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MATHEMATICAL PHYSICS- I - PHYC01

Credits: 4 Teaching Hours: 4 hrs / week

Objectives:

1. To develop knowledge in mathematical physics and its applications.

2. To develop expertise in mathematical techniques required in physics.

3. To enhance problem solving skills.

4. To enable students to formulate, interpret and draw inferences from mathematical solutions.

Unit I

Vector analysis: Vector differential operator and vector integration in Cartesian, cylindrical and spherical coordinate systems. Gauss' theorem and Stokes' theorem. Determinant and matrices: Matrices, orthogonal matrices, Hermitian matrices, Unitary matrices, Diagonal of matrices.

Unit II:

Infinite series: Fundamental concepts, convergence tests. Alternating series, algebra of series. Series of functions, Taylor's expansion and power series.

Unit III:

Functions of a complex variable I: analytic properties, complex algebra. Cauchy Riemann conditions. Cauchy's integral theorem, Cauchy's integral formula. Laurent series expansion.

Unit IV:

Functions of a complex variable II: Singularities – Poles, Branch points. Calculus of residues – Residue theorem, Cauchy principle value, Pole expansion of meromorphic functions, Product expansion of entire functions, Evaluation of definite integrals.

Unit V:

Fourier series: Advantages, applications and properties of Fourier series integral transforms. Development of Fourier integral. Fourier transforms. Inversion theorem. Fourier transform of derivatives and convolution theorem.

Textbook: Mathematical Methods for Physicists, G. B. Arfken & H. J. Weber, IV edn. (Academic Press, 2005, India)

Unit I: Chap.1, Secs.1.6 to 1.12: Chap.2, Secs.2.1 to 2.5.: Chap.3, Secs.3.2 to 3.5

Unit II: Chap.5, Secs.5.1 to 5.7.

Unit III: Chap.6, Secs.6.1 to 6.5

Unit IV: Chap.7, Secs.7.1 and 7.2

Unit V: Chap.14, Secs.14.1 to 14.4: Chap.15, Secs.15.2 to 15.5.

Reference books

1. Mathematical Physics, E. Butkov,(Addison-Wesley, 1968

2. Mathematical Physics for Engineers and Physicists, L.A. Pipes & L.R.Harvill, III edn.

3. Advanced Engineering Mathematics, E.Kreyszig, V edn. (New Age Publishers, New Delhi, 1996).

Course Outcomes:

CO1: Solve the partial differential equations

CO2: Evaluate second order linear differential equations and apply it for solving physics problems

CO3: Explain the concept of Gamma functions

CO4: Analyse the concept of Bessel functions and its properties

CO5: Apply Legendre functions and its properties

Course Content:

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

CO1: Explain the properties of linear vector space and matrices and apply them to analyze a broad range of physical models

CO2: Test the infinite series for convergence

CO3: Interpret the characteristics of complex functions

CO4: Evaluate residues and definite integrals

CO5: Expand the periodic functions using Fourier series and apply integral transforms to various

physical problems

Course Code and Title: PHY MATHEMATICAL PHYSICS- I			
Class	MSc (Physics)	Semester	I
Cognitive Level	K-1	Remember	10
	K-2	Understand	30
	K-3	Apply	20
	K-4	Analyse	15
	K-5	Evaluate	15
	K-6	Create	10

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CLASSICAL MECHANICS - PHYC02

Credits : 4 **Teaching Hours: 4 Hours / week**

Objective:

1. To emphasize the mathematical formulation of mechanic's problems and to physically interpret the solutions.

2. To apply the fundamental concepts of classical mechanics to the particle systems and rigid bodies.

3. To lay the solid background of mathematical methods to employ in modern physics.

4. To develop problem solving and critical thinking skills.

Unit-I:

Survey of elementary principles Mechanics of a particle and a system of Particles- Constraints-D'Alembert's principle and Lagrange's Equations - Velocity-dependent potential and dissipation Function-Simple applications of the Lagrangian formulation-Variational rinciple and Lagrange's EquationHamilton's Principle-Basic techniques of calculus of Variations-Derivation of Lagrange's equations from Hamilton's principle

Unit-II:

Two body central force problem Advantages of a variational principle Formulation-Conservation theorems and symmetry Properties-Two-body central force problem: Reduction to the equivalent one-body problem-The equation one-dimensional problem and classification of orbits-The virial theorem-The differential equation for the orbit and integrable power low potentials-The Kepler problem

Unit-III:

The kinematics of rigid body motion The independent coordinates of a rigid body-The Euler Angles-Euler's theorem on the motion of a rigid Body-Finite and infinitesimal Rotation-Rate

of change of a Vector-Coriolis Force-Angular momentum and kinetic energy of motion about a fixed Point-Moment of inertia tensor its Diagonalization-Equation of Torque-Free motion - Concepts of precession and nutation

Unit-IV:

Small oscillations Formulation of the Problem-Eigenvalue equation and the principle axes Transformation Frequencies of free vibrations and normal Coordinates-Free vibrations of a linear triatomic molecule. Legendre transformation and Hamilton's equations of motion - Cyclic coordinates and conservation theorems -Derivation of Hamilton's equation from a variational principle

Unit-V:

The equations of canonical transformation -Examples-The symplectic approach to canonical transformations -Poisson brackets and other canonical invariants -Equations of motion Infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation-Hamilton-Jacobi equation and its application to the harmonic oscillator problem

Textbook:

Classical Mechanices, H. Goldstein, II edn. (1980, Narosa)

Unit I Chap.1, Chap.2, Secs. 2.1-2.3

Unit II Chap.2, Secs.2.4-2.6, Chap.3 (except secs.3.6, 3.9-3.11)

Unit III Chap.4, Secs.4.1, 4.4, 4.6-4.10; Chap.5,Sect.5.1-5.4, 5.6

Unit IV Chap.6, Secs. 6.1-6.4; Chap.8, Secs.8.1, 8.2 & 8.5

Unit V Chap.9, Secs.9.1-9.5; Chap.10, Secs.10.1-10.2

Books for reference

1. Mechanics, L.D. Laudau and E.M. Lifshitz

2. Classical Mechanics, T.W.B. Kibble

3. Classical Mechanics, N.C. Rana and P.S. Juog

Websites :

1. NPTEL Course by Prof. V. Balakrishnan : https://nptel.ac.in/courses/122106034/ Course Outcomes:

At the end of the course, the students will be able to

CO1 Appraise the different types of constraints present in the system and set up generalized coordinates.

CO2 Analyze the two body central force problem using Lagrangian formalism

CO3 Formulate the kinematics of rigid body

CO4 Formulate the mechanical system as eigenvalue equation

CO5 practice the Hamiltonian formalism and the Hamilton Jacobi formalism.

Class MSc (Physics) Semester PHY CLASSICAL MECHANICS

Course Code and Title: PHY CLASSICAL MECHANICS			
Class	MSc (Physics)	Semester	I
Cognitive Level	K-1	Remember	--
	K-2	Understand	--
	K-3	Apply	35
	K-4	Analyse	35
	K-5	Evaluate	20
	K-6	Create	10

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ELECTRONICS - PHYC03

Credits: 4 **Teaching Hours: 4 hrs / week**

Objectives:

1. To enhance comprehension capabilities of students through understanding of electronic devices and to give clear understanding of operational amplifier and its importance.

2. To understand the physical construction, working and operational characteristics of semiconductor devices.

3. To introduce the basic building blocks of linear integrated circuits & digital converters

Unit-I:

The transistor at low frequencies – Graphical analysis of CE configuration – Two port devices – Hybrid Model – h parameters – conversion – Amplifier circuit using h parameters – Thevenin's and Norton's Theorems – The Emitter follower – Comparisons of configurations – Linear analysis – Miller and its Dual theorems – Cascading Amplifiers. Transistor Biasing – The operating point – Bias stability – Self bias, or Emitter bias.

Unit-II:

Field effect transistor: The Junction Field Effect Transistor – Pinch off voltage – JFET Voltage Ampere characteristic – FET small-signal model – MOSFET – digital MOSFET circuits – Low frequency common source and common drain amplifier – biasing the FET – FET as voltage variable resistor – common source and common drain amplifier at high frequencies.

UNIT – III:

OPAMP: General features – Virtual ground concept – inverting amplifier- noninverting amplifier – summing amplifier - subtractor - voltage follower – integrator – and differentiator – solution of simultaneous equations with two unknowns and harmonic oscillator problem – active filters: low pass, high pass, band pass and band reject (first order only)

UNIT – IV:

LOGIC CIRCUITS: Universal NAND and NOR gates – combinational logic circuits – half and full adders – half and full subtractors - Boolean laws and theorems – Boolean relation for OR and AND operations – duality theorem – sum of products and product of sum methods – sum of product and product of sum equations – Karnaugh maps – truth table to Karnaugh map – 3 and 4 variable maps – pairs, quads and octets – Karnaugh simplification – overlapping – rolling the map – eliminating redundant groups – don't care conditions.

UNIT – V:

FLIP FLOPS AND COUNTERS: RS flip flops – clocked RS flip flop – D flip flop – edge triggered D flip flop – JK flip flop – JK master slave flip flop – Synchronous and asynchronous counters – 3-bit binary ripple counter – 3 bit up-down counter – synchronous counter – mod – 8 parallel binary counter – mod 3 counter – mod 5 counter – mod 10 decade counter – shift counters – 3 stage shift registers – mod-10 shift counter.

Text Book:

1. Integrated Electronics: Millman and Halkias, TMH, 1995

Unit 1: 8.1 – 8.12, 9.1 – 9.3,

Unit 2: 10.1 – 10.11

2. Op-Amp and Linear Integrated Circuits, III Edn., Ramakant Gayakwad, PHI (1995).

3. Digital principles and applications, Malvino and Leech, Mc Graw Hill, (1986).

BOOKS FOR REFERENCE:

1. Digital Fundamentals, 3rd Edition, L.Floyd, Universal Book Stall, New Delhi (1998)

2. Digital Integrated Electronics, Herbert Taub and Donald Schilling, McGraw Hill, International Book Company, 11th Edition (1985)

Course Outcomes:

CO1 Students will acquire knowledge in two port networks, Thevenin's, Norton and Millers theorem. To develop the skill to analyses the electronic circuits

CO2 Improved understanding of FET, different types of MOSFET and their application. To develop the skill to design the circuit based on FET and MOSFET

CO3 To enhance the knowledge in Op-amp and their applications. To develop skill to design the circuit based on Op-amp

CO4 Student will develop the skill to use the universal gate to design logical circuit and to simply by the circuit using K-map

CO5 Enhanced knowledge in different types of flip-flops and designing the different types of counters and Registers using flip flop

Course Code and Title: PHYC ELECTRONICS

Course Code and Title: PHY ELECTRONICS			
Class	MSc (Physics)	Semester	I
Cognitive Level	K-1	Remember	10
	K-2	Understand	20
	K-3	Apply	20
	K-4	Analyse	20
	K-5	Evaluate	20
	K-6	Create	10

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MATHEMATICAL PHYSICS- II - PHYC04

Credits: 4 **Teaching Hours: 4 hrs / week**

Objectives:

1. To develop knowledge in mathematical physics and its applications.
2. To develop expertise in mathematical techniques required in physics.
3. To enhance problem solving skills.
4. To enable students to formulate, interpret and draw inferences from mathematical solutions

Unit I Differential equations: First order differential equations, separation of variables (Partial differential equations), singular points, Series solutions: Frobenius method and second solution.

Unit II Dirac delta functions & Sturm-Liouville theory: Self- Adjoint differential equations, Hermitian operators, Gram-Schmidt orthogonalization and Completeness of eigenfunctions.

Unit III The Gamma function (factorial function): Definitions, simple properties. Beta functions. Special functions: Hermite Functions, Laguerre Functions and Associated Laguerre Polynomials.

Unit IV Bessel functions: Bessel functions of the first kind – Generating functions, recurrence relations, Integral representation. Orthogonality – Normalization, Bessel series. Spherical Bessel functions.

Unit V Legendre functions: Generating functions, Recurrence relations and special properties, Orthogonality. Associated Legendre functions: Recurrence relations, Parity, Orthogonality. Spherical harmonics.

Books for study:

Mathematical Methods for Physicists – George Arfken & Hans J. Weber, VI Edn. (Prism Books Pvt. Ltd., Bangalore).

Unit I : **Chap.9**, Secs.9.2 to 9.6 (Page No: 543 – 592)

Unit II : **Chap.1**, Sec.1.15; **Chap.10**, Secs.10.1 to 10.4 (Page No: 83 – 87; 621 - 661)

Unit III: **Chap.8**, Secs. 8.1 & 8.4 (Page No: 499 – 510; 520 - 526),

Chap.13, Secs.13.1 & 13.2 (Page No: 817 – 848)

Unit IV: **Chap.11**, Secs.11.1, 11.2 and 11.7 (Page No: 675 – 699; 725 - 739)

Unit V : **Chap.12**, Secs. 12.1 - 12.3, 12.5 & 12.6 (Page No: 741 – 767; 771 – 793)

Books for reference:

1. **Mathematical Methods for Physicists: A Concise Introduction – Tai L. Chow,** Cambridge University Press, 2003.
2. **Mathematical Methods in the Physical Science – Mary L. Boas,** John Wiley & Sons, Inc., 2006.
3. **Advanced Engineering Mathematics – Erwin Kreyszig,** V Edn. (New Age Publishers, New Delhi, 1996)

Course Outcomes:

CO1: Solve the partial differential equations
CO2: Evaluate second order linear differential equations and apply it for solving physics problems
CO3: Explain the concept of Gamma functions
CO4: Analyse the concept of Bessel functions and its properties
CO5: Apply Legendre functions and its properties

Course Content: **Course Code and Title:** PHY1812C
MATHEMATICAL PHYSICS- II

Class	**MSc (Physics)**	**Semester**	**II**
Cognitive Level			
K-1		Remember	10
K-2		Understand	20
K-3		Apply	20
K-4		Analyse	20
K-5		Evaluate	20
K-6		Create	10

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STATISTICAL MECHANICS - PHYC05

Credits: 4 **Teaching Hours: 4 hrs /week**

Objectives:

1. To develop an understanding of the statistical methods applied to mechanical problems.
2. To acquire the knowledge of various statistical distributions.
3. To understand the applications of statistical mechanics in broad areas of modern physics

Unit-I: Simple random walk problem in one dimension -General discussion of mean values calculation of mean values for the random walk problem-probability distribution for large N, Statistical formulation of mechanical problem, ensembles, microstates, macrostates and density of states- Laws of thermodynamics.

Unit-II: Isolated system and system in contact with a heat reservoir -Simple applications of canonical distribution, system with specified mean energy -Calculation of mean values in a canonical ensemble -alternative derivation of canonical distribution -Partition functions and their properties -Ideal monatomic gas: Calculation of thermodynamic quantities, Gibbs paradox, validity of classical approximation

Unit-III: Proof of equipartition on theorem - Maxwell velocity distribution and related velocity Distributions and mean values –Collision time, scattering cross section and self-diffusion

Unit-IV: Classical and quantum statistics: Identical particles and symmetry requirements, formulation of statistical problem, the quantum distribution functions-MB statistics - Photon statistics -B E and FD statistics -Quantum states of a single particle -Evaluation of partition functions -Thermal ionization of hydrogen atom

Unit-V: Isolated system and system in contact with a heat reservoir-Langevin equation - Calculation of mean square displacement -Relation between dissipation and fluctuating force - Correlation function and friction constant - Nyquist's theorem

Text book:

Fundamentals of Statistical and Thermal Physics, F. Reif (1985, McGraw Hill, International edition)

Unit I - Chap.1, Secs.1.1to 1.5,
Chap.2, Secs.2.1 to 2.5;
Chap.3, Secs.3.3.11;
Chap.5, Secs.5.1 to 5.8;

Unit II - Chap.6, Secs.6.1 to 6.5& 6.10, Chap.7, Sec.7.1 to 7.4
Unit III - Chap.7, Secs.7.5, 7.6, 7.9 & 7.10, Chap.12, Secs.12.1, 12.2 and 12.5
Unit IV - Chap.9.1-9.11 (up to page 365)
Unit V - Chap.15, Secs.15.1, 15.2, 15.5 to 15.8 and 15.16

Reference books:
Statistical Mechanics, B.K. Agarwal and M. Eisner (1988, Wiley-Eastern)

Course Outcomes:

CO1 Explain statistical formulation of ensembles and density of states
CO2 Derive macroscopic prosperities of the system for various situations of physical interest
CO3 Evaluate distribution of systems in energy states and mean values
CO4 Explain classical and quantum statistics and evaluate partition function
CO5 Explain irreversible processes and examine how equilibrium is approached

CO6: Enhanced knowledge in relativistic theory **Course Code and Title:** PHYC05
STATISTICAL MECHANICS

Class Cognitive Level MSc (Physics)	**Semester**	**II**
K-1	Remember	10%
K-2	Understand	30%
K-3	Apply	30%
K-4	Analyse	15%
K-5	Evaluate	15%
K-6	Create	05%

Create

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ELECTROMAGNETIC THEORY – PHYC06

Credits : 4 **Teaching Hours: 4 hrs / week**

Objectives:

1. To develop theoretical knowledge in electromagnetism.
2. To develop skills on solving analytical problems in electromagnetism.
3. To understand the electromagnetism of radiating and relativistic systems.
4. To give basics of ideas about relativity.

Unit I: Electrostatics: Coulomb's law; the electric field – line, flux and Gauss's Law in differential form - the electrostatic potential; conductors and insulators; Gauss's law - application of Gauss's law – curl of E - Poisson's equation; Laplace's equation – work and energy in electrostatics – energy of a point charge distribution – energy of continuous charge distribution – induced charges – capacitors. Potentials: Laplace equation in one dimension and two dimensions – Dielectrics – induced dipoles – Gauss's Law in the presence of dielectrics.

Unit II: Magnetostatics: Lorentz force – magnetic fields – magnetic forces – currents – Biot-Savart Law – divergence and curl of B – Ampere's Law – comparison of magnetostatics and electrostatics – Magnetic vector potential. Magnetization: effect of magnetic field on atomic orbit – Ampere's Law in magnetized materials – ferromagnetism.

Unit III: Electromotive force – Ohm's Law – electromotive force – motional emf – Faraday's Law – induced electric field – inductance – energy in magnetic field – Maxwell's equation – continuity equation – Poynting theorem. Electromagnetic waves in vacuum: waves in one dimension – wave equation – sinusoidal waves – reflection and transmission – Polarization.

Unit IV: Electromagnetic waves: The wave equation for E and B – Monochromatic Plan waves – energy and momentum in electromagnetic waves – electromagnetic waves in matters –TE waves in rectangular waveguides – the co-axial transmission line. Potentials: potentials and fields – scalar and vector potentials – Gauge transformation – Coulomb Gauge and Lorentz Gauge – Lorentz force law in potential form.

Unit V: The special theory of relativity – Einstein's postulates – geometry of relativity – Lorentz transformations – Relativistic mechanics – proper time and proper velocity – Relativistic energy and momentum – Relativistic kinematics.

Text Book:

Introduction to Electrodynamics – David J. Griffiths, 4th Edition, Pearson
Unit I : Pages; 59-78, 83-84, 91-101, 105-112, 113-116, 167-170, 181-184
Unit II: Pages; 212-247, 269-277, 282-286, 291-295

Unit III: Pages; 300-338, 360-364, 387-398
Unit IV: Pages; 398-410, 433-436, 553-561, Unit V : Pages 479-502, 509-518

Books for Reference:

1. Fundamentals of Electromagnetic Theory, Third edition, Narosa Publishing House, New Delhi – John R.Reitz, Frederick J Milford and Robert W.Christy, 1998
2. Classical Electrodynamics – J.D. Jackson, II Edition, Wiley Eastern Limited, 1993
3. Electromagnetic Fields and Waves – P.Lorrain and D.Corson
4. Electromagnetic – B. Laud

Course Outcomes:

CO1: Students will acquire enhanced knowledge in electrostatic mechanics. They will develop problem solving skill using Poisson and Laplace equations. They will also understand the effect of dielectric media
CO2: Enhanced knowledge in magnetostatic process and their applications. Also will have enhanced knowledge in magnetic materials
CO3: Will have enhanced understanding of electromagnetic wave propagation, reflection, transmission and polarization
CO4: Students will have improved understanding about wave guides. Also will have enhanced understanding Gauge transformation

CO6: Enhanced knowledge in relativistic theory **Course Code and Title:** PHYC06 ELECTROMAGNETIC THEORY

Class Cognitive Level MSc (Physics)	**Semester**	**II**
K-1	Remember	10%
K-2	Understand	30%
K-3	Apply	30%
K-4	Analyse	15%
K-5	Evaluate	15%
K-6	Create	