SHAHEED MAJOR HARMINDERPAL SINGH (SHAURYA CHAKRA) GOVERNMENT COLLEGE, SAHIBZADA AJIT SINGH NAGAR

DEPARTMENT OF PHYSICS

UNITIZATION PLAN

B.Sc. I

Mechanics-I

August: Cartesian and spherical polar co-ordinate systems, area, volume, displacement, velocity and acceleration in these systems, Solid angle, Various forces in Nature(brief introduction), Centre of mass, Equivalent one body problem.
September: Central forces, Equation of motion under central force, Equation of orbit in inverse square, Force field and turning points, Kepler laws and their derivations, Relationship of conservation laws and symmetries of space and time.
October: Inertial frame of reference, Coriolis force and its applications, Variation of acceleration due to gravity with latitude, Focault pendulum (qualitative), Elastic collision in Laboratory and C.M. system, velocities, angels and energies.
November: Cross section of elastic scattering, Rutherford scattering (qualitative).

Mechanics-II

January: Rigid body motion: Rotational motion, principal moments and axe, Euler's equations; precession and elementary gyroscope, Galilean transformation and Invariance, Non-Inertial frames, concept of stationary universal frame of reference and ether.
February: Michelson-Morley experiment and its result, Postulates of special theory of relativity, Lorentz transformations, Observer and viewer in relativity, Relativity of simultaneity.
March: Length, Time, Velocities, Relativistic Doppler effect, Variation of mass with velocity, mass-energy equivalence, rest mass in an inelastic collision.
April: Relativistic momentum and energy, their transformation, concepts of Minkowski space, four vector formulation.

Vibrations and Waves-I

August: Simple harmonic motion, energy of a Simple Harmonic Oscillation (SHO), Compound pendulum, Electrical oscillations, Transverse vibrations of a mass on a string, composition of two perpendicular SHM of same period and of period ratio 1 : 2, Anharmonic oscillations.
September: Decay of free vibrations due to damping, Differential equation of motion, types of damping, Determination of damping co-efficient-logarithmic decrement, relaxation time and Q-Factor, Electromagnetic damping (Electrical oscillator).

October: Differential equation for forced mechanical and electrical oscillators, Transient and steady state oscillation, Displacement and velocity variation with driving force frequency, variation of phase with frequency resonance.
November: Power supplied to an oscillator and its variation with frequency, Q value of a forced oscillator and band width, Q-value as an amplification factor of low frequency response.

Vibrations and Waves-II

January: Stiffness coupled oscillators, Normal co-ordinates and normal modes of vibration, Inductance coupling of electrical oscillators, Types of waves, Wave equation (transverse) and its solution, The string as a forced oscillator, Characteristic impedance of a string, Impedance matching.
February: Reflection and transmission of energy, Reflection and Transmission Energy, Reflection and transmission of string, wave and group velocity, Standing waves on a string of fixed length, Energy of vibrating energy string, wave and group velocity.
March: Physical interpretation of Maxwell's equations, Electromagnetic waves and wave equation in a medium having finite permeability and permittivity but with conductivity $\sigma=0$, Pointing vector, Impedance of a dielectric to EM waves, EM waves in a conducting medium and skin depth, EM waves velocity in a conductor an anomalous dispersion.
April: Response of a conducting medium of EM waves, Reflection and transmission of EM waves at a boundary of two dielectric media for normal incidence, Reflection of EM waves from the surface of a conductor at normal incidence.

Electricity and Magnetism-I

August: Basic ideas of vector calculus, Gradient, Divergence, curl and their physical significance, Coulomb's law in vector form, long uniformly charged wire, Charged disc. Stokes's theorem and its applications in electrostatic field, curl E= 0.
September: Electric field as gradient of scalar potential, Calculation of E due to a point charge and dipole from potential, Potential due to arbitrary charge distribution and multipole moments, Poisson and Laplace's equations and their solutions in Cartesian and concept of electrical images.
October: Calculation of electric potential and field due a point charge placed near an infinitely conducting sheet, Current and current density, equation of continuity, Microscopic form of Ohm's Law, ($J=\sigma E$) and conductivity, Failure of Ohm's Law.
November: Invariance of charge, E in different frames of reference, Field of a point charge moving with constant velocity, Interaction between moving charges and force between parallel currents.

Electricity and Magnetism-II

January: Behaviour of various substances in magnetic field, Definition of **M** and **H** and their relation to free and bound currents, Permeability and susceptibilities and their inter-relationship, Orbital motion of electrons and diamagnetism, Electron spin and paramagnetism, Ferromagnetism, Domain theory of Ferromagnetism, Hysteresis Loss.
February: Magnetisation curve Ferrites**,** Lorentz's force, Definition of B, Biot-Savart's Law and its applications to long straight wire, circular current loop and solenoid, Ampere's Circuital law and its applications, Divergence and curl of **B**, Hall effect, expression and co-efficient.
March: Vector potential, Definition and derivation of current density and its use in calculation of change in magnetic field at a current sheet, Transformation equations for **E** and **B** from one frame to another, Faraday's Law and EM induction, Displacement current, Maxwell's equations.

April: Mutual inductance and reciprocity theorem, Self-inductance L for solenoid, Coupling of Electrical circuits, Analysis of LCR series and parallel resonant circuits, Q-factor, Power consumed, Power factor.

Sem I Practicals

August:

1. To establish relationship between torque and angular acceleration using fly wheel and hence to find inertia of flywheel.
2. To study one-dimensional collision using two hanging spheres of different materials.

September:

1. Study the dependence of moment of inertia on distribution of mass (by noting time periods of oscillations) using objects of various geometrical shapes but of same mass.
2. To set up CRO for Sine and Square wave and to find their frequency and amplitude.

October:

1. To study the efficiency of an electric kettle/heater element with varying input voltages.
2. To study the working of energy meter.

Sem II Practicals

January:

1. To study the variation of time period with distance between centre of suspension and centre of gravity for a bar pendulum and to determine
   i) Radius of gyration of bar pendulum about an axis through its Centre of Gravity and perpendicular to its length.
   ii) Value of Centre of Gravity, g.
2. Determination of g by Kater's pendulum.

February:

1. Determination of unknown capacitance by flashing and quenching of neon lamp.
2. To study the resonance in series and parallel LCR circuits for different resistances and calculate Q-value.

March:

1. Determination of modulus of rigidity of material of a wire using Maxwell's needle.
2. Verify laws of electromagnetic induction.

B.Sc. II

Statistical Physics and Thermodynamics-I

August: Basic ideas of statistical physics, Scope of statistical physics, Basic ideas about probability, distribution of four distinguishable particles in two compartments of equal size. Concept of macro states, microstates, thermodynamic probability, Effects of constraints on the system.

September: Distribution of n particles in two compartments, Deviation from the state of maximum probability, equilibrium state of dynamic system, Distribution of distinguishable n particles in k compartments of unequal sizes, Phase space and its division into elementary cells, Three kinds of statistics, The basic approach in the three statistics.

October: Maxwell Boltzmann (MB) statistics applied to an ideal gas in equilibrium, Experimental verification of Maxwell Boltzmann law of distribution of molecular speeds, Need for quantum statistics-Bose-Einstein (B.E.) statistics, Derivation of Planck’s law of radiation.

November: Deduction of Wien's displacement law and Stefan's law from Planck's law, Fermi-Dirac (F.D.) statistics, Comparison of M.B., B.E. and F.D. statistics.

Statistical Physics and Thermodynamics-II

January: Statistical definition of entropy, Change of entropy of a system, Additive nature of entropy, Law of increase of entropy, Reversible and irreversible process and their examples, Work done in a reversible process, Examples of increase of entropy in natural processes, Entropy and disorder, Brief review of terms and laws of thermodynamics.
February: Carnot's cycle, Entropy changes in Carnot cycle, Applications of thermodynamics to thermoelectric effect, Change of entropy along a reversible path in a P.V. diagram, Entropy of a perfect gas, Equation of state of an ideal gas from simple statistical consideration, Heat death of the universe.
March: Derivation of Maxwell's thermodynamical relations, Cooling produced by adiabatic stretching, Adiabatic compression, Change of internal energy with volume, specific heat at constant pressure and constant volume, Expression for Cp-Cv , Change of state and Clapeyron equation.
April: Thermodynamical treatment of Joule-Thomson effect, Use of Joule-Thomson effect, liquefaction of helium, Production of very low temperature by adiabatic demagnetization.

Optics

August: Concept of coherence, Spatial and temporal coherence, Coherence time, Coherence length, Area of coherence, Conditions for observing interference fringes, Interference by wave front division and amplitude division, Michelson's interferometer—working.
September: Principle and nature of fringes, Interference in thin films, Role of interference in anti-reflection and high reflection dielectric coatings, Multiple beam interference, Fabry-Perot interferometer, Nature of fringes, Newton Rings.
October: Huygens-Fresnel theory, half-period zones, Zone plates, Distinction between Fresnel and Fraunhofer diffraction, Fraunhofer diffraction at rectangular and circular apertures, Effects of diffraction in optical imaging, resolving power of telescope, The diffraction grating, its use as a spectroscopic element and its resolving power.
November: Concept and analytical treatment of un-polarized, plane polarized and elliptically polarized light. Double refraction, Nicol prism, Sheet polarizer, Retardation plates, Production and analysis of polarized light (quarter and half wave plates).

Lasers

January: Derivation of Einstein's relations, Concept of stimulated emission and population inversion, Broadening of spectral lines, natural, collision and Doppler broadening, Line width, Line profile, Absorption and amplification of a parallel beam of light passing through a medium.
February: Threshold condition, Introduction of three level and four level laser schemes, elementary theory of optical cavity, Longitudinal and transverse modes.
March: Types of lasers, Ruby and Nd: YAG lasers, He-Ne and CO_2 lasers-construction, mode of creating population inversion and output characteristics, Semiconductor lasers.
April: Dye lasers, Q-switching, Mode locking, Applications of lasers–a general outline, Basics of holography.

Quantum Mechanics-I

August: Brief introduction to need and development of quantum mechanics, Wave-particle duality, de-Broglie hypothesis, Complementarity and uncertainty principle, Gaussian wave-

packet, Schrodinger equation for a free particle, operator correspondence and equation for a particle subject to forces, Normalization and probability.
September: Interpretation of wave function, Super position principle, Expectation value, probability current and conservation of probability, Admissibility conditions on the wave function, Ehrenfest theorem, Fundamental postulates of wave mechanics, Eigen functions and eigen values, Operator formalism, Orthogonal systems, Expansion in eigen functions.
October: Hermitian operators, Simultaneous eigen functions, Equation of motion, Time dependent Schrodinger equation. Application to stationary states for one-dimension, Potential step, Potential barrier, Rectangular potential well, Degeneracy, Orthogonality, Linear harmonic oscillator.
November: Schrodinger equation for spherically symmetric potential, Spherical harmonics. Hydrogen atom energy levels and eigen functions. Degeneracy, Angular momentum.

Quantum Mechanics-II

January: Excitation of atom with radiation, Transition probability, Spontaneous transition, Selection rules and life time, Spectrum of hydrogen atom, Frank Hertz Experiment, Line structure, Normal Zeeman effect, Electron spin.
February: Stern Gerlach experiment, Spin orbit coupling (electron magnetic moment, total angular momentum), Hyperfine structure, Examples of one electron systems, Anomalous, Zeeman effect, Lande's-g factor (sodium D-lines).
March: Exchange symmetry of wave functions, exclusion principle, Shells, Sub shells in atoms, atomic spectra (Helium), L.S. coupling, Selection rules, Regularities in atomic spectra, Interaction energy, X-ray spectra, Mosley law, Absorption spectra, Auger effect, Molecular bonding.
April: Molecular spectra, Selection rules, Symmetric structures, Rotational, vibrational electronic level and spectra of molecules, Raman spectra.

Sem III Practicals

August:

1. Probability distribution using coloured dice coins.
2. Study the photoelectric effect and determine the value of Planck's constant.
3. To determine the refractive index of liquid using spectrometer.

September:

1. To determine the Cauchy's constants.
2. To study the refractive index of doubly refracting prism.

October:

1. To determine the wave length of a given light using bi-prism.
2. To determine the resolving power of a telescope.

Sem IV Practicals

January:

1. Study of rotation of plane of polarization with a polarimeter.
2. Set up Newton's rings to determine wave length of sodium light.

February:

1. To determine the wave length and dispersive power using plane diffraction grating (Use Hg source).
2. To determine the resolving power of a grating.
3. To determine the ionization potential of mercury.

March:

1. To measure an inaccessible height using sextant.

2. To study the absorption spectra of iodine vapours.
3. Study of variation of light intensity using photovoltaic cell/inverse square law.

B.Sc. III

Condensed Matter Physics-I

August: Crystal Structure, Symmetry operations for a two-dimensional crystal, Two dimensional Bravais lattices, Three dimensional Bravais lattices, Basic primitive cells.
September: Crystal planes and Miller indices, Diamond and NaCI structure, Packing fraction for Cubic and hexagonal closed packed structure.
October: Bragg's Law, Experimental methods for crystal structure studies, laue equations, Reciprocal lattices of SC, BCC and FCC.
November: Bragg's Law in reciprocal lattice, Brillouin zones and its derivation in two dimensions, Structure factor and atomic form factor.

Condensed Matter Physics -II

January: Lattice vibrations, Concepts of phonons, Scattering of protons by phonons, Vibration of mono-atomic, di-atomic, linear chains, Density of modes.
February: Einstein and Debye models of specific heat, Free electron model of metals, Free electron, Fermi gas and Fermi energy, Band theory, Kronig-Penney Model, Metals and insulators.
March: Conductivity and its variation with temperature in semiconductors, Fermi levels in intrinsic and extrinsic semiconductors, Qualitative discussion of band gap in semiconductors, superconductivity.
April: Magnetic field effect in superconductors, BCS theory, Thermal properties of superconductors.

Electronics-I

August: Concept of current and voltage sources, p-n junction, Biasing of diode, V-A characteristics. Diode equation, Breakdown diodes: Zener breakdown and avalanche breakdown, Zener diode. Rectification: half wave, full wave rectifiers and bridge rectifiers, Qualitative analysis of Filter circuits (RC LC and π filters) Efficiency, Ripple factor, Voltage regulation, Voltage multiplier circuits.
September: Structure and working, relation between different currents in transistors, Sign conventions, Amplifying action, Different configurations of a transistor and their comparison, CB and CE characteristics.
October: Structure, Characteristics, operation of FET, JFET and MOSFET, Pinch off voltage, Enhancement and Depletion mode, Comparison of JFETs and MOSFETs, Difference in field effect transistor and junction type transistor.
November: Photo-conductive devices: Photo-conductive cell, Photodiode, Solar cell, LED, LCD.

Electronics-II

January: Thyristor, SCR, TRIAC, DIAC: Construction, Characteristics and Operation; Comparison between transistors and thyristors; Difference between SCR and TRIAC, UJT: its construction, Equivalent circuit, Characteristics and parameters, uses, Thermistor: Types, Construction, Characteristics, Uses, Advantages over other temperature sensing devices.
February: IMPATT and TRAPATT devices, PIN diode: Construction, Characteristics, Applications, Gunn effect and diodes: Mechanism, Characteristic, Negative differential

resistivity and Domain formation, Tunnel diode: Tunnelling Phenomenon, Operation, Applications, Merits and Drawbacks.
March: Transistor biasing: Stabilization of operating point, Fixed bias, Collector to base bias, Bias circuit with emitter resistor, Voltage divider biasing circuit, CE amplifier: Working and analysis using h-parameters, Equivalent circuits, Determination of current gain, Power gain, Input impedance, FET amplifier: Voltage, Current and Power gain.
April: Feed-back in amplifiers: Types & advantage of negative feedback, Emitter follower as negative feed-back circuit.

Nuclear and Radiation Physics

August: Constituents of nucleus and their intrinsic properties, Qualitative facts about size, mass, density, energy, charge, Binding energy, angular momentum, magnetic moment and electric quadruple moments of the nucleus, Wave mechanical properties of nucleus, average binding energy and its variation with mass numbers.
September: Properties of nuclear forces, Non-existence of electrons in the nucleus and neutron-proton model, Liquid drop model and semi empirical mass formula, Conditions of nuclear stability, Fermi gas model, Nuclear shell model, Experimental evidence of magic numbers and its explanation.
October: Radioactivity, Modes of decay and successive radioactivity, Alpha emission, Electron emission, Positron emission, Electron capture, Gamma-ray emission, Internal conversion, Qualitative discussion of alpha, beta and gamma spectra, Geiger-Nuttal rule, Neutrino hypothesis of beta decay, Evidence of existence of neutrino.
November: Qualitative discussion of alpha and beta decay theories, Nuclear reactions, Reaction cross section, Conservation laws, Kinematics of nuclear reaction, Q-value and its physical significance, Compound nucleus, Possible reaction with high energy particles.

Nuclear and Particle Physics

January: Energy loss due to ionization (Bethe's formula), Energy loss of electrons, Bremsstrahlung, Interactions of gamma rays with matter, Radiation loss by fast electrons, Radiation length, Electron-positron annihilation.
February: Cyclotron, Betatron, Qualitative discussion of Synchrotron, Collider machines and linear accelerator, Ionization chamber, Proportional counter, GM counter, Scintillation counter, Solid state detectors, Elementary particles and their masses.
March: Decay modes, Classification of these particles, types of interactions, Conservation laws and quantum numbers, Concepts of isospin, Strangeness, Parity, Charge conjugation, Antiparticles, Gell-Mann method, Decay and strange particles.
April: Particle symmetry, Introduction to quarks and qualitative discussion of the quark model.

Sem V Practicals

August:

1. Measurement of reverse saturation current in p-n junction diode at various temperatures and to find the approximate value of energy gap.
2. To draw forward and reverse bias characteristics of a p-n junction diode and draw a load line.
3. Study of a diode as clipping element.

September:

1. To show the variation of resistance of a thermistor with temperature.

2. To measure the efficiency and ripple factors for a) Half-wave (b) full wave and (C) bridge rectifier circuits.
3. To draw the characteristics of a Zener diode.

October:

1. To study the stabilization of output voltage of a power supply with Zener diode.
2. To Plot common Emitter Characteristics of a transistor (pnp or npn).
3. To draw output and mutual Characteristics of an FET and determine its parameters.

Sem VI Practicals

January:

1. To trace the B-H curves for different materials using CRO and find the magnetic parameters from these.
2. Study of a diode as clamping element.

February:

1. To Plot common base Characteristics and determine h-parameters of a given transistor.
2. To study the characteristics of a thermistor and find its parameters.
3. To study the gain of an amplifier at different frequencies and to find band width and gain bandwidth product.

March:

1. To draw the plateau of a GM counter and find its operating voltage.
2. To study the statistical fluctuations of G.M. Counter to find its standard deviation.