Parvatibai Chowgule College of Arts and Science
(Autonomous)
Accredited by NAAC with Grade 'A+'
Best Affiliated College-Goa University Silver Jubilee Year Award

DEPARTMENT OF PHYSICS

SYLLABUS FOR THREE/FOUR YEAR UNDERGRADUATE DEGREE HONOURS OR HONOURS WITH RESEARCH PROGRAMME IN PHYSICS

(Implemented from the Academic Year 2023-2024 onwards)

COURSE STRUCTURE

SEMESTER	MAJOR CORE	MINOR/ VOCATIONAL	MULTI-DISCIPLINARY COURSE (MDC)	SKILL ENHANCEMENT COURSE (SEC)
I	**UG-PHY-101:** Mechanics-I	**UG-PHY-102:** Mechanics, Sound and Properties of Matter	**UG-PHY-MDC1:** General Physics: Fluids and Heat	**UG-PHY-SEC1:** Introduction to Mathematical Physics-I
II	**UG-PHY-103:** Electricity and Magnetism	**UG-PHY-104:** Electricity, Magnetism and Electronics	**UG-PHY-MDC2:** General Physics: Light and atoms	**UG-PHY-SEC2:** Introduction to Mathematical Physics-II
III	**UG-PHY-201:** Electromagnetic Theory-I	**UG-PHY-205:** Elementary Modern Physics	**UG-PHY-MDC3:** General Physics: Nucleus, Relativity and Beyond	**UG-PHY-SEC3:** Introduction to Error Analysis
	UG-PHY-202: Optics			
	UG-PHY-203: Modern Physics*			
	UG-PHY-204: Oscillation, Waves and Sound*			
IV	**UG-PHY-206:** Quantum Mechanics*	**UG-PHY-211:** Heat and Optics		
	UG-PHY-207: Heat and Thermodynamics*	**UG-PHY-VOC1:** Computational Physics		
	UG-PHY-208: Electronics-I			
	UG-PHY-209: Properties of Matter and Acoustics*			
	UG-PHY-210: Introduction to Astronomy and Astrophysics			
V	**UG-PHY-301:** Electromagnetic Theory-II	**UG-PHY-305:** Statistical Physics and Solid State Physics		
	UG-PHY-302: Solid State Physics*	**UG-PHY-VOC2:** Basics of Visualization and Scientific word processing		
	UG-PHY-303: Thermodynamics and Statistical Mechanics*			
	UG-PHY-304: Solid State Devices			
VI	**UG-PHY-306:** Atomic and Molecular Physics	**UG-PHY-310:** Atomic and Nuclear Physics		

	UG-PHY-307: Mechanics II*	**UG-PHY-VOC3:** Instrumentation		
	UG-PHY-308: Nuclear and Elementary Particle Physics			
	UG-PHY-PRJ: Project			
	UG-PHY-309: Introduction to Material Science			
VII	**UG-PHY-401:** Mathematical Physics			
	UG-PHY-402: Classical Mechanics*			
	UG-PHY-403: Electronics-II			
	UG-PHY-404: Laboratory (Electronics and Computer Programming)			
VIII	**UG-PHY-405:** Advanced Electromagnetic Theory			
	UG-PHY-406: Introduction to Special Theory of Relativity*			
	UG-PHY-407: Quantum Mechanics II			
	UG-PHY-408: Laboratory (General Physics)			
	UG-PHY-409: Advanced Solid State Physics			

* Courses maybe offered to the minor students

*** Implementation of fourth year (Semester VII & VIII) is subject to approval from DHE**

SEMESTER I

DISCIPLINE SPECIFIC CORE COURSE

Course Title : Mechanics I

Course Code: UG-PHY-101

Credits : 3 (Theory) + 1 (Practical)

Marks : 75 (Theory) + 25 (Practical)

Duration : 45 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives : This course provides an introduction to topics in mechanics, which are essential for advanced work in physics. An objective of this course is to train students to think about some of the physical phenomenon in mathematical terms.

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

CLO1: Develop understanding of Newtonian mechanics in one and two dimensions and solve the Newton equations for simple configurations.

CLO2: Understand the Law of Conservation of Linear Momentum and Angular Momentum and apply these laws to understand elastic and inelastic collision.

CLO3: Apply the knowledge of work and energy theorems in kinematics through examples.

CLO4: Understand the Principle of Conservation of Mechanical Energy (for conservative forces) and apply this law to problems of objects moving under the influence of conservative forces.

CLO5: Understand ideas of Newton's Law of gravity, gravitational field and potential energy by solving various problems.

Course Content

Theory:

Module I: **Elements of Newtonian Mechanics, Motion of Particle in one dimension[15 h]**

1. **Elements of Newtonian Mechanics [7 h]**

Mechanics an exact science, Brief description of classical view of Space and Time. Kinematics, the description of motion. Dynamics, the concept of Mass and Force. Newton's First and Second Laws; Inertial frames. Equations of motion. Interpretation of Newton's third Law as Conservation of Momentum. Units and dimensions, Some elementary problems in Mechanics (Applications of Newton's Laws) - Atwood Machine, Forces acting on a brick sliding down an inclined plane.

[Symon 1.1, 1.2, 1.3, 1.4, 1.6, 1.7, Taylor 1.1-1.7, Kleppner 2.4]

2. **Motion of Particle in one dimension** **[8 h]**

Momentum and Energy theorems, Discussion of the general problem of one dimensional motion, Applied force dependent on time, Damping force dependant on the velocity. Conservative force depending on position. Potential Energy, Falling bodies.

[Symon 2.1, 2.2, 2.3, 2.4, 2.5, 2.6]

Module II: **Motion of a particle in two dimensions** **[15 h]**

1. Motion of a particle in two dimensions **[15 h]**

Vector algebra, Applications to set of forces acting on a particle, differentiation and integration of vectors, kinematics in a plane, momentum and energy theorems, plane and vector angular momentum theorems, The harmonic oscillator in two dimensions, projectiles, potential energy.

[Symon 3.1, 3.2, 3.3, 3.4, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12]

Module III: **Motion of system of particles, Gravitation** **[15 h]**

1. **Motion of system of particles** **[8 h]**

Conservation of linear momentum, conservation of angular momentum,conservation of energy.

[Symon 4.1, 4.2, 4.3]

2. Gravitation **[7 h]**

Centres of gravity for extended bodies, Gravitational field and gravitational potential, Gravitational field equations.

[Symon 6.1, 6.2, 6.3]

Practicals: (Minimum Six)

1. Dimensions of different solid body
2. Moment of Inertia of a flywheel
3. Atwood Machine
4. Verification of Newton’s Second Law using Air Track
5. Conservation of linear momentum using Air Track
6. Spring Mass System: Determining the Spring Constant
7. Simple Pendulum
8. Determining “g” using time of flight method using Python

List of books recommended for reference

Mandatory Reading:

1. Symon Keith, 2016, Mechanics, Pearson Education

2. Taylor J. R., 2005, Classical Mechanics, University Science Books, USA

3. Kleppner, Kolenkow, 2013, Introduction to Mechanics, Cambridge University Press, UK

Supplementary Reading:

1. Kittle, Knight, 2011, Mechanics, Berkeley Physics Course, Vol. 1, McGraw Hill Education,

2. .Mathur D. S, 2005, Mechanics, S. Chand & Co., New Delhi

3. Takwale R. G., and Puranik P. S., 1997, Introduction to Classical Mechanics, Tata Mc-Graw Hill, New Delhi

4. Javier E. Hasbun, 2010, Classical Mechanics, Jones and Bartlett India Pvt. Ltd.

5. Atam Arya, 1997, Introduction to Newtonian Mechanics, Addison-Wesley

5. Symon K. R., 1971, Mechanics, Addison Wesley, New York

6. Brij Lal and N. Subramanyam, 2005, Mechanics and Electrodynamics, S. Chand and Company Ltd., New Delhi.

Online resources:

1. https://nptel.ac.in/courses/122106027/
2. https://ocw.mit.edu/courses/physics/8-01sc-classical-mechanics-fall-2016/
3. https://www.khanacademy.org/science/ap-physics-1/
4. https://www.feynmanlectures.caltech.edu/I_13.html
5. http://hep.physics.wayne.edu/~harr/courses/5200/f07/lecture06.htm

Course Title : Mechanics, Sound and Properties of Matter

Course Code : UG-PHY-102

Credits : 3 (Theory) + 1 (Practical)

Marks : 75 (Theory) + 25 (Practical)

Duration : 45 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives: This course provides an introduction to topics in mechanics, sound and properties of matter. An objective of this course is to build up an understanding of fundamental physical principles which are required for most of other physical sciences.

Course Learning outcomes: After successful completion of this course students will be able to:

CLO1: gain an introductory knowledge of Newtonian mechanics, its conservation laws and its applications to basic physical problems.

CLO2: gain knowledge of waves, sound and ultrasonic waves and its applications.

CLO3: Explain the concept of elasticity, including its various types and its applications.

CLO4: Explain the concept of surface tension, analyse and explain the role of surface tension in various natural phenomena such as capillary action.

CLO5: Interpret the concept of viscosity and its applications, describe the properties of fluids that determine their viscosity.

Course Content

Theory:

Module I: [20 h]

1. **Elements of Newtonian Mechanics [5 h]**
   Newton's Laws of motion, equation of motion. Elementary problems in mechanics: Atwood machine and motion along a rough inclined plane and free fall.
   [Symon 1.4, 1.7]

2. **Motion of a particle in one dimension [10 h]**
   Momentum and energy conservation theorems. Discussion of the general problem of one dimensional motion. Applied force depending on time. Motion under damping force depending on velocity. Conservative force depending on position. Brief review of simple harmonic motion and potential energy curve. Body falling under gravity in a resistive medium proportional to velocity.
   [Symon 2.1 - 2.7]

3. **Gravitation Field and potentials: [5 h]**
   Newton's Law of Gravitation. Gravitation field and Gravitation potential energy, Gravitational potential and field due to a thin spherical shell.

   [Brij Lal 5.5-5.8]

Module II: **[10 h]**

1. **Sound** **[10 h]**
   Transverse vibrations in strings. Velocity of longitudinal waves in gases. Newton's formula for velocity of sound. Velocity in a homogeneous medium. Laplace's correction. Kundt's tube-determination of velocity of sound in a gas and in solids. Intensity level and Bel and Decibel. Doppler Effect. Source and listener in relative motion (Normal incidence only). Production and detection of Ultrasonic waves and its applications.
   [Khanna 4.2, 5.3-5.5, 11.1, 11.3, 12.1-12.4, 19.6 and Subra. 11.23 11.25,11.27]

Module III: **[15 h]**

1. **Elasticity** **[9 h]**
   Modulii of elasticity, Poisson's ratio and relationship between them. Bending of beams-bending moment, flexural rigidity. Cantilever (rectangular bar). Depression of a beam supported at the ends and loaded at the center. A vibrating cantilever. Torsion in a string-couple per unit twist, Torsional Pendulum.
   [Mathur 8.8, 8.9, 8.12 -8.18, 8.22, 8.26, 8.29, 8.30]

2. **Surface Tension** **[3 h]**
   Brief review of molecular theory of surface tension. Relation between surface tension and surface energy. Angle of contact. Capillarity-rise of liquid in a capillary tube.
   [Mathur 14.1-14.4, 14.6, 14.14, 14.15 and 14.17]

3. **Viscosity** **[3 h]**
   Streamline flow, Turbulent flow, Critical velocity, Coefficient of viscosity, Poiseuille's formula for flow of liquid through a capillary tube.
   [Mathur 12.1, 12.2, 12.7, 12.11]

Practicals: (Minimum Six)

1. Dimensions of different solid body
2. Moment of Inertia of a flywheel
3. Spring Mass System: Determining the Spring Constant
4. Velocity of sound by Helmholtz Resonator
5. Young's Modulus by Vibration
6. Young's Modulus by Bending
7. Surface Tension by rise of a liquid in a capillary tube.
8. Coefficient of Viscosity by Poiseuille's Method.

List of books recommended for reference

Mandatory Reading:

1. K. R. Symon, *Mechanics (*Addison Wesley, 1971)
2. Brij Lal and N. Subrahmanyam, *Mechanics and Electrodynamics*, (S. Chand and Company LTD , 2005)
3. D. R. Khanna and R. S. Bedi ,*A Textbook of Sound* (Atma Ram and Sons, 1992)
4. N. Subrahmanyam and Brijlal,*Waves and Oscillation* (Vikas Publishing House 1994)
5. D. S. Mathur, *Elements of Properties of Matter* (S.Chand& Co. 2005

Supplementary Reading:

1. John Taylor, Classical Mechanics (University Science Books, 2004)
2. Atam Arya, *Introduction to Newtonian Mechanics*, (Addison-Wesley, 1997)
3. Kittle and Knight, Mechanics (Berkeley Physics Course, Vol. 1), (McGraw Hill Education, 2011)
4. R. G. Takawale and P. S. Puranik, *Introduction to Classical Mechanics*, (Tata McGraw-Hill, 1997)
5. R. Murugeshan and Er. KiruthigaSivaprasath, *Properties of Matter and Acoustics* (S. Chand & Co., 2011)

Online resources:

1. https://www.youtube.com/watch?v=ZFEExw-qUSk&list=PLVFqK_9GOGXnSnuU-x2qgX68mWyBqn6O8
2. https://www.youtube.com/watch?v=47bEFVyczLk&list=PLwdnzlV3ogoV-ATGY2ptuLS9mwLFOJoDw
3. https://www.youtube.com/watch?v=fa0zHI6nLUo&list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGyBEm
4. https://www.youtube.com/watch?v=yyqhgnc5cWI&list=PLbRMhDVUMngeGSqPVkrc8G_kApltxEEos
5. https://www.youtube.com/watch?v=CIws3dZEHMU&list=PL546CD09EA2399DAB&index=7

MULTDISCIPLINARY COURSES (MDC)

Course Title : General Physics: Fluids and Heat

Course Code : UG-PHY-MDC 1

Credits : 2 (Theory) + 1 (Practical)

Marks : 50 (Theory) + 25 (Practical)

Duration : 30 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives: The objective of this course is to build up an understanding of the fundamental laws and principles that govern the physical world. The course will help the students to understand the principles of fluid dynamics and the concepts of temperature, heat engines and laws of thermodynamics.

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

CLO1: Get an insight into the importance of measurement and mathematics in physics

CLO2: Identify and explain the physics behind every day phenomena such as the behaviour and motion of fluids.

CLO3: Understand the fundamental concepts of pressure, exploring the behavior of gases and liquids.

CLO4: Understand Pascal's principle, Archimedes' principle and Bernoulli's principle along with its applications.

CLO5: Understand the concept of temperature and its measurement, including the different temperature scales.

CLO6: Understand the basic concepts of thermodynamics, including the laws of thermodynamics, thermodynamic systems, thermodynamic properties and heat engines.

Course Content

Theory:

Module I: **[10 h]**

Physics, the Fundamental Science

Scope of Physics. Role of measurement and mathematics in Physics. Physics and Everyday Phenomenon.

[Griffiths: 1.2 - 1.4]

The Behavior of Fluids

Pressure and Pascal’s Principle. Atmospheric pressure and the behavior of gases. Archimedes principle. Fluids in motion. Bernoulli’s principle.

[Griffiths: 9.1 - 9.5]

Module II: **[20 h]**

Temperature of Heat

Temperature and its measurement, Heat and specific capacity, Joule's experiment and the First Law of thermodynamics. Gas behavior and the First Law. The Flow of heat.

[Griffiths: 10.1 - 10.5]

Heat Engines and Second Law of Thermodynamics

Heat engines. The second Law of Thermodynamics. Refrigerators, Heat Pumps and Entropy. Thermal Power plants and Energy Resources. Perpetual motion and Energy Frauds.

[Griffiths: 11.1 - 11.5]

Practicals: (Minimum Six)

1. Thermal conductivity of copper.
2. Jaegger's Method: Determination of Surface Tension
3. Viscosity of a liquid by Poiseuilles method
4. Capillarity: determination of Surface tension
5. Specific heat of Graphite
6. Thermal conductivity by Lee's method.
7. Silicon Diode as a thermometer
8. Pt-100 as a temperature sensor.

List of books recommended for reference

Mandatory Reading:

1. Griffiths Thomas and Brosing Juliet, 2009, *The Physics of Everyday Phenomenon: A conceptual introduction to Physics*, 6th Edition. McGraw-Hill Companies.

Supplementary Reading

1. Halliday, Resnick , Walker, 2008, *Fundamentals of Physics* Extended, 8th Edition, Wiley India Pvt Ltd.
2. H.C. Verma , 2021, *Concept of Physics* by H.C Verma, 1st Edition, Bharati Bhawan (Publishers & Distributors).
3. Hugh Young, Roger Freedman, 2019, *University Physics with Modern Physics*, 15th Edition, Pearson.
4. Yunus Cengel, 2007, *Introduction to Thermodynamics and Heat Transfer*, 2nd Edition, McGraw-Hill Education.
5. Feynman, R. 2012, *Feynman Lectures on Physics: Mechanics, Radiation and Heat (Volume - 1)*, Pearson Education, India.

Online resources

1. https://www.youtube.com/watch?v=wF0V51Imxx4
2. https://www.youtube.com/watch?v=clVwKynHpB0&list=RDQMf63I7XSVFD8&start_radio=1
3. https://www.youtube.com/watch?v=mb8LqNlHeLY
4. https://www.youtube.com/watch?v=YxGHbnwqd14
5. https://www.youtube.com/watch?v=DeNBWsZHXTE
6. https://www.youtube.com/watch?v=kLqduWF6GX

SKILL ENHANCEMENT COURSE (SEC)

Course Title : Introduction to Mathematical Physics-I

Course Code : UG-PHY-SEC 1

Credits : 2 (Theory) + 1 (Practical)

Marks : 50 (Theory) + 25 (Practical)

Duration : 30 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives : To develop basic competence in certain areas of mathematics required for understanding several important topics in physics.

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

CLO1: Understand various tests used to examine the convergence and divergence of different kinds of series and learn how to expand a function in power series.

CLO2: Understand the basics of complex numbers.

CLO3: Learn basics of partial differentiation and its application in physics.

CLO4: Solve ordinary first and second order differential equations important in the physical sciences,

CLO5: Use mathematical and computational techniques to solve several problems in physics and enhance problem solving skills.

Theory:

Module I: [15 h]

1. **Infinite Series and Power Series [10 h]**
   Geometric Series and other infinite series. Convergent and Divergent Series. Testing series for convergence. Power series. Expanding functions in power series. Techniques for obtaining power series expansion.
   [Boas 1.1-1.7, 1.10-1.13]

2. **Complex Numbers [5 h]**
   Real and imaginary Parts of a complex number. Complex plane. Complex algebra. Euler's formula. Powers and roots of complex numbers. Exponential and trigonometric functions.
   [Boas 2.1-2.5, 2.9-2.11]

Module II: **[15 h]**

1. **Partial Differentiation** **[6 h]**
   Definition of the partial derivative. Total differentials. Exact and inexact differentials. Theorems of partial differentiation. Chain rule. Thermodynamic relations. Differentiation of Integrals.
   [Boas 4.1-4.5, 4.7, Riley 5.11, 5.12]

2. **Ordinary Differential Equation** **[9 h]**
   Introduction. Linear differential equation of the first order. Homogenous and inhomogeneous linear differential equation of the second order.
   [Boas 8.1-8.6 and Harper 5.1-5.2]

Practicals: (Minimum Six)

1. Introduction to a programming language.
2. Programs that involve the management of program flow using conditional statements such as "if" and "elif".
3. Programs that require looping and iteration using control structures such as "for" and "while" loops.
4. Programs that employ built-in functions as well as functions that are created by the user.
5. Programs that utilize standard libraries like Numpy and Scipy.
6. Exploring series expansions using a programming language and its applications in physics.
7. Exploring complex numbers in Physics analysis using a programming language.
8. Using programming to solve Partial Differentiation.
9. Applying programming techniques to solve ordinary differential equations.
10. Simulation of radioactive decay using rolling of dice
11. Curve fitting using Excel.

List of books recommended for reference

Mandatory Reading:

1. Riley K. F., Hobson M. P., Bence S . J., 1998, *Mathematical Methods for Physics and Engineering*, Cambridge University Press, UK
2. Mary L. Boas, *Mathematical Methods in Physical Sciences* 3rd Edition, John Wiley and Sons, USA
3. Charlie Harper, *Introduction to Mathematical Physics*, Prentice Hall of India, New Delhi

Supplementary Reading:

1. B. D. Gupta, 2004. *Mathematical Physics,* Vikas Publishing House, New Delhi
2. C. Hill, Learning. 2020, *Scientific Programming with Python*, 2nd Edition, Cambridge University Press.

Online resources:

1. https://ocw.mit.edu/resources/res-18-007-calculus-revisited-multivariable-calculus-fall-2011/
2. https://www.youtube.com/watch?v=BP7Ujbyu-NE
3. https://nptel.ac.in/courses/111108081/
4. https://www.math.upenn.edu/~deturck/m104/notes/week6.pdf
5. http://tutorial.math.lamar.edu/Classes/CalcIII/CalcIII.aspx

SEMESTER II

DISCIPLINE SPECIFIC CORE COURSE

Course Title : Electricity and Magnetism

Course Code : UG-PHY-103

Credits : 3 (Theory) + 1 (Practical)

Marks : 75 (Theory) + 25 (Practical)

Duration : 45 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives : The objective of this course is to introduce fundamentals of electricity and magnetism to the students, which is an essential preparation for more advanced courses like Electromagnetic theory.

Course Learning Outcomes: After successful completion of this course, student will be able to:

CLO1: Understand and apply Gauss law, Coulomb's law and apply it to determine electric field of systems of point charges, surface, and volume distributions of charges.

CLO2: Understand and differentiate the vector (electric fields) and scalar (electric potential, electric potential energy) formalisms of electrostatics.

CLO3: Understand and determine the dielectric properties, magnetic properties of materials, and also the phenomena of electromagnetic induction.

CLO4: Analyse and understand the working of DC circuits, AC circuits and AC bridges using appropriate theoretical tools.

CLO5: In the laboratory course the student will be able to construct and understand the working and use of DC circuits, AC circuits with help of various measuring instruments.

Course Content

Theory:

Module I: [15 h]

1. **Electrostatics [10 h]**

Coulomb's law: Statement, Vector form of Coulomb's law for like and unlike charges, Variation of force with distance (F.vs.r graph), Concept of electric field and Electric Field Lines: Electric field, Electric field due to (i) a Point Charge, (ii) an Electric Dipole,

(iii) a Line of Charge and (iv) a Charged Disk, Concept of electric flux: Gauss' Law of electrostatics (Conceptual explanation), Applications of Gauss law: Coulomb's Law from Gauss' Law, Electric Field due to (i) an isolated uniformly charged sphere, (ii) an uniform distribution of charge throughout the sphere and (iii) an uniformly charged hollow cylinder, Electric Field near (i) a charged infinite cylindrical conductor or a cable and (ii) a plane of sheet charge, Concept of Electric Potential: Electric Potential Energy, Equipotential Surfaces, Calculating the Potential from the Field Potential due to (i) a Point Charge, (ii) a Group of Point Charges and (iii) an Electric Dipole Calculating the Field from the Potential

[Halliday: 22.4, 23.2-23.7, 24.1-24.5, 25.1-25.7, 25.9] [Vasudeva: 2.4(1-6)]

2. **Capacitors and Dielectrics** **[5 h]**

Capacitance: Calculation of capacitance of (i) a Parallel-Plate Capacitor, (ii) a Cylindrical Capacitor and (iii) a Spherical Capacitor; Energy stored in an electric field, Capacitor with a Dielectric, Dielectrics: An Atomic View, Dielectrics and Gauss' Law, Relation between three electric vectors (E, D and P)(Without derivation, qualitative discussion only)

[Halliday: 26.1- 26.3, 26.5-26.8]

Module II: **[15 h]**

1. **Magnetostatics** **[6 h]**

Concept of magnetic field: Definition and properties of magnetic field Biot–Savart's law and its applications: (i) a long straight wire and (ii) a current carrying circular loop (for a point on the axis only) Ampere's circuital law and its applications: (i) Field of solenoid and (ii) Field of toroidal solenoid Magnetic Field lines and Magnetic flux; Gauss' law for magnetism

[Halliday: 29.1, 29.2, 30.1, 30.3, 30.4, 32.2][Young:27.2, 27.3]

2. **Self and Mutual Inductance** **[9 h]**

Self induction; Calculation of self inductance of (i) a long solenoid, (ii) long parallel wires and (iii) a coaxial cable, Mutual inductance, Coefficient of coupling; Calculation of mutual inductance between two coaxial solenoids, Mutual inductance of two coils in series, Energy stored in a magnetic field and Energy density of a magnetic field

[Fewkes: 5.1, 5.2, 5.8, 5.9] [Halliday:31.8, 31.10, 31.11, 31.12]

Module III: **[15 h]**

1. **Transient Circuits** **[6 h]**

   Transient currents, Growth and Decay of current in an inductive (L-R) circuit, Physical meaning of time constant, Charging and Discharging of a capacitor through resistor in C-R circuit, Physical meaning of time constant, Charging and Discharging of a capacitor through resistor and inductor in L-C-R circuit: Over damped, Critically damped and Under damped conditions of L-C-R circuit.

   [Fewkes:5.3, 5.4, 5.13, 5.14]

2. **Alternating Current Circuits** **[9 h]**

   Inductive and Capacitive reactance, Variation of inductive reactance and capacitance reactance with frequency Introduction to vector or phasor diagrams method and its application to A.C. circuits(Series L-R, Series C-R, Series L-C-R and Parallel L-C-R) Introduction to j-operator method and its application to A.C. circuits (Series L-C-R and Parallel L-C-R) Physical significance of Series resonance, Parallel resonance, Quality factor and Bandwidth, Graphical representation of resonance A.C. bridges: Maxwell's inductive bridge, Maxwell's L/C bridge, de Sauty's capacitance bridge, Wien's frequency bridge.

   [Vasudeva:22.3, 22.4, 22.6, 22.7, 22.8, 22.9, 22.10, 22.13, 22.14] [Vasudeva: 22.19, 22.20, 22.21(b), 22.22] [Fewkes:6.5, 6.6, 6.7(c), 6.9, 6.14, 6.20, 6.21, 6.22, 6.24]

Practicals: (Minimum Six)

1. Susceptibility measurement of a parallel plate capacitor in a dielectric medium
2. Step Response of RC circuit with DC emf.
3. Study of LR circuit to DC using Excel worksheet
4. LCR- Transient Response
5. Response of LR circuit to A.C. - phasor diagrams
6. Response of CR circuit to A.C. - phasor diagrams
7. LCR- Series resonance –Resonant frequency, Q value and Bandwidth
8. LCR- Parallel resonance –Resonant frequency, Q value and Bandwidth
9. de Sauty's bridge - comparison of capacitance
10. Maxwell's Inductive bridge - determination of mutual inductance

List of books recommended for reference

Mandatory Reading:

1. Halliday David, Resnik Robert and Walker Jearl, 2003, *Fundamentals of Physics*, John Wiley & Sons, Inc., 6th Edition.
2. Vasudeva D. N., 1999, *Fundamentals of Magnetism and Electricity*, S. Chand & Company Ltd., 12th Revised Edition.
3. Young Hugh D., Freedman Roger A. and Ford A. Lewis, 2012, Sears and Zemansky's *University Physics with Modern Physics*, Addison-Wesley Publishers, 13th Edition(PDF).
4. FewkesJ. H. and Yarwood John,1991, *Electricity, Magnetism and Atomic Physics*, Volume I, Oxford University Press Ltd., 10th Impression.

Supplementary Reading:

1. Purcell Edward M., *Electricity and Magnetism-Berkeley Physics Course*,Volume 2, McGraw-Hill Book Company (PDF)
2. Brij Lal and Subramaniam, 1966, *Electricity and Magnetism*, Ratan Prakashan, New Delhi.
3. Thereja B.L., 1990, *Text Book of Electrical Technology*, S. Chand and Co Ltd. New Delhi.

Online resources

1. https://youtu.be/T8bjzTsZyqE
2. https://youtu.be/KNERqAu3aWU
3. https://youtu.be/7jxUT5sIbxY
4. https://youtu.be/iqzpuxVloUc
5. https://youtu.be/iqzpuxVloUc
6. https://physicscatalyst.com/elec/electric-potential-energy.php
7. https://physicscatalyst.com/elec/electric-potential.php
8. https://physicscatalyst.com/elec/relation-between-electric-field-and-potential.php
9. https://physicscatalyst.com/elec/equipotential-surfaces.php
10. https://physicscatalyst.com/elec/electric-potential-dipole.php
11. https://physicscatalyst.com/elec/potential-energy-of-dipole.php
12. https://ocw.mit.edu/courses/physics/8-02t-electricity-and-magnetism-spring-2005/lecture-notes/

Course Title : Electricity, Magnetism and Electronics

Course Code : UG-PHY-104

Credits : 3 (Theory) + 1 (Practical)

Marks :75 (Theory) + 25 (Practical)

Duration : 45 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives: The objective of this course is to introduce fundamentals of electricity, magnetism and basic electronics to the students, which are essential allied learning components for most of the subjects of Physical Sciences.

Learning Outcome: At the end of this course students will be able to:

CLO1: Comprehend basic concepts like: laws of electrostatics and magnetostatics, self and mutual inductions.
CLO2: Understand the working of d.c. and a.c. circuits in terms of the role of passive components like capacitor and inductor present in the circuits.
CLO3: Understand the working and application of various electronic circuits like rectifier, voltage regulator, CE Amplifier.
CLO4: Correlate the theoretical basis of various concepts of electricity, magnetism and electronics while performing experiments.

Course Content

Theory:

Module I: [15 h]

1. **Laws of Electrostatics [8 h]**
   Coulomb's law: Statement, Vector form of Coulomb's law for like and unlike charges, Variation force with distance (F v/s r graph), Concept of electric field and Electric Field Lines, Concept of electric flux: Gauss's theorem in electrostatics (conceptual explanation), Coulomb's Law from Gauss' Law, Concept of Electric Potential: Electric Potential Energy, Equipotential Surfaces, Calculating the Potential from the Field, Calculating the Field from the Potential.
   [Halliday: 22.4, 23.2, 23.3, 24.1-24.5, 25.1-25.4, 25.9] [Vasudeva: 2.4(1)]

2. **Laws of Magnetostatics [7 h]**
   Concept of magnetic field, Definition and properties of magnetic field, Biot – Savart's law and its applications: (i) Long straight conductor and (ii) Current carrying circular loop (for a point on the axis only) Ampere's circuital law and its application: Field of solenoid. Magnetic Field lines and Magnetic flux, Gauss's law for magnetism.
   [Halliday: 29.1, 29.2, 30.1, 30.3, 32.2][Young:27.2, 27.3]

Module II: [15h]

1. **Self and Mutual Inductance [6 h]**
   Self induction; Calculation of self inductance of (i) a long solenoid, (ii) long parallel wires and (iii) a coaxial cable. Mutual inductance, Coefficient of coupling; Mutual inductance of coils in series. Energy stored in the magnetic field
   [Fewkes: 5.1, 5.2, 5.8] [Halliday:31.8, 31.10, 31.12]

2. **Transient Circuits and Alternating Current Circuits [9 h]**
   Transient currents: Growth and Decay of current in an inductive (L-R) circuit, Physical meaning of time constant, Charging and Discharging of a capacitor through resistor in C-R circuit, Physical meaning of time constant. Inductive and Capacitive reactance, Variation of inductive reactance, capacitance reactance with frequency. Introduction to vector or phasor diagrams method and its application to A.C. circuits (Series L-R and Series C-R); Physical significance of Quality factor A.C. bridges: Maxwell's Inductive bridge and de Sauty's Capacitance bridge
   [Fewkes:5.3, 5.4]
   [Vasudeva:22.3, 22.4, 22.6, 22.7, 22.8, 22.9, 22.10] [Fewkes: 6.20, 6.21, 6.22]

Module III.
[15 h]

1. **Rectifiers and Regulators [7 h]**
   Volt-ampere characteristics of Junction diode, Working of Half Wave and Full Wave Rectifiers without and with capacitive filters, Percentage regulation, Ripple factor and Rectification efficiency (only qualitative explanation with respect to HWR and FWR). Zener diode characteristics and its use as a simple voltage regulator. Thermistor characteristics and its use in A.C. voltage regulation.
   [Halliday: 4.1-4.7 and Vasudeva: 6.1-6.4, 6.13-6.17]

2. **Transistors [8 h]**
   Basic configurations of transistors, Transistor's leads identification, Biasing of Transistor and working of Transistor as a switch Transistor characteristic in CE and CB mode, Current gains and their interrelation, Leakage currents in transistor Basic Amplifier Characteristics: Current gain, Voltage gain, Power gain, Input resistance, Output resistance, Classes of amplifier operations, DC load Line, Frequency response and Amplifier bandwidth of CE Amplifier.
   [Young: 8.1, 8.4, 8.7-8.12, 8.17, 8.18, 8.26] [Vasudeva: 7.1-7.7, 7.10, 8.7, 8.8] [Fewkes: 7.6]

Practicals: (Minimum Six)

1. Step Response of RC circuit Charging and discharging of a capacitor
2. Response of LR and CR circuits to A.C. using phasor diagrams
3. de Sauty's capacitance bridge
4. Self inductance of a coil using Maxwell's inductive bridge
5. Mutual inductance of two coils in series
6. Half wave and Full wave rectifier using Junction Diode, Load regulation characteristics.

7. Zener Diode Regulation
8. Transistor characteristics
9. C.E. Amplifier: Gain v/s Load, Input and Output Impedance

List of books recommended for reference

Mandatory Reading:

1. Halliday David, Resnik Robert and Walker Jearl, *Fundamentals of Physics*, John Wiley & Sons, Inc., 6th Edition (2003)
2. Vasudeva D. N., *Fundamentals of Magnetism and Electricity*, S. Chand & Company Ltd., 12th Revised Edition (1999)
3. Young Hugh D., Freedman Roger A. and Ford A. Lewis, Sears and Zemansky's *University Physics with Modern Physics*, Addison-Wesley Publishers, 13th Edition (PDF) (2012)
4. Fewkes J. H. and Yarwood John, *Electricity, Magnetism and Atomic Physics,* Volume I, Oxford University Press Ltd., 10th Impression (1991)

Supplementary Reading:

1. Bhargava N. N., Kulshreshtha D. C. and Gupta S. C., *Basic Electronics and Linear Circuits*, Tata McGraw Hill Education Private Ltd., 54th Reprint (2010)
2. Mottershed Allen, *An Introduction to Electronics Devices and Circuits*, Prentice-Hall of India Private Ltd., Eastern Economy Edition (2008)
3. Metha V. K. and Mehta Rohit, *Principles of Electronics*, S. Chand & Company, Multicolour Revised Edition (2008)
4. Malvino A. P., *Electronic Principles*, Tata McGraw Hill Education Private Ltd., 5th Edition (1996)

Online resources:

1. https://youtu.be/T8bjzTsZyqE
2. https://youtu.be/KNERqAu3aWU
3. https://physicscatalyst.com/elec/electric-potential-energy.php
4. https://physicscatalyst.com/elec/electric-potential.php
5. https://ocw.mit.edu/courses/physics/8-02t-electricity-and-magnetism-spring-2005/lecture-notes/
6. https://www.elprocus.com/different-types-rectifiers-working/
7. https://www.pitt.edu/~qiw4/Academic/ME2082/Transistor%20Basics.pdf
8. https://nptel.ac.in/courses/115/102/115102014/

MULTDISCIPLINARY COURSES (MDC)

Course Title : General Physics: Light and atoms

Course Code : UG-PHY-MDC 2

Credits : 2 (Theory) + 1 (Practical)

Marks : 50 (Theory) + 25 (Practical)

Duration : 30 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives : The objective of the course is to familiarize students with wave nature of light, geometrical optics and the structure of the atom.

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

CLO1: Understand the principles of wave motion and its properties.
CLO2: Understand the nature of electromagnetic waves, the principles of wave interference, including constructive and destructive interference, diffraction grating and their applications in the study of light.

CLO3: Get an insight into the properties and the applications of polarized light

CLO4: Create a foundation in the principles of light and image formation, including the properties of lenses, mirrors, and other optical devices.

CLO5: Understand the principles of atomic and subatomic particles, including the historical development of the atomic theory and the contributions of key scientists.

CLO6: Get a brief idea of the principles of radioactivity, atomic spectra, and matter waves.

Course Content

Theory:

Module I: [20 h]

Wave motion

Wave pulses and periodic waves. Waves on a rope. Interference and standing waves. Sound waves. The Physics of music.

[Griffiths: 15.1 - 15.5]

Light waves

Electromagnetic waves. Wavelength and color. Interference of light waves. Diffraction gratings. Polarized light.

[Griffiths: 16.1 - 16.5]

Light and Image formation

Reflection and image formation. Refraction of light. Lenses and image formation. Focusing light with curved mirrors. Eyeglasses. Microscopes and telescope.

[Griffiths: 17.1 - 17.5]

Module II **[10 h]**

The Structure of the Atom

The existence of atoms. Cathode rays, electrons and X-rays. Radioactivity and discovery of the nucleus. Atomic spectra and Bohr model of the atom. Particle waves and Quantum Mechanics.

[Griffiths: 18.1 - 18.5]

Practicals: (Minimum Six)

1. Newton's Rings
2. Wedge shaped air film
3. Single Slit Diffraction using LASER/Sodium source.
4. Diffraction Grating using LASER/Sodium source.
5. Photoelectric effect.
6. Determination of e/m of electrons using Thomson's method.
7. Frank Hertz Experiment.
8. X-ray Emission (characteristic lines of copper target)- Calculation of wavelength and Energy.

References:

1. Griffiths Thomas and Brosing Juliet, 2009, The Physics of Everyday Phenomenon: A conceptual introduction to Physics, 6th Edition. McGraw-Hill Companies.

Additional References:

1. Halliday, Resnick , Walker, 2008, Fundamentals of Physics Extended, 8th Edition, Wiley India Pvt Ltd.
2. H.C. Verma , 2021, Concept of Physics by H.C Verma, 1st Edition, Bharati Bhawan (Publishers & Distributors).
3. Hugh Young, Roger Freedman, 2019, University Physics with Modern Physics, 15th Edition, Pearson.
4. Eugene Hecht , A. R. Ganesan , 2019. Optics, 5th Edition, Pearson Education.

Web references

1. https://www.youtube.com/watch?v=D_RIzl1uCxY
2. https://www.youtube.com/watch?v=F6dZjuw1KUo
3. https://www.youtube.com/watch?v=HH58VmUbOKM
4. https://www.youtube.com/watch?v=CJ6aB5ULqa0
5. https://www.youtube.com/watch?v=f7TK3KUBR1o
6. https://www.youtube.com/watch?v=3YcmyYgonlE

SKILL ENHANCEMENT COURSE (SEC)

Course Title : Introduction to Mathematical Physics-II

Course Code : UG-PHY-SEC 2

Credits : 2 (Theory) + 1 (Practical)

Marks : 50 (Theory) + 25 (Practical)

Duration : 30 hrs. (Theory) + 30 hrs. (Practical)

Course Objectives: The brief objective of this course is to provide a foundation in mathematical concepts and techniques that are essential for further study in physics.

Course Learning Outcomes: After successful completion of this course, the students will be able to

CLO1: understand vector analysis and its application in physics.

CLO2: familiarize with spherical and cylindrical coordinate systems.

CLO3: understand matrix operations and properties of matrices.

CLO4: describe the characteristics of the normal distribution, including its bell-shaped curve and the empirical rule

CLO5: calculate the standard deviation and use it to determine the acceptability of a measured answer.

CLO6: understand the properties of the binomial distribution including the use of the binomial distribution formula.

CLO7: understand the properties of the Poisson distribution and use it to solve problems and make predictions.

Course Content

Theory:

Module I **[15 h]**

1. **Vector Algebra** **[5 h]**
   Scalars and vectors. Basis vectors and components. Multiplication of Vectors. Equation of lines and planes. Using vectors to find distances.
   [Boas 3.4-3.5]

2. **Coordinate Systems** **[3 h]**
   Plane polar coordinates. Cylindrical and Spherical polar coordinates.
   [Harper 1.6.6, Riley 8.9]

3. **Matrices** **[7 h]**
   Matrix Analysis and Notation, Matrix Operations, Properties of matrices. Transpose matrix. Complex Conjugate Matrix, Hermitian Matrix, Unit matrix, Diagonal matrix, Adjoint and self-adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix. Solution of a system of linear equations. The eigenvalue problem.
   [Harper 2.3-2.8]

Module II: **[15 h]**

1. **The Normal Distribution** **[7 h]**
   Histograms and Distributions, Limiting distributions. The normal distribution. The standard deviation as 68% confidence limit. Justification of the mean as the best estimate. Justification of addition in quadrature. Standard deviation of the mean. Acceptability of the measured answer.
   [Taylor: 5.1-5.8]

2. **The Binomial Distribution** **[4 h]**
   Distributions. Probability in dice throwing. Definition of binomial distribution. Properties of binomial distribution. The Gauss distribution for random errors. Application: testing of hypothesis
   [Taylor: 10.1-10.6]

3. **The Poisson Distribution** **[4 h]**
   Definition of Poisson distribution. Properties of Poisson distribution. Applications. Subtracting a background.
   [Taylor: 11.1-11.4]

Practicals: (Minimum Six)

1. Exploring vector algebra using a programming language and its applications in physics.
2. Investigating Matrix Operations in Physics using a Programming Language -I
3. Statistical analysis with normal distribution using a programming language/Excel.
4. Exploring the binomial distribution through programming/Excel.
5. Exploring the Poisson distribution through programming/Excel.
6. Investigating Matrix Operations in Physics using a Programming Language -II
7. Plotting of various algebraic and trigonometric functions using Excel.
8. Non-linear curve fitting using Excel.

List of books recommended for reference

Mandatory Reading

1. Mary L. Boas, *Mathematical Methods in Physical Sciences* 3rd Edition, John Wiley and Sons, USA
2. Charlie Harper, *Introduction to Mathematical Physics*, Prentice Hall of India, New Delhi
3. Taylor J, 1997, *An Introduction to Error analysis*, University Science Books.

Supplementary Reading:

1. B. D. Gupta, 2004. *Mathematical Physics,* Vikas Publishing House, New Delhi
2. Riley K. F., Hobson M. P., Bence S. J., 1998, *Mathematical Methods for Physics and Engineering*, Cambridge University Press, UK
3. C. Hill, Learning. 2020, *Scientific Programming with Python*, 2nd Edition, Cambridge University Press.

Online resources:

1. https://www.youtube.com/playlist?list=PL1C22D4DED943EF7B
2. http://home.iitk.ac.in/~peeyush/102A/Lecture-notes.pdf
3. http://www.jimahoffman.com/MathB30/Matrices/Matrix1.pdf
4. http://web.pas.rochester.edu/~physlabs/manuals/L2C-StatisticsForWeb-AB5-short.pdf
5. https://library2.lincoln.ac.nz/documents/Normal-Binomial-Poisson.pdf
6. https://www.youtube.com/playlist?list=PLU6SqdYcYsfLRq3tu-g_hvkHDcorrtcBK