M.Sc. Examination
PHYSICS
M.Sc. (Previous)

1. The Examination shall consists of five theory papers & a practical.
2. There shall be a practical course for each Group.

The distribution of marks shall be as following :-

Theory papers

Paper–I Mathematical Physics	100 Marks
Paper–II Electromagnetic Theory & Plasma Physics	100 Marks
Paper–III Quantum Mechanics	100 Marks
Paper–IV Atomic & Molecular spectroscopy	100 Marks
Paper–V Electronics	100 Marks

Practicals

A condidate has to perform two experiments during examination one from each group. Times allotted for each experiment will be four hours. There will be some sessional work also. The distribution of marks will be as follows :–

	Regular candidate	Ex-candidate
(1) Experiment – I (Group A)	60	90
(2) Experiment – II (Group B)	60	90
(3) Viva	70	70
(4) Record	30	
(5) Sessional work	30	
Total	250	250

1st Paper : MATHEMATICAL PHYSICS

UNIT I :

Differential equations and special functions; Second order Linear ODEs with variable coefficients; Solution by series expansion; Legendre, Bessels, Hermite equations, Physical applications, Generating functions; recursion relations.

Integral Transforms, Laplace transform; First and second shifting theorems. Inverse LT by partial fractions; LT of derivative and intergal of a function; Fourier series; FS of arbitrary period; Half-wave expansions; Partial sums; Fourier integral and transforms; FT of delta function.

UNIT II :- COMPLEX VARIABLES :

General function of complex variables cauchy by –Riemann differential eqn. Anayticity Conformal mapping (translation, rotation, inverion) cauchy's integral formula, Taylor's & Laurent series, Singularity poles, Residue theorem, Evaluation of definite integral (around unit circle semicircle using jordan's lemma with poles lying on real axis & integration involving multiple valued function-branch point).

UNIT III :-

Introduction to computer languages; Fortran constants & variables, arithmatic expressions, input-output statements control statements, Do statements Subscripted variables, Format specifications logical expressions, Function & Subroutines Declaration, Common Equivalence & double precision Introduction to C language.

Text and Reference Books :

1. Mathematical methods for Physics by Murphy and Morgan
2. Special functions by ED rainville
3. Special Functions by WW Bell
4. Mathematics for Physicists by Mary L. Boas
5. Mathematical Physics B, S, Rajput-Pragati Prakashan Meerut.

2nd Paper : Electomagnetic theory & Plasma Physics

UNIT I :- Electomagnetic Theory :

(i) *Maxwell Equations:* Microscopic and Macroscopic fields, Macroscopic Maxwell equations, fields, D & H Dielectric tensor, Principal dielectric axes.

(ii) *Potential and Guages:* Scalar and vector potentials, Guage transformation, Lorentz guage and Transverse guage, Maxwell equations in terms of electomagnetic Potentials.

(iii) *Four Dimensional formulation:* Minkowski space, Intervals, Proper time lorentz transformation, Transformation of velocities, relativistic doppler effect, Four vectors, four Tensor, Principle of least action, Four-momentum of a free particle.

(iv) *Propagation of Electromamatic Waves:* Propagation of electromagnetic waves in free space, conducting and non-conducting medium, Reflection and refraction at plane interface between dielectrics, Polarisation by reflection, dispersion Normal and anomalous, metallic reflection. Electromagnetic waves propagation in bound media.

UNIT II :- Plasma Physics :

(i) *Plasma State & its Properties:* Elementary ideas of plasma state of matter, Motion of charge particles in uniform E & B fields, non-uniform fields, drifting motion, electrostatic and magnetostatic lenses; Time varying E & B fields, Adiabatic invariants, Plasma confinements (Pinch effect, Mirror confinement, Van Allen Belts), Elementary idea of fusion technology.

(ii) *Hydrodynamical Description of Plasma:* Hydrodynamical description, Equation of magneto hydrodynamics, High frequency plasma oscillation, Short wavelength limit and Debye-screeming distance.

(iii) *Kinetic Theory of Plasma:* Boltzmann-Vlasov equation, landau damping. Collision damping.

(iv) *Wave Phenomenon in Magneto-Plasma:* Electromagnetic waves per-pendicular to Bo phase velocity, Polarization cut off and resonances, Electromagnetic waves parallel to B0 Magnetosonic and alfven wave,

References :

1. The classical Theory of Fields by L.D. landau and E.M. Lisfshitz (Pergmon Press, Oxford)
2. Foundation of Electromagnetic Theory by Reitz, Milford & Christy (Narosa, Delhi)
3. Classical Electrodynamics by J.D. Jackson (Wiley East. Ltd., Delhi)
4. Introduction to Plasma Physics by F.f. Chen (Plenum Press, New York)
5. Plasma Physics by S.N. Sen (Pragati Prakashan, Meerut)

3rd Paper : Quantum Mechanics

UNIT I :- Bra and Ket Notation:

Dirac'sbra and ket notations, vector representation of states, bra and ket vectors, projection and projection operators; Linear operator eigenvalue equation, orthonormality and completness relation, relation between kets and wave function, concept of Hilbert space.

UNIT II : Matrix Formulation and Theory of Angular Momentum :-

Matrix form of wave function, Matrix representation of observable, Change of basis. Equation of motion in Matrix form, schrodinger,

Heisenberg and interaction representation. Matrix theory of linear harmonic oscillator and general proof of uncertainty principle in matrix mechanics, total angular momentum operators, commutation relation of total angular momentum, ladder operators, addition of angular momenta, clebsch gordon coefficients pauli matarices, bra and ket notation.

UNIT III :- Approximation Methods :-

Perturbation theory for degenerate case and its application to Zeeman effect, Variation method and its application to normal He atom and one dimentional harmonic oscillator of unit mass, Time dependent perturbation theory. Transition Probability, fermi-Golden rule, application to semiclassical theory of radiation, Selection rules, WKB method, Application to potential barrier penetration problem (alpha decay).

UNIT IV :- Scattering Theory :-

Scattering cross-section, quantum mechanical description, Expansion of plane wave in spherical harmonics (partial wave analysis), scattering by spherical symmetic potentials, Born approximation, Validity of Born's approximation Scattering from threedimensional square well and screened coulomb potential.

UNIT V :- Identical Particles :-

Indistinguishability of identical particles and exchange energy, permutation symmetry and Symmetrization postulates, Self-consistent field approximation (Hartee method), Slater determinant, Hartee-fock method. Application of quantum mechanics to two electron systems e.g. hydrogen molecule and He atom.

UNIT VI :- Kleing-Gorden and Dirac Equation :-

K.G. equation, Plane wave solution of Dirac equation. Negative energy states and prediction, of posirron Spin and Intrinsic magnetic moment of Dirac electron.

References :-

1. Quantum Mechanics by L.I. Schiff
2. Quantum Mechanics by Pauling & wilson
3. Quantum Mechanics by B.K. Agrawal
4. Quantum Mechanics by Msrt
5. Quantum Mechanics by Ghatak & Lokanathan
7. Quantum Mechanics by Satya Prakash

4th Paper : Atomic & Molecular Spectroscopy

UNIT I :-

Atomic spectroscopy :- Quantum states of one electron atoms :- Atomic orbitals - Hydrogen Atom - Pauli's principle & non equivalent electrons Normal & anomalous zeeman effect, Paschen back effect stark effect Two electron systems, interaction energy in LS & JJ coupling Hyperfive structure (Qualitative), Line broad mechanisms (generalideas).

UNIT II :-

Rotational spectra & vibrational spectra of diatomic molecules, Principle features of the spectra by means of various model. Dissociation energy, intensity in roational & rotational vibrational spectra symmetry property of the roatational levels influence of nuclear spin, isotope effect, Rotation & vibration of triatomic molecule & effect on spectra.

UNIT III :-

Polarization of light & Raman effect, rotational Raman effect, vibrapional raman effect Raman & I.R spectras as tool of structure determination, Laser Raman Spectroscopy technique & its Application.

UNIT IV :-

Electronic spectra of diatomic molecule, vibrational structure of electronic bands Progression, sequence, Deslander Tables, Vibrational Constants, Isotopic displacement & proof of existence of zero point energy, Rotational structure of electronic bands brouches of a band, fortrate diagran, band head formation & shading of bands, Rotational constants, Frank-condon principle.

UNIT V :-

Classification of electronic states of diatomic molecules, coupling cases, electronic transition, pauli Principle in molecules, Building up principles & electronic configurations, term manifold.

References :

1. Atomic spectra : H.E. White
2. Molecular spectra and Molecular Structure Vol, I,II,III : G. Herzberg.
3. Fundamentals of molecular spectroscopy - C.B. Banwell (T)

5th Paper : Electronics

UNIT I :-

Passive Networks:- Wave filters, Low high, Band, Pass & Band elimination filters. Coupled circuits, capacitive & Inductive coupling, coupled resonance circuits. Transformer & Attenuator.