M.Sc Semester III Physics Paper I P C 3081

ADVANCED QUANTUM MECHANICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Scattering (non-relativistic): Differential and total scattering cross section, transformation from CM frame to Lab frame, solution of scattering problem by the method of partial wave analysis, expansion of a plane wave into a spherical wave and scattering amplitude, the optical theorem, Applications-scattering from a delta potential, square well potential and the hard sphere scattering of identical particles, energy dependence an resonance scattering, Brit-Winger formula, quasi Stationary states.

The Lippman-Schwinger equation and the Green's functions approach for scattering problem, Born approximation and its validity for scattering problem, Coulomb scattering problem under first Born approximation in elastic scattering.

Unit - II

Relativistic Formulation ad Dirac, Equation: Attempt for relativistic formulation of quantum theory, the Klein-Gordon equation, Probability density and probability current density, solution free particle KG equation

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in momentum representation, interpretation of negative probability density and negative energy solutions.

Dirac equation for a free particle, properties of Dirac matrices and algebra of gamma matrices, non-relativistic correspondence of the Pauli equation (inclusive of electromagnetic interaction). Solution of the free particle Dirac equation, orthogonality and completeness relations for Dirac spinors, interpretation of negative energy solution and hole theory.

Unit - III

Symmetries of Dirac Equation: Lorentz covariance of Dirac equation, proof of covariance and derivation of Lorentz boost and rotation matrices for Dirac spinors, Projection operation involving four momentum and spin, Parity (P), charge conjugation (C), time reversal (T) and CPT operators for Dirac spinors. Billinear covariant, and their transformations, behaviors under Lorentz transformation, P, C, T and CPT, expectation values of coordinates and velocity involving only positive energy solution and the associated problems, inclusion of negative energy solution, Zitterbewegung, Klain paradox.

Unit - IV

the Quantum Theory of Radiation: Classical radiation field, Transversality condition, Fourier decomposition and radiation oscillators, Quantization of radiation oscillator, creation, annihilation and number operators, photon states, photon as a quantum mechanical excitations of the radiation field, fluctuations and the uncertainty relation, validity of the classical description, matrix element for emission and absorption, spontaneous emission in the dipole approximation, Raleigh scattering, Thomson scattering and the Raman effect, Radiation damping and Resonance fluorescence.

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M.Sc Semester III Physics Paper II P C 3082

NUCLEAR PHYSICS - I

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Two Nucleon system and Nuclear forces: General nature of the force between nucleons, saturation of nuclear forces, charge independence and spin dependence, General forms of two nucleon interaction, Central, non-central and velocity dependent potential, Analysis of the ground state (3S1) of deuteron using a square well potential, range-depth relationship, exited states of deuteron, discussion of the ground state of deuteron under non-central force, calculation of the electric quadrupole and magnetic dipole moments and the D-state admixture.

Unit - II

Nucleon-Nucleon Scattering and Potential: partial wave analysis of the neutron – proton scattering at low energy assuming central potential with square well shape, concept of the scattering length, coherent scattering of neutrons by protons in (ortho and para), hydrogen molecule; conclusions of these analysis regarding scattering lengths, range and depth of the potential; the effective range theory (in neutron –proton scattering) and the shape independence of the nuclear potential; A qualitative discussion of proton-

proton scattering at low energy; General feature of two – body scattering at high energy, effect of exchange force. Phenomenological Hamada-Johnston hard-core potential and Reid hard-core and soft-core potentials; Main features of the one Boson exchange potential (OBEP) no derivation.

Unit - III

Interaction of radiation and charged particle with matter (Not derivation) : Law of absorption and attenuation coefficient photoelectric effect, Compton, scattering, pair production; Klein-Nishina cross sections for polarized and unpolarized radiation angular distribution of scattering photon and electrons, energy loss of charged particles due to ionization , Bremstrahlung; energy target and projectile dependence of all three processes, range- energy curve; straggling.

Unit - IV

Experimental Techniques: Gas filled counters; Scintillation counter; Cerenkov counter; Solids state detectors; Surface barrier detectors; electronic circuits used with typical nuclear detector; Nuclear emulsions, techniques of measurement and analysis of tracks; proton synchrotron, Linear accelerators; Acceleration of heavy ions.

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M.Sc Semester III Physics Paper III P C 3083

STATISTICAL AND SOLID STATE PHYSICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Basic principles, Canonical and Grand Canonical ensembles: Concept of statistical distribution. Phase space, density of states, Liouville's theorem, systems and ensembles, entropy in statistical mechanics Connection between thermodynamic and statistical quantities micro canonical ensemble, equation of state, specific hear and entropy of a perfect gas using micro canonical ensemble.

Canonical ensemble, thermodynamic functions for canonical ensemble, calculation of mean values, energy fluctuation in a gas, grand canonical ensemble, thermodynamic functions for the grand canonical ensemble, density fluctuations.

Unit - II

Partition function and Statistics: Partition function and properties, partition function for an ideal gas and calculation of thermodynamic quantities, Gibbs paradox, validity of classical approximation, determination of translational, rotational an vibrational contributions to the partition function of an ideal diatomic gas. Specific heat of a diatomic gas, ortho and para hydrogen.

Identical particles and symmetry requirement, difficulties with Maxwell-Bolzman statistics, quantum distribution function, Bose Einstein and Fermi-Dirac statistics and Plank's formula, Bose Einstein condensation, liquid He4 as a Boson system, quantization of harmonic oscillator and creation and annihilation of phonon operators, quantization of fermion operators.

Unit - III

Theory of metals: Fermi-Dirac distribution function, density of states, temperature dependence of Fermi energy, specific heat, use of Fermi-Dirac statistics in the calculation of thermal conductivity and electrical conduction band, Drude theory of light, absorption in metals.

Unit - IV

Band Theory: Block theorem, Kronig Penny model, and effective mass of electron, Wigner-Seitz approximation, NFE model, tight binding method and calculation of density for a band in simple cubic lattice, pseudo potential method.

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M.Sc Semester III Physics Paper IV P C 12-3184

ELECTRONICS AND COMMUNICATION - I

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Field distribution in rectangular waveguide in TE and TM modes, Phase velocity, Group velocity, Characteristic impedance, wall current, cylindrical cavity resonators and their excitation techniques, Scattering matrix for Microwave Tees and hybrid junction directional coupler, Construction and working of precision attenuator and phase shifter.

Unit - II

Microwave propagation in ferrites, Faraday rotation, Microwave devices employing Faraday rotation: Gyrator, Isolator and Circulator,

Solid state devices: Avalanche transit time devices: Read diode, negative resistance of an avalanching p-n junction diode,

Transferred electron devices: Gunn effect, two valley model, High field domains, Different modes for microwave generation,

Parametric devices: Varactor, Nonlinear reactance and Manley- Rowe power relations, Parametric Up-converter amplifier and its noise properties.

Unit - III

Power Electronics: Characteristics of power diodes, power transistor, TRIAC and DIAC. SCR: Construction and its characteristics, simple firing circuit using UJTs. Controlled rectifiers: Single and three phase half wave and full wave controlled rectifiers. Commutation Circuits: Line commutation and different commutation circuits, Inverters: Single phase tapped and bridge inverter circuits, Basic chopper circuits, 2 and 4 quadrant choppers. Principle of operation of cycloconverter.

Unit - IV

Microwave Measurements: Power, frequency, attenuation and VSWR measurements, Return loss measurement, Concept of Smith chart and its use in impedance measurement, Microwave antenna measurement, measurement of dielectric properties of a solid materials using wave guide method.

Measurement devices: Digital voltmeter- ramp type and integrating type, Measurement of time, phase, frequency using digital instruments, Q meter, Transducers as input elements to instrumentation systems: Classification, constructional and operational features, strain gauges, displacement, velocity, force, torque and pressure transducers.

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M.Sc Semester IV Physics Paper I P C 4081

INTRODUCTORY QUANTUM FIELD THEORY

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

Unit - I

Scalar and vector fields, Classical Lagrangian field theory, Euler-Lagrange's equation, Lagrangian density for electromagnetic field. Occupation number representation for simple harmonic oscillator, linear array of coupled oscillators, second quantization, of identical bosons, second quantization of the real Klein Gordan field and complex Klein-Gordan field, the meson propagator.

UNIT II

The occupation number representation for fermions, second quantization of the Dirac field, the fermion propagator, the em interaction and gauge invariance, covariant quantization of the free electromagnetic field, the photon propagator.

UNIT III

S-matrix, the S-matrix expansion, Wick's theorem, Diagrammatic representation in configuration space, the momentum representation, Feynman diagrams of basic processes, Feynman rules of QED.

UNIT IV

Applications of S - matrix formalism: the Coulomb scattering, Bhabha scattering, Moller scattering, Compton scattering and pair production.

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M.Sc Semester IV Physics Paper II P C 4082

NUCLEAR PHYSICS - II

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

UNIT - I

Nuclear shell model: Single particle and collective model in nuclei: Assumptions and justification of the shell model, average shell potential, spin orbit coupling; single particle wave functions and level sequence; magic numbers; shell model predictions for ground state parity; angular momentum, magnetic dipole and electric-quadrupole moments; and their comparison with experimental data; configuration mixing; single particle transition probability according to the shell model; selection rules; approximate estimates for the transition probability and Weisskopf units: Nuclear isomerism.

UNIT II

Collective nuclear models: Collective variable to describe the cooperative modes of nuclear motion; Parametrization of nuclear surface; A brief description of the collective model Hamiltonian (in the quadratic approximation); Vibrational modes of a spherical nucleus, Collective modes of a deformed even-even nucleus and moments of inertia; Collective spectra and electromagnetic transition in even nuclei and comparison with experimental data; Nilsson model for the single particle states in deformed nuclei.

UNIT III

Nuclear gamma and beta decay: Electric and magnetic multipole moments and gamma decay probabilities in nuclear system (no derivations) Reduced transition probability, Selection rules; internal conversion and zero-zero transition.

General characteristics of weak interaction; nuclear beta decay and lepton capture; electron energy spectrum and Fermi- Kurie plot; Fermi theory of beta decay (parity conserved selection rules Fermi and Gamow-Teller) for allowed transitions; ft-values; General interaction Hamiltonian for beta decay with parity conserving and non conserving terms; Forbidden transitions, Experimental verification of parity violation; The V-A interaction and experimental verification

UNIT IV

Nuclear Reactions: Theories of Nuclear Reactions; Partial wave analysis of reaction Cross section; Compound nucleus formation and breakup, Resonance scattering and reaction- Breit-Wigner dispersion formula for S-waves (l= 0), continuum cross section; statistical theory of nuclear reactions, evaporation probability and cross section for specific reactions; The optical model, Stripping and pick-up reactions and their simple theoretical description (Butler theory) using plane wave Born approximation (PWBA) Shortcomings of PWBA Nuclear structure studies with deutron stripping (d,p) reactions.

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M.Sc Semester IV Physics Paper III P C 4083

SOLID STATE PHYSICS

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

UNIT I

Lattice dynamics and optical properties of solids: Interatomic forces and lattice dynamics and simple metals, ionic and covalent crystals, optical phonons and dielectric constants, Inelastic neutron scattering. Mossbauer effect. Debye-Waller factor, Anharmonicity, thermal expansion and thermal conductivity. Interaction of electrons and phonons with photons, Direct and indirect transitions Absorption in insulators, polarizations, one-phonon absorption, Optical properties of metals, skin effect and anomalous skin effect.

UNIT II

Semiconductors: law of mass action, doping of semiconductors, calculation of impurity conductivity, ellipsoidal energy surfaces in Si and Ge, Hall effect, recombination mechanism, optical transitions and Schockley-Read theory, excitations, photoconductivity, photo-Luminescence. Measurement of bandgap in semiconductors, the infrared absorption.

UNIT III

Magnetism: Larmor diamagnetism. Paramagnetism, Curie Langevin and Quantum theories. Susceptibility of rare earth and transition metals. Ferromagnetism: Domain theory, Weiss molecular field and exchange, spin waves: dispersion relation and its experimental determination by inelastic neutrons scattering, heat capacity. Nuclear Magnetic resonance: Conditions of resonance, Bloch equations. NMR-experiment and characteristics of an absorption line.

UNIT IV

Superconductivity: (a) Experimental results: Meissner effect, heat capacity, microwave and infrared properties, isotope effect, flux quantization, ultrasonic attenuation, density of states, nuclear spin relaxation, Giaver and AC and DC, Josephson tunneling. (b) Cooper pairs and derivation of BCS Hamiltonian, results of BCS theory (no derivation).

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M.Sc Semester IV Physics Paper IV P C 12-4184

ELECTRONICS AND COMMUNICATION

Scheme of examination: *MM: 70*

1. *In Semester End Examination there will be 5 questions in each paper. All questions are compulsory and of 14 mark each. Candidate has to answer all questions in the main answer book only.*
2. *Q. No. 1 shall be of short answer type, compulsory, and covering entire syllabus.*
3. *Each paper is divided in four units. There will be two questions from each unit. Student has to answer one question from each unit.*

UNIT I

Conventional Microwave sources: Two cavity Klystron, Reflex Klystron, their working and efficiency. Magnetron and its operating characteristics, Hull cut-off condition. Introduction to Gyratron and Travelling wave tubes, their construction and working. Introduction to antenna parameters. Electromagnetic horn antennas. Introduction to microstrip patch antennas and array antennas.

UNIT II

Optical Fiber Communication: Principles of light propagation in fibers, step and graded index fibers, mono mode & multimode fibers, transmission losses, fiber attenuation, bandwidth, power & cut-off wavelength, multiplexing in fibers.

Microwave communication: LOS microwave systems, Derivation of communication range, OTH microwave systems, Derivation of field strength of troposphere waves. Introduction to RADAR, Satellite and Mobile communications.

UNIT III

Digital communication: Principles of Digital communication, Pulse modulation systems, Sampling Theorm, Low pass and Band pass Signals. PAM. Channel BW for a PAM signal. Natural sampling. Signal recovery through holding. Quantization of signals. Quantization. Differential pulse code modulation PCM, Delta modulation, Adaptive delta modulation, Noise in pulse code and delta modulation systems. CVSD. Various digital modulation techniques.

UNIT IV

Microprocessor interfacing and application: Basic Interfacing Concepts & Peripherals, Memory mapped and Peripherals mapped I/O. Description, programming & interfacing of 8155, 8255, 8253, 8259, 8279 with 8085. Direct memory access: Basic concepts, DMA techniques. A/D and D/A converters, Serial I/O & Bus standards: Interfacing of AD558, AD7522, ADC0801, 0808 with 8085. Basic concepts in serial I/O, software controlled serial I/O, RS 232C standard, data communication buses-S-100 bus, IEE488 bus and CAMAC standard.

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