PHYSICAL SCIENCE

PAPER - II

1. **Basic Mathematical Methods :**
   Calculus : Vector algebra and vector calculus, Linear algebra, matrices, Linear differential equations, Fourier-series, Elementary complex analysis.

2. **Classical Dynamics :**
   Basic principles of classical dynamics, Lagrangian and Hamiltonian formalisms, Symmetries and conservation laws, Motion in the central field of force, Collisions and scattering, Mechanics of a system of particles, Small oscillations and normal modes, Wave motion-wave equation, phase velocity, group velocity, dispersion. Special theory of relativity-Lorentz tranformations, addition of velocities, mass-energy equivalance.

3. **Electromagnatics :**
   Electrostatics-Laplace and Poisson equations, boundary value problems, Magnetostatics-Ampere's theorem, Blot-Sayart law, electromagnetic induction, Maxwell's equations in free space and in linear isotropic media. Boundary conditions on the fields at interfaces, Scaler and vector potentials, Gauge invarience, Electromagnetic waves-reflection and refraction, dispersion, interferance, coherence, diffraction, polarization, Electrodynamics of a charged particle in electric and magnetic fields. Radiation from moving charges, radiation from a dipole, Retarded potential.

4. **Quantum Physics and Applications :**
   Wave-particle duality, Heisenberg's uncertainity Principle. The Schrodinger equation particle in a box., Harmonic Oscillator, Tunnelling through a barrier, motion in a central potential,Orbital angular momentum. Angular momentum algebra, spin. Addition of angular momenta. Time independent

   perturbation theory. Ferml's Golden Rule. Elementary theory of scattering in a central potential, Phase shifts, partial wave analysis, Borm approximation, identical particles, spin-statistics connection.

5. **Thermodynamic and Statistical Physics :**
   Laws of thermodynamics and their consequences. Thermodynamic potentials and Maxwell's relations. Chemical potential, phase equilibria. Phase space, microstates and microststes. Partition function, Free Energy and connection with thermodynamic quantities. Classical and quantum statistics, Degenerate electron gas. Blackbody radiation and Planck's distribution law, Boss-Einstein condensation. Einstein and Debye models for latticce specific heat.

6. **Experimental Design :**
   Measurement of fundamental constants; e.h.c. Measurement of High & Low Resistences, L and C.
   Detection of X-rays, Gamma rays, charged particles, neutrons etc. Ionization chamber, proportional counter, GM counter, Scintillation detectors, Solid State detectors, Emission and Absorption Spectroscopy, Measurement of Magnetic field, Hall effect, magnetoresistance. X-ray and neutron Diffrection, Vacuum Techniques; basic idea of conductance, pumping speed etc. Pumps; Mechanical Pump, Diffusion pump; Gauges; Thermocouple, Penning, Pirani, Hot Cathode. Low Temperature; Cooling a sample over a range upto 4K and measurement of temperature. Measurement of Energy and Time using electronic signals from the detectors and associated instrumentation; Signal processing, A/D conversion & multichannel analyzers, Time-of-flight technique; Coincidence measurements; true to chance ratio, correlation studies.
   Error Analysis and Hypothesis testing Propagation of errors, Plotting of Graph, Distributions, Least aquares fitting, criteria for goodness of fite-chi square test.

PAPER - III
Syllabus of Paper-II and the Following

1. Electronics :

Physics of p-n junction, Diode as a circuit element; clipping, clamping; Rectification, Zener regulated power supply : Transistor as a circuit element : CC, Cb, and CE configuration, 'Transistor as a switch, OR, AND, NOT gates. Feed back in Amplifiers. Operational amplifier and its applications : inverting , non-inverting amplifier, adder, integrator, differentiator, wave form generator, comparator, & Schmidt trigger. Digital integrated circuits-NAND & NOR gates as building blocks, X-OR Gate, simple combinational circuits, Half & Full adder, Flip-flop, shift register, counters. Basic principles of A/D & D/A converters; Simple applications of A/D & D/A converters.

2. Atomic & Molecular Physics :

Quantum states of an electron in an atom. Hydrogen atom spectrum. Electron spin. Stern-Gerlach experiment. Spin-orbit coupling, fine structure, relativistic correction, spectro-scopic terms and selection rules, hyperfine structure. Exchange symmetry of wave functions. Pauli's exclusion principle, periodic table alkali-type spectra, LS & JJ coupling, Zeeman, Paschen-Back and Stark effects. X-Rays and Auger transitions, Compton effect

Principles of ESR, NMR

Molecular Physics : Convalent, Ionic and Vander Waal's interaction.

Rotation/Vibration spectra. Raman Spectra, selection rules, nuclear spin and intensity alternation, isotope effects, electronic states of diatomic molecules, Frank-Condom principle. Lasers-spontaneous and stimulated emission, optical pumping, population inversion, coherence (temporal and spatial) simple description of Ammonia maser, CO_2 and He-Ne Lasers.

3. Condensed Matter Physics :

Crystal classes and systems, 2d & 2d lattices, Bonding of common crystal structures, reciprocal lattice, diffraction and

structure factor, elementary ideas about point defects and dislocations.

Latics vibrations, Phonons, specific heat of solids, free electron theory-Fermi statistics; heat capacity.

Electron motion in periodic potential, energy bands in metals, insulators and semi-conductors; tight binding approximation; Impurity levels in doped semi-conductors.

Electronic transport from classical kinetic theory, electrical and thermal conductivity. Half effect and thermo-electric power transport in semi-conductors.

Di-electrics-Polarization mechnisms, Clausius-Mossotti equation, Piezo, Pyro and ferro electricity.

Dia and Para megnetism; exchange interactions, magnetic order, ferro, anti-ferro and ferrimagnetism.

Super conductivity-basic phenomenology; Meissner effect, Type-1 & Type-2 Super conductors, BCS Pairing mechanism.

4. Nuclear and Particle Physics :

Basic nuclear properties-size, shape, charge distribution, spin & parity, binding, empirical mass formula, liquid drop model. Nature of nuclear force, elements of two-body problem, charge independence and charge symmetry of nuclear forces. Evidence for nuclear shell structure. Single particle shell model-its validity and limitations, collective model.

Interactions of charged particles and e.m. rays with matter. Basic principles of particle detectors-ionization chamber; gas proportional counter and GM counter, scintillation and semiconductor detectors.

Radio-active decays (a By), basic theoretical understanding

Nuclear reactions, elementary ideas of reaction mechanisms, compound nucleus and direct reactions, elementary ideas of fission and fusion.

Particle Physics : Symmetrice and conservation laws, classification of fundamental forces and elementary particles, iso-spin, strangeness, Gell-Mann Nishijima formula, Quark model. C.P.T. invariance in different interactions, party-nonconservation in weak interaction.