CRITERIA 1.1.2

The Programmes offered by the institution focus on employability/entrepreneurship/ skill development and their course syllabi are QM adequately revised to incorporate contemporary requirements.

Programme – B.Sc. Physics

Color Coding: -

1) **EMPLOYABILITY**
2) **ENTREPRENEURSHIP**
3) **SKILL DEVELOPMENT**

Course Curriculum

for

Undergraduate Program in Physics

Netaji Subhas University

Pokhari, Jamshedpur

B.Sc Physics Hons.

Effective from Academic Session 2018- 2021

Dinesh
Head
Department of Physics
Netaji Subhas University

Dean Academics
Netaji Subhas University
Jamshedpur, Jharkhand

NETAJI SUBHAS UNIVERSITY JAMSHEDPUR

Undergraduate B.Sc Hons Program in Physics

Course Structure for B.Sc Phy Hons Program

Hons. /Core Course CC (14 courses)	**Discipline Specific Elective DSE (4 courses)**	**Skill Enhancement Course SEC (2 courses)**	**Generic Elective (GE) (4 courses)**	**Compulsory Course AECC (2courses)**	**Total Courses (CC+DSE+SEC+ GE+AECC)**
Physics	Physics Specific	SEC in Physics	Mathematics	Language Communication EVS	26

Generic Elective Courses of Physics for other Departments

Se	**Code**	**Papers**	**Credit Points**				**Theory Int +Ext**		**Lab Int+Ext**		**Total**
			L	**T**	**P**	**Total**					
1	**GE1**	**Mechanics**	**3**	**1**	**2**	**6**	**20**	**50**	**10**	**20**	**100**
11	**GE2**	**Electricity & Magnetism**	**3**	**1**	**2**	**6**	**20**	**50**	**10**	**20**	**100**
111	**GE3**	**Thermal & Statistical**	**3**	**1**	**2**	**6**	**20**	**30**	**10**	**20**	**100**
1V	**GE4**	**Waves and Optics**	**3**	**1**	**2**	**6**	**20**	**30**	**10**	**20**	**100**

Total Marks for each Semester

Sl. No.	**Semester**	**Total marks**
1	I	350
2	II	350
3	III	450
4	IV	450
5	V	400
6	VI	400
Grand Total		2400

List of Core Courses

SEM	CORE COURSE CODE	NAME OF THE CORE COURSES	CREDIT POINTS			
			L	T	P	TOTAL
I	C1	Mathematical Physics -I	3	1	2	6
	C2	Mechanics	3	1	2	6
II	C3	Electricity & Magnetism	3	1	2	6
	C4	Waves and Optics	3	1	2	6
III	C5	Mathematical Physics -II	3	1	2	6
	C6	Thermal Physics	3	1	2	6
	C7	Digital Systems and Applications	3	1	2	6
IV	C8	Mathematical Physics-III	3	1	2	6
	C9	Elements of Modern Physics	3	1	2	6
	C10	Analog Systems and Applications	3	1	2	6
V	C11	Quantum Mechanics and Applications	3	1	2	6
	C12	Solid State Physics	3	1	2	6
VI	C13	Electromagnetic Theory	3	1	2	6
	C14	Statistical Mechanics	3	1	2	6

List of DSE courses

SEM	CODE	NAME OF THE COURSE	CREDIT POINTS			
			L	T	P	TOTAL
V	DSE 1	Nuclear and Thermal Physics	4	2	-	6
	DSE 2	Classical Dynamics	4	2	-	6
VI	DSE 3	Dissertation	4	2	-	6
	DSE 4	Experimental Techniques	4	2	-	6

List of DSE courses

SEM	CORE PAPER CODE	NAME OF THE PAPER
V	DSE 1	**Nuclear and Thermal Physics**
	DSE 2	**Classical Dynamics**
VI	DSE 3	**Dissertation**
	DSE 4	**Experimental Techniques**

Detailed Marking System for Each Semester in B.Sc Physics Hons.

Sem	Core Hons. Papers, DSE, AECC and GE Courses		Examination and Marking Structure						
	Code	Courses	Internal Theory Marks	End Sem Theory Marks	Total Theory Marks	Internal Lab Marks	External Lab Marks	Total Lab Marks	Total Marks (Theory+ Lab)
I	C1	Mathematical Physics-I + Lab	20	50	**70**	10	20	**30**	100
	C2	Mechanics + Lab	20	50	**70**	10	20	**30**	100
	GE1	Mathematics	30	70	**100**	-	-	-	100
	AECC 1	English Language Communication Skills	20	30	**50**	-	-	-	50
II	C3	Electricity & Magnetism +Lab	20	50	**70**	10	20	**30**	100
	C4	Waves and Optics +Lab	20	50	**70**	10	20	**30**	100
	GE2	Mathematics	30	70	**100**	-	-	-	100
	AECC 2	Environmental Science (EVS)	20	30	**50**	-	-	-	50
III	C5	Mathematical Physics- II + Lab	20	50	**70**	10	20	**30**	100
	C6	Thermal Physics+ Lab	20	50	**70**	10	20	**30**	100
	C7	Digital Systems and Applications + Lab	20	50	**70**	10	20	**30**	100
	GE3	Mathematics	30	70	**100**	-	-	-	100
	SEC1	Elementary Computer Application Software+ Lab	10	25	**35**	5	10	**15**	50
IV	C8	Mathematical Physics-III +Lab	20	50	**70**	10	20	**30**	100
	C9	Elements of Modern Physics +Lab	20	50	**70**	10	20	**30**	100

	C10	**Analog Systems and Applications +Lab**	20	50	**70**	10	20	**30**	100
	GE4	**Mathematics**	30	70	**100**	-	-	-	100
	SEC2	**Electrical Circuit Network Skills +Lab**	10	25	**35**	5	10	**15**	50
V	**C11**	**Quantum Mechanics and Applications +Lab**	20	50	**70**	10	20	**30**	100
	C12	**Solid State Physics +Lab**	20	50	**70**	10	20	**30**	100
	DSE1	**Nuclear and Thermal Physics**	30	70	**100**	-	-	-	100
	DSE2	**Classical Dynamics**	30	70	**100**	-	-	-	100
VI	**C13**	**Electro-magnetic Theory +Lab**	20	50	**70**	10	20	**30**	100
	C14	**Statistical Mechanics + Lab**	20	50	**70**	10	20	**30**	100
	DSE3	**Dissertation**	-	-	**25 (Viva)**	-	-	**75 Project**	100
	DSE4	**Experimental Techniques +Lab**	20	50	**70**	10	20	**30**	100
							Grand Total		2400

Semester Wise Course Summary

Sem	Core Course	Ability Enhancement Course(AECC)	Skill Enhancement Course(SEC)	Discipline Specific Elective (DSE)	Elective	Project	Total
I	2	1			1		4
II	2	1			1		4
III	3		1		1		5
IV	3		1		1		5
V	2			2			4
VI	2			1		1	4

Program Outcomes (POs)

The Undergraduate program for Physics Hons. aims to cater to the students the necessary concepts and applications in the field of Physics. The various core papers included are appropriately chosen to help the students to understand all the basic diversified branches of Physics and build an interest for further development in comprehension in the post graduate programs.
The discipline specific electives and the generic electives are included for helping out the students with proper concepts and tools for cultivating a keen interest in their journey of the physical world. The topics included take care of the requirements of various competitive examinations too.
The computing tools and the application of knowledge of computer in various calculation processes included in the course will be helpful for higher studies in Physics as well as in their research journey. On the whole, efforts have been made to make the students theoretically and practically competent to move ahead confidently in the world of Physics with insights and intelligence.

PO1: Scientific Knowledge
Develop a fundamental and applied understanding of physics concepts, including classical mechanics, electromagnetism, quantum mechanics, statistical mechanics, and solid-state physics.

PO2: Problem-Solving & Analytical Skills
Analyze physical problems, apply mathematical models, and develop solutions using logical reasoning and computational tools.

PO3: Experimental and Laboratory Proficiency
Conduct physics experiments, interpret data, and use scientific instruments with precision and accuracy.

PO4: Research & Innovation
Engage in scientific research, understand recent developments in physics, and contribute to knowledge creation through project-based learning.

PO5: Application of Technology
Utilize computational and simulation techniques for modeling physical systems and analyzing experimental data.

PO6: Environmental & Social Awareness
Understand the environmental impact of physics applications, energy conservation, and sustainable development in line with global challenges.

PO7: Ethics & Professionalism
Develop a sense of professional ethics, responsibility, and scientific integrity in research and practical applications.

PO8: Effective Communication
Communicate scientific ideas effectively through oral, written, and graphical means for diverse audiences.

PO9: Teamwork & Leadership
Work effectively in multidisciplinary teams, contribute to collaborative projects, and develop leadership skills.

PO10: Lifelong Learning
Engage in continuous learning and professional development in physics and interdisciplinary fields through higher studies, research, and self-driven exploration.

Program Specific Outcomes (PSOs)

PSO1 - Master Fundamental Physics Concepts
Gain in-depth knowledge of core physics principles and their applications in real-world scenarios.

PSO2 - Develop Computational and Analytical Skills
Use mathematical and computational tools (e.g., Python, MATLAB, LAMMPS) to analyze and simulate physical systems.

PSO3 - Conduct Experimental Research
Perform advanced physics experiments, including spectroscopy, optics, electronics, and materials science, with hands-on laboratory experience.

PSO4 - Apply Physics in Industry & Research
Utilize physics concepts in industrial applications, including materials science, semiconductor technology, plasma physics, and environmental physics.

PSO5 - Engage in Multidisciplinary Applications
Integrate knowledge of physics with emerging fields such as nanotechnology, computational physics, biophysics, and sustainable energy.

PSO6 - Prepare for Higher Studies & Careers
Develop skills necessary for higher education, competitive exams (e.g., JAM, GATE, NET), and careers in research, teaching, and technology-driven industries.

The syllabus is highlighted to show the various components in the curriculum-

- ✓ **Employability – Yellow**
- ✓ **Entrepreneurship- green**
- ✓ **Skill Development - blue**

SEMESTER I

4 Courses

MATHEMATICAL PHYSICS-I (C1)

I. CORE COURSE –C 1:

Course Objectives:

- To introduce mathematical methods essential for understanding and solving physical problems.
- To develop problem-solving skills using differential equations, linear algebra, complex analysis, and vector calculus.
- To apply mathematical techniques to physical systems and analyze their behavior.

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Theory: 60 Lectures

Unit-1

Calculus:

Recapitulation: Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). First Order Differential Equations and Integrating Factor **(6 Lectures)**

Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral for typical source terms like polynomials, exponential, sine, cosine etc and their combinations. **(12 Lectures)**

Calculus of multivariable functions: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

(6 Lectures)

Unit -2

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their geometrical interpretation. Scalar and Vector fields.

(5 Lectures)

Unit -3

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.

(10 Lectures)

Unit-4

Vector Integration: 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). Dirac Delta function and its properties:

(14 Lectures)

Unit -5

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Expression for Gradient, Divergence, Curl and Laplacian in orthogonal curvilinear co-ordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

(7 Lectures)

Reference Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
2. Differential Equations, George F. Simmons, 2007, McGraw Hill. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
3. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
4. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
5. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
6. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
7. Mathematical Physics, B. D. Gupta.
8. Mathematical Physics, B. S. Rajput. Mathematical Physics, H. K. Dass.
9. Mathematical methods in Physics, E. Butkov.
10. Mathematical methods in Physics, Potter and Goldberg.

PHYSICS PRACTICAL- C 1 LAB

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlights the use of computational methods to solve physical problems*
- *The course will consist of lectures (both theory and practical) in the Lab*
- *Evaluation done not on the programming but on the basis of formulating the problem*
- *Aim at teaching students to construct the computational problem to be solved*
- *Students can use any one operating system Linux or Microsoft Windows*

Topics	**Description with Applications**
Introduction and Overview	Computer architecture and organization, memory and 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 &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 and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (*If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops*), Arrays (*1D & 2D*) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs:	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of π
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solving $\alpha = \tan\alpha$; $I = I_0 [(\sin\alpha)/\alpha]^2$ in optics
Interpolation by Newton Gregory, Forward and Backward difference formula, Error estimation.	Evaluation of trigonometric functions e.g. *sinθ, cosθ, tanθ, etc.*

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd
2. Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw Hill Pub.
3. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. , 2007, Cambridge University Press.
4. A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
5. Elementary Numerical Analysis, K.E. Atkinson, 3 r d Edn. , 2 0 0 7 , Wiley India Edition.
6. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
7. An Introduction to computational Physics, T.Pang, 2nd Edn. , 2006,Cambridge Univ. Press

Course Outcomes (COs):

CO1: Understand vector calculus and its applications.
CO2: Solve differential equations relevant to physical problems.
CO3: Learn Fourier series, transforms, and their applications.
CO4: Use complex analysis in physics-related problems.
CO5: Apply numerical techniques and computational methods for problem-solving.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	1	0	1	1	1	2
CO2	3	3	3	2	1	0	1	1	1	1
CO3	3	3	3	2	1	0	1	1	1	2
CO4	3	3	3	2	1	0	1	1	1	2
CO5	3	2	3	2	3	0	1	1	0	1

MECHANICS (C2)

II. CORE COURSE- C 2:

Course Objectives:

- To understand the fundamental principles of classical mechanics.
- To develop skills in solving problems related to Newtonian mechanics, conservation laws, and rotational motion.
- To introduce concepts of rigid body dynamics and oscillatory motion..

Theory: 60 Lectures

Unit- 1

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

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

Unit-2

Elasticity:
Elastic constants and interrelation between them. Twisting torque on a Cylinder or Wire and twisting couple.
(5 Lectures)

Flexure of beam:
Bending of beam, Cantilever.
(3 Lectures)

Unit-3

Surface Tension:
Ripples and Gravity waves, Determination of Surface Tension by Jaeger's and Quinke's methods. Temperature dependance of Surface Tension.
(6 Lectures)

Fluid Motion:
Kinematics of Moving Fluids, velocity profile: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube and the corrections.
(2 Lectures)

Unit- 4

Central Force Motion:
Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution.. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.
(6 Lectures)

Oscillations:
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.
(8 Lectures)

Unit -5

Special Theory of Relativity:
Galilean transformations; Galilean invariance. Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy- Momentum Minkowski space and Four Vector.
(12 Lectures)

Reference Books:

1. An Introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
7. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
8. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
9. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning

PHYSICS PRACTICAL-C 2 LAB

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine **g** and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
9. To determine the Modulus of Rigidity of a bar by method of bending.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.

Course Outcomes (COs):

CO1: Understand Newtonian mechanics and its applications.
CO2: Analyze motion using Lagrangian and Hamiltonian mechanics.
CO3: Study small oscillations and rigid body motion.
CO4: Learn the central force problem and planetary motion.
CO5: Explore non-inertial frames and their effects on motion.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	1	0	1	1	2
CO2	3	3	3	2	3	1	0	1	1	2
CO3	3	3	3	2	3	1	0	1	1	2
CO4	3	3	3	2	3	1	0	1	1	2
CO5	3	2	3	2	3	1	0	1	1	1

III. GENERIC ELECTIVE (GE 1)

GE1: Mathematics - Differential and Integral Calculus

Course Objectives:

- To develop a strong foundation in **differential and integral calculus** and their applications in solving physical and engineering problems.
- To introduce the concept of **limits, continuity, and differentiability** for understanding the behavior of functions.
- To explore the **rules and techniques of differentiation** and their applications in curve sketching, optimization, and motion analysis.
- To study **integration techniques**, including definite and indefinite integrals, and their applications in computing areas, volumes, and solving physical problems.
- To understand **sequences, series, and convergence** for mathematical modeling and approximation techniques.

Course Outcomes (COs):

- CO1: Understand the fundamental principles of the subject.
- CO2: Analyze mathematical structures and their applications.
- CO3: Develop problem-solving and computational skills.
- CO4: Apply concepts in real-world mathematical and scientific problems.
- CO5: Enhance logical reasoning and abstract thinking.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

IV. ABILITY ENHANCEMENT COMPULSORY COURSE (AECC 1)

AECC1: English Language Communication Skills

Course Objectives:

- To develop **effective communication skills** in English for academic, professional, and social contexts.
- To enhance **reading, writing, speaking, and listening skills** for clear and confident communication.
- To improve **grammar, vocabulary, and pronunciation** for better language proficiency.
- To strengthen **writing skills**, including report writing, letter writing, and essay composition.
- To develop **critical thinking and analytical skills** through comprehension and discussion of texts.

Course Outcomes (COs):

- CO1: Develop a foundational understanding of the subject.
- CO2: Apply concepts in real-world scenarios.
- CO3: Enhance problem-solving and analytical skills.
- CO4: Utilize technology and techniques for practical applications.
- CO5: Improve communication and research skills.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	2	3	3	1	1
CO2	3	3	3	2	3	2	3	3	1	1
CO3	3	3	3	2	3	2	3	3	1	2
CO4	3	3	3	2	3	2	3	3	1	2
CO5	3	2	3	2	3	2	3	3	1	1

SEMESTER II

4 Courses

ELECTRICITY AND MAGNETISM (C3)

I. CORE COURSE -C 3:

Course Objectives:

- To develop a deep understanding of electrostatics, magnetostatics, and electrodynamics.
- To apply Maxwell's equations to analyze electromagnetic waves and circuits.
- To explore applications of electromagnetic theory in modern technologies.

Theory: 60 Lectures

Unit -1

Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

(6 Lectures)

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson Equations and their solutions. The Uniqueness Theorem. Potential and Electric Field due to a dipole. Force and Torque on a dipole.

(6 Lectures)

Electrostatic energy of system of charges. Conductors in an electrostatic Field. Surface charge and force on a conductor. Parallel-plate capacitor. Capacitance of an isolated conductor.

(10 Lectures)

Unit-2

Dielectric Properties of Matter:

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.

(8 Lectures)

Magnetic Field:

Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) on point charge (2) on current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.

(11 Lectures)

Unit- 3

Magnetic Properties of Matter:
Magnetizàtion vector **(M).** Magnetic Intensity **(H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis.

Electromagnetic Induction:
Recapitulation of Faraday's Law, Lenz's Law, Self Inductance and Mutual Inductance. Superposition Theorem. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.
(6 Lectures)

Unit-4
Electrical Circuits:
AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.
(5 Lectures)

Unit-5
Ballistic Galvanometer:
Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.
(4 Lectures)

Reference Books:

1. Electricity, Tayal D. C.
2. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
3. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
4. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
5. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
6. Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press. Electricity and Magnetism, Chattopadhyaya and Rakshit
7. Electricity and Magnetism, Mahajan and Rangwala
8. Electricity and Magnetism, K. K. Tewary.

PHYSICS PRACTICAL –C3 LAB

1. Use a Multimeter for measuring
   (a) Resistances, (b) AC and DC Voltages, (c) DC Current,
   (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To compare capacitances using De'Sauty's bridge.
5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
6. To verify the Thevenin and Norton theorems.
7. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its
    (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and
    (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its
    (a) Anti resonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
    Determine a high resistance by leakage method using Ballistic Galvanometer.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

Course Outcomes (COs):

CO1: Understand electrostatics and Gauss's law applications.
CO2: Study magnetostatics and Ampère's law.
CO3: Learn Maxwell's equations and their implications.
CO4: Analyze electromagnetic waves and their propagation.
CO5: Apply concepts to electrical circuits and materials

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

WAVES AND OPTICS (C4)

II. CORE COURSE -C 4:

Course Objectives:

- To explore the physics of wave motion, including interference, diffraction, and polarization.
- To study the principles of wave optics and its applications in instruments like interferometers.
- To analyze sound and electromagnetic waves through wave equations and Fourier analysis.

Theory: 60 Lectures

Unit - 1

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.
(6 Lectures)

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.
(6 Lectures)

Unit- 2

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.
(5 Lectures)

Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. 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.
(12 Lectures)

Unit- 3

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer – theory and applications.
(6 Lectures)

Unit -4

Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula and its application to rectangular slit.

(6 Lectures)

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Single slit. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

(10 Lectures)

Unit- 5

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

Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. (9 Lectures)

Reference Books:

1. Waves and Acoustics, P. K. Chakraborty and Satyabrata Chowdhury.
2. Introduction to Geometrical and Physical Optics, B. K. Mathur.
3. Optics, Singh and Agarwal.
4. Geometrical and Physical Optics, P. K. Chakraborty.
5. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
6. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
7. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
8. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
9. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
10. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

PHYSICS PRACTICAL- C 4 LAB

1. Familiarization with: Schuster`s focusing; determination of angle of prism.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
4. To determine wavelength of sodium light using Fresnel Biprism.
5. To determine wavelength of sodium light using Newton'sRings.
6. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
7. To determine wavelength of (a) Na source and (b) spectral lines of Hg source using plane diffraction grating.
8. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

Course Outcomes (COs):

CO1: Understand simple harmonic motion and damped oscillations.
CO2: Analyze wave motion and the mathematical description of waves.
CO3: Study interference, diffraction, and polarization of light.
CO4: Learn Fourier optics and its applications.
CO5: Apply principles of wave optics in real-world applications.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

III. GENERIC ELECTIVE (GE 2):

GE2: Mathematics - Vector Analysis and Analytical Geometry of 2D

Course Objectives:

- **To develop a fundamental understanding of vector algebra and calculus**, including vector operations, dot and cross products, and their applications in physics and engineering.

- **To introduce the concepts of gradient, divergence, and curl**, and their significance in physical interpretations such as fluid flow and electromagnetism.

- **To explore two-dimensional (2D) analytical geometry**, including straight lines, circles, conic sections, and transformations, for solving geometric problems.

- **To apply vector methods in solving problems related to geometry and motion**, including parametric equations and coordinate transformations.

- **To strengthen problem-solving skills through real-world applications**, including mechanics, physics, and engineering, where vector analysis and 2D geometry play a crucial role.

Course Outcomes (COs):

- **CO1: Understand the fundamental principles of the subject.**
- **CO2: Analyze mathematical structures and their applications.**
- **CO3: Develop problem-solving and computational skills.**
- **CO4: Apply concepts in real-world mathematical and scientific problems.**
- **CO5: Enhance logical reasoning and abstract thinking.**

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

IV. ABILITY ENHANCEMENT COMPULSORY COURSE (AECC 2)

AECC 2 – ENVIRONMENT STUDIES

Course Objectives:

- **To create awareness about environmental issues and the impact of human activities** on ecosystems, biodiversity, and natural resources.

- **To develop an understanding of ecological concepts**, including ecosystems, food chains, and sustainable resource management.

- **To study environmental pollution (air, water, soil, and noise) and climate change**, along with mitigation and adaptation strategies.

- **To explore environmental laws, policies, and conservation efforts** for promoting sustainable development and environmental protection.

- **To encourage responsible environmental behavior and sustainable practices** through case studies, field visits, and practical approaches.

Theory: 30 Lectures

Unit 1 : Introduction to environmental studies

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

(2 lectures)

Unit 2 :

Ecosystems:

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :

a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem

Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

(2 lectures)

Unit 3 : Natural Resources : Renewable and Non--renewable Resources

- Land resources and landuse change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water : Use and over--exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter--state).

Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

(5 lectures)

Unit 4 : Biodiversity and Conservation

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega--biodiversity nation; Endangered and endemic species ofIndia
- Threats to biodiversity : Habitat loss, poaching of wildlife, man--wildlife conflicts, biological invasions; Conservation ofbiodiversity : In--situ and Ex--situ conservation ofbiodiversity.

Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

(5 lectures)

Unit 5 : Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management : Control measures of urban and industrial waste.

Pollution case studies.

Unit 6 : Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).

Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

(4 lectures)

Unit 7 : Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management : floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.

  Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi). **(3 lectures)**

Unit 8 : Field work

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site--Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.

Study of simple ecosystems--pond, river, Delhi Ridge, etc.

Reference Books:

1. Raziuddin, M.., Mishra P.K. 2014, *A Handbook of Environmental Studies*, Akanaksha Publications, Ranchi. Mukherjee, B. 2011: *Fundamentals of Environmental Biology*.Silverline Publications, Allahabad.
2. Gadgil, M., & Guha, R.1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press. Gleeson, B. and Low, N. (eds.) 1999.*Global Ethics and Environment*, London, Routledge.
3. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
4. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll.*Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006..
5. Odum, E.P., Odum, H.T. & Andrews, J. 1971.*Fundamentals of Ecology*. Philadelphia: Saunders.
6. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
7. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India. Tripathi 1992*. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
8. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.

Course Outcomes (COs):

- **CO1**: Understand the fundamental concepts of the environment and ecology, including ecosystems, biodiversity, and natural resource management.

- **CO2**: Identify various types of environmental pollution (air, water, soil, and noise) and propose sustainable solutions for their prevention and control.

- **CO3**: Analyze the impact of human activities on climate change, global warming, and natural disasters, and explore mitigation strategies.

- **CO4**: Demonstrate knowledge of environmental laws, policies, and conservation initiatives for sustainable resource management and ecological balance.

- **CO5**: Adopt environmentally responsible behavior and sustainable lifestyle practices by applying theoretical knowledge to real-world environmental challenges.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	3	3	1	2	3
CO2	3	3	3	2	3	3	3	1	2	3
CO3	3	3	3	2	3	3	3	1	2	3
CO4	3	3	3	2	3	3	3	1	2	3
CO5	3	2	3	2	3	3	3	1	2	3

SEMESTER III

5 Courses

MATHEMATICAL PHYSICS-II

I. CORE COURSE -C 5

Course Objectives:

- **To introduce advanced mathematical techniques** such as Fourier series, Fourier transforms, and Laplace transforms for solving physical problems.
- **To develop problem-solving skills using partial differential equations (PDEs)** and their applications in wave, heat, and Laplace equations.
- **To explore complex analysis**, including contour integration and Cauchy's theorems, and their applications in physics.
- **To understand special functions like Legendre polynomials, Bessel functions, and their role in solving boundary value problems.**
- **To apply numerical methods** such as interpolation, differentiation, and integration for solving mathematical physics problems computationally.

Theory: 60 Lectures

Unit 1

Fourier Series:
Periodic functions. Orthogonality of sine and cosine functions, Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Analysis of saw-tooth and square wave.Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series.

(14 Lectures)

Unit- 2
Frobenius Method and Special Functions:
Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality.

(24 Lectures)

Unit- 3

Some Special Integrals:

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

(4 Lectures)

Unit- 4

Theory of Errors:

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

(4 Lectures)

Unit- 5

Partial Differential Equations:

Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string. **(14 Lectures)**

Reference Books:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
4. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
5. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
6. Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books
7. Mathematical Physics, B. D. Gupta.
8. Mathematical Physics, B. S. Rajput.
9. Mathematical Physics, H. K. Dass.
10. Mathematical methods in Physics, E. Butkov.
11. Mathematical methods in Physics, Potter and Goldberg.

PHYSICS PRACTICAL-C 5 LAB

60 Lectures

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem

Topics	Description with Applications
Introduction to Numerical computation software Scilab	**Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting, Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization. User defined functions, Introduction to Scilab functions, variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program.**
Curve fitting, Least square fit, Goodness of fit, standard deviation	**Ohms law to calculate R, Hooke's law to calculate spring constant**
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems	**Solution of mesh equations of electric circuits (3 meshes)** **Solution of coupled spring mass systems (3 masses)**
Solution of ODE First order Differential equation Euler, modified Euler and Runge- Kutta second order methods Second order differential equation Fixed difference method	**First order differential equation, Radioactive decay, Current in RC, LC circuits with DC source, Newton's law of cooling, Classical equations of motion, Second order Differential Equation, Harmonic oscillator (no friction), Damped Harmonic oscillator, Over damped, Critical damped, Oscillatory, Forced Harmonic oscillator, Transient and, Steady state solution** **Apply above to LCR circuits also.**

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J.Bence, 3rd ed., 2006, Cambridge University Press
2. Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
3. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
4. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
5. Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
6. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
7. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

Course Outcomes (COs):

CO1: Learn advanced vector calculus and special functions.

CO2: Understand matrices and determinants in physics applications.

CO3: Solve boundary value problems using differential equations.

CO4: Study probability theory and statistics in physics.

CO5: Implement computational techniques for numerical problem-solving

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

THERMAL PHYSICS

II. CORE COURSE -C 6:

Course Objectives:

- **To develop a fundamental understanding of the laws of thermodynamics**, including the concepts of heat, work, and internal energy.
- **To explore the kinetic theory of gases** and derive macroscopic properties from microscopic principles.
- **To study entropy and thermodynamic potentials**, emphasizing their role in equilibrium and spontaneous processes.
- **To analyze phase transitions and critical phenomena** using thermodynamic principles.
- **To introduce the basics of statistical mechanics**, including Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac distributions.

Theory – (60 Lectures)

Unit – 1

Zeroth and First Law of Thermodynamics:
Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes.

(8 Lectures)

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. **(10 Lectures)**

Unit- 2

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics (Nernst's Heat Theorem). Unattainability of Absolute Zero. **(7 Lectures)**

Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films. Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples. **(7 Lectures)**

Unit- 3

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, (1) Clausius Clapeyron equation, (2) Value of C_p-C_v, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases. **(7 Lectures)**

Unit-4

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas. Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. **(7 Lectures)**

Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion.

(4 Lectures)

Unit- 5

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Critical Constants. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling. **(10 Lectures)**

Reference Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
   Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
4. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
5. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
6. Heat and Thermodynamics, A. B. Gupta and H. P. Roy.
7. Heat and Thermodynamics, P. K. Chakraborty.

PHYSICS PRACTICAL- C 6 LAB

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee's disc method.
4. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
5. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
6. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method and to determine Neutral Temperature.

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes,D.P.Khandelwal,1985, Vani Pub.

Course Outcomes (COs):
CO1: Learn laws of thermodynamics and entropy.
CO2: Understand thermodynamic potentials and Maxwell's relations.
CO3: Study kinetic theory of gases and transport phenomena.
CO4: Analyze heat engines and refrigerators.
CO5: Apply thermodynamic concepts to phase transitions

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

DIGITAL SYSTEMS AND APPLICATIONS

III. CORE COURSE -C 7

Course Objectives:

- To understand the fundamentals of digital electronics, including logic gates, Boolean algebra, and sequential circuits.
- To study microprocessors, memory organization, and their applications in modern computing.
- To develop problem-solving skills in designing digital circuits and systems.

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Theory -60 lectures

Unit- 1

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates. NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.
(10 Lectures)

Unit-2

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.
(10 Lectures)

Unit-3

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.
(6 Lectures)

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders, 4-bit binary Adder.
(6 Lectures)

Unit- 4

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.
(10 Lectures)

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.
(6 Lectures)

Unit- 5

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).
(6 Lectures)

Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.
(6 Lectures)

Reference Books:

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
6. Microprocessor Architecture Programming & applications with 8085, 2002, R.S.Goankar, Prentice Hall. Digital Electronics, Floyd.
7. Digital Computer Electronics, Malvino
8. Digital Logic and Computer Design, M. Morris Mano

PHYSICS PRACTICAL-C 7 LAB

1. To measure
   (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Adder and Full Adder Truth table verification using I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To design an astable multivibrator of given specifications using 555 Timer.
12. To design a monostable multivibrator of given specifications using 555 Timer.

Reference Books:

1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill
3. Microprocessor Architecture Programming and applications with 8085, R.S.Goankar, 2002, Prentice Hall.
4. Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

Course Outcomes (COs):

CO1: Understand Boolean algebra and logic gates.
CO2: Learn combinational and sequential circuits.
CO3: Study microprocessors and microcontrollers.
CO4: Explore memory devices and data storage techniques.
CO5: Implement digital circuits in real-world applications.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

IV. GENERIC ELECTIVE (GE 3)

Mathematics (Real Analysis & Differential Equation)

Course Objectives:

- **To develop a rigorous understanding of real numbers, sequences, and series**, focusing on limits, convergence, and continuity.
- **To explore the concepts of differentiation and integration of real functions**, emphasizing their theoretical foundations and applications.
- **To introduce ordinary differential equations (ODEs) and their solutions**, covering first-order and higher-order equations.
- **To apply real analysis techniques to solve problems related to continuity, differentiability, and integration.**
- **To study the applications of differential equations in physics, engineering, and other applied sciences..**

Course Outcomes (COs):

- **CO1**: Understand the fundamental concepts of real analysis, including sequences, series, and limits.
- **CO2**: Apply the principles of continuity, differentiability, and integrability to solve real-world problems.
- **CO3**: Solve ordinary differential equations using analytical and numerical techniques.
- **CO4**: Demonstrate proficiency in handling convergence tests for sequences and series.
- **CO5**: Utilize differential equations to model and analyze physical and engineering systems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

SKILL ENHANCEMENT COURSE (SEC 1):

ELEMENTARY COMPUTER APPLICATION SOFTWARES:

SEC1: Elementary Computer Application Software + Lab

Course Objectives:

- **To introduce the fundamental concepts of computer systems and their components**, including hardware and software.
- **To develop proficiency in using essential application software**, such as word processors, spreadsheets, and presentation tools.
- **To familiarize students with database management systems (DBMS)** and their applications in data handling.
- **To enhance problem-solving skills through the use of computational tools** and basic programming concepts.
- **To provide hands-on experience in internet applications**, including email, web browsing, and cloud computing for academic and professional use.

Theory- 30 lectures

UNIT I: Basics of computers and their evolution- Characteristics of Computer, Application of Computer, Various fields of Computer, Classification of Computer, Generation of Computer.
Software and its types, Compiler & Interpreter, Generation of Language Introduction of software development tool and its importance Data representation - Different Number Systems, Inter Conversion between Number Systems, Binary Arithmetic.

UNIT II: Input devices: Keyboard, Point & draw devices, Data Scanning Devices, Digitizer, etc,
Output Devices: Monitors, Printers, Plotters, Voice Response System, etc., Main Memory / Primary Memory: RAM ROM, PROM, and EPROM: Cache Memory, Secondary Memory, SASD, DASD Concept, Magnetic Tape, Magnetic Disk, Optical Disk, etc. Business Data Processing: File Management System, Database Management System

UNIT III: Operating System Concept: Introduction to Operating System, Functions of Operating System, Types of Operating System, Details of Basic System configuration. Introduction to GUI-Windows Operating System, All Directory Manipulations, File Manipulation. Introduction to Word Processor, Spread Sheets, PowerPoint.

UNIT IV: Concept Of Data Communication & Networking: Network Concepts, Types of Network, Communication Media, Modes of Transmission, Analog & Digital Transmission, Synchronous & Asynchronous Transmission, Different Topologies, And Introduction to Internet

UNIT V: Introduction of MS Word and the use of its different tools. Introduction of Microsoft Excel and working on spreadsheet by using mathematical and logical functions. Introduction of MS Power Point and create the presentation by using different tools.

Reference Books

_ 1. Nishit Mathur, Fundamentals of Computer , Aph publishing corporation(2010) Misty E. Vermaat,.Microsoft word 2013 1st Edition (2013).
_ 2. Satish Jain, M.Geeta, MS- Office 2010 Training Guide, BPB publication (2010)
_ 3. Joan Preppernau, Microsoft PowerPoint 2016 step by step, Microsoft press(2015)
_ 4. Douglas E Corner, The Internet Book 4th Edition, prentice –Hall(2009)
_ 5. Faithe wempen, word 2016 in depth 1st edition, que publishing(2015)

SKILL ENHANCEMENT LAB- SEC 1 LAB

The Lab of UNIT-V (of Theory part) must be followed by the prescribed Lab Manual.

Reference Books:

_ 1. Faithe wempen, word 2016 in depth 1st edition, que publishing(2015)
_ 2. Steven Welkler, Office 2016 for beginners, Create Space Independent publishing plateform(2016)
3. Elaine Marmel, office 2016 simplified, 1st Edition, John Wiley and Sons Inc(2016)
_ 4. Patrice-Anne Rutledge, Easy office 2016 1st edition, Que publishing(2016)

Course Outcomes (COs):

- **CO1**: Understand the basic components of a computer system, including hardware, software, and operating systems.
- **CO2**: Efficiently use word processing, spreadsheet, and presentation software for academic and professional tasks.
- **CO3**: Apply database management concepts to organize, store, and retrieve data effectively.
- **CO4**: Utilize basic programming concepts and problem-solving techniques in computational applications.
- **CO5**: Demonstrate proficiency in internet applications, including email communication, web browsing, and cloud-based tools..

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	1	1	1	1	3
CO2	3	3	3	2	3	1	2	1	2	3
CO3	3	3	3	2	3	1	2	1	2	3
CO4	3	3	3	2	3	1	1	1	2	3
CO5	3	2	3	2	3	2	1	1	2	3

SEMESTER- IV
5 Courses

MATHEMATICAL PHYSICS-III (C8)

II. <u>CORE COURSE -C 8:</u>

C8: Mathematical Physics - III

Course Objectives:

- **To introduce advanced mathematical techniques** such as Green's functions and integral transforms for solving complex physical problems.
- **To develop an understanding of tensor analysis** and its applications in physics, including relativity and continuum mechanics.
- **To study special functions such as Hermite, Laguerre, and Legendre polynomials**, which play a crucial role in solving quantum mechanics and electrodynamics problems.
- **To explore advanced partial differential equations (PDEs)** and their applications in physics, including wave and heat equations.

- **To apply group theory and complex variable techniques** in solving physical and mathematical problems..

Theory: 60 Lectures

Unit- 1

Complex Analysis:

Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles, order of singularity,

Unit -2

Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

(30 Lectures)

Unit- 3

Integrals Transforms:

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral.

Unit- 4

Fourier transform of derivatives, Inverse Fourier transform, Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

(15 Lectures)

Unit -5

Laplace Transforms:

Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

(15 Lectures)

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
3. Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
4. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett. Mathematical Physics, B. D. Gupta.
5. Mathematical Physics, B. S. Rajput.
6. Mathematical Physics, H. K. Dass.
7. Mathematical methods in Physics, E.Butkov.
8. Mathematical methods in Physics, Potter and Goldberg.

PHYSICS PRACTICAL-C 8 LAB

60 Lectures

Scilab based simulations experiments based on Mathematical Physics problems

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
4. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
5. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
6. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

Course Outcomes (COs):

- **CO1**: Apply Green's functions and integral transforms to solve boundary value problems in physics.
- **CO2**: Understand and utilize tensor analysis in physical theories such as general relativity and fluid dynamics.
- **CO3**: Solve differential equations using special functions like Hermite, Laguerre, and Legendre polynomials.
- **CO4**: Analyze and apply advanced PDE methods in mathematical physics and engineering applications.
- **CO5**: Use group theory and complex variable methods in quantum mechanics, crystallography, and symmetry analysis.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

CORE COURSE -C 9:

ELEMENTS OF MODERN PHYSICS

Course Objectives:

- **To introduce the fundamental concepts of modern physics**, including the limitations of classical physics and the need for quantum mechanics.
- **To explore the principles of special relativity**, including time dilation, length contraction, and mass-energy equivalence.
- **To study the wave-particle duality of matter and radiation**, emphasizing experiments like the photoelectric effect and Compton scattering.
- **To understand the basics of quantum mechanics**, including Schrödinger's equation and quantum states.
- **To analyze atomic and nuclear structures**, including Bohr's model, nuclear reactions, and radioactivity.

Theory: 60 Lectures

Unit 1

Quantum theory of Light:

Wave-particle duality, Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.

(15 Lectures)

Unit 2

Quantum Uncertainty:

Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.

(6 Lectures)

Unit 3

Matter waves and wave amplitude;

Unit Schrodinger equation for non-relativistic particles; Physical quantities as operators, Position, Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.

(10 Lectures)

Unit 4

One dimensional infinitely rigid box-

Energy eigenvalues and eigenfunctions, normalization; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier.

(10 Lectures)

Unit 5

Radioactivity:

Stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay-energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. (10 Lectures)

Fission and fusion-

Mass deficit, Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

(3 Lectures)

Unit 6

Lasers:

Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Quantum mechanics, Nikhil Ranjan Roy, 2016, Vikash Publishing House Pvt. Ltd.
3. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
4. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
5. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
6. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan
7. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
8. Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
9. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
10. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
11. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill

PHYSICS PRACTICAL-C 9 LAB

60 Lectures

1. Measurement of Planck's constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the value of e/m by using a Bar magnet.
6. To show the tunneling effect in tunnel diode using I-V characteristics.
7. To determine the wavelength of laser source using diffraction of single slit.
8. To determine the wavelength of laser source using diffraction of double slits.
9. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal

Course Outcomes (COs):

- **CO1**: Understand the limitations of classical physics and the emergence of modern physics concepts.
- **CO2**: Apply the principles of special relativity, including time dilation, length contraction, and mass-energy equivalence.
- **CO3**: Explain wave-particle duality through key experiments like the photoelectric effect and Compton scattering.
- **CO4**: Solve basic quantum mechanics problems using Schrödinger's equation and quantum states.
- **CO5**: Analyze atomic and nuclear structures, including Bohr's model, nuclear reactions, and radioactivity.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

CORE COURSE -C 10:

ANALOG SYSTEMS AND APPLICATIONS (C10)

Course Objectives:

- To introduce semiconductor devices like diodes, transistors, and operational amplifiers.
- To explore the working principles of amplifiers, oscillators, and analog communication systems.

- To develop skills in designing and analyzing analog circuits.

Theory: 60 Lectures

Unit- 1

Semiconductor Diodes:
P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

(10 Lectures)

Unit 2
Two-terminal Devices and their Applications:
(1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.

(6 Lectures)

Unit-3
Bipolar Junction transistors:
n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cut off and Saturation Regions.

(6 Lectures)

Unit- 4
Amplifiers:
Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. **10 Lectures)**

Unit-5

Coupled Amplifier: RC-coupled amplifier and its frequency response.

Feedback in Amplifiers:

Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion

Unit -6

Sinusoidal Oscillators:

Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

(6 Lectures)

Operational Amplifiers (Black Box approach):

Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

Applications of Op-Amps:

(1) Inverting and non-inverting amplifiers, (2) Adder,
(3) Subtractor, (4) Differentiator,
(5) Integrator, (6) Log amplifier **(9 Lectures)**

Reference Books:

- **"Electronic Devices and Circuit Theory"** – Robert L. Boylestad & Louis Nashelsky (Pearson)
- **"Microelectronic Circuits"** – Adel S. Sedra & Kenneth C. Smith (Oxford University Press)
- **"Integrated Electronics: Analog and Digital Circuits and Systems"** – Jacob Millman & Christos C. Halkias (McGraw-Hill)
- **"Electronic Principles"** – Albert Malvino & David J. Bates (McGraw-Hill).
- **"Operational Amplifiers and Linear Integrated Circuits"** – Ramakant A. Gayakwad (Pearson)
- **"Analog Electronics"** – L.K. Maheshwari & M.M.S. Anand (PHI Learning)
- **"The Art of Electronics"** – Paul Horowitz & Winfield Hill (Cambridge University Press)

PHYSICS PRACTICAL-C 10 LAB

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
6. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
7. To design a phase shift oscillator of given specifications using BJT.
8. To study the Colpitt`s oscillator.
9. To study the analog to digital convertor (ADC) IC.
10. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
11. To design inverting amplifier using Op-amp (741,351) and study its frequency response
12. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
13. To add two dc voltages using Op-amp in inverting and non-inverting mode
14. To investigate the use of an op-amp as an Integrator.
15. To investigate the use of an op-amp as a Differentiator.

Reference Books:

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
3. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
4. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson

Course Outcomes (COs):

- **CO1: Understand the fundamental concepts.**
- **CO2: Analyze various principles and applications.**
- **CO3: Solve problems using theoretical knowledge.**
- **CO4: Utilize computational techniques in problem-solving.**
- **CO5: Apply concepts in real-world scenarios.**

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

GENERIC ELECTIVE (GE 4)

GE4: Mathematics - Complex Analysis & Abstract Algebra

Course Objectives:

- **To introduce the fundamental concepts of complex analysis**, including complex functions, analytic functions, and contour integration.
- **To develop an understanding of Cauchy's theorem, Cauchy's integral formula, and residue theorem** for evaluating integrals and solving problems in physics and engineering.
- **To explore abstract algebraic structures**, such as groups, rings, and fields, and their applications in mathematical reasoning.
- **To study homomorphisms, isomorphisms, and group actions**, emphasizing their role in symmetry and transformations.
- **To apply concepts from complex analysis and abstract algebra** to solve real-world problems in physics, computer science, and cryptography..

Course Outcomes (COs):

- **CO1**: Understand the basic concepts of complex functions, analyticity, and complex differentiation.
- **CO2**: Apply Cauchy's theorem, integral formula, and residue theorem to evaluate complex integrals.
- **CO3**: Demonstrate knowledge of group theory, including subgroups, cosets, normal groups, and cyclic groups.
- **CO4**: Analyze the properties of rings and fields and their significance in algebraic structures.
- **CO5**: Utilize complex analysis and abstract algebra in solving mathematical and applied science problems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

SKILL ENHANCEMENT COURSE SEC 2:

ELECTRICAL CIRCUIT NETWORK SKILLS (SEC 2)

SEC2: Electrical Circuit Network Skills + Lab

Course Objectives:

- **To introduce the fundamental concepts of electrical circuits**, including Ohm's law, Kirchhoff's laws, and circuit components.
- **To develop skills in analyzing AC and DC circuits**, including series, parallel, and combination circuits.
- **To understand network theorems** such as Thevenin's theorem, Norton's theorem, and superposition theorem for circuit analysis.
- **To gain hands-on experience in designing and troubleshooting electrical circuits** using practical laboratory exercises.
- **To explore the applications of electrical circuits in real-world systems**, including power distribution and signal processing.

Theory: 30 Lectures

Unit -1

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.

(4 Lectures)

Unit -2

Understanding Electrical Circuits:

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

(6 Lectures)

Unit -3

Generators and Transformers:

DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

(4 Lectures)

Unit-4

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)

Electric Motors:

Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

(6 Lectures)

(6 Lectures)

Unit-5

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.

(4 Lectures)

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand & Co. A text book of Electrical Technology - A K Theraja
2. Performance and design of AC machines - M G Say ELBS Edn.

List of Practicals:

1. Use of multimeter, voltmeter and ammeter
2. To observe current and voltage drop across the DC circuit elements.
3. To track the connections of elements and identify current flow and voltage drop.
4. To observe the working of transformer under no load and full load condition
5. Use of diode as half wave, full wave and bridge rectifier
6. To observe the response of inductor and capacitor with DC or AC sources
7. To understand the importance of interfacing DC or AC sources to relay protection device
8. To prepare an extension board with more than one input terminal (3 pin socket) and check its working.

Course Outcomes (COs):

- **CO1**: Explain the fundamental principles of electrical circuits, including Ohm's law and Kirchhoff's laws.
- **CO2**: Analyze AC and DC circuits using techniques such as mesh analysis, nodal analysis, and circuit theorems.
- **CO3**: Apply network theorems like Thevenin's, Norton's, and superposition to simplify and solve complex circuits.
- **CO4**: Design, construct, and troubleshoot electrical circuits using laboratory tools and techniques.
- **CO5**: Demonstrate practical knowledge of electrical circuits in real-world applications, such as power distribution and signal processing.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	3
CO2	3	3	3	2	3	2	0	1	1	3
CO3	3	3	3	2	3	2	0	1	1	3
CO4	3	3	3	2	3	2	0	1	1	3
CO5	3	2	3	2	3	2	0	1	1	3

SEMESTER V
4 Courses

<u>CORE COURSE -C 11:</u>

QUANTUM MECHANICS AND APPLICATIONS

C11: Quantum Mechanics and Applications

Course Objectives:

- To introduce the fundamental postulates of quantum mechanics.
- To study wave-particle duality, Schrödinger's equation, and quantum states.
- To explore applications of quantum mechanics in atomic and molecular systems..

Theory: 60 Lectures

Unit-1
Time dependent Schrodinger equation:

Postulates of Quantum Mechanics, Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.

(8 Lectures)

Unit-2
Time independent Schrodinger equation:

Hamiltonian, stationary states and energy eigen values; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Position-momentum uncertainty principle. **(12 Lectures)**

Unit-3

General discussion of bound states in an arbitrary potential

Continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle. **(14 Lectures)**

Unit-4

Atoms in Electric & Magnetic Fields:

Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Moment. Stern-Gerlach Experiment. Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

(14 Lectures)

Unit-5

Hydrogen and Many electron atoms:

Pauli's Exclusion Principle, Symmetric & Antisymmetric Wave Functions (Qualitative idea only). Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms- L-S and J-J couplings. Hund's Rule. Term symbols, Spectra of Hydrogen and Alkali Atoms (Na etc.).

(12 Lectures)

Reference Books:

1. Introduction to Quantum mechanics, Nikhil Ranjan Roy, 2016, Vikash Publishing House Pvt. Ltd.
2. A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
3. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
4. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
5. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
6. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
7. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
8. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
9. Quantum mechanics, Satya Prakash
10. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
11. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
12. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

PHYSICS PRACTICAL-C 11 LAB

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

   $d^2y/dr^2 = 2m/h^2 \; [V(r) - E]$ where $V(r) = -e^2/r$

   Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is

$\approx$ -13.6 eV. Take $e = 3.795\ (eVÅ)^{1/2}$, $\hbar c = 1973\ (eVÅ)$ and $m = 0.511 \times 10^6\ eV/c^2$.

Solve the s-wave radial Schrodinger equation for an atom:

Laboratory based experiments:

2. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
3. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
4. To show the tunneling effect in tunnel diode using I-V characteristics.
5. Quantum efficiency of CCDs

Reference Books:

- 1. Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw-–Hill Publication
- 2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
- 3. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
- 4. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
- 5. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
- 6. Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing ISBN:978-6133459274

Course Outcomes (COs):

CO1: Understand the fundamental postulates of quantum mechanics.
CO2: Solve the Schrödinger equation for simple potentials.
CO3: Learn angular momentum and spin operators.
CO4: Analyze hydrogen atom solutions and spectra.
CO5: Explore perturbation theory and applications.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	1
CO2	3	3	3	2	3	2	0	1	1	1
CO3	3	3	3	2	3	2	0	1	1	2
CO4	3	3	3	2	3	2	0	1	1	2
CO5	3	2	3	2	3	2	0	1	1	1

II. CORE COURSE -C 12:

SOLID STATE PHYSICS (C12)

C12: Solid State Physics

Course Objectives:

- To explore the structure and properties of solid materials.
- To study crystal structure, band theory, and electronic properties of materials.
- To understand applications in semiconductors, superconductors, and magnetic materials

Theory: 60 Lectures

Unit- 1

Crystal Structure:
Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.
(12 Lectures)

Unit 2

Elementary Lattice Dynamics:
Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law.

(12 Lectures)

Unit 3

Magnetic Properties of Matter:
Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of Dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss

(10 Lectures)

Unit – 4 Dielectric Properties of Materials:
Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. **(9 Lectures)**

Unit 5

Elementary band theory:

Periodic potential and Bloch Theorem, Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient.

(11 Lectures)

Superconductivity:

Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, Idea of BCS theory (No derivation) **(6 Lectures)**

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
3. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage
4. Learning Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
5. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
6. Solid State Physics, M.A. Wahab, 2011, Narosa Publications
7. Solid State Physics, Dekker
8. Introduction to Solid State Physics, Arun Kumar
9. Solid State Physics, J. P. Srivastava
10. Solid State Physics, Mahan and Mahto

PHYSICS PRACTICAL-C 12 LAB 60 Lectures

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. Verification of Curie-Weiss Law for a ferroelectric material.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the refractive index of a dielectric layer using SPR
6. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
7. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150^0C) and to determine its band gap.
8. To determine the Hall coefficient of a semiconductor sample.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

Course Outcomes (COs):

CO1: Understand crystal structure and lattice dynamics.
CO2: Learn electrical and thermal properties of solids.
CO3: Analyze band theory and semiconductors.
CO4: Explore superconductivity and magnetic materials.
CO5: Study nanomaterials and modern solid-state technologies

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	3
CO2	3	3	3	2	3	2	0	1	1	3
CO3	3	3	3	2	3	2	0	1	1	3
CO4	3	3	3	2	3	2	0	1	1	3
CO5	3	2	3	2	3	2	0	1	1	3

PHYSICS SPECIFIC (DSE 1):

NUCLEAR AND PARTICLE PHYSICS (DSE1)

Course Objectives:

- To introduce nuclear models, nuclear reactions, and decay processes.
- To study fundamental particles and forces in nature.
- To analyze experimental techniques used in nuclear and high-energy physics.

Theory: 75 Lectures

Unit-1

General Properties of Nuclei:
Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

(10 Lectures)

Unit -2

Nuclear Models:
Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

(12 Lectures)

Unit-3

Radioactivity decay:
(a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

(12 Lectures)

Unit -4
Nuclear Reactions:
Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

(10 Lectures)

Interaction of Nuclear Radiation with matter:

Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.

(7 Lectures)

Unit -5

Detector for Nuclear Radiations:

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

(10 Lectures)

Particle Physics:

Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Concept of quark model.

(14 Lectures)

Reference Books:

1. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008)
2. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
3. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
4. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
5. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
6. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
7. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
8. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
9. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007). Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991

Course Outcomes

- **CO1: Understand Nuclear Structure and Properties**
- **CO2: Analyze Nuclear Reactions and Decay Processes.**
- **CO3: Explore Particle Physics and Fundamental Interactions**
- **CO4: Apply Theoretical Models in Nuclear Physics**
- **CO5: Study Experimental Techniques in Nuclear Physics**

CO PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	3
CO2	3	3	3	2	3	2	0	1	1	3
CO3	3	3	3	2	3	2	0	1	1	3
CO4	3	3	3	2	3	2	0	1	1	3
CO5	3	2	3	2	3	2	0	1	1	3

PHYSICS SPECIFIC (DSE 2):

CLASSICAL DYNAMICS (DSE 2)

DSE2: Classical Dynamics

Course Objectives:

1. **To develop a strong foundation in Newtonian mechanics**, including forces, motion, and energy conservation principles.
2. **To introduce advanced formulations of classical mechanics**, such as Lagrangian and Hamiltonian mechanics.
3. **To study the motion of rigid bodies**, including rotational dynamics, moment of inertia, and angular momentum conservation.
4. **To analyze central force problems and planetary motion** using Kepler's laws and the two-body problem.
5. **To explore nonlinear dynamics and chaos theory**, emphasizing real-world applications in physics and engineering.

Theory: 75 Lectures

Unit 1- Classical Mechanics of Point Particles:

Generalised coordinates and velocities. Hamilton's Principle, Lagrangian and Euler-Lagrange equations. Applications to simple systems such as coupled oscillators. Canonical momenta

Unit-2

Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, particle in a central force field. Poisson brackets. Canonical transformations.

(22 Lectures)

Unit-3 Special Theory of Relativity:

Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. Time-dilation, length contraction & twin paradox. Four-vectors: space-like, time-like & light-like. Four-velocity and acceleration. Four-momentum and energy-momentum relation. Doppler effect from a four vector perspective. Concept of four-force.

Unit-4

Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. Electric and magnetic fields due to a uniformly moving charge. Equation of motion of charged particle & Maxwell's equations in tensor form. Motion of charged particles in external electric and magnetic fields.

(38 Lectures)

Unit-5 Electromagnetic radiation:

Review of retarded potentials. Potentials due to a moving charge: Lienard Wiechert potentials. Electric & Magnetic fields due to a moving charge: Power radiated, Larmor's formula and its relativistic generalisation.

(15 lectures)

Reference Books:

1. Intoduction to Classical mechanics, Nikhil Ranjan Roy, 2016, Vikash Publishing House Pvt. Ltd.
2. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
3. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
4. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
5. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
6. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
7. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

Course Outcomes

- **CO1**: Apply Newtonian mechanics to analyze the motion of particles and systems using force and energy concepts.
- **CO2**: Utilize Lagrangian and Hamiltonian formulations to solve problems in classical mechanics.
- **CO3**: Understand and analyze rotational motion, moment of inertia, and conservation of angular momentum in rigid body dynamics.
- **CO4**: Solve central force problems, including planetary motion, using Kepler's laws and the two-body problem.

- **CO5**: Explore nonlinear dynamics and chaos theory, understanding their significance in complex physical systems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	3
CO2	3	3	3	2	3	2	0	1	1	3
CO3	3	3	3	2	3	2	0	1	1	3
CO4	3	3	3	2	3	2	0	1	1	3
CO5	3	2	3	2	3	2	0	1	1	3

SEMESTER VI

4 Courses

ELECTROMAGNETIC THEORY (C13)

CORE COURSE -C 13:

Course Objectives

1. **To develop a deep understanding of electrostatics and magnetostatics**, including Coulomb's law, Gauss's law, and Ampère's law.
2. **To explore Maxwell's equations** and their role in unifying electricity and magnetism.
3. **To analyze electromagnetic wave propagation** in different media, including reflection, refraction, and waveguides.
4. **To study the concepts of electromagnetic potentials**, gauge transformations, and their applications in electrodynamics.
5. **To apply electromagnetic theory to real-world problems**, such as transmission lines, antennas, and optical fiber communication.

Theory: 60 Lectures

Unit-1 Maxwell Equations:

Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting vector and Poynting Theorem. Electromagnetic (EM) Energy Density.

(14 Lectures)

Unit-2

EM Wave Propagation in Unbounded Media:

Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth.

(10 Lectures)

Unit- 3

EM Wave in Bounded Media:

Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves.

(12 Lectures)

Unit-4

Polarization of Electromagnetic Waves:

Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary

& extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light

(12 Lectures)

Rotatory Polarization:

Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter.

(5 Lectures)

Unit-5

Optical Fibers:-

Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

(3 Lectures)

Reference Books:

1. Electromagnetic Theory, Chopra and Agarwal.
2. Electromagnetics, B. B. Laud.
3. Electromagnetic Theory,, Satya Prakash
4. Electromagnetic Theory, Gupta and Kumar
5. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
6. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
7. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett
8. Learning Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
9. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
10. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
11. Electromagnetic Fields & Waves, P.Lorrain & D.Corson, 1970, W.H.Freeman & Co.
12. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
13. Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press

PHYSICS PRACTICAL-C 13 LAB

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To determine the refractive Index of
   (a) glass and (b) a liquid by total internal reflection using a Gaussian eyepiece.
5. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
6. To verify the Stefan`s law of radiation and to determine Stefan's constant.
7. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
4. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Course Outcomes (COs):

- **CO1**: Apply fundamental laws of electrostatics and magnetostatics to solve field problems.
- **CO2**: Derive and interpret Maxwell's equations in both differential and integral forms.
- **CO3**: Analyze the behavior of electromagnetic waves in free space, conductors, and dielectrics.
- **CO4**: Utilize vector potentials and gauge transformations in solving electrodynamics problems.
- **CO5**: Implement electromagnetic theory concepts in practical applications like antennas, waveguides, and optical fiber systems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	3
CO2	3	3	3	2	3	2	0	1	1	3
CO3	3	3	3	2	3	2	0	1	1	3
CO4	3	3	3	2	3	2	0	1	1	3
CO5	3	2	3	2	3	2	0	1	1	3

II. CORE COURSE -C 14:

STATISTICAL MECHANICS (C14)

C14: Statistical Mechanics

Course Objectives:

- **To introduce the fundamental principles of statistical mechanics**, linking microscopic states to macroscopic thermodynamic properties.
- **To develop an understanding of probability distributions**, ensemble theory, and phase space concepts.
- **To study classical and quantum statistics**, including Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac distributions.
- **To explore the thermodynamic behavior of ideal and interacting systems**, such as gases, solids, and phase transitions.
- **To apply statistical mechanics in various physical phenomena**, including blackbody radiation, heat capacity, and critical phenomena.

Theory: 60 Lectures

Unit-1

Classical Statistics:

Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations. (18 Lectures)

Unit-2

Classical Theory of Radiation:

Properties of Thermal Radiation. Blackbody Radiation. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Rayleigh-Jean's Law.

(9 Lectures)

Unit-3

Quantum Theory of Radiation:

Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

(5 Lectures)

Unit-4

Bose-Einstein Statistics:

B-E distribution law, Thermodynamic functions of a Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

(13 Lectures)

Unit-5 Fermi-Dirac Statistics:
Fermi-Dirac Distribution Law, Thermodynamic functions of a Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

(15 Lectures)

Reference Books:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
3. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
6. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press Statistical Mechanics, K. Huang.

PHYSICS PRACTICAL-C 14 LAB — 60 Lectures

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
2. Plot Specific Heat of Solids by comparing
   (a) Dulong-Petit law, (b) Einstein distribution function,
   (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases
3. Plot Maxwell-Boltzmann distribution function versus temperature.
4. Plot Fermi-Dirac distribution function versus temperature.
5. Plot Bose-Einstein distribution function versus temperature.

Reference Books:

1. Elementary Numerical Analysis, K.E.Atkinson, 3 r d Edn. 2007, Wiley India Edition
2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W.Sears and Gerhard L. Salinger, 1986, Narosa.
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
5. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
6. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
7. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

Course Outcomes (COs):

- **CO1**: Understand the fundamental principles of statistical mechanics and their connection to thermodynamics.
- **CO2**: Apply ensemble theory (microcanonical, canonical, and grand canonical) to describe thermodynamic systems.
- **CO3**: Differentiate between classical (Maxwell-Boltzmann) and quantum (Bose-Einstein and Fermi-Dirac) statistical distributions.
- **CO4**: Analyze phase transitions and critical phenomena using partition functions and correlation functions.
- **CO5**: Solve real-world problems in thermodynamics, condensed matter physics, and astrophysical systems using statistical mechanics principles.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	3
CO2	3	3	3	2	3	2	0	1	1	3
CO3	3	3	3	2	3	2	0	1	1	3
CO4	3	3	3	2	3	2	0	1	1	3
CO5	3	2	3	2	3	2	0	1	1	3

PHYSICS SPECIFIC (DSE 3): DISSERTATION (DSE3)

Course objectives for **Dissertation (DSE3)**:

1. **Develop Research Skills** – Conduct independent research using appropriate methodologies.
2. **Apply Physics Principles** – Use theoretical and experimental concepts to analyze a specific problem.
3. **Enhance Analytical Abilities** – Interpret data critically and draw meaningful conclusions.
4. **Improve Scientific Communication** – Write a structured dissertation and present findings effectively.
5. **Promote Ethical and Independent Work** – Maintain academic integrity and manage research independently.

Course Outcomes (COs) for a Dissertation in UG Physics:

- **CO1:** Develop the ability to identify, analyze, and solve scientific problems using fundamental physics concepts.
- **CO2:** Gain hands-on experience in laboratory techniques, data analysis, and computational tools relevant to physics research.
- **CO3:** Enhance skills in writing research reports, preparing presentations, and effectively communicating scientific findings.
- **CO4:** Understand academic integrity, plagiarism, and ethical considerations in conducting and presenting research.
- **CO5:** Build a strong foundation for pursuing higher education (M.Sc., Ph.D.) or careers in research, industry, and academia.

Student alone or in a group of not more than five, shall undertake one Project Dissertation approved by the Subject Teacher/H.O.D. of the Department concerned. The progress of the Project Dissertation shall be monitored by the faculty members at regular intervals.

CO PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	3	3	3	3
CO2	3	3	3	2	3	2	3	3	3	3
CO3	3	3	3	2	3	2	3	3	3	3
CO4	3	3	3	2	3	2	3	3	3	3
CO5	3	2	3	2	3	2	3	3	3	3

PHYSICS SPECIFIC (DSE 4):

EXPERIMENTAL TECHNIQUES (DSE4)

Course Objectives

- **To introduce fundamental principles of experimental physics**, including measurement techniques and data analysis.
- **To familiarize students with modern scientific instruments** used in physics experiments, such as oscilloscopes, spectrometers, and vacuum systems.
- **To develop an understanding of error analysis and uncertainty**, ensuring accuracy and reliability in experimental results.
- **To explore various material characterization techniques**, such as X-ray diffraction (XRD), scanning electron microscopy (SEM), and thermal analysis.
- **To apply experimental methods in real-world applications**, including electronics, optics, and condensed matter physics.

Theory: 60 Lectures

Unit-1

Measurements:

Accuracy and precision. Significant figures. Error and uncertainty analysis.
Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Guassian distribution.

(8 Lectures)

Unit -2 Signals and Systems:

Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise

(8 Lectures)

Unit-3 Shielding and Grounding:

Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference.

Unit-4 Transducers & industrial instrumentation (working principle, efficiency, applications):

Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75). Sinear Position transducer: Strain gauge, Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.

Digital Multimeter:

Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.

(5 Lectures)

Vacuum Systems:

Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).

(14 Lectures)

Reference Books:

1. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
2. Experimental Methods for Engineers, J.P. Holman, McGraw Hill
3. Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
4. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
5. Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill
6. Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
7. Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk, Springer

DSE-4 LAB: EXPERIMENTAL TECHNIQUES **60 Lectures**

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of Strain using Strain Gauge.
3. Measurement of level using capacitive transducer.
4. To study the characteristics of a Thermostat and determine its parameters.
5. Study of distance measurement using ultrasonic transducer.
6. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2m length, understanding of importance of grounding using function generator of mV level & an oscilloscope.
8. To design and study the Sample and Hold Circuit.
9. Design and analyze the Clippers and Clampers circuits using junction diode
10. To plot the frequency response of a microphone.
11. To measure Q of a coil and influence of frequency, using a Q-meter.

Reference Books:

- Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008
- Springer Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill
- Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning.

Course Outcomes

CO1: About accuracy and precision, different types of errors and statistical analysis of data.
CO2: About Noise and signal, signal to noise ratio, different types of noises and their identification.
CO3: Concept of electromagnetic interference and necessity of grounding.
CO4: About transducers and basic concepts of instrumentation-Different types of transducers and sensors.
CO5: Working of a digital multi-meter, Vacuum systems including ultrahigh vacuum systems.

CO PO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	0	1	1	3
CO2	3	3	3	2	3	2	0	1	1	3
CO3	3	3	3	2	3	2	0	1	1	3
CO4	3	3	3	2	3	2	0	1	1	3
CO5	3	2	3	2	3	2	0	1	1	3

COURSES OF STUDY FOR GENERIC ELECTIVE 'B. Sc. Hons' PROGRAMME IN

"PHYSICS"

SEMESTER I	GENERIC ELECTIVE	1Course

I.GENERIC ELECTIVE (GE 1): (Course Objectives, Outcomes and Mapping is according to Course C2)

All Four Generic Electives (One Course to be studied in each semester) of Physics to be studied by the Students having Other than Physics Honours.

MECHANICS

Unit-1 Vectors:
Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. **(4 Lectures)**

Ordinary Differential Equations:
1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. **(6 Lectures)**

Unit-2 Laws of Motion:
Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. **(10 Lectures)**

Momentum and Energy:
Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. **(6 Lectures)**

Unit-3 Rotational Motion:
Angular velocity and angular momentum. Torque. Conservation of angular momentum. **(5 Lectures)**

Gravitation:
Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts. **(8 Lectures)**

Unit-4 Oscillations:
Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.

Unit-5 Elasticity
Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work

done in twisting a wire – Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and σ by Searles method.

(8 Lectures)

Speed Theory of Relativity:

Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities. **(7 Lectures)**

Note: *Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to the radial coordinate.*

Reference Books:

1. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison-Wesley
2. Mechanics Berkeley Physics, v.1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.
3. Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
5. A textbook of General Physics, Edser
6. Oscillations and waves, Satya Prakash.
7. A textbook of oscillation, waves and Acoustics, M. Ghosh and D. Bhattacharya

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GE 1 LAB: MECHANICS

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Moment of Inertia of a Flywheel.
3. To determine the Young's Modulus of a bar by method of bending.
4. To determine the Elastic Constants of a Wire by Searle's method.
5. To determine g by Bar Pendulum.
6. To determine g by Kater's Pendulum.
7. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

SEMESTER II	GENERIC ELECTIVE	1 Paper

GENERIC ELECTIVE (GE 2) **(Course Objectives, Outcomes and Mapping is according to Course C3)**

ELECTRICITY AND MAGNETISM

Theory: 60 Lectures

Unit-1 Vector Analysis:
Scalar and Vector product, gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

(12 Lectures)

Unit-2 Electrostatics:
Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

(22 Lectures)

Unit-3Magnetism:
Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferromagnetic materials.

(10 Lectures)

Unit-4 Electromagnetic Induction:
Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

(6 Lectures)

Unit-5 Maxwell`s equations and Electromagnetic wave propagation:
Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization. **(10 Lectures)**

Reference Books:

1. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
2. Electricity & Magnetism, J.H. Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press
3. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. D.J.Griffiths,
5. Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings
6. Electricity and Magnetism, Chattopadhyaya and Rakshit
7. Electricity and Magnetism, Mahajan and Rangwala
8. Electricity and Magnetism, K. K. Tewary.

GE 2 LAB: ELECTRICITY AND MAGNETISM

60 Lectures

1. To use a Multimeter for measuring
   (a) Resistances, (b) AC and DC Voltages,
   (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer:
   (i) Measurement of charge and current sensitivity
   (ii) Measurement of CDR
   (iii) Determine a high resistance by Leakage Method
   (iv) To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. To study the Characteristics of a Series RC Circuit.
5. To study a series LCR circuit LCR circuit and determine its
   (a) Resonant frequency, (b) Quality factor
6. To study a parallel LCR circuit and determine its
   (a) Anti-resonant frequency and (b) Quality factor Q
7. To verify the Thevenin and Norton theorems
8. To verify the Superposition, and Maximum Power Transfer Theorems

Reference Books

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal

SEMESTER III — GENERIC ELECTIVE — 1 Paper

GENERIC ELECTIVE (GE 3)

(Course Objectives, Outcomes and Mapping is according to Course C6)

THERMAL PHYSICS AND STATISTICAL MECHANICS

Unit -1 Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

(22 Lectures)

Unit -2 Thermodynamical Potentials:
Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for ($C_P - C_V$), C_P/C_V, TdS equations.

(10 Lectures)

Unit-3 Kinetic Theory of Gases:
Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) & its applications to specific heat of gases; mono-atomic and diatomic gases.

(10 Lectures)

Unit-4 Theory of Radiation:
Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

(6 Lectures)

Unit-5 Statistical Mechanics:
Maxwell-Boltzmann law - distribution of velocity – Quantum statistics - Phase space - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.

(12 Lectures)

Reference Books:

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
3. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and G.L. Salinger. 1988, Narosa University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
4. Heat and Thermodynamics, A. B. Gupta and H. P. Roy.
5. Heat and Thermodynamics, P. K. Chakraborty.
6. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
7. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
8. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
9. Statistical Mechanics, K. Huang.

GE 3 LAB: THERMAL PHYSICS AND STATISTICAL MECHANICS

1. Measurement of Planck's constant using black body radiation.
2. To determine Stefan's Constant.
3. To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
4. To determine the coefficient of thermal conductivity of a bad conductor by Lee disc method.
5. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
6. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
7. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system

Reference Books:

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal, 1985, Vani Publication.

SEMESTER IV **GENERIC ELECTIVE**

<u>GENERIC ELECTIVE (GE 4)) **(Course Objectives, Outcomes and Mapping is according to Course C4)**</u>

WAVES AND OPTICS

Unit-1 Wave Motion:
Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

(6 Lectures)

Unit- 2 Velocity of Waves:
Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

(6 Lectures)

Unit-3 Wave Optics:
Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

(5 Lectures)

Unit-4 Interference:
Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. 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.

(12 Lectures)

Unit-5 Interferometer:
Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer –theory and applications.

(6 Lectures)

Unit-6 Fraunhofer diffraction:
Single slit. Circular aperture, Resolving Power of a telescope. Single slit. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

(10 Lectures)

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.

(9 Lectures)

Reference Books

_ 1. Waves and Acoustics, P. K. Chakraborty and Satyabrata Chowdhury.
_ 2. Introduction to Geometrical and Physical Optics, B. K. Mathur. Optics, Singh and
_ Agarwal.
3. Geometrical and Physical Optics, P. K. Chakraborty.
_ 4. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata
_ McGraw-Hill.
5. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
_ 6. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999,
_ Pergamon Press. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
_ 7. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley
_ and Sons.
8. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

GE 4 LAB: WAVES AND OPTICS

1. Familiarization with: Schuster`s focusing; determination of angle of prism.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
4. To determine wavelength of sodium light using Fresnel Biprism.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
7. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
8. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

_ 1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia
_ Publishing House
_ 2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

SAMPLE CALCULATION FOR SGPA & CGPA
FOR UNDERGRADUATE 'B.Sc Honours" PROGRAMME

Distribution of Credits Semester wise for Undergraduate Honours Courses

Table B-1: UG (B.Sc. Hons. Programme) Semester wise distribution of 140 Credits

	CC	AECC	GE	SEC	DSE	Total credits
Semester I	12	02	06			20
Semester II	12	02	06			20
Semester III	18		06	02		26
Semester IV	18		06	02		26
Semester V	12				12	24
Semester VI	12				12	24
	84	**04**	**24**	**04**	**24**	**140**

CC=Core Course; AECC=Ability Enhancement Compulsory Course; GE=Generic Elective; SEC=Skill Enhancement Course; DSE=Discipline Specific Elective

Table B-3: Sample calculation for SGPA for B.Sc Honours Programme

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit X Grade)	SGPA (Credit Point/Credit)
Semester I					
C-1	06	A	8	48	
C-2	06	B+	7	42	
AECC-1	02	B	6	12	
GE-1	06	B	6	36	
Total	**20**			**138**	**6.9 (138/20)**
Semester II					
C-3	06	B	6	36	
C-4	06	C	5	30	
AECC-2	02	B+	7	14	
GE-2	06	A+	9	54	
Total	**20**			**134**	**6.7 (134/20)**
Semester III					
C-5	06	A+	9	54	
C-6	06	0	10	60	
C-7	06	A	8	48	
SEC-1	02	A	8	16	
GE-3	06	0	10	60	
Total	**26**			**238**	**9.15 (238/26)**
Semester IV					
C-8	06	B	6	36	
C-9	06	A+	9	54	
C-10	06	B	6	36	
SEC-2	02	A+	9	18	
GE-4	06	A	8	48	
Total	**26**			**192**	**7.38 (192/26)**
Semester V					
C-11	06	B	6	36	
C-12	06	B+	7	42	
DSE-1	06	0	10	60	
DSE-2	06	A	8	48	
Total	**24**			**186**	**7.75 (186/24)**
Semester VI					
C-13	06	A+	9	54	
C-14	06	A	8	48	
DSE-3	06	B+	7	42	
DSE-4	06	A	8	48	
Total	**24**			**192**	**8.0 (192/24)**
CGPA					
Grand Total	**140**			**1080**	**7.71 (1080/140)**

Table B-4: Sample calculation for CGPA for B.Sc. Honours Programme

Semester I	Semester II	Semester III	Semester IV	Semester V	Semester VI
Credit:20; SGPA:6.9	Credit:20; SGPA: 6.7	Credit:26; SGPA: 9.15	Credit:26; SGPA: 7.38	Credit:24; SGPA: 7.75	Credit:24; SGPA: 8.0

Thus CGPA= (20x6.9+20x6.7+26x9.15+26x7.38+24x7.75+24x8.0)/140=**7.71**

Dinesh
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Department of Physics
Netaji Subhas University

NETAJI SUBHAS UNIVERSITY ★ JAMSHEDPUR

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