UPSC Mains

B.Sc. (Physics)- I Year

Semester – I

Paper – I:: Mechanics and Oscillations

(DSC - Compulsory)

Unit – I

1. Vector Analysis (10)

Scalar and Vector fields, Gradient of a Scalar field and its physical significance. Divergence and Curl of a Vector field and related problems. Vector integration, line, surface and volume integrals. Stokes', Gauss's and Green's theorems- simple applications.

Unit – II

2. Mechanics of Particles (6)

Laws of motion, motion of variable mass system, motion of a rocket, multi-stage rocket, conservation of energy and momentum. Collisions in two and three dimensions, concept of impact parameter, scattering cross-section.

3. Mechanics of Rigid Bodies (6)

Definition of Rigid body, rotational kinematic relations, equation of motion for a rotating body, angular momentum and inertial tensor. Euler's equation, precession of a top, Gyroscope.

Unit – III

4. Central Forces (7)

Central forces – definition and examples, conservative nature of central forces, conservative force as a negative gradient of potential energy, equation of motion under a central force, gravitational potential and gravitational field, motion under inverse square law, derivation of Kepler's laws.

5. Special theory of Relativity (7)

Galilean relativity, absolute frames, Michelson-Morley experiment. Postulates of special theory of relativity. Lorentz transformation, time dilation, length contraction, addition of velocities, mass-energy relation. Concept of four vector formalism.

Unit – IV

6.Oscillations(12)

Simple harmonic oscillator, and solution of the differential equation- Physical characteristics of SHM, torsion pendulum measurements of rigidity modulus, compound pendulum, measurement of g', combination of two mutually perpendicular simple harmonic vibrations of same frequency and different frequencies, Lissajous figures.

Damped harmonic oscillator, solution of the differential equation of damped oscillator. Energy considerations, logarithmic decrement, relaxation time, quality factor, differential equation of forced oscillator and its solution, amplitude resonance, velocity resonance.

Note: Problems should be solved at the end of every chapter of all units.

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B.Sc. (Physics)- I Year

Semester – II

Paper – II:: Thermal Physics

(DSC - Compulsory)

Unit – I

1. Kinetic theory of gases: (4)

Introduction – Deduction of Maxwell's law of distribution of molecular speeds. Transport Phenomena – Viscosity of gases – thermal conductivity – diffusion of gases.

2. Thermodynamics: (8)

Basics of Thermodynamics- Carnot's engine (qualitative)-Carnot's theorem -Kelvin's and Clausius statements – Thermodynamic scale of temperature – Entropy, physical significance – Change in entropy in reversible and irreversible processes – Entropy and disorder – Entropy of universe – Temperature- Entropy (T-S) diagram – Change of entropy of a perfect gas-change of entropy when ice changes into steam.

Unit – II

3. Thermodynamic potentials and Maxwell's equations: (6)

Thermodynamic potentials – Derivation of Maxwell's thermodynamic relations – Clausius-Clayperon's equation – Derivation for ratio of specific heats – Derivation for difference of two specific heats for perfect gas. Joule Kelvin effect – expression for Joule Kelvin coefficient for perfect and Vanderwaal's gas.

4. Low temperature Physics: (6)

Joule Kelvin effect – liquefaction of gas using porous plug experiment. Joule expansion – Distinction between adiabatic and Joule Thomson expansion – Expression for Joule Thomson cooling – Liquefaction of helium, Kapitza's method – Adiabatic demagnetization – Production of low temperatures – Principle of refrigeration, vapour compression type.

Unit – III

5. Quantum theory of radiation: (12)

Black body-Ferry's black body – distribution of energy in the spectrum of Black body – Wein's displacement law, Wein's law, Rayleigh-Jean's law – Quantum theory of radiation - Planck's law – deduction of Wein's law, Rayleigh-Jeans law, Stefan's law from Planck's law. Measurement of radiation using pyrometers – Disappearing filament optical pyrometer – experimental determination – Angstrom pyro heliometer - determination of solar constant, effective temperature of sun.

Unit – IV

6. Statistical Mechanics: (12)

Introduction, postulates of statistical mechanics. Phase space, concept of ensembles and some known ensembles ,classical and quantum statistics and their differences, concept of probability, Maxwell-Boltzmann's distribution law -Molecular energies in an ideal gas- Maxwell-Boltzmann's velocity distribution law, Bose-Einstein Distribution law, Fermi-Dirac Distribution law, comparison of three distribution laws.

NOTE: *Problems should be solved at the end of every chapter of all units*

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B.Sc. (Physics)- II Year

Semester – III

Paper – III:: Electromagnetic Theory

(DSC - Compulsory)

Unit I : Electrostatics (11 hrs)

Electric Field:- Concept of electric field lines and electric flux, Gauss's law (Integral and differential forms), application to linear, plane and spherical charge distributions. Conservative nature of electric field 'E', Irrotational field. Electric potential:- Concept of electric potential, relation between electric potential and electric field, potential energy of a system of charges. Energy density in an electric field. Calculation of potential from electric field for a spherical charge distribution.

Unit II : Magnetostatics (12 hrs)

Concept of magnetic field 'B' and magnetic flux, Biot-Savart's law, B due to a straight current carrying conductor. Force on a point charge in a magnetic field. Properties of B, curl and divergence of B, solenoidal field. Integral form of Ampere's law, Applications of Ampere's law: field due to straight, circular and solenoidal currents. Energy stored in magnetic field. Magnetic energy in terms of current and inductance. Magnetic force between two current carrying conductors. Magnetic field intensity. Ballistic Galvanometer:- Torque on a current loop in a uniform magnetic field, working principle of B.G., current and charge sensitivity, electromagnetic damping, critical damping resistance.

Unit III: Electromagnetic Induction and Electromagnetic waves (13)

Faraday's laws of induction (differential and integral form), Lenz's law, self and mutual Induction. Continuity equation, modification of Ampere's law, displacement current. Maxwell equations. Maxwell's equations in vacuum and dielectric medium, boundary conditions, plane wave equation, transverse nature of EM waves, velocity of light in vacuum and in medium. Poynting's theorem.

UNIT IV:

Varying and alternating currents (6)

Growth and decay of currents in LR, CR and LCR circuits - Critical damping. Alternating current, relation between current and voltage in pure R, C and L-vector diagrams - Power in ac circuits. LCR series and parallel resonant circuit - Q-factor. AC & DC motors-single phase, three phase (basics only).

Network Theorems(6):

Passive elements, Power sources, Active elements, Network models: T and π Transformations, Superposition theorem, Thevenin's theorem, Norton's theorem. Reciprocity theorem and Maximum power transfer theorem (Simple problems).

Text Books

1. Fundamentals of electricity and magnetism By Arthur F. Kip (McGraw-Hill, 1968)
2. Telugu Academy
3. Electricity and magnetism by J.H.Fewkes& John Yarwood. Vol.I (Oxford Univ. Press, 1991).
4. Introduction to Electrodynamics, 3rd edition, by David J. Griffiths, (Benjamin Cummings,1998).
5. Electricity and magnetism By Edward M. Purcell (McGraw-Hill Education, 1986)
6. Electricity and magnetism. By D C Tayal (Himalaya Publishing House,1988)
7. Electromagnetics by Joseph A.Edminister 2nd ed.(New Delhi: Tata McGraw Hill, 2006).

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B.Sc. (Physics) - II Year
Semester – IV
Paper – IV:: Waves and Optics
(DSC - Compulsory)

Unit-I Waves(12)

Fundamentals of Waves -Transverse wave propagation along a stretched string, general solution of wave equation and its significance, modes of vibration of stretched string clamped at ends, overtones, energy transport, transverse impedance.
Longitudinal vibrations in bars- wave equation and its general solution. Special cases (i) bar fixed at both ends ii) bar fixed at the mid point iii) bar free at both ends iv) bar fixed at one end. Transverse vibrations in a bar- wave equation and its general solution. Boundary conditions, clamped free bar, free-free bar, bar supported at both ends, Tuning fork.

Unit II: Interference: (12)

Principle of superposition – coherence – temporal coherence and spatial coherence – conditions for Interference of light.
Interference by division of wave front: Fresnel's biprism – determination of wave length of light. Determination of thickness of a transparent material using Biprism – change of phase on reflection – Lloyd's mirror experiment.

Interference by division of amplitude: Oblique incidence of a plane wave on a thin film due to reflected and transmitted light (Cosine law) – Colours of thin films – Non-reflecting films – interference by a plane parallel film illuminated by a point source – Interference by a film with two non-parallel reflecting surfaces (Wedge shaped film) – Determination of diameter of wire-Newton's rings in reflected light with and without contact between lens and glass plate, Newton's rings in transmitted light (Haidinger Fringes) – Determination of wave length of monochromatic light – Michelson Interferometer – types of fringes – Determination of wavelength of monochromatic light, Difference in wavelength of sodium D_1,D_2 lines and thickness of a thin transparent plate.

Unit III: Diffraction: (12)

Introduction – Distinction between Fresnel and Fraunhofer diffraction, Fraunhofer diffraction:- Diffraction due to single slit and circular aperture – Limit of resolution – Fraunhofer diffraction due to double slit – Fraunhofer diffraction pattern with N slits (diffraction grating).
Resolving Power of grating – Determination of wave length of light in normal and oblique incidence methods using diffraction grating.
Fresnel diffraction-Fresnel's half period zones – area of the half period zones –zone plate – Comparison of zone plate with convex lens – Phase reversal zone plate – diffraction at a straight edge – difference between interference and diffraction.

Unit IV: Polarization (12)

Polarized light : Methods of Polarization, Polarizatioin by reflection, refraction, Double refraction, selective absorption , scattering of light – Brewster's law – Malus law – Nicol prism polarizer and analyzer – Refraction of plane wave incident on negative and positive crystals (Huygen's explanation) – Quarter wave plate, Half wave plate – Babinet's compensator – Optical activity, analysis of light by Laurent's half shade polarimeter.

NOTE: *Problems should be solved at the end of every chapter of all units.*

Suggested books

1. **Optics** by Ajoy Ghatak. *The McGraw-Hill companies.*
2. **Optics** by Subramaniyam and Brijlal. *S. Chand & Co.*
3. **Second Year Physics** – *Telugu Academy.*
4. **Modern Engineering Physics** by A.S. Vasudeva. *S.Chand & Co. Publications.*
5. **Fundamentals of Optics** by Jenkins A. Francis and White E. Harvey, *McGraw Hill Inc.*
6. K. Ghatak, **Physical Optics'**
7. D.P. Khandelwal, Optical and Atomic Physics' (Himalaya Publishing House, Bombay,1988)
8. Jenkins and White: 'Fundamental of Optics' (McGraw-Hill)
9. Smith and Thomson: 'Optics' (John Wiley and sons).

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B.Sc. (Physics)- III Year

Semester – V

Paper – V :: (A) Modern Physics

(DSE – Elective I)

UNIT - 1 : SPECTROSCOPY (12)

Atomic Spectra: Introduction - Drawbacks of Bohr's atomic model - Sommerfeld's elliptical orbits - relativistic correction (no derivation). Stern & Gerlach experiment. Vector atom model and quantum numbers associated with it. L-S and j-j coupling schemes. Spectral terms, selection rules, intensity rules - spectra of alkali atoms, doublet fine structure, Zeeman Effect, Paschen-Back Effect and Stark Effect (basic idea).

Molecular Spectroscopy: Types of molecular spectra, pure rotational energies and spectrum of diatomic molecule. Determination of inter nuclear distance. Vibrational energies and spectrum of diatomic molecule. Raman effect, classical theory of Raman effect. Experimental arrangement for Raman effect and its applications.

UNIT – II : Quantum Mechanics (14)

Inadequacy of classical Physics: Spectral radiation - Planck's law (only discussion). Photoelectric effect - Einstien's photoelectric equation. Compton's effect - experimental verification.

Matter waves & Uncertainty principle: de Broglie's hypothesis - wavelength of matter waves, properties of matter waves. Phase and group velocities. Davisson and Germer experiment. Double slit experiment. Standing de Brogile waves of electron in Bohr orbits. Heisenberg's uncertainty principle for position and momentum (x and p_x), Energy and time (E and t). Gamma ray microscope. Diffraction by a single slit. Position of electron in a Bohr orbit. Complementary principle of Bohr.

Schrodinger Wave Equation

Schrodinger time independent and time dependent wave equations. Wave function properties - Significance. Basic postulates of quantum mechanics. Operators, eigen functions and eigen values, expectation values.

Unit - III : Nuclear Physics (10)

Nuclear Structure: Basic properties of nucleus - size, charge, mass, spin, magnetic dipole moment and electric quadrupole moment. Binding energy of nucleus, deuteron binding energy, p-p, n-n, and n-p scattering (concepts), nuclear forces. Nuclear models- liquid drop model, shell model.

Alpha and Beta Decays: Range of alpha particles, Geiger - Nuttal law, Gammow's theory of alpha decay, Geiger - Nuttal law from Gammow's theory. Beta spectrum - neutrino hypothesis.

Particle Detectors: GM counter, proportional counter, scintillation counter.

UNIT: IV: Solid State Physics & Crystolography (12)

Crystal Structure : Crystalline nature of matter. Cystal lattice. Unit Cell, Elements of symmetry. Crystal systems, Bravais lattices. Miller indices. Simple crystal structures (S.C., BCC, FCC, CsCl, NaCl, diamond and Zinc Blende)

X-ray Diffraction: Diffraction of X -rays by crystals, Bragg's law, Experimental techniques - Laue's method and powder method.

Bonding in Crystals: Types of bonding in crystals - characteristics of crystals with different bondings. Lattice energy of ionic crystals - determination of Madelung constant for NaCl crystal. Calculation of Born Coefficient and repulsive exponent. Born-Haber cycle.

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B.Sc. (Physics)- III Year

Semester – VI

Paper – VI :: A. Electronics

(DSE- Elective I)

Unit – I: (12 Hrs)

Band theory of P-N junction

1. Energy band in solids (band theory), valence band, conduction band and forbidden energy gap in solids, insulators, semiconductors and pure or intrinsic semiconductors and impure or extrinsic semi-conductors. N-type semi-conductors, P-type semi-conductors, Fermi level, continuity equation.

2. Diodes: P-N junction diode, Half-wave, full-wave and bridge rectifier. Zener diode & its characteristics. Zener diode as voltage regulator.

Unit-II: (12 Hrs)

1. Bipolar Junction Transistor (BJT) – p-n-p and n-p-n transistors, current components in transistors, CB, CE and CC configurations – transistor as an amplifier - RC coupled amplifier – Frequency response (Qualitative analysis).

2. Feedback concept & Oscillators: Feedback, General theory of feedback – Concepts of oscillators, Barkhausen's criteria, Phase shift oscillator – Expression for frequency of oscillation.

Unit-III : (10 hrs)

Special devices- Construction and Characteristics: Photo diode - Shockley diode - Solar cell, Opto-couplers - Field Effect Transistor (FET) - FET as an Amplifier - Uni Junction Transistor (UJT). UJT as a relaxation oscillator - Silicon controlled rectifier (SCR) - SCR as a switch.

Unit-IV: (14 Hrs)

1. Digital Electronics

Binary number system, convertion of binary to decimal and vice-versa. Binary addition and subtraction (1's and 2's complement methods). Hexadecimal number system. Conversion from binary to hexadecimal and vice-versa, Decimal to hexadecimal and vice-versa.

2. Logic gates:

OR, AND, NOT gates, truth tables, realization of these gates using discrete components. NAND, NOR as universal gates, Exclusive – OR gate (EX-OR). De Morgan's Laws – Verification.

NOTE: Problems should be solved from every chapter of all units.

Suggested books

1. Electronic devices and circuits – Millman and Halkias. *Mc.Graw-Hill Education.*
2. Principles of Electronics by V.K. Mehta – *S. Chand & Co.*
3. Basic Electronics (Solid state) – B. L. Theraja , S. Chand & Co.
4. A First Course in Electronics- Anwar A. Khan &Kanchan K. Dey, PHI.
5. Physics of Semiconductor Devices- S. M. Sze
6. Physics of Semiconductors- Streetman.
7. Basic Electronics – Bernod Grob.
8. Third year Electronics – Telugu Academy
9. Digital Principles & Applications – A.P. Malvino and D.P. Leach

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B.Sc. Semester VI-Theory Syllabus

Subject : (Physics) (DSE- Elective-II)

Paper-VI:: B. APPLIED OPTICS

Unit I (11hrs)

Principles of Lasers: Emission and absorption of Radiation – Einstein Relations. - Pumping Mechanisms – Optical feedback - Laser Rate equations for two, three and four level lasers. Pumping threshold conditions. – Properties of Laser beams. Classification of laser systems – Gas, Liquid and Solid Lasers: He- Ne, and Argon lasers, their energy level schemes - Ruby laser and YAG laser, GA-As laser, and their applications in various fields.

Unit II (11 hrs)

Holography: Basic Principles of Holography- Recording of amplitude and phase- The recording medium- Reconstruction of original wave front- Image formation by wave front reconstruction- Gaber Hologram- Limitations of Gaber Hologram-Off axis Hologram- Fourier transform Holograms- Volume Holograms, Applications of Holograms.

Unit III (10 hrs)

Fourier and Non-Linear Optics:Fourier optics- Thin lens as phase transformation – Thickness function- Various types of lenses- Fourier transforming properties of lenses – Object placed in front of the lens- Object placed behind the lens.

Non-Linear Optics: Harmonic generation- Second harmonic generation- Phase matching condition- Optical mixing- Parametric generation of light – Self focusing of light.

Unit IV (10 hrs)

Optical Fibers: Fiber types and their structures. Ray optics representation, acceptance angle and numerical aperture. Step index and graded index fibers, single mode and multimode fibers. Fiber Materials for glass fibers and plastic fibers. Signal attenuation in optical fibers: Absorption, scattering and bending losses in fibers, core and cladding losses. Material dispersion, wave guide dispersion, intermodes distortion and pulse broadening.

NOTE: Problems should be solved at the end of every chapter of all units.

Suggested Books:

1. Opto Electronics- An Introduction – Wilson & JFB Hawkes 2nd Edition.
2. Introduction to Fourier optics – J.W. Goodman
3. Lasers and Non-Linear optics – B.B. Laud
4. Optical Electronics – Ghatak nd Thyga Rajan.
5. Principles of Lasers – O. Svelto
6. Optical Fiber Communications – by Gerad Keiser
7. Optical Fiber Communications – by John M. Senior (PHI)

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Physics UPSC - mains

UNION PUBLIC SERVICE COMMISSION

EXAMINATION NOTICE NO. 04/2021-CSP DATE: 04/03/2021

(LAST DATE FOR RECEIPT OF APPLICATIONS: 24/03/2021) of CIVIL SERVICES EXAMINATION, 2021

(The Commission's Website: www.upsc.gov.in)

IMPORTANT

1. **CANDIDATES TO ENSURE THEIR ELIGIBILITY FOR THE EXAMINATION:** All candidates (male/female/transgender) are requested to carefully read the Rules of Civil Services Examination notified by the Government (Department of Personnel and Training) and this Notice of Examination derived from these Rules. The Candidates applying for the examination should ensure that they fulfill all eligibility conditions for admission to examination. Their admission to all the stages of the examination will be purely **provisional** subject to satisfying the prescribed eligibility conditions. Mere issue of e-Admit Card to the candidate will not imply that his/her candidature has been finally cleared by the Commission. The Commission takes up verification of eligibility conditions with reference to original documents only after the candidate has qualified for Interview/Personality Test.

2. **HOW TO APPLY:**

Candidates are required to apply Online by using the website **https://upsconline.nic.in** Detailed instructions for filling up online applications are available on the above mentioned website. Brief Instructions for filling up the "Online Application Form" given in Appendix-IIA.

2.1 Candidate should have details of one Photo ID Card viz. Aadhaar Card/Voter Card/PAN Card/Passport/Driving Licence/Any other Photo ID Card issued by the State/Central Government. The details of this Photo ID Card will have to be provided by the candidate while filling up the online application form. The candidates will have to upload a scanned copy of the Photo ID whose details have been provided in the online application by him/her. This Photo ID Card will be used for all future referencing and the candidate is advised to carry this Photo ID Card while appearing for Examination/Personality Test.

2.2 The facility of withdrawal of Application is available for those candidates who do not want to appear for Civil Services (Preliminary) Examination. In this regard, Instructions are mentioned in Appendix IIB of this Examination Notice

3. **LAST DATE FOR RECEIPT OF APPLICATIONS :**

The online Applications can be filled up to 24th March, 2021 till 6:00 PM. The eligible candidates shall be issued an e-Admit Card three weeks before the commencement of the examination. The e-Admit Card will be made available in the UPSC website [https://upsconline.nic.in] for downloading by candidates. No Admit Card will be sent by post.

4. **PENALTY FOR WRONG ANSWERS:**

Candidates should note that there will be penalty (negative marking) for wrong answers marked by a candidate in the Objective Type Question Papers.

5. **FACILITATION COUNTER FOR GUIDANCE OF CANDIDATES:**

Government strives to have a workforce which reflects gender balance and women candidates are encouraged to apply.

In case of any guidance/information/clarification regarding their applications, candidature etc. candidates can contact UPSC's Facilitation Counter near gate 'C' of its campus in person or over Telephone No. 011-23385271/011-23381125/011-23098543 on working days between 10.00 hrs and 17.00 hrs.

6. **MOBILE PHONES BANNED:**

(a) The use of any mobile phone (even in switched off mode), pager or any electronic equipment or programmable device or storage media like pen drive, smart watches etc. or camera or blue tooth devices or any other equipment or related accessories either in working or switched off mode capable of being used as a communication device during the examination is strictly prohibited. Any infringement of these instructions shall entail disciplinary action including ban from future examinations.

(b) Candidates are advised in their own interest not to bring any of the banned items including mobile phones/pagers to the venue of the examination, as arrangement for safe-keeping cannot be assured.

7. Candidates are advised not to bring any valuable/costly items to the venue of the examination, as safe-keeping of the same cannot be assured. Commission will not be responsible for any loss in this regard.

F. No. 1/13/2020-E.I(B) : Preliminary Examination of the Civil Services Examination for recruitment to the Services and Posts mentioned below will be held by the Union Public Service Commission on 27th June, 2021 in accordance with the Rules published by the Department of Personnel & Training in the Gazette of India Extraordinary dated 4th March, 2021. All candidates must carefully read the Civil Services Examination-2021 Rules together with all the Appendices along with the Annexures thereof and this Examination Notice derived from the CSE Rules, 2021 in entirety for gaining awareness of the current Rules and Regulations as changes may have been incorporated since the previous Examination Rules.

(i) Indian Administrative Service
(ii) Indian Foreign Service
(iii) Indian Police Service
(iv) Indian Audit and Accounts Service, Group 'A'
(v) Indian Civil Accounts Service, Group 'A'
(vi) Indian Corporate Law Service, Group 'A'
(vii) Indian Defence Accounts Service, Group 'A'
(viii) Indian Defence Estates Service, Group 'A'
(ix) Indian Information Service, Junior Grade Group 'A'
(x) Indian Postal Service, Group 'A'
(xi) Indian P&T Accounts and Finance Service, Group 'A'
(xii) Indian Railway Protection Force Service, Group 'A'
(xiii) Indian Revenue Service (Customs & Indirect Taxes) Group 'A'
(xiv) Indian Revenue Service (Income Tax) Group 'A'
(xv) Indian Trade Service, Group 'A' (Grade III)
(xvi) Armed Forces Headquarters Civil Service, Group 'B' (Section Officer's Grade)
(xvii) Delhi, Andaman and Nicobar Islands, Lakshadweep, Daman & Diu and Dadra & Nagar Haveli Civil Service (DANICS), Group 'B'
(xviii) Delhi, Andaman and Nicobar Islands, Lakshadweep, Daman & Diu and Dadra & Nagar

15. Nyaya—Vaiesesika : Theory of Categories; Theory of Appearance; Theory of Pramana; Self, Liberation; God; Proofs for the Existence of God; Theory of Causation; Atomistic Theory of Creation.
16. Samkhya; Prakrit; Purusa; Causation; Liberation.
17. Yoga; Citta; Cittavrtti; Klesas; Samadhi; Kaivalya.
18. Mimamsa: Theory of Knowlegde.
19. Schools of Vedanta : Brahman; Isvara; Atman; Jiva; Jagat; Maya; Avida; Adhyasa; Moksa; Aprthaksiddhi; Pancavidhabheda.
20. Aurobindo: Evolution, Involution; Integral Yoga.

PAPER-II

Socio-Political Philosophy

1. Social and Political Ideals : Equality, Justice, Liberty.
2. Sovereignty : Austin, Bodin, Laski, Kautilya.
3. Individual and State : Rights; Duties and Accountability.
4. Forms of Government : Monarchy; Theocracy and Democracy.
5. Political Ideologies: Anarchism; Marxism and Socialism.
6. Humanism; Secularism; Multi-culturalism.
7. Crime and Punishment : Corruption, Mass Violence, Genocide, Capital Punishment.
8. Development and Social Progress.
9. Gender Discrimination : Female Foeticide, Land and Property Rights; Empowerment.
10. Caste Discrimination : Gandhi and Ambedkar.

Philosophy of Religion

1. Notions of God : Attributes; Relation to Man and the World. (Indian and Western).
2. Proofs for the Existence of God and their Critique (Indian and Western).
3. Problem of Evil.
4. Soul : Immortality; Rebirth and Liberation.
5. Reason, Revelation and Faith.
6. Religious Experience : Nature and Object (Indian and Western).
7. Religion without God.
8. Religion and Morality.
9. Religious Pluralism and the Problem of Absolute Truth.
10. Nature of Religious Language : Analogical and Symbolic; Cognitivist and Non-cognitive.

PHYSICS

PAPER-I

Government strives to have a workforce which reflects gender balance and women candidates are encouraged to apply.

1. (a) Mechanics of Particles :

Laws of motion; conservation of energy and momentum, applications to rotating frames, centripetal and Coriolis accelerations; Motion under a central force; Conservation of angular momentum, Kepler's laws; Fields and potentials; Gravitational field and potential due to spherical bodies, Gauss and Poisson equations, gravitational self-energy; Two-body problem; Reduced mass; Rutherford scattering; Centre of mass and laboratory reference frames.

(b) Mechanics of Rigid Bodies :

System of particles; Centre of mass, angular momentum, equations of motion; Conservation theorems for energy, momentum and angular momentum; Elastic and inelastic collisions; Rigid Body; Degrees of freedom, Euler's theorem, angular velocity, angular momentum, moments of inertia, theorems of parallel and perpendicular axes, equation of motion for rotation; Molecular rotations (as rigid bodies); Di and tri-atomic molecules; Precessional motion; top, gyroscope.

(c) Mechanics of Continuous Media :

Elasticity, Hooke's law and elastic constants of isotropic solids and their inter-relation; Streamline (Laminar) flow, viscosity, Poiseuille's equation, Bernoulli's equation, Stokes' law and applications.

(d) Special Relativity :

Michelson-Morely experiment and its implications; Lorentz transformations length contraction, time dilation, addition of relativistic velocities, aberration and Doppler effect, mass-energy relation, simple applications to a decay process. Four dimensional momentum vector; Covariance of equations of physics.

2. Waves and Optics :

(a) Waves :

Simple harmonic motion, damped oscillation, forced oscillation and resonance; Beats; Stationary waves in a string; Pulses and wave packets; Phase and group velocities; Reflection and refraction from Huygens' principle.

(b) Geometrial Optics :

Laws of reflection and refraction from Fermat's principle; Matrix method in paraxial optic-thin lens formula, nodal planes, system of two thin lenses, chromatic and spherical aberrations.

(c) Interference :

Interference of light -Young's experiment, Newton's rings, interference by thin films, Michelson interferometer; Multiple beam interference and Fabry Perot interferometer.

(d) Diffraction :

Fraunhofer diffraction - single slit, double slit, diffraction grating, resolving power; Diffraction by a circular aperture and the Airy pattern; Fresnel diffraction: half-period zones and zone plates, circular aperture.

(e) Polarisation and Modern Optics :

Production and detection of linearly and circularly polarized light; Double refraction,

quarter wave plate; Optical activity; Principles of fibre optics, attenuation; Pulse dispersion in step index and parabolic index fibres; Material dispersion, single mode fibers; Lasers-Einstein A and B coefficients. Ruby and He-Ne lasers. Characteristics of laser light-spatial and temporal coherence; Focusing of laser beams. Three-level scheme for laser operation; Holography and simple applications.

3. Electricity and Magnetism :

(a) Electrostatics and Magnetostatics :

Laplace and Poisson equations in electrostatics and their applications; Energy of a system of charges, multipole expansion of scalar potential; Method of images and its applications. Potential and field due to a dipole, force and torque on a dipole in an external field; Dielectrics, polarisation. Solutions to boundary-value problems-conducting and dielectric spheres in a uniform electric field; Magnetic shell, uniformly magnetised sphere; Ferromagnetic materials, hysteresis, energy loss.

(b) Current Electricity :

Kirchhoff's laws and their applications. Biot-Savart law, Ampere's law, Faraday's law, Lenz' law. Self-and mutual- inductances; Mean and rms values in AC circuits; DC and AC circuits with R, L and C components; Series and parallel resonance; Quality factor; Principle of transformer.

4. Electromagnetic Waves and Blackbody Radiation :

Displacement current and Maxwell's equations; Wave equations in vacuum, Poynting theorem; Vector and scalar potentials; Electromagnetic field tensor, covariance of Maxwell's equations; Wave equations in isotropic dielectrics, reflection and refraction at the boundary of two dielectrics; Fresnel's relations; Total internal reflection; Normal and anomalous dispersion; Rayleigh scattering; Blackbody radiation and Planck 's radiation law- Stefan-Boltzmann law, Wien's displacement law and Rayleigh-Jeans law.

5. Thermal and Statistical Physics :

(a) Thermodynamics :

Laws of thermodynamics, reversible and irreversible processes, entropy; Isothermal, adiabatic, isobaric, isochoric processes and entropy changes; Otto and Diesel engines, Gibbs' phase rule and chemical potential; Van der Waals equation of state of a real gas, critical constants; Maxwell-Boltzmann distribution of molecular velocities, transport phenomena, equipartition and virial theorems; Dulong-Petit, Einstein, and Debye's theories of specific heat of solids; Maxwell relations and application; Clausius-Clapeyron equation. Adiabatic demagnetisation, Joule-Kelvin effect and liquefaction of gases.

(b) Statistical Physics :

Macro and micro states, statistical distributions, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac Distributions, applications to specific heat of gases and blackbody radiation; Concept of negative temperatures.

PAPER-II

1. Quantum Mechanics :

Wave-particle duality; Schroedinger equation and expectation values; Uncertainty principle;

Solutions of the one-dimensional Schroedinger equation for free particle (Gaussian wave-packet), particle in a box, particle in a finite well, linear harmonic oscillator; Reflection and transmission by a step potential and by a rectangular barrier; Particle in a three dimensional box, density of states, free electron theory of metals; Angular momentum; Hydrogen atom; Spin half particles, properties of Pauli spin matrices.

2. Atomic and Molecular Physics :

Stern-Gerlach experiment, electron spin, fine structure of hydrozen atom; L-S coupling, J-J coupling; Spectroscopic notation of atomic states; Zeeman effect; Franck-Condon principle and applications; Elementary theory of rotational, vibrational and electronic spectra of diatomic molecules; Raman effect and molecular structure; Laser Raman spectroscopy; Importance of neutral hydrogen atom, molecular hydrogen and molecular hydrogen ion in astronomy. Fluorescence and Phosphorescence; Elementary theory and applications of NMR and EPR; Elementary ideas about Lamb shift and its significance.

3. Nuclear and Particle Physics :

Basic nuclear properties-size, binding energy, angular momentum, parity, magnetic moment; Semi-empirical mass formula and applications. Mass parabolas; Ground state of a deuteron, magnetic moment and non-central forces; Meson theory of nuclear forces; Salient features of nuclear forces; Shell model of the nucleus - success and limitations; Violation of parity in beta decay; Gamma decay and internal conversion; Elementary ideas about Mossbauer spectroscopy; Q-value of nuclear reactions; Nuclear fission and fusion, energy production in stars. Nuclear reactors.

Classification of elementary particles and their interactions; Conservation laws; Quark structure of hadrons : Field quanta of electroweak and strong interactions; Elementary ideas about unification of forces; Physics of neutrinos.

4. Solid State Physics, Devices and Electronics :

Crystalline and amorphous structure of matter; Different crystal systems, space groups; Methods of determination of crystal structure; X-ray diffraction, scanning and transmission electron microscopies; Band theory of solids—conductors, insulators and semi-conductors; Thermal properties of solids, specific heat, Debye theory; Magnetism: dia, para and ferromagnetism; Elements of super-conductivity, Meissner effect, Josephson junctions and applications; Elementary ideas about high temperature super-conductivity.

Intrinsic and extrinsic semi-conductors- p-n-p and n-p-n transistors; Amplifiers and oscillators. Op-amps; FET, JFET and MOSFET; Digital electronics-Boolean identities, De Morgan's laws, Logic gates and truth tables. Simple logic circuits; Thermistors, solar cells; Fundamentals of microprocessors and digital computers.

POLITICAL SCIENCE AND INTERNATIONAL RELATIONS

PAPER- I

Political Theory and Indian Politics :

1. Political Theory: meaning and approaches.
2. Theories of state : Liberal, Neo-liberal, Marxist, Pluiralist, post-colonial and Feminist.

Solid State Physics, Devices and Electronics: Crystal structure, Bravais lattices and basis. Miller indices. X-ray diffraction and Bragg's law; Intrinsic and extrinsic semiconductors, variation of resistivity with temperature. Fermi level. p-n junction diode, I-V characteristics, Zener diode and its applications, BJT: characteristics in CB, CE, CC modes. Single stage amplifier, two stage R-C coupled amplifiers. Simple Oscillators: Barkhausen condition, sinusoidal oscillators. OPAMP and applications: Inverting and non-inverting amplifier. Boolean algebra: Binary number systems; conversion from one system to another system; binary addition and subtraction. Logic Gates AND, OR, NOT, NAND, NOR exclusive OR; Truth tables; combination of gates; de Morgan's theorem

IIT JAM

PHYSICS (PH)

Mathematical Methods: Calculus of single and multiple variables, partial derivatives, Jacobian, imperfect and perfect differentials, Taylor expansion, Fourier series. Vector algebra, Vector Calculus, Multiple integrals, Divergence theorem, Green's theorem, Stokes' theorem. First order equations and linear second order differential equations with constant coefficients. Matrices and determinants, Algebra of complex numbers.

Mechanics and General Properties of Matter: Newton's laws of motion and applications, Velocity and acceleration in Cartesian, polar and cylindrical coordinate systems, uniformly rotating frame, centrifugal and Coriolis forces, Motion under a central force, Kepler's laws, Gravitational Law and field, Conservative and non-conservative forces. System of particles, Center of mass, equation of motion of the CM, conservation of linear and angular momentum, conservation of energy, variable mass systems. Elastic and inelastic collisions. Rigid body motion, fixed axis rotations, rotation and translation, moments of Inertia and products of Inertia, parallel and perpendicular axes theorem. Principal moments and axes. Kinematics of moving fluids, equation of continuity, Euler's equation, Bernoulli's theorem.

Oscillations, Waves and Optics: Differential equation for simple harmonic oscillator and its general solution. Superposition of two or more simple harmonic oscillators. Lissajous figures. Damped and forced oscillators, resonance. Wave equation, traveling and standing waves in one-dimension. Energy density and energy transmission in waves. Group velocity and phase velocity. Sound waves in media. Doppler Effect. Fermat's Principle. General theory of image formation. Thick lens, thin lens and lens combinations. Interference of light, optical path retardation. Fraunhofer diffraction. Rayleigh criterion and resolving power. Diffraction gratings. Polarization: linear, circular and elliptic polarization. Double refraction and optical rotation.

Electricity and Magnetism: Coulomb's law, Gauss's law. Electric field and potential. Electrostatic boundary conditions, Solution of Laplace's equation for simple cases. Conductors, capacitors, dielectrics, dielectric polarization, volume and surface charges, electrostatic energy. Biot-Savart law, Ampere's law, Faraday's law of electromagnetic induction, Self and mutual inductance. Alternating currents. Simple DC and AC circuits with R, L and C components. Displacement current, Maxwell's equations and plane electromagnetic waves, Poynting's theorem, reflection and refraction at a dielectric interface, transmission and reflection coefficients (normal incidence only). Lorentz Force and motion of charged particles in electric and magnetic fields.

Kinetic Theory, Thermodynamics: Elements of Kinetic theory of gases. Velocity distribution and Equipartition of energy. Specific heat of Mono-, di- and tri-atomic gases. Ideal gas, van-der-Waals gas and equation of state. Mean free path. Laws of thermodynamics. Zeroth law and concept of thermal equilibrium. First law and its consequences. Isothermal and adiabatic processes. Reversible, irreversible and quasi-static processes. Second law and entropy. Carnot cycle. Maxwell's thermodynamic relations and simple applications. Thermodynamic potentials and their applications. Phase transitions and Clausius-Clapeyron equation. Ideas of ensembles, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distributions.

Modern Physics: Inertial frames and Galilean invariance. Postulates of special relativity. Lorentz transformations. Length contraction, time dilation. Relativistic velocity addition theorem, mass energy equivalence. Blackbody radiation, photoelectric effect, Compton effect, Bohr's atomic model, X-rays. Wave-particle duality, Uncertainty principle, the superposition principle, calculation of expectation values, Schrödinger equation and its solution for one, two and three dimensional boxes. Solution of Schrödinger equation for the one dimensional harmonic oscillator. Reflection and transmission at a step potential, Pauli exclusion principle. Structure of atomic nucleus, mass and binding energy. Radioactivity and its applications. Laws of radioactive decay.