# UNIVERSITY OF DELHI

## SCHEME OF EXAMINATION
## AND
## COURSES OF READING
## FOR
## B.Sc. (Hons.) EXAMINATION IN PHYSICS



Part I Examination 1990
Part II Examination 1991
Part III Examination 1992





*Syllabus applicable for students seeking admission to the B.Sc. (Hons.) Physics Course in the Academic Year 1989-90.*

*Price :* ₹2.00

*B.Sc. (Hons.) Physics*

## SCHEME OF EXAMINATION

*Part I Examination* : 1990

| | | *Duration Hours* | *Maximum Marks* |
|---|---|---|---|
| Paper I : | Mathematical Physics I | 3 | 50 |
| Paper II : | Mechanics | 3 | 50 |
| Paper III : | Elect. & Mag. | 3 | 50 |
| Paper IV : | Practicals | 4 | 75 |

*Part II Examination* : 1991

| | | | |
|---|---|---|---|
| Paper V : | Mathematical Physics II | 3 | 50 |
| Paper VI : | Thermal Physics I | 3 | 50 |
| Paper VII : | Vibrations and Wave Optics | 3 | 50 |
| Paper VIII : | Practicals | 5 | 75 |

*Part III Examination* : 1992

| | | | |
|---|---|---|---|
| Paper IX : | Mathematical Physics III | 3 | 50 |
| Paper X : | Thermal Physics II | 3 | 50 |
| Paper XI : | Electromagnetic Theory | 3 | 50 |
| Paper XII : | Electronics | 3 | 50 |
| Paper XIII : | Atomic Physics and Quantum Mechanics | 3 | 50 |
| Paper XIV : | Physics of Materials | 3 | 50 |
| Paper XV : | Practicals | 5 | 75 |
| Paper XVI : | Practicals | 5 | 75 |

*Note* : One fourth of the marks for the practical pape shall be reserved for the Laboratory record the candidates.

The Honours Examination for the degree of Bachelor of Scienc shall include :

1. A qualifying test in English at the end of the first year.
   (i) Students who have not read English beyond class X in school will study the first year English B course.

(ii) Students who have not read English even upto class X in school will study the above mentioned course, but they may, if so advised, also take the Remedial English Course in addition.

(iii) Students who read core English in classes XI and XII will study the first year English 'A' course.

(iv) Students who have read Elective English in classes XI and XII will study the first year Elective English Course.

*Note :*—Composition exercises, where set will include topics of interest to students in Science and Vocational Courses.

2. A qualifying test in one of the following subjects at the end of the second year—One Paper 100 Marks.

(a) Physical Sciences consisting of Physics or Chemistry/ Mathematical Science including Statistics.

(b) Life Sciences consisting of Botany/Zoology and Anthropology.

(c) Earth Sciences comprising basically of Geological Science.

(d) Mathematical Sciences including Statistics and Operational Research.

(e) Behavioural Sciences.

(f) History of Science and Scientific Method.

*Subsidiary Subjects :* Two Examinations in each of two subsidiary subjects. (First Examination at the end of first year and second examination at the end of second year).

(a) Chemistry; and

(b) Mathematics

*Detailed Courses of Reading*

## PAPER—I : MATHEMATICAL PHYSICS—I

*Vector Algebra :* Scalar and vector products; polar and Axial vectors and their examples from Physics. Triple and quardupule products Vector equation of a straight line, plane and sphere.

*Series Solution of Linear second order differential equations and special functions :*

Singular points of second order differential equations and their importance. Series method (Frobenius). Solution of Harmonic Oscillator. Legendre, Bessel, Hermite and Laguerre differential equations, Gamma, Beta, functions and Riemann Zeta function.

*Orthogonal Polynomials :*

Legendre polynomials, Rodrigue's formula; Generating function, Recurrence relations, Orthogonality. Associated Legendre functions, Hermite and Laguerre polynomials; their generating functions, Rodrigue's formulas, Recurrence relations and Orthogonality. Bessel functions.

*Bessel Functions :*

Bessel functions of first and second kind, Generating function, Recurrence formulas, zeros of Bessel functions, Orthogonality and Asymptotic formulas. Series expansion of a function in terms of a complete set of othogonal functions. Fraunhoffer Diffraction integral, Hankel function and Cylindrical travelling waves. Medified Bessel functions and Fresnel intgrals.

*Partial Differential Equations :*

Wave equation in 3-dimention. Transverse vibration of stretched string 'D' Alembert's solution. Oscillation of hanging chain. Vibrations of rectangular and circular membrane. Heat conduction and Diffusion equations. Derivation of the equation of heat conduction Linear flow. Two and three dimensional heat conduction. Temperature inside circular plate. Laplace equation in cartesian, cylindrical and spherical coordinate systems. Problems of steady flow of heat in an infinite and semi infinite rod, Rectangular and circular plate. Potential of a ring. Potential about a spherical surface. Circular and spherical harmonics.

## PAPER—VI : THERMAL PHYSICS—I

*Thermodynamics—Concepts and Applications :* Concepts : zeroth and First law of thermodynamics. Reversible and Irreversible processes. Conversion of heat into work. Carnot theorem. Second law of thermodynamics. Thermodynamic temperature. Clausius inequality. Entropy. Entropy changes in reversible processes. Temperature. Entropy diagrams. The principal of increase of Entropy.

*Applications :*

Ideal gases : Equation of state, internal energy, Specific heats entropy. Isothermal and Adiabatic processes. Compressibility and expansion coefficient. Adiabatic lapse rate.

*Real gases :* Deviations from the ideal gas equation. The virial equation Andrew's experiments on $CO_2$ gas, continuity of liquid and gaseous state. Vander Waal's equation. Critical constants and law of corresponding states. Free expansion, Joule-Thompson effect.

*Magnetism :* Magnetic work Magnetic cooling by adiabatic demagnetisation. Approach to absolute zero.

*Thermodynamic Potentials :* Enthalpy, Cibb's Helmholtz functions, Maxwells' relations and their applications. T-ds equations. Gibb's Helmholtz equation. EMF of a reversible cell.

*Equilibria of Physico-chemical system :* Change of phase, Equilibrium between a liquid and its vapor, Clausius-Clapeyron equation. The triple point, Second order phase transitions. Chemical potentials. phase equilibrium. The Gibb's phase rule and its application.

*Kinetic Theory of Gases :* Derivation of Maxwell's law of distribution of velocities and its experimental verification. Mean-free path. Transport phenomena-viscosity, conduction and diffusion. One dimensional Random walk. Brownian motion. Langevin and Einstein's theories and experimental determination of Avogadro's number. Examples of Brownian motion in physics- Galvanometer mirror. Sedimentation and Johnson noise.

## PAPER—VII : VIBRATIONS AND WAVE OPTICS

*Vibrations :* Free oscillations with one degree of freedom. Linearity and superposition principle. System with two degrees of freedom (coupled oscillators). Normal coordinates and normal modes. Energy transfer. Normal modes of N coupled oscillators plucked and struck string.

*Waves :* Waves equation. Travelling waves. Plane and spherical waves. Huygen's principle. Law of reflection. Superposition of two harmonic waves. Superposition of N harmonic waves. Pulses and wave packets.

*Wave Optics* : Light waves. Electromagnetic nature of light waves.

Two-beam interference : Division of amplitude. Division of wave front. Young's double slit. Fresnel's Biprism. Michelson's interferometer. Circular and straight fringes. Visibility curve. Standardization of metre.

*Multiple Beam Interference* : Interference in thin films. Haidinger and Brewster fringes. Localized fringes. Newton's Rings. Fabry-Perot inter-ferometer. Airy's formula for intensity. Resolving power and range Fabry-Perot etalon. Method of exact fractions. Channelled spectra.

Interference between two independent sources. Time of coherence. (Qualitative discussions). Spatial and Temporal Coherence Partial coherence. Holography.

*Fraunhoffer Diffraction* : Diffraction at a single slit, circular aperture and at two parallel slits. Plane diffraction grating. Resolving power of telescope and microscope. Numerical aperture. Resolving power and dispersive power of a plane diffraction grating.

*Fresnel's Diffraction* : Division of wavefront into half-period zones Rectilinear propagation. Zone Plate. Fresnel's integrals. Cornu's spiral applications of Cornu's spiral to the analysis of diffraction at a straioght edge, a slit, a wire, an cpapue strip and a circular aperture.

## PAPER—VIII : PRACTICALS

1. Ultrasonic grating-determination of frequency.
2. Diameter of a wire by diffraction method, wavelength of light by Biprism.
3. Refractive index by Total Internal reflection using Gaussian eye piece.
4. Michelson Interferometer.
5. Diffraction grating (wave length and resolving power).
6. Newton's rings.
7. Spectrometer-Cauchy's constants, Resolving power and Dispersive power of the prism.
8. Study of B.G.
9. Thermal conductivity of Bad conductors by Lees' method.
10. M. by B.G. and L/M Maxwell's Bridge method.

11. Viscosity of a gas (Anderson's method).
12. High Resistance by leakage.
13. Dielectric constant by the ratio of units.
14. Magnetic field measurement by Search Coil.

## PAPER—IX : MATHEMATICAL PHYSICS III

*Linear Vector Spaces and Matrices* : Vector Space and Linear independence—Basis and dimensions. Linear transformations.

Non-Singular transformations. Matrix representation of linear transformation. Matrix algebra. Special matrices. Hermitian and Skewhermitian matrices. Singular and non-singular matrices. Inverse of a matrix. Change of basis. Similarity transformation. Eigen vectors and Eigen values. Diagonalization. Reduction of coupled linear differential equation of eigen value problem. Trace of a matrix. Inner products of vectors. Unitary and orthogonal matrices.

*Cartesian Tensors* : Transformation of coordinates. Tensorial Character of the physical quantities, Symmetric and antisymmetric tensors. Contraction and differentiation. Pseudotensors. Kronecker and alternating tensors. Moment of Intertia tensor and Euler's equation of motion. Stress and strain tensor Elastic constant. Polarization tensor.

*Integral Transform* : Fourier Integral Theorem. Fourier Integral transform. Sine and cosine transform Convolution theorem. Laplace transform of elementary function of derivatives, integrals and unit step-function and of periodic functions, Translation substitution and convolution theorem. Laplace inverse transform.

*Applications of Laplace Transform* : Solution of first and second order ordinary differential equations with constant coefficients and simultaneous first order ordinary differential equations. Solution of one dimensional diffusion and wave equation-Heat flow in an infinite and semi-infinite rod.

Dirac Delta function. Green functions and their use in solution of one dimensional differential equations.

*Calculus of Variation* : Maxima and minima of a function of several variables. Constrained maxima and minima. Method of Lagrange undetermined multipliers. Variational principle. Euler's equation and its application to geodesics and minimum surface area.

*Fluid Motion* : The continuity equation $\left(\vec{\Delta}.\vec{J}+\frac{\partial \rho}{\partial t}=0\right)$ Equation of motion

$$\left(\frac{\partial \vec{v}}{\partial t}+\left(\vec{v}.\vec{\Delta}\right)\vec{v}=-\frac{\Delta p}{\rho}-\Delta\varphi\right)$$ Steady Flow Bernoulli's Theorem Circulation, Vortex lines, Viscous Flow-Poiseuille's Formula. Reynold number : Flow past a Circular cylinder.

## PAPER—X THERMAL PHYSICS II

*Classical Statistics* : Entropy and thermodynamic probability. Maxwell Boltzmann distribution. Thermodynamic functions of a system having a finite number of energy levels; negative temperature. Thermodynamic functions of an ideal gas Classical entropy expression. Gibb's Paradox. Law of equipartition of energy and its application to specific heats. Specific heat of hydrogen. Ortho and para hydrogen.

*Classical Theory of Radiation* : Properties and thermodynamics of thermal radiation. Kirchhoff's law. Stefan's law. Wien's displacement law. Temperature of Stellar atmosphere.

*Quantum Theory of radiation* : Planck's law—Derivation and experimental verification.

*Quantum Statistics* : Bose-Einstein and Fermi-Dirac distribution laws. Calculation of the thermodynamic functions of an ideal weekly degenerate gas.

*Strong Degeneration* :

Calculation of thermodynamic functions of an ideal Bose gas. Bose Einstein condensation. Properties of liquid $^4$He. (qualitative description),

Radiation as a gas of photons and Bose's derivation of Plank's law Flux of radiant energy. Radiation pressure. Thermal equilibrium of radiation. Einstein's A and B coefficients. Working principle of Lasers.

Fermi energy. Thermodynamic functions of an ideal Fermi gas. Relativistic Fermi gas. White dwarf stars. Chandrashekhar mass limit. Saha's ionization formula. Third law of thermodynamics. Absolute definition of entropy. Consequences of third law. Unattainability of absolute zero.

## PAPER—XI : ELECTROMAGNETIC THEORY

Maxwell's equations. Displacement current Vector and scalar potentials. Boundary conditions at interfaces between different media. Wave equation. Plane waves in dielectric media. Poynting theorem and Poynting vector. Polarization of e.m. Wave. Description of linear, circular and elliptic polarization.

Reflection and refraction of a plane wave at a plane interface between dielectrics. Fresnel formulae and their verification. Total internal reflection. Waves in conducting media. Metallic reflection (normal incidence) Skin depth. Elementary theory of the optical constants of metals and their determination. Rectangular and cylindrical cavities. Wave guides. Modes in a rectangular wave guide. Energy flow and attenuation in wave guides. Resonant cavities. Power loss in a cavity. Q of a cavity. Production of polarized light by specular reflection (Brewster's angle) by control of emission, by selective absorption.

Propagation of e.m. waves in anisotropic media Fresnel's formula. Light propagation in uniaxial crystal. Double refraction. Nicol Rochon and Wollaston prism, Production of circularly and elliptically polarized light. Babinet compensator. Analysis of polarized light.

Maxwell's equations in microscopic media (Plasma) Characteristic plasma frequency. Refractive index. Reflection of microwoves in ionosphere.

Lorenz-Lorentz formula. Elementary theory of normal and anomalous dispersion. Cauchy and Sellmier's relation. Wood experiment.

## PAPER—XII : ELECTRONICS

*Linear Network* : Multimesh Networks—Loop and Junction Analysis Superposition theorem. Frequency spectrum method. Phasor diagrams.

*Non-linear elements and their linear equivalents* : Diode, Triode, Pentode and their characteristics. Crystal diodes and Transistors. Transistor configurations. 4-terminal equivalent circurt representation of Triode and Transistors Hybrid model of Transistors. Elementary idea of Field effect Transistor and Tunnel Diode.

*Linear Circuits with Active Elements* :

Tube and Transistor Amplifier : Basic principle, untuned amplifiers, its classifications, and frequency response, R-C. coupled and Transformer-

coupled amplifiers. Feed back in amplifiers and its advantages. Amplifier distortion. Tuned voltage amplifier.

*Oscillators :* Barkhausen criterion for self-sustained oscillations. Tuned plate oscillator. Crystal oscillator. R-C Oscillators. Sawtooth generators. Multivibrator.

*Non-Linear Parametric Networks :* Amplitude modulation-small signal (square law), modulators. Demodulation-plate detection and Diode detection. Elementary ideas of Frequency modulation and phase modulation. Non-Linear effects in Amplifiers Power Amplifier (pushpull type).

*Rectifiers and Power Supplies :* Semiconductor Diode as halfwave and full wave rectifers, their efficiency and ripple factors. Bridge rectifiers. Harmonic generation in rectifier circuits. Series inductance filter shunt capacitance filters. L-section and pi-section filters, Regulation characteristics and ripple factors.

*Instruments :* Basic principles of Radio and Television receivers and Transmitters, Oscilloscope, and V.T.V.M.

## PAPER—XIII : ATOMIC PHYSICS & QUANTUM PHYSICS

*Atomic Structure, Energy levels and Spectra :* Alpha—particle scattering. Bohr-Sommerfeld theory of hydrogen atom; correspondence principle, stationary states. Quantum numbers J. Q. M. and their detailed discussions, energy levels degeneracy spectral lines and selection rules. Examples of hydrogen and hydrogen like atoms. Electron spin. Sodium D lines. Spin-orbit coupling and fine structure effects. Romoval of degeneracy. Zeeman effect. Bohr magneton and Stern-Gerlach experiment. Vector model of the atom. Many-electron atoms. Pauli's Principle. Periodic table.

*Quantum Mechanics :* Wave Particle Dualism for light and Matter Photo electric effect. Einstein's equation. Determination of Planck's constant. Inverse Photoelectric effect (X-ray production and determination of h). Wave nature of Matter : Electron diffraction. (Davisson-Germer Expt.) De Brogile Waves Packets. Uncertainly principle. Illustration of wave-particle dualism : Compton scattering. Simple ideas of Pair creation and annihilation and Bremsstrahlung.

Two slit experiment superposition principle. Need for probability amplitude. Wave function. Schrodinger equation. One dimensional barrier and rectangular well problems. Particle in a box and linear harmonic oscillator. Rigid Rotator.

*Elementary Nuclear Physics :* Size, mass and charge of the nucleus binding energy. Nuclear force. Semi-empirical mass formula. Liquid drop, Nuclear fission. Elementary ideas of shall model. Nuclear reactions and Radioactivity. Laws of decay and growth. $\alpha$-decay (Gamow's theory), $\beta$ decay (neutrino hypothesis) and $\gamma$ decay.

*Detection and Acceleration of Elementary Particles* : Motion of charged particles in electric and megnetic fields. Focussing electrons in electric and megnetic fields. Electron microscope, Principle of linear accelerator, cyclotron and Aston mass spectrograph. Working principle of G.M. Counter, cloud chamber and bubble chamber.

## PAPER XIV : PHYSICS OF MATERIALS

*Crystal Structure :* Elementary ideas of Crystal structure : lattice translation vectors. Lattice with a basis, Unit Cell, reciprocal lattice. Types of lattices. Crystal Diffraction : Bragg's law, Diffraction of X-rays.

*Elementary Lattice Dynamics* : Lattice vibrations—linear monoatomic and diatomic chains. Acoustical and optical phonons. Qualitative description of the phonon spectrum in solid, Brillouin zones, Einstein and Debye theories of specific heat of solids. The $T^3$ law.

*Dielectric properties of materials* : Polarization. Local electric field at an atom. Depolarization field. Lorentz field of dipoles inside a cavity, Field in dielectric between capacitor plates.

*Dielectric Constant and Polarizability* : Electric susceptibility polarizability, Clausius—Mossoti Equation Classical Theory of electronic polarizability. Orientational polarizability and Langevin-Debye equation. Conducting and dielectric sphere in a Uniform field. Qualitative discussion of ferroelectric properties of materials.

*Megnetic Properties of Matter* : Response of substances to megnetic field. Dia, para and ferri and ferromegnetic materials, Absence of megnetic charge, electric currents in atoms, electron spin and megnetic moment. Measurements of the susceptibility of paramagnetic substances. Larmor procession and gyromognetic ratio. Langevin's theory of dia and

paramegnetism. Curie's law. Weiss theory of ferromognetism. Ferromegnetic domains. B—H Curve and energy loss in hysteresis.

*Elementary Band Theory :* Kronig Penny model. Band gaps. Conductors. Semiconductors and Insulators.

Free electron gas model for metals. Specific heat of metals. Richardson's equation. Wiedemann-Franz law. Thermoelectric effects.

## PAPER—XV AND XVI : PRACTICALS

1. R-C Coupled (two stage) Amplifier.
2. Tuned plate Oscillator.
3. Study of simple power supply.
4. Transistor Amplifier
5. Transistor Oscillator.
6. B-H Curve.
7. Magnetic Susceptibility.
8. e/m bar magnet Magnetron Magnetic focussing.
9. Use of oscilloscope study of pulse wave form using a neon tube circum.
10. Half life of radioactive decay (G-M Counter),
11. Study of elliptically polarized light.
12. Polarimeter.
13. Cornu's method for elastic constants.
14. Constant deviation spectrometer—Mercury Spectrometer.
15. To measure low voltage accurate upto I microvolt.
16. Stefan's constant
17. Jamin's interferometer : refractive index.
18. 'e' by Millikan's method.

In additions to the above experiments, a student will be required to take up a project of his choice with the prior permission of the teacher-in-charge. A suggestive list of projects is given below. Projects of similar nature may be added :—

1, To construct and study a regulated power supply of a given range.

2. Design of a R-C coupled amplifier and to study variation of phase with frequency.
3. To construct and calibrate a valve voltameter of given range.
4. To construct a D.C. dynamo.
5. To assemble a Transistor receiver.

*Note* :—25% marks for the project.

25% marks for the note books and

50% marks for two experiments spread over two days 5 hours each day.

I Year : Theory 12 periods per week
Practicals : 6 period per week.

II Year : Theory : 12 periods per week.
Practicals : 9 periods per week.

III Year : Theory : 18 periods per week.
Practicals : 18 periods per week.

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