B.Sc. (GENERAL) PROGRAMME
PHYSICS (PHYG)

PREAMBLE

Why Physics?

"Physics is the most fundamental and all inclusive of the sciences, and has had a profound effect on all scientific development. In fact, physics is the present day of what used to be called *natural philosophy*, from which most of our modern sciences arose."- Prof. R.P. Feynmann wrote in his famous "Feynmann Lectures on Physics".

Being a description of nature, physics is our best friend from the day of our existence. In the interaction between various sciences, physics plays a special role because the laws it develops and handles are universal. They are as applicable to chemical reactions as to biological growth; they apply as much to machines used by mechanical engineers as to human body systems like bones and muscles. The flow of both knowledge and technology is in most cases one-sided: from physics to other branches of science and also technology.

Physics is both elegant and exciting and that is the reason why one must learn physics. We hardly need the salesmanship of several applied physics areas to sell basic physics. Knowledge by itself has great value, and if that knowledge is unifying, full of beauty, elegance charm and excitement, then it is certainly worth pursuing.

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SCHEME OF COURSES

COURSE STRUCTURE AND ALLOTMENT OF PAPERS FOR EACH SEMESTER EXAMINATION TO BE CONDUCTED BY THE UNIVERSITY

SEMESTER- I	**PHYG - 101**	**Mechanics &Thermodynamics**	**80+20**
SEMESTER -II	**PHYG - 201**	**Optics**	**56+14**
	PHYG - 202	**Practical-I**	**24+6**
SEMESTER -III	**PHYG - 301**	**Electricity, Magnetism and Electromagnetic theory**	**80+20**
SEMESTER - IV	**PHYG - 401**	**Quantum Mechanics & Mathematical Physics**	**56+14**
	PHYG – 402	**Practical-II**	**24+6**
SEMESTER - V	**PHYG - 501**	**Atomic and Nuclear Physics**	**80+20**
SEMESTER - VI	**PHYG - 601**	**Electronics & Solid state Physics**	**56+14**
	PHYG – 602	**Practical -III**	**24+6**
		Total	**600**

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PHYG -101
Mechanics &Thermodynamics

Total Marks: 80
Internal Assessment: 20

The knowledge of the mechanical properties of matter in the solid and the liquid state is essential for every student of physics. A good foundation of the concepts of mechanical and thermal properties of matter helps in better understanding of several other branches of modern physics. Thermal Physics is concerned with transformation of energy of one kind into another. Actually, relation of heat to other forms of energy such as magnetic, electrical, etc., also come under the scope of thermal physics

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

Laws of conservation of linear momentum and angular momentum of a system of particles, torque, moment of inertia of a rigid body and its physical significance, radius of gyration, kinetic energy of rotation, theorems on moment of inertia, calculation of moment of inertia of uniform rectangular lamina, spherical shell and solid sphere.

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

Constraints and their types, D' Alembert's principle, Lagrangian and its application, simple pendulum, symmetry and conservation laws, Hamiltonian on total energy

Unit III: (No. of Lectures 10: Marks 15)

Stress and strain, Young's modulus, Bulk modulus, modulus of rigidity, Poisson's ratio, relation among the constants, work done in twisting a wire. Surface tension of a liquid, surface energy, excess pressure inside a curved surface, rise of liquid in a capillary tube.

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

Zeroth and first law of thermodynamics, adiabatic and isothermal changes, second law of thermodynamics, reversible and irreversible process, Carnot's engine, definition of Entropy.

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

Kirchhoff's law, Stefan-Boltzman law, Spectral distribution, Wien's displacement law, Rayleigh-Jean's law and ultra violet catastrophe, Planck's hypothesis, Planck's black body distribution law

Suggested Readings:

For Units I, II & III

1. Elements of Properties of matter, D.S Mathur , S Chand & Company Ltd.
2. Classical Mechanics , H Goldstein , Narosa Publishing House
3. Classical Mechanics, Gupta, Kumar and Sharma , Pragati Prakashan
4. Elements of Mechanics, Gupta, Prakash, Agarwal, Pragati Prakashan

For Units IV&V

1. Heat, Thermodynamics and Statistical Physics, Brijlal, N. Subrahmanyam , & P. S Hemne, S Chand & Company Ltd.

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PHYG-201

Optics

Total Marks: 56
Internal Assessment: 14

UNIT I: (No. of Lectures 20: Marks 25)

Refraction at spherical surfaces, thin lenses, combination of lenses, lenses in contact and separated by a distance, achromatic combination of lenses, spherical and chromatic aberration, eyepieces, telescopes and microscopes. Huygen's theory, reflection and refraction from curved surface, interference of light, Young's double slit experiment, Biprism

UNIT II: (No. of Lectures 10: Marks 15)

Diffraction of light, Fresnel and Fraunhoffer diffraction, Zone plate, diffraction at a straight edge, single slit, double slit,

UNIT III: (No. of Lectures 10: Marks 16)

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

Suggested Readings:

1. Optics- A B Gupta, Books and Allied Ltd
2. Optics- B K Mathur
3. Optics- A.K. Ghatak Tata McGraw Hill

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PHYG -202
Practical -I

Total Marks: 24
Internal Assessment: 6

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 4 hrs.

List of experiments:

1. To determine the acceleration due to gravity at your place with the help of a bar pendulum.
2. To determine surface tension of a liquid by Jaeger's method.
3. To determine the coefficient of viscosity of water by measuring the flow through a Capillary tube.
4. To determine the magnetic moment of the given bar magnet
5. To determine the value of horizontal intensity of earth's magnetic field at your place.
6. To verify the inverse square law of force in magnetism
7. To determine the angle of the given prism with a spectrometer obtaining the angle of minimum deviation
8. To draw the I-D curve using a spectrometer for two monochromatic radiations
9. To convert a galvanometer into a ammeter and a voltmeter.
10. To compare the e.m.f of two cells using a potentiometer

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PHYG -301
Electricity, Magnetism and Electromagnetic Theory

Total Marks: 80
Internal Assessment: 20

Not only are the electromagnetic forces overwhelmingly the dominant ones in everyday life; they are also at present, the only ones that are completely understood. Electrodynamics, a beautifully complete and successful theory, which is also the first example of a unified theory in physics, has become a kind of reference point for the physicists and ideal model that all other theories strive to emulate.

Unit I : Electricity (No. of Lectures 20 : Marks 30)

Gauss's law and its application to calculation of fields due to hollow and solid sphere ,energy density in electric field ,capacitance and dielectrics ,RC-circuits, charging and discharging of a capacitor ,time constants , AC through R , C, and L , L-C-R circuits and resonance

Unit II: Magnetism (No. of lectures 9: Marks 15)

Magnetic potential, field intensity, magnetic shell, magnetic permeability, susceptibility, magnetization, magnetic intensity and their relation

Unit III: Electromagnetic Theory (No. of Lectures 12: Marks 20)

Dielectric medium, displacement current, Biot-Savart law, Ampere's circuital law, vector potential, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic waves, Hertz experiment.

UNIT IV: (No. of 9: Marks 15)

Equation of motion of a progressive wave, longitudinal and transverse wave, superposition of waves, standing waves, transverse waves on a string, velocity of sound in a medium (solid, liquid and gas) Doppler effect

Suggested Readings:

For Unit I, II & III

1. Fundamentals of Magnetism and Electricity, D.N. Basudeva, S. Chand Company Ltd.
2. Electricity and Magnetism with Electromagnetic Theory and Special Theory of Relativity, D. Chattopadhyaya, Books and Allied, Kolkata
3. Electromagnetic B.B. Laud, New Age International.

UNIT IV

1. Waves and Oscillations, N.Subrahmanyam, Vani Educational Books, New Delhi
2. Waves and Oscillations, Gupta and Verma, S. Chand and Company Ltd.

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PHYG -401
Quantum Mechanics & Mathematical Physics

Total Marks: 56
Internal Assessment: 14

At the present stage of human knowledge, quantum mechanics can be regarded as the fundamental theory of atomic phenomena. The experimental data on which it is based are derived from physical events that lie almost entirely beyond the range of direct human perception. It is not surprising, therefore, that the theory embodies physical concepts that are foreign to common daily experience. The knowledge of quantum mechanics is basic to the study of modern physics.

Mathematics forms an integral part of physics education. All physical laws and relations are represented in mathematical terms. Understanding of the physical laws and appreciation of the elegance and beauty of physics requires a good knowledge of mathematics. The course content would equip the students to comprehend Physics better.

Unit I: (No. of Lectures 12: Marks 16)

Inadequacy of classical physics, wave particle duality of matter, de-Broglie hypothesis, experimental verification of wave nature of particle (Davision-Germer experiment), Heisenberg's uncertainty principle with examples, gamma ray experiment, Bohr's complimentary principle

Unit II: (No. of Lectures 12: Marks 16)

Schrodinger equation, interpretation of wave function, probability density and Probability current density, concept of wave packet, expectation values of physical variables, operators, particle in a one- dimensional box.

Unit III: (No. of Lectures 10: Marks 14)

Scalar and vector fields, Gradient of scalar field, Divergence of a vector field, curl of a vector field, idea of line, surface and volume integration, Gauss' and Stokes' theorems.

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

Classifications of differential equations, Variables are separable, homogeneous and non-homogeneous equations, linear equations, simple cases of ordinary differential equation of second order.

Suggested Readings:

For Units I & II

1. Quantum Mechanics: G Aruldhas, Prentice Hall of India
2. Quantum Mechanics: S P Kuila, New Central Book Agency (P) Ltd.
3. Quantum Mechanics: A.K Ghatak and S Lokanathan, McGraw Hill

For Units III & IV

1. Mathematical Physics: B.S Rajput, Pragati Prakashan

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PHYG -402
Practical II

Total Marks: 24
Internal Assessment: 6

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 4 hrs.

List of experiments:

1. To determine the wave length of a monochromatic radiation using Newton's ring.
2. To determine the thermal conductivity of a metallic rod by Searl's method.
3. To determine the resistance of a galvanometer by half-deflection method.
4. To determine the current in an external circuit by potential drop method using a potentiometer.
5. To study the static characteristics of a junction transistor in common emitter configuration.
6. To study a junction diode as a rectifier and to draw the I-V characteristics.
7. To determine the ratio of two specific heats of a gas by Clement and Desorme's method.
8. To determine the moment of inertia of a given body about an axis passing through its centre of gravity by the torsional oscillation method.
9. To determine the angular magnifying power of a telescope.

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PHYG -501
Atomic and Nuclear Physics

Total Marks: 80
Internal Assessment: 20

Atomic Physics remains a key component of physics, both because of its fundamental importance to the understanding of many aspects of modern physics and also because of the exciting new developments that have occurred in this field.

The developments in nuclear physics have affected our worldview at ends, the microscopic and macroscopic. With dimensions of the order of 10 m and energies of the order of several MeV involved in nuclear phenomena, the entire structure of classical mechanics fall apart. We have to involve relativity, which changed the meaning of space and time; and we also have to employ quantum mechanics to have a coherent understanding of the phenomena at the microscopic level. Certain developments, which had their roots in nuclear physics, have changed the world and also still creating controversies among different countries.

UNIT I: (No. of Lectures 18: Marks 30)

Cathode rays, Franck-Hertz experiment, determination of e/m by Thomson's Method, Millikan's oil drop experiment. Production and properties of X-rays, Characteristic and continuous X-ray spectrum, photoelectric effect and its properties, Einstein's photoelectric equation, determination of Planck's Constant, Compton effect.

UNIT II: (No. of Lectures 14: Marks 20)

Bohr atom model, origin of spectral lines, Bohr's Correspondence principle, Somerfield's relativistic atom model, designation of spectral term symbol, Atomic spectra, atomic transition and origin of spectral lines, fine structure, L-S Coupling, j-j coupling, Zeeman effect, Stark effect.

Unit III: (No. of Lectures 18: Marks 30)

Qualitative introduction to the nature of nuclear forces, Bohr-Wheeler theory, energy released in fission , liquid drop model of the nucleus .Nuclear reactions and cross-sections, induced radioactivity ,nuclear fission and fusion. Accelerators: Van-de-Graff generator, linear accelerator, cyclotron.

Suggested Readings:

1. Atomic Physics: J.B.Rajam ,S Chand & Company Ltd.
2. Nuclear Physics: D.C.Tayal ,Himalaya Publishing House
3. Atomic and Nuclear Physics: S.Chand and Company Ltd.

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PHYG -601
Electronics & Solid State Physics

Total Marks: 56
Internal Assessment: 14

Electronics is a major discipline of physics, which has developed tremendously and has changed daily lives to an extent that was unimaginable a few decades back. There is still tremendous scope of further developments in this field of physics and thus it is essential that the students of physics have a good foundation of electronics, which the course intends to achieve.

Solid State Physics commonly termed as Condensed Matter Physics is concerned with the properties, often astonishing and often of great utility that result from the distribution of electrons in metals, semiconductors and insulators. Superconductivity and the science of nano-materials are two of the most attractive and emerging disciplines, which arose from the developments made in the field of solid-state physics. These are two fields with many practical and theoretical aspects. Thus, the knowledge of solid-state physics is very essential to those who would like to venture in the fields of nanoscience and superconductivity in the future.

Unit I: (No. of lectures 10: Marks 15)

Semiconductor and insulators, electrons and holes in semiconductors, donor and acceptor impurity, generation and recombination of charge, diffusion, equation of continuity, Junction diode characteristics : The open circuit P-N junction, I-V characteristics P-N junction diode, breakdown diodes, diode as rectifier, half wave and full wave rectifier with resistance load, ripple factor, smoothing filters.

Unit II: (No. of lectures 10: Marks 13)

Transistor: PNP and NPN transistor, transistor as an amplifier, common emitter, common base and common collector connections, transistor biasing and thermal stabilization, amplifier, equivalent circuits, small signal transistor ,voltage amplifier, R- C coupled, L-C coupled amplifier. Oscillator: Transistor as sinusoidal oscillator, Barkhausen criterion, tuned collector, Hartley, RC oscillator.

UNIT III: (No. of lectures 10: Marks 13)

Basic ideas of lattice and crystals, primitive lattice vectors, unit cell, translational lattice vectors, two and three dimensional Bravais lattices, some simple crystal structures (sc, bcc, fcc, hcp, Nacl) ,Miller indices and lattice planes,

packing fraction for cubic crystal structure, Braggs law of diffraction by crystal planes.

UNIT IV: (No. of lectures 10: Marks 15)

Free electron theory of metals, Drude model, electrical and thermal conductivity, Wiedmann-Franz law, Band theory of solids, Classification of solids, metals, semiconductor and insulator. Phenomenon of superconductivity, critical temperature, Meissner effect Type I and Type II superconductors.

Suggested Reading:

1. Principles of electronics: V.K. Mehta, S. Sand and Company Ltd.
2. Hand Book of Electronics: S.L. Gupta and V.Kumar, Pragati Prakashan
3. Introduction to Solid State Physics, C.Kittel, Wiley Eastern
4. Introduction to Condensed Matter Physics, K.C Barua, Narosa Publishing House
5. Solid State Physics: S.O. Pillai, New Age International

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PHYG -602
Practical III

Total Marks: 24
Internal Assessment: 6

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 4 hrs.

List of experiments:

1. To determine the value of 'g' using Kater's pendulum.
2. To determine the surface tension of a liquid by the capillary rise method and verify Jurin's law.
3. To verify the laws of transverse vibration of string by Melde's method.
4. To find the optical rotation produced by an optically active solution using a polarimeter and then determine its specific rotations.
5. To determine the number of rulings per cm of a plane diffraction grating.
6. To study the Network Theorems.
7. To determine the modulus of rigidity using Maxwell's needle method.
8. To determine the resistivity of a wire using meter bridge.

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B.Sc. (Major) PROGRAMME
PHYSICS (PHYM)
SCHEME OF COURSES

COURSE STRUCTURE AND ALLOTMENT OF PAPERS FOR EACH SEMESTER
EXAMINATON TO BE CONDUCTED BY THE UNIVERSITY

(Any one the optional course, PHYM –604 (A), (B), (C), (D) should be chosen in VI Semester)

SEMESTER- **I**	PHY**M - 101**	**Mechanics and Properties of Matter**	**80+20**
SEMESTER- **II**	PHY**M - 201**	**Thermal Physics & Waves and Oscillation**	**80+20**
SEMESTER- **III**	PHY**M - 301**	**Optics**	**60+15**
	PHY**M - 302**	**Electricity & Magnetism**	**60+15**
	PHY**M - 303**	**Laboratory**	**40+10**
		Total	**200**
SEMESTER- **IV**	PHY**M - 401**	**Mathematical Physics I**	**60+15**
	PHY**M - 402**	**Quantum Mechanics**	**60+15**
	PHY**M - 403**	**Laboratory**	**40+10**
		Total	**200**
SEMESTER- **V**	PHY**M - 501**	**Mathematical Physics II**	**60+15**
	PHY**M - 502**	**Electrodynamics & Special Relativity**	**60+15**
	PHY**M - 503**	**Atomic & Molecular Physics**	**60+15**
	PHY**M - 504**	**Electronics**	**60+15**
	PHY**M - 505**	**Laboratory**	**80+20**
		Total	**400**
SEMESTER- **VI**	PHY**M - 601**	**Statistical Mechanics**	**60+15**
	PHY**M - 602**	**Condensed Matter Physics**	**60+15**
	PHY**M - 603**	**Nuclear Physics**	**60+15**
	PHY**M - 604 Optional**	**(A) Astrophysics & Particle Physics**	**60+15**
	PHY**M - 604 Optional**	**(B) Space & Atmospheric Physics**	**60+15**
	PHYM **- 604 Optional**	**(C) Laser and its Application**	**60+15**
	PHYM **- 604 Optional**	**(D) Material Science and Nano Materials**	**60+15**
	PHYM **- 605**	**Laboratory**	**80+20**
		Total	**400**

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PHYM -101
Mechanics and Properties of matter

Total Marks: 80
Internal Assessment: 20
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, and 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

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PHYM -201

Thermal Physics and Waves and Oscillation

Total Marks: 80

Internal Assessment: 20

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

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PHYM -301

Optics

Total Marks: 60
Internal Assessment: 15

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 Huygens's, use of different telescopes (Ray diagrams for Galilean, Newtonian and Cassegrain telescopes)

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

Concept of physical optics, coherent source, interference by division of wave fronts, Young's double slit experiment, interference with white light, displacement of fringes, Fresnel bi prism, 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.

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PHYM -302
Electricity and Magnetism

Total Marks: 60
Internal Assessment: 15

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

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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

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PHYM -303
Laboratory

Total Marks: 40
Internal Assessment: 10

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.

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

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

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

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

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PHYM -401
Mathematical Physics I

Total Marks: 60
Internal Assessment: 15

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

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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

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PHYM -402
Quantum Mechanics

Total Marks: 60
Internal Assessment: 15
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 complimentary 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

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PHYM -403
Laboratory

Total Marks: 40
Internal Assessment: 10

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.

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PHYM -501
Mathematical Physics-II

Total Marks: 60
Internal Assessment: 15
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
5. Applied Mathematics for Engineers and Physicists
   L.A. Pipes and L.R. Harvill, McGraw Hill
6. Mathematical Methods for Physicists, G.B. Arfken and H.J. Weber Academic Press

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PHYM -502

Electrodynamics and Special Relativity

Total Marks: 60

Internal Assessment: 15

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

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PHYM -503
Atomic and Molecular Physics

Total Marks: 60
Internal Assessment: 15
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

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PHYM -504
Electronics

Total Marks: 60
Internal Assessment: 15
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-resistor, 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

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PHYM -505
Laboratory

Total Marks: 80
Internal Assessment: 20

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.

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PHYM -601
Statistical Mechanics

Total Marks: 60
Internal Assessment: 15
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

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PHYM -602
Condensed Matter Physics

Total Marks: 60
Internal Assessment: 15
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.

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PHYM -603
Nuclear Physics

Total Marks: 60
Internal Assessment: 15

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 Courses [any one of the following, PHYM 604 (A), (B), (C), (D)]

PHYM -604
(A) Astrophysics and Particle Physics
(Optional Course)

Total Marks: 60
Internal Assessment: 15
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), bosonsand 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.

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PHYM -604

(B) **Space and Atmospheric Physics**

(Optional Course)

Total Marks: 60

Internal Assessment: 15

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

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PHYM -604
(C) Laser and its Applications
(Optional Course)

Total Marks: 60
Internal Assessment: 15
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 .

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

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PHYM -604
(D) Material Science and Nanomaterials
(Optional Course)

Total Marks: 60
Internal Assessment: 15
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 Education

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PHYM -605
Laboratory

Total Marks: 80
Internal Assessment: 20

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 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.
MII To study the basic logic gates using the NAND gate.
MIV To fabricate half-adder using NAND gate
MV 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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