PAPER CODE 22-3071

M. Sc (Phy) SEMESTER III

PAPER-I: ADVANCED QUANTUM MECHANICS

Note: 100 marks assigned to theory papers are distributed in following manner

Continuous Evaluation	*30 Marks*
Term End Main Examination	*70 Marks*

Max. Marks: 70 *Duration: 3 Hrs.*

Note: In all five questions are to be set. Four questions will be out of the four units taking one question from every unit with 100% internal choice. Fifth question will be of short answer type covering entire course with no choice. The candidates will be required to attempt all the five questions.

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. Breit-Wigner 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 – III

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 K.G. equation 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, nonrelativistic 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 Dirace equation, proof of covariance and derivation of Lorentz boost and rotation matrices for Dirac spinors, Projection operators involving four momentum and spin, Parity (P), charge conjugation (C), time reversal (T) and CPT operators for Dirac spinors, Bilinear covariants, and their transformations, behaviour under Lorentz transformation,P,C,T and CPT, expectation values of coordinate and velocity involving only positive energy solutions and the associated problems, inclusion of negative energy solution, Zitterbewegung, Klein 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, Rayleigh scattering. Thomson scattering and the Raman effect, Radiation damping and Resonance fluorescence.

Reference Books:

1. Ashok Das and A.C.Milissiones: Quantum mechanics - A Modern Approach (Garden and Breach Science Publishers).
2. Eugen Merzbacher: Quantum Mechanics, Second Edition (John Wiley and Sons).
3. Bjorken and Drell: Relativistic Quantum Mechanics (McGraw Hill).
4. J.J. Sakurai: Advanced Quantum Mechanics (John Wiley)

PAPER CODE 22-3072

M.Sc. (Phy.) Semester III

PAPER-II Nuclear Physics

Note:- 100 Marks assigned to theory papers are distributed in following manner.

Continuous Evaluation	**30 Marks**
Term End Main Examination	**70 Marks**

Max. Marks: 70

Duration 3 Hrs.

***Note:-** In all five questions are to be set. Four questions will be out of the four units taking one question from every unit with 100% internal choice. Fifth question will be of short answer type covering entire course with no choice. The candidates will be required to attempt all the five questions.*

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, excited 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 Potentials: 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 analyses regarding scattering lengths, range and depth of the potential; the effective range theory (in neutron-proton scattering) and the shape independence of nuclear potential: the effective range theory (in neutron-proton scattering) and the shape independent of nuclear potential; A qualitative discussion of proton-proton scattering at low energy; General features of two-body scattering at high energy effect of exchange forces. Phenomemonological Hamada-Johnston hard-core potential and Reid hard-core and soft-core potentials; Main features of the One Boson Exchange Potentials (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 scattered photon and electrons, Energy loss of charged particles due to ionization, Bremstrahlung; energy target and projectile dependence of all three processes, Range-energy curves; Straggling.

Unit – IV

Experimental techniques: Gas filled counters; Scintillation counter; Cerenkov counters; solid 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.

Reference Books

1. J.M. Blatt and V.E. Weisskipf: theoretical Nuclear Physics.
2. L.R.B. Elton: Introductory Nuclear Theory (ELBS Publication, London, 1959).
3. B.K. Agarwal; Nuclear Physics (Lokbharti Publication Allahabad. 1989).
4. R.R. Roy and B.P. Nigam: Nuclear Physics (Willey-Easter, 1979).
5. M.A. Preston & R.K. Bhaduri: Structure of the Nucleus (Addition – Wesley, 1975).
6. R.M. Singru : Introductory Experimental Nuclear Physics.
7. England – Techniques on Nuclear Structure (Vol I).
8. R.D. Evans: The Atomic Nucleus (Mc Graw Hills, 1955)
9. H.Enge: Introduction Nuclear Physics (Addition-Wesley, 1970).
10. W.E. Burcham: Elements of Nuclear Physics (ELBS. Longma. 1988)
11. B.L. Cohen: Concept of Nuclear Physics (Tata McGraw Hills, 1988).
12. E.Segre: Nuclei and Particles (Benjamin, 1977).
13. I. Kaplan: Nuclear Physics (Addison Wesley, 1963)
14. D.Hallidy : Introductory Nuclear Physics (Wiley, 1955).

PAPER CODE 22-3073

M.Sc. (Phy) SEMESTER –III

PAPER- III: Statistical and solid state

Note: 100 marks assigned to theory papers are distributed in following manner

Continuous evaluation	**30 marks**
Term End Main Exam	**70 marks**

Max marks: 70 **Duration: 3 hour**

Note:- In all five questions are to be set. Four questions will be out of the four units taking one question from every unit with 100% internal choice. One question will be of short answer type covering entire course with no choice. The candidates will be required to attempt all the five questions.

UNIT: 1

Basic principle, canonical and Grand Canonical ensembles:
Concept of statistical distribution, phase space, density of states, Liouville's theorem, System and ensemble, entropy in statistical mechanics connection between thermodynamics and statistical quantities micro canonical ensemble, equation of state, specific heat and entropy of perfect gas using micro canonical ensemble

Canonical ensemble, thermodynamic function from canonical ensemble, calculation of mean values, energy fluctuation in gas, grand canonical ensemble, thermodynamic function for the grand canonical ensemble, density fluctuation.

UNIT: 2

Partition functions and Statistics: Partition functions and properties, partition function for an ideal gas and calculation of thermodynamics quantities, Gibbs Paradox, validity of classical approximation, determination of translational, rotational vibration contributions to the partition function of an ideal diatomic gas, Specific heat of gas, ortho and para hydrogen

Identical particles and symmetry requirement, Difficulties with Maxwell-Boltzmann statistics, Quantum distribution functions, 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: 3

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 conductivity, Drude theory of Light, absorption in metals.

UNIT:4

Band Theory: Block theorem, Kroning Penny model, effective mass of electrons, Wigner-Seitz approximation, NFE model, tight binding method and calculation of energy band in simple cubic lattice. Pseudo potential method.

Reference Books:

1 Hung: Statistical Mechanics
2. F. Reif: Fundamentals of Statistical and Thermodynamically Physics
3. Rice: Statistical mechanics and thermal Physics
4. Kittle: Elementary statistical mechanics.
5. Kittle: Introduction to solid state physics
6. Palteros: Solid State Physics
7. Levy: Solid State Physics.

30/3/22

PAPER CODE 22-3074

MSc (Final) Physics

Semester III

Paper-IV: ELECTRONICS AND COMMUNICATION -I

Note: 100 marks assigned to theory papers are distributed in following manner

Continuous Evaluation	30 Marks
Term End Main Examination	70Marks

Max. Marks 70
Duration 3 Hrs

Note: In all five questions are to be set in the paper. Four questions will be out of the four units taking one question from every unit with 100% internal choice. Fifth question will be of short answer type covering entire course with no choice. The candidates will be required to attempt all the five *questions.*

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 phase 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 quadrants, 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 material using wave guide method. Q meter transducers as input element of instrumentation system: classification, constructions and operational features, strain gauge, displacement, velocity, force torque and pressure transducer

30/3/22

Reference Books:

1. Electromagnetic waves & Radiating Systems: Jorden & Balmain.
2. Theory and application of microwaves by A.B. Brownwell & RE. Beam (McGraw Hill) .
3. Introduction to microwave theory by Atwater (McGraw Hill).
4. Foundations of microwave engineering by RE. Collin. (McGraw Hill).
5. Microwave Semiconductor Devices and their Circuit applications by H.A. Watson
6. Microwave by M.L. Sisodia and Vijay Laxmi Gupta. New Age, New Delhi.
7. Microwave electronics by RE Soohoo (Addisen Westey pubblic company,).
8. Microwave Active Devices, Vacuoums by M.L. Sisodia new Age International New Delhi.
9. Hand book of microwave measurement Vol-II by M. Sucher & J.Fox (polytechnic Press,New York).
10. Microwave Principles by H.J. Reich (CBS).

PAPER CODE 22-4071

M. Sc (Phy) SEMESTER IV

PAPER-I: INTRODUCTORY QUANTUM FIELD THEORY

Note: 100 marks assigned to theory papers are distributed in following manner

Continuous Evaluation	*30 Marks*
Term End Main Examination	*70 Marks*

Max. Marks: 70 ***Duration: 3 Hrs.***

Note: In all five questions are to be set. Four questions will be out of the four units taking one question from every unit with 100% internal choice. Fifth question will be of short answer type covering entire course with no choice. The candidates will be required to attempt all the five questions.

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-Gordon Field and Complex Klein-Gordon 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, and Compton scattering. Pair production.

Reference Books:

1. Quantum Field Theory: F. Mandal & G. Shaw (Honh-Wiley).
2. Relativistic Quantum Mechanics: J.D. Bjorken & S. Drell (McGraw Hill Book Co.).
3. Advanced Quantum Mechanics:J.J. Sakaurai.
4. Element of Advanced Quantum Theory: J.M. Ziman. (Cambridge University Press).

PAPER CODE 22-4072

M.Sc. (Phy.) Semester IV
PAPER-II Nuclear Physics

Note:- 100 Marks assigned to theory papers are distributed in following manner

Continuous Evaluation	**30 Marks**
Term End Main Examination	**70 Marks**

Max. Marks: 70
Duration 3 Hrs.

Note:- In all five questions are to be set. Four questions will be out of the four units taking one question from every unit with 100% internal choice. Fifth question will be of short answer type covering entire course with no choice. The candidates will be required to attempt all the five questions.

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 quadruple 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; Parameterization of nuclear surface; A brief description of the collective model Hamiltonian (in the quadratic approximations); 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 reaction; 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 deuteron stripping (d,p) reactions.

30/3/22

Reference Books:

1. M.A. Preston and R.K.Bhaduri: Structure of Nucleus, Addision Wesley, 1975.
2. R.R.Roy and B.P. Nigam, Nuclear Physics, Wiley-Eastern, 1979.
3. L.R.B. Elton: Introductory Nuclear Theory, ELBS Pub. London, 1959.
4. B.K. Agarwal: Nuclear Physics, Lokbharti Publication, Allahabad 1989.
5. M.K. Pal-Nuclear Structure, Affiliated East-West Press, 1982.
6. J.B. Blatt and V.F. Weisskopf-Theoretical. Nuclear Physics.
7. H.Enge.: Introduction to Nuclear Physics, Addison – Wesley, 1970.
8. B.L. Cohen-concept of Nuclear Physics, Tata McGraw Hill, 1988.
9. W.E. burcham – Element of Nuclear Physics, ELBS, Longman, 1988.
10. R.D. Evans: The Atomic Nucleus, Mc Graw Hill, 1955.
11. E.Segre: Nuclei and Particles, Benjamin, 1977.
12. I.Kaplan- Nuclear Physics, Addison Weslev, 1963

PAPER CODE 22-4073

M.Sc. (Phy) SEMESTER –IV

PAPER-III SOLID STATE PHYSICS

Note: 100 marks assigned to theory papers are distributed in following manner

Continuous evaluation	**30 marks**
Term End Main Exam	**70 marks**

Max marks: 70 **Duration: 3 hour**

Note:- In all five questions are to be set. Four questions will be out of the four units taking one question from every unit with 100% internal choice. One question will be of short answer type covering entire course with no choice. The candidates will be required to attempt all the five questions.

UNIT:I

Lattice dynamics and optical properties of solids: Inter atomic forces and lattice dynamics and simple metals ionic and covalent crystals, Optical phonons and dielectric constants, Inelastic neutron Scattering, Anharmonicity, thermal expansion and thermal conductivity, Direct and indirect transition, Absorption in insulators, polarizations, One phonon absorption, optical properties of metals, skin effect and anomalous skin effect.

UNIT: 2

Semiconductors: Law of mass action, doping of semiconductors calculation of impurity conductivity, ellipsoid energy surfaces in Si and Ge, hall effect, recombination mechanism, optical transition and Schockely –Read theory, Excitons, photoconductivity, Photoluminescence measurement of band gap in semiconductor, Infrared absorption

UNIT:3

Magnetism: Larmour diamagnetism, Paramagnetism, Curie Langevin and Quantum theories, Susceptibility of rare earth and transition metal, Ferromagnetism: Domain theory, Weiss molecular field and exchange, spin waves : dispersion relation and its experiment determination by inelastic neutron scattering, heat capacity, nuclear Magnetic Resonance: condition of resonance ,Black equations. NMR- experiment and characteristics of an absorption line

UNIT:4

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 tunnellings.

(b) Cooper pairs and derivation of BCS Hamiltonian, Result of BCS Theory

Reference Books:

1. Kittle: Introduction to solid State Physics.
2. Levy –Solid State Physics
3 Patterson- Solid State Physics
4. Mckelvy- Solid State and Semiconductor Physics.

PAPER CODE 22-4074

MSc (Final) Physics
Semester IV
Paper-IV: ELECTRONICS AND COMMUNICATION -II

Note: 100 marks assigned to theory papers are distributed in following manner

Continuous Evaluation	30 Marks
Term End Main Examination	70Marks

Max. Marks 70
Duration 3 Hrs

Note: In all five questions are to be set in the paper. Four questions will be out of the four units taking one question from every unit with 100% internal choice. Fifth question will be of short answer type covering entire course with no choice. The candidates will be required to attempt all the five questions.

UNIT - I

Convectional Microwave sources: Two cavity Klystron, Reflex Klystron, their working and efficiency. Magnetron and its operating characteristics, Hull cut-off condition. introduction to Gyrotron 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

Modulation and Demodulation:

Amplitude modulation: Double sideband suppressed carrier (DSBSC) modulation and demodulation. Generation of DSBSC waves, coherent detection of DSBSC waves. SSB modulation and demodulation. Generation and detection of SSB waves. Vestigial sideband modulation. Frequency division multiplexing (FDM).

Angle modulation: Concept of instantaneous frequency, generalized concept of angle modulation, bandwidth. Wideband FM, generation of PM waves. Demodulators, receiver

UNIT –III

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

Microwave communication: LOS microwave system, derivation of communication range, OTH microwave system, derivation of field strength of troposphere wave, introduction to RADAR, satellite and mobile communication.

UNIT – IV

Digital communication: Principal of digital communication, Pulse modulation system: Sampling theorem, Low pass and band pass signals, PAM, Channel BW for a PAM signal, Natural sampling, Signal recovery through holding, Quantization of signal. PCM, Differential pulse code modulation (DPCM), Delta Modulation (DM), Adaptive Delta Modulation (ADM), Noise in pulse code and delta modulation systems. CVSD, Various digital modulation techniques.

Reference Books:

1. Theory and application of microwaves by A.B. Brownwell & RE. Beam (McGraw Hill) .
2. Microwave Circuits & Passive Devices by M.L. Sisodia and G.S. Raghuvanshi (New Age Int., New Delhi)
3. Foundations of microwave engineering by RE. Collin. (McGraw Hill).
4. Microwave Semiconductor Devices and their Circuit applications by H.A. Watson
5. Antenna Theory, Part-I by RE. Collin & EJ. Zucker (McGraw Hill, New York)
6.Microstrip Antennas by Bahl & Bhartiya (Artech House, Messachausetts)
7. Antenna Theory Analysis by C.A. Balanis Harper & Row. Pub. & Inc. New York.
8. Antenna Theory Analysis by E.A. W01""(J. Willey & Sons)
9. Antenna Theory & Design by RS Elliott (LPHI Ltd. New Delhi)
10.Microwave Active Devices, Vacuoums by M.L. Sisodia, New Age International New Delhi.
11. Semiconductors & Electronics device by A. Barle vs (PHI, India).
12. Solid State physical electronics by A.Vanderziel, (PHI, India).