

Detection of plane, circularly and elliptically polarized light.

Optical activity and its origin, Two types of optically active substance, Fresnel's theory of optical rotation, Polarimeter.

10 Hours

Course Content

Semester: III (Major)
Course Name: Waves and Optics

Course Code: Major: PHYS3012
(Credits: Theory-04, Practicals-02)

Course Outcome: The outcome of the paper includes the knowledge of vibrations, propagation of waves, vibrations of air column, and harmonics of the strings. The paper has another outcome of offering knowledge of wave properties of light & corresponding phenomena.

Practical: 30 Lectures

List of Experiments

1. To draw n-l curve with the help of a sonometer and hence find the frequency of an unknown fork

2. Determination of the frequency of ac mains with a sonometer using a magnetic wire

3. Determination of the velocity of ultrasonic waves in a given liquid

4. To determine the refractive index of the material of a prism using sodium source

5. To determine the dispersive power and Cauchy constants of the material of a prism

6. To determine the wavelength of sodium light using Fresnel Biprism

7. To determine the wavelength of sodium light using Newton’s Rings

8. Determination of the width of a single slit producing a Fraunhofer diffraction pattern

9. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using a plane diffraction grating

10. Calibration of a polarimeter and determination of the concentration of an active solution

11. To determine the resolving power of a plane diffraction grating

Sl. No.	Course Outcome (CO)	Knowledge Level	POs	PSOs
Theory				
1	**Interpret** the principles of harmonic motion and superposition in collinear, perpendicular, and coupled oscillations, applying vector and analytical methods to **understand** phenomena such as beats, Lissajous figures, normal modes, and resonance in systems of coupled oscillators.	L2: Understanding	1, 2, 3, 4, 5, 8, 9	1,2,3
2	**Formulate** and **analyze** the physics of 1D wave motion in strings, sound waves in gases, and elastic waves in solids, understanding their equations, energy distribution, Doppler effect, and **characteristics** of wave velocity, nodes, and antinodes.	L4: Analyzing	1, 2, 3, 4, 5, 6, 9	1,2,3
3	**Understand** the principles of three-dimensional wave propagation, superposition including concepts of coherence, wavefront formation, and **explain** interference patterns through experiments like Young's double slit, Michelson, and Fabry-Perot interferometers for wavelength and resolving power measurements.	L2: Understanding	1,2,3, 4,5,6,7,8 9	1,2,3
4	**Apply** diffraction principles to analyze light propagation and patterns for different apertures using Huygens–Fresnel theory, Fraunhofer and Fresnel diffraction, and grating resolution.	L3: Applying	1, 2, 3, 4, 5, 6, 9	1,2,3
5	Analyze polarization types, production methods, and optical activity principles, applying concepts like Brewster angle, Malus's law, and phase retardation plates.	L4: Analyzing	1,2,3,4,5, 6,7,8,9	1,2,3
Practical				
1	Apply experimental techniques to measure frequency, velocity, refractive index, wavelength, and dispersive properties using instruments like sonometers, prisms, and diffraction gratings.	L3: Applying	1,2,3,4,5,6,7,8, 9	1,2,3
2	Analyze optical properties such as diffraction, interference, and optical activity by calibrating a polarimeter and determining the resolving power of diffraction gratings.	L4: Analyzing	1,2,3,4,5,6,7,8,9	1,2,3

Programme Articulation Matrix (CO-PO Matrix)

	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
Theory	1	3	3	2	3	3	-	-	2	3	3	3	2
	2	3	3	2	3	2	2	-	-	2	3	3	2
	3	2	2	2	2	-	3	2	2	3	2	2	2
	4	2	2	3	3	3	3	-	-	2	2	2	3
	5	3	2	3	2	3	3	3	2	2	3	2	3
Practical	1	2	3	3	3	2	2	3	3	3	2	3	3
	2	3	3	3	2	2	2	3	3	3	3	3	3
Average		2.6	2.5	2.6	2.6	2.5	2.5	2.7	2.4	2.6	2.6	2.5	2.6

Course Content

Semester: III Course name: Basic Instruments and their Usage	Course Code: SEC-3: PHYS3051 (Credits: Theory-03)

SEC-3: PHYS3051: F.M.=50 (Theory-40, Internal Assessment–10)

COURSE OBJECTIVE: This course is designed to give the students an exposure with various aspects of electrical and optical instruments and their applications in experimental physics.

Theory: 45 Lectures

Electrical/ Electronic Instruments

Unit 1: Voltage and current sources, Principles of measurement of dc voltage & current, ac voltage & current and a resistance, Specifications of an electronic voltmeter/ multi-meter and their significance, Advantages of electronic voltmeter over conventional multi-meter for the measurement of voltage, Instrumental accuracy, Precision, Sensitivity, Resolution, Range etc., Errors in measurements and loading effects.
Unit 2: Cathode Ray Oscilloscope: Block diagram of basic CRO, Time base operation, Synchronization, Front panel controls, Specifications of a CRO and their significance, Use of CRO for the measurement of voltage (dc and ac), frequency, Special feature of dual trace.
Unit 3: Signal Generators: Block diagram, Explanation and specifications of low frequency signal generators, Pulse generators and function generators.
Unit 4: Digital Instruments: Principle and function of a digital meter, Characteristics of a digital meter, Comparison of analog & digital instruments.

Optical Instruments

Unit 1: Optical microscope: Simple microscope, Compound microscope, Electron microscope: Principal components, Working principle and uses.
Unit 2: Telescope: Principal components, Working principle and uses of different types of telescopes (Astronomical telescope, Terrestrial telescope, Reflecting telescope).
Unit 3: An objective lens and an eyepiece or ocular lens: Elements, Angular magnification of a telescope, Angular magnification of a microscope, Huygens eyepiece, Ramsden eyepiece.
Unit 4: Spectrometer: Principal components, Role of individual components, Uses, Ultraviolet-Visible (UV-VIS), Near-infrared (NIR) and Raman spectrometers.

Course Outcome (CO) Paper: SEC-2: PHYS3051

Sl. No.	Course Outcome (CO)	Knowledge Level (Bloom's Level)	Pos	PSOs
1	**Identify** the basic principles and specifications of voltage and current sources, measurement techniques, and the functions and applications of electronic voltmeters, multimeters, and cathode ray oscilloscopes (CRO).	**L1: Remembering**	**1,2,3,5,9**	**1,2,3**
2	**Explain** the working principles and specifications of signal generators and digital meters, and compare the characteristics and functions of digital and analog measurement instruments.	**L2: Understanding**	**1,2,3,4,5,7,9**	**1,2,3**
3	**Apply** the principles of optical and electron microscopy and various types of telescopes to understand their components, functionality, and applications in scientific observation and analysis.	**L3: Applying**	**1,2,3,4,5,6,7,9**	**1,2,3**
4	**Analyze** and **evaluate** the optical elements, angular magnification, and eyepiece designs of telescopes and microscopes, and assess the components and applications of various spectrometers, including UV-VIS, NIR, and Raman types.	**L4: Analyzing**	**1,2,3,4,5,7,8,9**	**1,2,3**

Programme Articulation Matrix (CO-PO Matrix)

CO	Program Outcome (PO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
1	3	3	2	-	2	-	-	-	2	3	3	2
2	3	3	2	2	2	-	2	-	2	3	3	2
3	2	2	3	3	3	2	3	-	3	2	2	3
4	3	3	3	3	3	-	3	2	3	3	3	3
Average	2.8	2.8	2.5	2.6	2.5	2.0	2.6	2.0	2.5	2.8	2.8	2.5