PHYSICS (MAJOR)
COURSE STRUCTURE AND ALLOTMENT OF PAPERS FOR EACH SEMESTER EXAMINATON TO BE CONDUCTED BY THE UNIVERSITY
(Any one the optional papers, PHYM 60410-PHYM 60440 should be chosen in VI Semester)

SEMESTER I	**PHYM 10100**	**Mechanics and Properties of Matter**	**80+20**
SEMESTER II	**PHYM 20100**	**Thermal Physics & Waves and Oscillation**	**80+20**
SEMESTER III	**PHYM 30100**	**Optics**	**60+15**
	PHYM 30200	**Electricity & Magnetism**	**60+15**
	PHYM 30300	**Laboratory**	**50**
		Total	**200**
SEMESTER IV	**PHYM 40100**	**Mathematical Physics I**	**60+15**
	PHYM 40200	**Quantum Mechanics**	**60+15**
	PHYM 40300	**Laboratory**	**50**
		Total	**200**
SEMESTER V	**PHYM 50100**	**Mathematical Physics II**	**60+15**
	PHYM 50200	**Electrodynamics & Special Relativity**	**60+15**
	PHYM 50300	**Atomic & Molecular Physics**	**60+15**
	PHYM 50400	**Electronics**	**60+15**
	PHYM 50500	**Laboratory**	**100**
		Total	**400**
SEMESTER VI	**PHYM 60100**	**Statistical Mechanics**	**60+15**
	PHYM 60200	**Condensed Matter Physics**	**60+15**
	PHYM 60300	**Nuclear Physics**	**60+15**
	PHYM 60410 Optional	**Astrophysics & Particle Physics**	**60+15**
	PHYM 60420 Optional	**Space & Atmospheric Physics**	**60+15**
	PHYM 60430 Optional	**Laser and its Application**	**60+15**
	PHYM 60440 Optional	**Material Science and Nano Materials**	**60+15**
	PHYM 60500	**Laboratory**	**100**
		Total	**400**

PHYSICS (Major)

Semester-I

Paper Code: PHYM 10100
Paper Name: Mechanics and Properties of matter
Total Marks: 80
Total No. of Lectures: 50

Unit I: Newtonian Mechanics (No. of Lectures: 15)(Marks:25)

Concept of frame of references (inertial and non inertial), transformation of space and time in Galilean Relativity, two-body problem, reduction of two-body problem to one-body problem, angular momentum, angular momentum of a system of particles about their centre-of-mass.

Unit- II: Forces and Collisions (No. of Lectures: 10)(Marks:10)

Conservative force, central force, conservation of angular momentum, the inverse square law, Kepler's laws of planetary motion, gravitational field and potential, gravitational field and potential at a point due to a spherical shell and solid sphere.

Elastic and inelastic collisions, laboratory and centre-of-mass reference frames, kinematics of elastic collisions.

Unit III: Properties of matter (No.of Lectures: 15) (Marks:20)

Equation of motion of rotating rigid bodies, moment of inertia, theorems on moment of inertia, calculation of moment of inertia of a circular lamina, a solid cylinder, a hollow sphere and a solid sphere.

Elasticity, Young's modulus, Bulk modulus, Modulus of rigidity, Poisson's ratio, relation between the elastic constants, bending of beams, the cantilever.

Surface tension, excess pressure inside a curved surface, rise of liquid in a capillary tube.

Unit IV: Classical Mechanics (No. of Lectures: 10) (Marks: 25)

Elements of classical mechanics, constrained motion, constraints, degrees of freedom, generalized coordinates, virtual work, D'Alembert's principle, Lagrange's equation of motion, simple harmonic oscillator and simple pendulum.

Accelerated frames and fictitious forces, rotating frames and Coriolis force, components of Coriolis force at any latitude when velocity is horizontal, deviation of freely falling bodies from the vertical, the Foucault's pendulum.

Suggested readings:

1. Classical Mechanics
   H. Goldstein
   Narosa Publishing House
2. Classical Mechanics
   Rana and Joag
   Tata McGraw Hill
3. Classical Mechanics
   Gupta, Kumar and Sharma
   Pragati Prakashan

4. Elements of Properties of Matter
D.S. Mathur
S. Chand and Company
5. Mechanics
B.S.Agarwal

Semester-II

Paper Code: PHYM 20100
Paper Name: Thermal Physics and Waves and Oscillation
Total Marks: 80
Total No. of Lectures: 50

Unit I: Kinetic Theory of gases (No. of Lectures: 15)(Marks: 25)

Maxwell's law of distribution of velocities (derivation not required), law of equipartition of energy, mean free path, transport phenomena (viscosity, conduction and diffusion), Avogadro number-experimental determination by the kinetic theory method, Brownian motion (theory of translational Brownian movement). Compressibility and expansion coefficient of gases, difference between ideal and real gases, Andrew's experiment for carbon dioxide, Vander Waal's equation of state, critical constant and law of corresponding states.

Unit II: Thermodynamics (No. of Lectures: 15) (Marks: 25)

The zeroth law, indicator diagram, work done, first law of thermodynamics, internal energy, Carnot cycle and its efficiency, Carnot's theorem, second law of thermodynamics, entropy as a thermodynamic variable, entropy changes in reversible and irreversible processes, principle of increase of entropy, thermodynamic temperature, Clausius inequality.

Thermodynamic relationships: Maxwell's relations, Clausius-Clapeyron's equation and some simple applications, and Joule-Thomson effect. Thermodynamic potential and its relation to thermodynamic variables

Unit III: Blackbody radiation (No. of Lectures: 8) (Marks: 10)

Kirchhoff's law, Stefan-Boltzmann law, spectral distribution, Wein's displacement law, Wien's distribution law, Rayleigh-Jean's law and ultra violet catastrophe, Planck's hypothesis, Planck's black body distribution law, pressure due to radiation.

Unit IV: Waves and Oscillations (No.of Lectures: 12) (Marks: 20)

Mechanical waves and its types, propagating waves and wave equation, particle velocity in a transverse wave, wave equation for a vibrating string, plucked string and struck string.Velocity of sound in gaseous mediums, dispersion relations, Lissajou's figure, damped and forced vibration.

Suggested readings:

1. Thermal Physics
Garg, Bansal and Ghosh
Tata McGraw Hill
2. A Treatise on Heat
M.N. Saha and B.N. Shrivastava

Indian Press, Allahabad
3. Heat and Thermodynamics
A.W. Zemansky
McGraw Hill

4. University Physics
Hugh D. Young
Roger A. Freedman
5. Mathematical Physics
B.S.Rajput
6. Text Book of Sound
M.Ghosh

Semester III

Paper Code: PHYM 30100
Paper Name: Optics
Total Marks: 60
Total no. of Lectures: 40

Unit I: Geometrical optics (No. of Lectures: 10) (Marks: 15)

Aberrations: chromatic aberration, spherical aberration, methods of minimizing the defects of monochromatic images, coma, astigmatism and curvature of field, distortion, achromatic combination of lenses and prism, eyepieces-Ramsden and Huygen's, use of different telescopes (Ray diagrams for Galilean, Newtonian and Cassegrain telescopes)

.

Unit II: Interference (No. of Lectures: 12) (Marks: 24)

Concept of physical optics, coherent sourse, interference by division of wavefronts, Young's double slit experiment, interference with white light, displacement of fringes, Fresnel biprism, Lloyd's mirror.

Interference by division of amplitude: interference by a plane parallel film, the cosine law, non-reflecting films, expression for the reflected wave, wedge shaped film, colour of thin films, Newton's rings, Michelson interferometer, application in the determination of closely spaced wavelengths, visibility of fringes, Jamin's and Fabry-Perrot interferometer.

Unit III: Diffraction (No. of Lectures: 10) (Marks:10)

Fraunhoffer diffraction: single slit diffraction-circular and rectangular, two slit diffraction, N-slit diffraction, plane diffraction grating, resolving and dispersive power of a plane diffraction grating, secondary maxima.

Fresnel diffraction: Fresnel's integrals, Cornu's spiral, Fresnel diffraction pattern at a straight edge and at a slit, Fresnel's half period zones, zone plate.

Unit IV: Polarisation and Dispersion (No. of Lectures: 8) (Marks: 11)

Polarization: production of polarized light, Brewster's law, Malus' law, double refraction, circular and elliptical polarization, analysis of polarized light, optical rotation, polarimeter.

Dispersion: normal and anomalous dispersion.

Suggested readings:

1. Optics
A.K. Ghatak
Tata McGraw Hill
2. Optics
B.K. Mathur
3. Optics
A.B. Gupta
Books and Allied Ltd.
4. Fundamentals of optics
Zenkins and White
Tata McGraw-Hill.

Paper Code: PHYM 30200
Paper Name: Electricity and Magnetism
Total Marks: 60
Total No. of Lectures: 40

Unit I : Electrostatics (No. of Lectures: 12)(Marks:22)

Ideas of gradient, divergence and curl, Gauss's theorem, Stoke's theorem, Gauss' law in electrostatics, some applications (spherical shell and infinite sheet of charge) of Gauss' law, Laplace's equation and its application, capacity of various types of condensers- parallel plate, spherical and cylindrical; energy stored in parallel plate capacitor, dielectric-polarization and displacement vector, Clausius-Mosotti equation.

Unit II: Current electricity (No.of Lectures: 10) (Marks:10)

Kirchhoff's law and its applications, moving coil and moving magnet galvanometers, dc bridges, Kelvin's double bridge, measurement of high resistance, measurement of very low emfs, thermoelectric effects, Seebeck effect, Peltier effect, Thomson effect, measurement of thermo emf, growth and decay of current in L-R, C-R and LCR circuit.

Unit III: Magnetism (No. of Lectures: 8) (Marks:11)

Magnetic field due to a circular current loop and solenoid, Gauss' theorem in magnetism and its applications, magnetic permeability and susceptibility, magnetization, magnetic intensity and their relation, dia-, para-, ferromagnetism

.

Unit IV: Electromagnetic Induction (No. of Lectures: 10) (Marks: 17)

Electromagnetic induction, Faraday's law and Lenz's law, self and mutual inductance, methods of measurements.

AC and DC generators and motors, transformer, relation between maximum, average and virtual or effective (rms) values of current, AC through resistance (R), inductance (L) and capacitance (C), AC through RL, RC and LCR circuits, phasor diagrams, measurements of self inductance by Anderson's bridge, measurements of mutual inductance by ballistic galvanometer, power in AC circuits.

Suggested readings:

1. Fundamentals of Magnetism and Electricity
D.N. Basudeva

S. Chand and Company

2. Electricity and Magnetism
   Khare and Shrivastava
   Atmaram and Sons
3. Electricity and Magnetism
   D.C.Tayal
   Himalaya Publication
4. Electricity and Magnetism
   Brijlal and Subramanyan
   S.Chand

Paper Code: PHYM 30300
Paper Name: Laboratory
Total Marks: 50

At least 75% of the experiments listed below are required to be performed by each student during the course. The examination should be on one experiment in 6 hrs.

List of experiments:

MI Determine the value of g with the help of Kater's pendulum reversible pendulum. Obtain true length and time period of the equivalent simple pendulum with the help of graphical plot of distance between knife edges and the time periods.

MII To determine Young's modulus of a material in the form of a rectangular beam by bending. Show graphically that the depression is directly proportional to the cube of its length.

MIII To determine the surface tension of a liquid by capillary tube method and to verify Jurin's law graphically.

MIV To determine coefficient of viscosity of water by capillary flow method.

MV To draw the I-D curve using a spectrometer and hence determine the refractive index of the material of the prism used.

MVI To determine the wavelength of the monochromatic radiation using Newton's ring method.

Semester IV

Paper Code: PHYM 40100
Paper Name: Mathematical Physics I
Total Marks: 60
Total No. of Lectures: 40

Unit I: Vector calculus (No. of Lectures: 13) (Marks: 22)

Scalar and vector fields, differentiation of a vector with respect to a scalar, unit

tangent vector, normal vector.

Derivatives of vectors: gradient of a scalar, flux of a vector field, divergence and curl of a vector field, ideas of line, surface and volume integration, Gauss's Stoke's Laplacian in Cartesian, spherical and cylindrical coordinate system

.

Unit II: Tensor Algebra (No. of Lectures: 7)(Marks:10)

Introduction, transformation of coordinates, scalars, contravariant vector, covariant vector, transformation rules for tensor of arbitrary rank (contravariant and covariant), symmetric and antisymmetric tensors, contraction, Kronecker Delta, Levi-Civita tensor

.

Unit III: Matrices (No. of Lectures: 8) (Marks:17)

Definition, types of matrices, transformation of matrices, characteristic equation, solution of inhomogeneous linear equations, eigen values and eigen vectors, diagonalization of matrices.

Unit IV: Calculus of variation (No.of Lectures: 12)(Marks:11)

Variational principle, Euler-Lagrange equation, geodesics on a plane, cylindrical and spherical surface, Brachiostochrone problem, constrained maxima and minima, method of Lagrange undetermined multipliers and its application to one or two simple problems (e.g., the isoperimetric problem)

Suggested readings:

1. Mathematical Physics
   B.D. Gupta
   Vikash Publishing House
2. Mathematical Physics
   B.S. Rajput
   Pragati Prakashan
3. Essentials of mathematical methods for physicists
   Arfken and Weber

Paper Code: PHYM 40200
Paper Name: Quantum Mechanics
Total Marks: 60
Total No. of Lectures: 40

Unit I: Introduction (No. of Lectures: 14) (Marks: 22)

Inadequacies of classical physics, Planck's quantum hypothesis , wave particle duality , photoelectric effect, Compton effect, de-Broglie hypothesis , phase and group velocity of de-Broglie waves, experimental verification of de-Broglie hypothesis (Davison-Germer experiment), Bohr's complimentarity principle, Young's double slit experiment-electron interference, Heisenberg's uncertainty principle, gamma ray microscope experiment to illustrate the uncertainty principle.

Unit II: Wave equation (No. of Lectures: 13) (Marks: 22)

Schrödinger's equation for a free particle and for a particle in a field, physical interpretation of the wave function, equation of continuity and probability current density, separation of Schrödinger's equation into space and time parts, time independent Schrödinger's equation, stationary states.

Applications of Schrödinger's equation to simple problems: 1) free particle, 2) particle in a one-dimensional box with rigid walls, 3) step potential, calculation of transmission and reflection coefficients.

Unit III: Operator formalism (introduction) (No.of Lectures: 13) (Marks:16)

Operators in Quantum mechanics, linear, hermitian and unitary operators, eigenvalues and eigenfunctions of an operator, orthonormality of eigenfunctions of a hermitian operator, expectation values of an observable, Ehrenfest's theorem

Suggested readings:

1. Quantum Mechanics
   P.M. Mathews and K. Venkateshan
   Tata McGraw Hill
2. Quantum Mechanics
   A.K. Ghatak
   McMillan
3. Quantum Mechanics
   V. Thankappan
   New Age International
4. Principles of Quantum Mechanics
   S.P. Kuila
   New Central Book Agency P Ltd.
5. Quantum Mechanics
   G. Aruldhas
   Prentice Hall of India
6. Advanced Quantum Mechanics
   Satya Prakash

Paper Code: PHYM 40300
Paper Name: Laboratory
Total Marks: 50

At least 75% of the experiments listed below are required to be performed by each student during the course. The examination should be on one experiment in 6 hrs.

List of experiments:

MI	Verification of the laws of transverse vibrations of a string by Melde's experiment.
MII	To determine the Cauchy's constants.
MIII	To determine the modulus of rigidity of a given specimen by static method.
MIV	To determine the modulus of rigidity of a given specimen by Maxwell's needle method.
MV	To measure the width of a double slit by diffraction of monochromatic radiation and verify the result by microscopic measurement.
MVI	To determine the wavelength of the given monochromatic radiation using a biprism/Lloyd's mirror.

Semester V

Paper Code: PHYM 50100
Paper Name: Mathematical Physics-II
Total Marks: 60
Total No. of Lectures: 40

Unit I: Differential equations and special functions (No. of Lectures: 15) (Marks:29)

Classification of differential equations, homogenous and non-homogeneous equations, solutions in simple cases of ordinary differential equations of second order, linear differential equations with constant and variable coefficients, Forbenius' method.

Special functions: Legendre's polynomials, beta, gamma and error functions and their inter relations.

Unit II: Complex variables (No. of Lectures: 15)(Marks:15)

Graphical representation of complex numbers, functions of complex variables, limit and continuity, analytic functions, Cauchy-Riemann conditions and applications, singularities, contour integration, Cauchy's theorem, Cauchy's integral formula, Taylor's and Laurent's expansion, residue theorem and its application in evaluation of integrals.

Unit III: Fourier series (No. of Lectures: 10) (Marks:16)

Fourier series: Fourier sine and cosine series, determination of coefficients, applications to analysis of saw tooth and square waves.

Suggested readings:

1. Mathematical Physics
   B.D. Gupta
   Vikash Publishing House
2. Mathematical Physics
   B.S. Rajput
   Pragati Prakashan
3. Complex Variables
   M. Spiegel
   McGraw Hill
4. Mathematical Physics
   H.K.Dass and Rama verma
   S.Chand and Company.

Additional References:

1. Applied Mathematics for Engineers and Physicists
   L.A. Pipes and L.R. Harvill
   McGraw Hill
2. Mathematical Methods for Physicists
   G.B. Arfken and H.J. Weber
   Academic Press

Paper Code: PHYM 50200
Paper Name: Electrodynamics and Special Relativity
Total Marks: 60
Total No. of Lectures: 40

Unit I: Electromagnetic fields (No. of Lectures: 15) (Marks: 24)

Electromagnetic induction, displacement current , Maxwell's field equations and their interpretations (integral and differential forms), electromagnetic potentials, (scalar and vector potential) Derivation of Maxwell's wave equations, waves in free space, relation between wave vector and fields, Lorentz and Coulomb gauge, field energy and field momentum (Poynting vector and Poynting theorem), Radiation from accelerated charge, radiation from electric dipole.

Unit II: Propagation of electromagnetic waves (No.of Lectures: 10)(Marks: 20)

Plane waves in non-conducting media, polarization, plane waves in a conducting medium, skin effect.

Boundary conditions, Reflection and refraction of a plane wave at a plane interface (normal and oblique incidence) between two dielectrics, Fresnel's formula, total internal reflection, Brewster's angle.

Unit III: Special Relativity (No. of Lectures: 15) (Marks: 16)

Problem of absolute motion in classical physics, Ether hypothesis, nullity of ether hypothesis, Michelson-Morley experiment, Einstein's postulates of special relativity, Lorentz transformation, length contraction, time dilation, twin paradox, relativistic mass, mass energy relation.

Suggested readings:

1. Introduction to Electrodynamics
   D.J. Griffiths
   Pearson Education
2. Electromagnetics
   B.B. Laud
   New Age International
3. Electromagnetic Waves and Radiating Systems
   Jordan and Balmain
   Prentice Hall of India
4. Mathematical Physics
   B.S. Rajput, Pragati Prakasan
5. Modern Physics
   A.Beiser, Tata McGraw Hill.
6. Introduction to Classical Mechanics
   R.G.Takwale and P.S.Puranik
   Tata McGraw-Hill
7. Classical Mechanics
   H.Goldstein
   Narosa Publishing House

Paper Code: PHYM 50300
Paper Name:Atomic and Molecular Physics
Total Marks: 60
Total no. of Lectures: 40

Unit I: Quantum Theory of Atoms (No. of Lectures: 15) (Marks: 24)

Background of Quantum Theory: Bohr's model of the hydrogen atom, origin of spectral lines, Bohr's correspondence principle, Sommerfeld's atom model, designation of spectral term symbol.

Vector atom model, space quantization, Larmor precession, the four quantum numbers, spectral terms arising from L-S coupling and j-j coupling, selection rules

Unit II: Fine structures of atoms (No. of Lectures: 11) (Marks: 15)

Fine structure of hydrogen spectra, doublet spectra of Na-atom

Gyromagnetic ratio for orbital and spin motion, Lande's 'g' factor, strong and weak field effects, Zeeman Effect (normal and anomalous), qualitative ideas of Stark effect

Unit III: Molecular spectra and lasers (No. of Lectures: 14) (Marks: 21)

Molecular spectra: Pure rotation spectra, theory of pure rotation spectra, selection rules, vibration spectra and selection rules, theory of rotation-vibration spectra, P and R branches, Rayleigh and Raman scattering, Raman effect, classical theory of Raman effect

Introduction to Lasers: Spontaneous and stimulated emission, population inversion, Einstein's A and B coefficients, qualitative ideas of Ammonia beam maser, ruby laser, He-Ne laser

Suggested readings:

1. Atomic Physics
   J.B. Rajam
   S. Chand and Company
2. Fundamentals of Molecular Spectroscopy
   Banwell and McCash
   Tata McGraw Hill
3. Molecular Structure and Spectroscopy
   G. Aruldhas
   Prentice Hall of India

Additional references:

1. Atomic Spectra
   H.E. White
   McGraw Hill
2. Modern Physics
   G. Aruldhas and P. Rajagopal
   Prentice Hall of India

Paper Code: PHYM 50400
Paper Name: Electronics
Total Marks: 60
Total No. of lectures: 40

Unit I : Semiconductors (No. of Lectures: 13)(Marks:20)

Charged particles, electronic structure of elements, energy band theory of crystals, conductors, semiconductors and insulators, electrons and holes in semiconductor, donor and acceptor impurity, generation and recombination of charge, diffusion, continuity equation. Junction diode characteristics: the open circuited P-N junction, I-V characteristics of P-N diode, breakdown diodes, diode as a rectifier, half-wave and full-wave rectifier with resistance load, ripple factor, smoothing filters, DC power supply

Unit II: Transistors and amplifiers (No. of Lectures: 10) (Marks:15)

Transistors: NPN and PNP transistors, transistor action, common emitter, common base and common collector connections, transistor biasing (fixed bias, base-registor, voltage divider) and thermal stabilization, amplifier equivalent circuits ,hybrid parameters, small signal transistor voltage amplifier, RC coupled, LC coupled amplifier, power amplifier (Class A and Class B), distortion in amplifier, amplifier with negative feedback, effect of negative feedback on gain, output impedance and distortions

Unit III: Oscillators and integrated circuits (No. of Lectures: 8) (Marks:12)

Oscillators: transistor as sinusoidal oscillator, Barkhausen criterion, tuned collector, Hartley, RC, Wein Bridge and crystal oscillator.

Integrated Circuit: basic ideas, differential amplifier, operational amplifiers, common mode rejection ratio, inverting, non-inverting, basic mathematical operations- addition, differentiation, integration.

Unit IV: Digital electronics (No.of Lectures: 9) (Marks: 13)

Logic gates: binary numbers, decimal to binary and binary to decimal conversion, logic gates and their realization by P-N diodes and transistor, half adder, full adder, NAND, NOR and XOR gates, Boolean algebra, de Morgan's theorem and its applications, K-maps

Suggested readings:

1. Semiconductor Materials and Devices
   M.S. Tyagi
   John Wiley and Sons
2. Physics of Semiconductor Devices
   S.M. Sze
   Wiley Eastern Ltd.
3. Semiconductor Devices, Basic Principles
   Jasprit Singh
   John Wiley and Sons
4. Electronic Principles
   A.P. Malvino
   Tata McGraw Hill
5. Opamps and Linear Integrated Circuits
   R.K. Gaekwad
   Prentice Hall of India
6. Solid state electronic devices

Streetman and Banerji
Prentice Hall of India.
7. Fundamentals of electronics
Chattopadhyai and Rakshit
8. Principles of electronics
V.K.Mehta
9. Integrated Electronics: Analog and Digital Circuit Systems
Millman and Halkias
McGraw Hill
10. Digital Principles and Applications
D.P. Leach and A.P. Malvino
Tata McGraw Hill

Paper Code: PHYM 50500
Paper Name: Laboratory
Total Marks: 100

At least 75% of the experiments listed below are required to be performed by each student during the course. The examination should be on one experiment in 6 hrs.

List of experiments:

MI	Determination of thermal conductivity of a material by Searle's method.
MII	Determine the ratio of two specific heats of a gas by Clement and Desorme's method.
MIII	Determine the boiling point of the given liquid using platinum resistance thermometer.
MIV	Determine the melting point of a solid by means of a thermocouple.
MV	Determine the constant of a given ballistic galvanometer by passing a steady current through it.
MVI	Determine the E.C.E. of copper (using a potentiometer).
MVII	To find the optical rotation produced by solution of the given optically active substance at different concentrations with the help of a polarimeter. Hence to determine the specific rotation and the unknown concentration of the given solution.
MVIII	To measure the self induction of a given solenoid using Anderson's bridge method and compare the result with theoretical value.
MIX	To study a series and parallel resonant circuit and to determine the Q-factor.
MX	To study half wave and full wave rectifier and to determine the ripple factor.

Semester: VI

Paper Code: PHYM 60100
Paper Name: Statistical Mechanics
Total Marks: 60
Total No. of Lectures: 40

Unit I: Classical statistical physics (No. of Lectures: 10) (Marks: 15)

Postulates of classical statistical mechanics, phase space, Liouville's theorem, Ensembles: micro canonical, canonical and grand canonical, Maxwell-Boltzmann (MB) distribution laws, thermodynamic interpretation of the Lagrange's undetermined multipliers appearing in the distribution laws

Unit II: Entropy and partition function (No. of Lectures: 8) (Marks: 10)

Statistical definition of entropy, Boltzmann relation between entropy and probability, Equilibrium condition, Partition function, thermodynamic variables in terms of partition function, calculation of partition function for an ideal monatomic gas

Unit III: Quantum statistical physics (No. of Lectures: 10) (Marks: 24)

Limitation of Maxwell–Boltzann distribution law, basic postulates of quantum statistical mechanics, classical limit, symmetry of wave function of two particles, distribution laws for distinguishable and indistinguishable particles, Fermi-Dirac (FD) and Bose Einstein (BE) distribution functions, reduction of FD and BE statistics to MB statistics

Unit IV: Application of quantum statistical mechanics (No.of Lectures: 12)(Marks: 11).

Application of Bose-Einstein distribution law to an ideal Bose gas, photons as an ideal Bose gas, derivation of Planck's law of blackbuody radiation and Stefan's law, Bose-Einstein condensation, application of Fermi-Dirac statistics to white dwarf stars, Chandrasekhar limit

Suggested readings:

1. Statistical Mechanics
   K.M. Khanna
   Today and Tomorrow, New Delhi
2. Statistical Mechanics
   R.K. Patharia
   Butterwork Heinemann
3. Statistical Mechanics
   K. Huang
   John Wiley and Son
4. Statistical Mechanics
   B.K.Agarwal, M.Eisner
   New Age International Publishers
5. Fundamentals of Statistical Mechanics
   B.B.Laud
   New Age International Publishers
6. A Primer of Statistical Mechanics
   R.B.Singh
   New Age International Publishers

Paper Code: PHYM 60200
Paper Name: Condensed Matter Physics
Total Marks: 60
Total No. of Lectures: 40

Unit I: Crystal structure (No. of Lectures: 13) (Marks: 20)

Crystal structure, idea of a lattice, unit cell, Bravais' lattice, primitive lattice vectors, translational lattice vectors, Wigner-Seitz cell, Miller indices, some simple crystal structures (sc, bcc, fcc, hcp, diamond, zinc blend, NaCl, CsCl structures).

X-ray diffraction, Bragg's equation, reciprocal lattice for sc, bcc and fcc lattice, concept of Brillouin zone, lattice energy of ionic crystals, Born's theory, Madelung constant

Unit II: Properties of solids (No.of Lectures: 12) (Marks: 24)

Electrical and thermal conductivity of metals from classical free electron theory, Ohm's law, Wiedemann-Franz's law

Free electron Fermi gas, electron gas in one dimension and three dimensions, density of states, E-k diagram, Fermi-Dirac distribution and Fermi level of energy.

Band theory of solids, formation of bands in a solid, classification of solids into metal, insulator and semiconductor, crystal potential due to periodic array of atoms, one dimensional Bloch theorem, Kronig-Penney model (qualitative idea only), important conclusions from the model, energy band diagram in reduced zone representation, effective mass

Unit III: Semiconductor materials and Superconductivity (No. of Lectures: 15) (Marks:16)

Semiconductor materials, intrinsic and extrinsic semiconductors, carrier concentration in an intrinsic semiconductor, Fermi energy, position of Fermi level in intrinsic and extrinsic semiconductors (qualitative ideas only), conductivity in semiconductor in terms of mobility.

Superconductivity: electrical and magnetic properties in the superconducting state, Meisner effect, type I and type II superconductors

Suggested readings:

1. Solid State Physics
   A.J. Dekker
   McMillan
2. Solid State Physics
   C. Kittel
   John Wiley and Sons
3. Elementary Solid State Physics
   M. Ali Omar
   Pearson Education
4. Solid State Physics
   S.O. Pillai
   New Age International
5. Introduction to Condenced Matter Physics
   K.C.Barua
   Narosa Publishing House Pvt Ltd.

Paper Code: PHYM 60300
Paper Name: Nuclear Physics
Total Marks: 60
Total No. of Lectures: 40

Unit I: Properties of Atomic Nuclei (No. of Lectures: 10) (Marks: 15)

Introduction, nuclear size and its determination, hypotheses of nuclear composition (proton-electron and proton-neutron hypothesis), mass of nucleus and nuclear atoms, quantum numbers of individual nucleus, quantum properties nuclear states, nuclear angular momentum, nuclear magnetic dipole moment, binding energy of nucleus, mass defect, packing fraction, disintegration energy, semi-empirical mass formula

Unit II: Nuclear models (No. of Lectures: 15)(Marks:10)

Qualitative introduction to the nature of nuclear forces, qualitative discussion of the liquid drop model of the nucleus in relation to the semi-empirical mass formula, qualitative discussion on the Shell model of the nucleus

Unit III: Nuclear reactions and cosmic rays (No. o f Lectures: 10) (Marks: 22)

Nuclear reactions, qualitative discussion on induced radioactivity, spontaneous and proton induced reaction, alpha induced reaction, sustained nuclear chain reaction, nuclear fission and fusion, particle accelerators-van de Graph generators, linear accelerators, cyclotron.

Unit IV: Elementary particles (No. of Lectures: 5) (Marks: 13)

Cosmic ray and elementary particles: discovery and properties of cosmic rays, classification of elementary particles, qualitative introduction to leptons, quarks and gauge bosons

Suggested readings:

1. Nuclear Physics
   D.C. Tayal
   Himalaya Publishing House
2. Concepts of Nuclear Physics
   I.B. Cohen
   Tata McGraw Hill
3. Atomic and Nuclear Physics
   K. Gopalakrishnan
   McMillan
4. Atomic Physics
   J.B. Rajam
   S. Chand and Company
5. Nuclear Physics
   Irving Kaplan
   Narosa Publishing House
6. Modern Physics
   A.Beiser
   Tata McGraw-Hill.

Optional Papers (any one of the following, PHYM 60410-PHYM 60440)

SEMESTER VI

Paper Code: PHYM 60410
Paper Name: Astrophysics and Particle Physics
Total Marks: 60
Total No. of Lectures: 40

Objectives:

Astronomy and Astrophysics is the most nascent and growing field of physics. Every human child is fascinated by the beauty of tapestry of the stars in the night sky. The often asked questions are 'What are the stars?' , 'How far they are?' , 'How big they are?' , 'How many of them are there in space?' , 'How they emit light ?' and many more. In fact we are ourselves living on a planet around a medium sized star called Sun which is amongst the vast collection of stars that we see in the night sky. Through the advent of atomic theory, quantum mechanics and theory of relativity we have learned the basic physical structures of stars and also how they are born and get evolved. We have also learned from observations carried out by several big telescopes around the globe that stars are conglomerated in vast galaxies which are billions in number in the universe. Observations in optical, ultraviolet, radio, X ray and gamma ray range have uncovered the most exotic objects in the universe like supernovae, gamma ray bursts and black holes. All disciplines of physics are unified when one is in astronomy and astrophysics. We are infact made of star-stuff. Elements of our body like carbon, nitrogen and oxygen are continuously being synthesized inside stars. We must understand the physical processes that give rise to life here on Earth.

Particle physics comes hand in hand with Astrophysics these days. It helps astronomers to understand particle and radiation outflow of stars. Knowledge of fundamental forces like electromagnetic and weak force has propelled stellar studies. It specifically tells us how radiation is produced inside stars like our Sun and gets transported to the surface wherefrom it gets emitted.

The basic motivation for keeping this paper in the curriculum is to motivate the students (after their exposure to various disciplines in the previous semesters) for understanding the physical processes going on inside stars and to make them know how astronomers observe stars and determine their properties. In this rapidly developing pace this fertile field they need to know inevitably how big our universe is how everything in it moves. This paper is expected to be a preliminary background for the students who have motivation for higher studies in theoretical physics in any corner of the country.

Unit I: Basic Concepts of Astronomy (No. of Lectures: 7) (Marks: 8)

Introduction to astronomy and astrophysics, ideas of celestial sphere, equator, ecliptic and constellations, optical telescopes (workings of Galilean, Newtonian and Cassegrain telescopes), radio telescopes; ideas of optical, radio, X ray, gamma ray astronomy.

Unit II: Magnitude system and properties of stars (No. of Lectures: 10) (Marks: 12)

Apparent and absolute magnitudes of stars, distance modulus, color index, distance measurements by trigonometric parallax and Cepheid variables, bolometric magnitudes, flux

of radiation, surface temperature of stars, mass-luminosity relation of main sequence stars, variable stars, star clusters (open and globular clusters), spectral classification, Hertzsprung-Russel diagram.

Unit III: Stellar structure and evolution (No. of Lectures: 5) (Marks: 10)

Hydrostatic equilibrium, temperature gradient, proto star, main sequence, nuclear energy generation, P-P chain and CNO cycle, red giants and super giants.

Unit IV: Galaxies and cosmology (No. of Lectures: 8) (Marks: 10)

Types of galaxies, Hubble's classification (tunning fork diagram), size and shape of the Milky Way, difference between spirals and ellipticals; basic idea of cosmology, Newtonian cosmology, expansion of the universe, Hubble's law.

Unit V: Properties of elementary particles (No. of Lectures: 5) (Marks: 10)

Concept of elementary particles, types of elementary particles, hadrons and leptons, intrinsic properties of elementary particles (mass, charge, spin, isospin, strangeness, hypercharge), bosons and fermions, particles and antiparticles, discovery of elementary particles.

Unit VI: Fundamental interactions and conservation laws (No. of Lectures: 5) (Marks: 10)

Nature of interaction between elementary particles, four fundamental interactions, conservation laws for interaction of elementary principles, different particle reactions, conservation laws for electromagnetic, weak and strong force, Internal structure of protons, quarks and gluons

Suggested readings:

1. Introduction to Astrophysics: H. L. Duorah and K. Dourah (Authors)
2. An Introduction to Astrophysics: B. Basu (Prentice-Hall of India)
3. Astrophysics: Stars and Galaxies: K. D. Abhyankar(Orient Longman)
4. Galaxies: Structure and Evolution: R. J. Tayler (Cambridge University Press)
5. Introductory Astronomy and Astrophysics: S. A. Gregory and M. Zeilik (Brooks Cole)
6. Modern Physics: A. Beiser, TataMc Graw-Hill
7. Introduction to elementary particles, D.J.Griffiths, John Willey & Sons
8. Quarks and Leptons, F.Halzen & A.D.Martin, John Willey & Sons.

SEMESTER VI

Paper Code: PHYM 60420
Paper Name: Space and Atmospheric Physics
Total Marks: 60
Total No. of Lectures: 40

Lower Atmosphere: 22 Marks (No of Lectures: 12)
Atmospheric Structure, composition and thermodynamics:

Pressure, density and composition, Temperature structure, Equation of state, Changes of pressure with altitude, Entropy and potential temperature, Parcel concept, the available potential energy, Water in the atmosphere, The saturated adiabatic lapse rate, First law of thermodynamics

Upper Atmosphere: 19 Marks (No of Lectures: 14)
The earth's ionosphere:

The D region, the E and F1 layers, the F region, F region anomalies, The balance of ionization, The basic theory of photoionization, Production of the ionospheric layers
Loss reactions

Physics of the Sun: 19 Marks (No of Lectures: 14)

The sun and the magnetic field in the sun, Solar activity, Prominences, Coronal heating, Solar flares, The solar wind

Suggested readings:

1. Introduction to Atmospheric Physics
   D.G. Andrews
   Cambridge University Press
2. Introduction to Ionospheric Physics
   H. Rishbeth and O.K. Garriot
   Academic Press
3. Introduction to Space Physics
   M.G. Kivelson and C.T. Russell
   Cambridge University Press

SEMESTER VI

Paper Code: PHYM 60430
Paper Name: Laser and its Applications
Total Marks: 60
Total No. of Lectures: 40

Unit I: Introduction to Lasers: **(**No. of Lectures: 12) (Marks: **20**)

Absorption and emission of radiation, Spontaneous emission of radiation, stimulated emission, Einstein coefficients, significant of Einstein coefficients Basic Laser system requirements, Method of creation of population inversion, optical resonator, Q factor, optical cavity, Standing wave , Threshold condition for laser oscillator .

Unit II: Laser system **(**No. of Lectures: 8) (Marks: **10**)

Description of Ammonia beam Maser, Ruby Laser, He-Ne Laser, Semi conductor Laser.

Unit III: Properties of Laser radiation**(**No. of Lectures: 8) (Marks: **10**)

Intensity, Monochromaticity, Coherence properties of Laser radiation, spatial, and Temporal Coherence, Purity of spectral line and Temporal Coherence relation with Coherence, visibility of fringes and degree of coherence relation between visibility and coherence.

Unit IV: Laser Applications **(**No. of Lectures: 6) (Marks: **10**)

Introduction: Basic principle of Fiber optics, structure and classification, acceptance angle and numerical aperture, Intermodel dispersion in a step index fiber, Ray path in index fiberAdvantages of fiber optics communication.

Unit V. Magneto-Optics and Electro Optics **(**No. of Lectures: 6) (Marks: **10**)

Faraday effect- Determination of magnetic rotation, Classical theory of Faraday Effect, Kerr electro Optic effect, Harmonic generation, second harmonic generation

References

1. Modern Optics: Dr. A.B.Gupta, Books and Allied Pvt. Ltd. Kolkata.
2. Opto electronics: J. Wilson and J.F.B.Hawkes prentice Hall of India.
3. Lasers (Theory & applications): K, Thyagraian and A.K.Ghatak, Macmillan India.
4. Lasers and Nonlinear Optics: B.B. Laud, New age international, Delhi
5. Laser and nonlinear optics: G DBaruah ,Pragati prkashan Meerut

SEMESTER VI

Paper Code: PHYM 60440
Paper Name: MATERIAL SCIENCE AND NANOMATERIALS
Total Marks: 60
Total No. of Lectures: 40

Unit I: Classification and selection of Materials: **(**No. of Lectures: 14) (Marks: **26**)

Classification of materials, requirement of classifications, Engineering requirements, classification of engineering materials, organic, inorganic and biological materials. Semiconductors, Biomaterials, Advanced materials, Smart materials, nanostructured materials, quantum dots, spintronics, Material structure, Engineering metallurgy, Selection of Materials..

Composites: Composite materials and its characteristics, Particle reinforced composites; Fibre reinforced composites and fabrication of composite materials

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Unit II: Nano materials: **(**No. of Lectures: 8) (Marks: **10**)

Idea of nano structured materials, electron confinement in infinitely deep potential well, quantum dots, quantum wires, confined states in quantum wells, dots and wires, Carbon nanotubes

Unit III: Preparation of nanostructured materials: **(**No. of Lectures: 8) (Marks: **12)**

Different Physical and chemical methods, Plasma arcing, Chemical vapour deposition, Sol-gel technique, Electrodeposition, Chemical bath deposition

Unit IV: Nanomaterials characterization: **(**No. of Lectures: 10) (Marks: **12)**

Instruments, principle of measurements, measurement techniques: X-ray diffraction, scanning electron microscopy, transmission electron microscopy, scanning tunneling microscopy

Applications: nanostructured materials, Sensors, Catalysis, medical applications, advanced electronic materials, nano machines and novel devices

Books recommended:

1. Physics of semiconductor nanostructures: K P Jain, Narosa
2. Nanoparticles an nanostructured films; Preparation, characterization and applications: J H Fendler, John Wiley & sons
3. Nanotechnology: Mick Wilson, K K G Smith, M Simmons, B Raguse; Overseas Press
4. Elements of Solid State Physics: J P Srivastava, Prentice Hall of India
5. Material Science: Kakani & Kakani
6. Nanotechnology: M Ratner & D Ratner , Pearson Educatin

Paper Code: PHYM 60500,
Paper Name: Laboratory
Total Marks: 100

At least 75% of the experiments listed below are required to be performed by each student during the course. The examination should be on one experiment in 6 hrs.

List of experiments:

M1	Compare two high resistances using mirror galvanometer method.
MII	Determine the current in an external circuit by potentiometer and to compare emfs of two cells.
MIII	To study the basic logic gates using the NAND gate.
MIV	To fabricate half-adder using NAND gate
MV laser	To determine the number of rulings per meter in a diffraction grating using a beam.
MVI	To study the characteristic curve of a Zener diode and to study it as a voltage regulator.
MVII	To determine Planck constant by using photocell.

MVIII To determine the energy band gap of a junction diode or LED.

MIX To study frequency response curve of an RC couple amplifier using transistor.

MX To study the characteristics of full wave bridge rectifier and determine ripple factor and rectifier efficiency.

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