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.

UNIT II :-

Op-Amp :- Introduction to operational Amplifier, Basic Parameters, Applicability of Op-amp in Analog computation, op-amp as voltage follower Adder, subtracter, Integrator, Differentiator, log amplifier Antilog amplifier, Analog multiplier & Divider Circuit.

UNIT III :-

Transistor Oscillators :- Oscillator as positive feedback amplifier, Condition of sustained oscillations, Phase shift & Wien bridge Oscillator, Hartley & colipits circuits. Negative resistance oscillator, frequency stability & distortion in oscillators Miller circuit.

UNIT IV :-

Non Sinusoidal Generators :- Multi vibrators, Bistable, Mono stable & astable multivibrator, Saw tooth wave generator, Pulse generator, clipping & clamping circuits.

UNIT V :- *Power Electronics :-*

(i) *Power Devices :* SCR, Basic structure, I-V characterisitics and two transistor model, DIAC and TRIAC, Basic structure, operation and equivalent and I-V characteristics, TRIAC as high power switch, DIAC as triggering device of TRIAC, UJT in over voltage protection, Saw tooth wave generation using UJT.

(ii) *Regulator Circuits :* Load and Line Regulation stabilization ratio Internal impedance and temperature coefficent of voltage regulation, Linear voltage regulator circuit.

(iii) *Controlled Rectification :* SCR Controlled Half and Full wave rectifier circuit and their analysys, elements of SMPS, SCR control and stability in SMPS.

Reference :-

1. Principle of electronics by V.. Mehta (S. Chand & Company, New Delhi)

2. Switch Mode Power Conversion Basic Theory and Design by Kitsum (Marcel Deknar Inc, New York)

3. Power Electronics by PC sen (Tata Mc Graw Hill, New Delhi)

4. Electronics devices & circuits : Milliman & Halkias

5. Solid state electronic devices : B.G. Streetman

6. Functional Electronics : Raja Raman

PRACTICALS : List of Experiments :

Group – A

1. Study of Regulator circuit.
2. Study of Switch mode Power supply.
3. Study of characteristics of SCR.
4. Study of RC coupled Amplifier.
5. Study of emitter follower.
6. Study of Phase shift oscillator
7. Multivibrator (555 Timer)
8. Study of saw tooth generator by UJT
9. Application of Op-Amp
10. MOSFET

Group – B

1. Half effect
2. Velocity of ultrasonic wave
3. E/M by bar magnet
4. Photonic devices
5. Rectifier & Filters
6. Use of constant deviation spectrograph
7. Use of Michelson Interferometer
8. He-Ne Laser
9. Programming on PC
10. Absorption Spectrum of Iodine vapour
11. Hydrogen Spectrum & Rydberg's Constant

M.Sc. Examination
PHYSICS
M.Sc. (Final)

1. The Examination shall consists of five theory papers & a practical. Three theory papers namely I, II, & III will be compulsory & papers IV & V will be special papers.

2. There shall be a practical course for each special paper.

The distribution of marks shall be as following :

Compulsory Theory papers

Paper-I Nuclear & Particle Physics	100 Marks
Paper-II Condenced Matter Physics	100 Marks
Paper-III Electrodynamics & Numerical Anaylsis	100 Marks

Special Theory papers (Electronics)

Paper-IV Communication Electronics	100 Marks
Paper-V Digital Electronics & Microprocesor	100 Marks

Practicals

A condidate has to perform two experiments during examination one from each group. Time allotted for each experiment will be five 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)	75	60
2. Experiment – II (Group B)	75	60
3. Viva	30 + 30	40 + 40
4. Record	10 + 10	
Sessional work		
1. Seminar & Project	10 + 10	25 + 25
Total	250	250

Paper I : Nuclear & Particle Physics

Unit-I

Nuclear Models : Liquid drop madel; Bethe-Weisacker formulae and its application to alpha and beta decay stabilities; fermi Gas model; Evidence of Nuclear cell structure; Nuclear Potential and sequence of energy levels of nucleons, spin orbit potential and explanation of magic

number, prediction and limitations of single particle cell model; individual particle model; collective model; concept of nuclear core, Nilson inified model for deformed potential; elementary discussion of superfluid and optical models.

Unit – II

Nuclear Reaction :- General features and concept of cross section; partial wave analysis of cross section, optical theorem and shadow scattering, compound nucleus hypothesis; Breit-Wigner on level formula, effect of Barrier penetration; overlapping levels and statistical model, Ghoshal experiment, evaporation model, Direct reaction peripheral scattering process pickup and stripping reactions, optical model in nuclear reaction, elementary discussion of nuclear reaction mechanism at different stages, Nuclear fission; Bohr-Wheeler theory and its improvement using quantum effects, Nuclear fusion.

Unit – III

Nuclear Reactors : Fission Reactor : Neutron multiplication factor in fission chain reaction; fermi's four factor formula, resonance escape probability and thermal utilization factor; Basic reactor theory critical size of reactor, Reactor materials reactor control by delayed neutrons. Basic ideas of breeding and fast neutron reactors.

Fusion Reactor : Fusion reaction, its cross section, reaction rate and critical temperature; Lawson,s criteria; different methods of satisfying Lawsons criteria, magnetic confinement techniques, Tokamak and magnetic mirror devices, Pellet fusion.

(d) Nuclear decay : Electromagnetic (Gamma) decay, electric and magnetic dipole (and multipole) transitions and selection rules, Internal Conversion and O-O transition in Gamma decay, Mossbaer effect and its application (brief); Beta decay, Energy (liner and angular) momentum crisis in beta-decay, Pauli's neutrino hypotheisis, Fermi four point theory of beta-decay, Fermi-Curie Plot and comparative halflives, selection rules and classification of transitions. Parity non-conservation: Theoretical Prediction and confirmation by Wu's experiment; Alpha decay and Gamow's quantum theory of alpha-decay.

(e) Nuclear Forces : Investigation of nature of nuclear forces from simple two body problem deutron (np) bound state & nucleon – nucleon (np and pp) scattering, deutron problem low energy (n-p) and (p-p) scattering, scattering length, effective range theory, study of spin-dependence of n-p interaction and noncentral and exchange forces from deutron bound and (n-p) and (p-p) scattering data.

(f) Elementary particles : Concept of elementary particles, Basic idea of fundamental interactions in nature, classification of elementary particles, continuous & discrete symmetry transformations, External & internal symmetries and conservation, Isotropic spin, Strangeness and other quantum nos in strong interacton physics. Quark model of Hadrons, Gell-Mann- Nishijima Electric charge formula for Hadrons, Gauge transformation and Introductory gauge theory of different basic interactions.

Reference :

1. Atomic and Nuclcar Physics Vol II by S.N. Ghoshal (S. Chand and Company Ltd., New Delhi 1994)
2. Nuclear Physics Vol I by YM Shirikov and NP Yudin, (Mir Publisher, Moscow 1982).
3. Theory of Nuclear structure by MK pal (Affiliated East West Press, New Delhi 1982).
4. Nuclear and Particle Physics by E.B. Paul (North Holland Publishing Company, Amsterdam 1969).
5. Nuclear Physics (Theory and Experiment) by R.R. Roy and B.P. Nigam (Wiley Eastem Ltd., New Delhi 1993).
6. Quams and Leptons by F. Halzen and A.D. Martin (John Wiley and sons 1984).
7. The Second creations by R.P. Crease and C.C. Mann (Affiliated East West Private Limited, 1986).
8. Nuclear Physics by D.C. Tayal.

Paper –II : Condensed Matter Physics

UNIT I : Electrons in solids and Surface States

Interacting electron Gas : Hartree and Hartree-Fock approximations, correlation energy. Screeing, plasma oscillations. Dielectric function of an electron gas in random phase approximation. Limiting cases and friedel oscillation, strongly-interacting Fermi system. Elementary introduction to Landau's quasi-particle theory of a fermi liquid. Strongly correlated electron gas. Elementary ideas regarding surface states, metallic surfaces and surface reconstruction.

UNIT- II : Disordered Systems

Point-defects : Shallow impurity states in semiconductors. Localised lattice vibrational states in solids. Vacancies, interstitials and colour centres in ionic crystals.

Disorder in condensed matter, substitutional, positional and topographical disorder, short and long range order, Atomic correlation function and structural descriptions of gases and liquids.

Anderson model for random systems and electron localization, mobility edge, qualitative application of the idea to amorphous semiconductors and hopping conduction.

UNIT-III

Superconductivity : superconductors and their properties, electron – electron interaction and screening; Electron-phonon-electron interaction and cooper pairs, BCS theory through Bogoliubov method, super conduction ground state, Quasi particle and energy gap, Persistent current and coherence length High Tc superconductors: Theoretical model, Charge transfer model of Cuprates, Defect ordering and superconductivity, Organic superconductors.

UNIT – V

Mossbauer Effect : Difficulties in observing resonance fluorescence of nuclear system, Recoil energy, Natural and dipole broadenings, Classical and quantum theories of Mossbauer effect, experimental method and principal uses of Mossbauer effect.

Reference:

1. Principle of theory of solid by J.M. Ziman (Cambridge University press, London)
2. Theorectical solid state Physics Vol. I and Vol II by W. Jones and N.H. March (John Wiley and Sons, London)
3. Quantum Theory of solid by C, Kittel (John Wiley and sons, London)
4. Quantum Theory of solid by R.E. Peirls (Oxford University Press, London)
5. Principles of Magnetic Resonance by C.P. Slichter (Horper and Row, New York)

6. Mossbauer Effect and its Application by V.G. Bhinde
7. Theoretical solid state Physics-Wuang

Paper – III : Electrodynamics & Numerical Analysis

UNIT – I : Electodynmics :

Electromagnetic potentials, Maxwell's field equations in terms of electromagnetic potentials, Lorente guage, retarded and advanced potentials, calculation of electromagnetic fields using electromagnetic potentials.

Retraded potentials-lienard Wichert potentials electromagnetic field due to uniformly moving point charge, four vector potential, Invariance of maxwell's field equations under reltivestic transformations cavarience and tensor form of Maxwell field equation, electromagnetic field tensor covariant form of electric and magnetic field equations transformation relations for electric and magnetic field vectors.

UNIT – II : Numerical Analysis :

Interpolation & methods of interpolation, least square curve fitting, Methods of equal intervals, Unequal intervals central defferences, Inverse interpolation: Iteration of successive approximation exchange of dependent and independent variables and reversion of series Numerical differentiation; Method based on interpolation on finite difference, operator and on undertermined coefficients, Numerial intergration: Simpson's one – third and one – eighth rule, Euler – Maclaurin formula, Quadrature formulae, Numerical Solution to ordinary differential equation by Euler's and Runge – Kutta methods, Solution of algebraic and transcedental equations : Newton – Raphson medhod, Iterative methods.

Reference:

1. Matrices and tensors in physics by A.W. Joshi (Wiley Eastern Ltd., New Delhi)
2. Mathematics for physics by P. Dennery and A. Dizynicki (Haper and Row, New York)
3. Numeric Analysis by Balguruswammy.
4. Numerical Analysis by Harper.
5. Text book of Numerical Analysis by S. Sharma., G.C. Sharmaand, S.S. Choudhary (Ratna Pakistan Mandir, Agra)
6. Classical Electrodynamics by J.D. Jackson.
7. Classical theory of Fields by J.d. Sandau & e.M. Lifshitz.

Paper – IV : (Electronics Special Paper)
Communication Electronics

UNIT : I : Analog & Digital Communication :

Amplitude modulation, depth of modulation, spectrum of AM signal, square law modulator, balanced modulator, DSBSC modulation, SSB modulation, vestigal sideband modulation, frequency modulation, phase modulation, relationship between phase & frequency modulation, spectrum of FM signal, generation & detection of signal, Comparison of FM & AM signal, sampling quantization & companding, fundamentals of PAM, PAW & PPM, ASK, FSK & PSK.

UNIT – II : Microwave Devices :

Klystrons, Maghnetrons & traveling Wave tubes, velocity modulation Basic principles of two cavity klystrons & Reflex Klystrons principles of operation of magnetrons, Helix traveling wave tubes, Wave modes.

Transferred electron devices, Gunn effect, Principles of operation, Modes of operation, Read diode, IMPATT diode, TRAPATT diode.

UNIT – III : Microwave Communication :

Advantages & disadvantages of microwave transmission, loss in free space, propagation of microwaves atmospheric effects on propagation. Fresnel Zone problem, ground reflection, fading sources, detectors, omponents, antennas used in MW communication systems.

UNIT – IV : Satellite Communication & Radar System :

Principle of satellite communication, communication Satellite link design, satellite orbit inclination, Radar introduction Radar range equation. Pulse radar, Duplexer, Modulator, Continuous Wave radar, CW – FM radar, tracking radar MTI radar & radar application.

UNIT – V : Optical Communication :

Fundamental of Optical Fiber-Ray transmission step Index, graded index Fiber, single mode & mode multimode Feber, Fundamental of Light emitting Diode, Communication theory for fiber optic transmission system, Introduction to coherent fiber optic communication.

Reference:

1. Principles of communication – Taub & Schilling
2. Communication system - S. Haykins.
3. Communication system – Kennedy
4. Satellite communication – D.C. Agarwal
5. Micro wave Devices – Liao

6. Radar system – Skolnik
7. Optical Fiber communication – Keiserl & senior
8. Microwaves by K.L. Gupta, Wiley Eastern Ltd., New Delhi.

Paper : V : (Electronics Special Paper)
Digital electronics & Microprocessor

UNIT – I

Number systems, code (Gray code, ASCII code & BCD Code) Basic logic gates, DTL, RTL TTL, & ECL logic circuits, Analysis & synthesis of combinational logic circuits, Karnaugh map, pairs, Quad & Octets.

UNIT – II :

Arithmetic logic circuits, Half adder, Full adder, Half Subtracter, Full subtracter, Controlled, Inverter & adder Subtracter circuits, Data processing circuits, multiplexers, Denultiplexers, encoder & Decoder (1 of 16 decoder BCD Decoder & LED Decoder).

UNIT – III :

Introduction to FF, R-S, D, T, J-K, & J-K master slave FF, synchronous & asynchronous counters, mod counters, serial & parallel shift registers.

Introduction to semi conductor memories, RAM, ROM, EPROM & their addressing techniques A/D & D/A converter, 555 timer & its application.

UNIT – IV : Microprocessor Architecture & programming :

Introduction to microprocessor, Architecture of 8085 system components, control signal of 8085 system timing diagram, Memory R/W cycle.

Instruction set of 8085, Addressing modes, elementary programming concept of 8085 M.P.

UNIT – V : Data Tansfer Scheme & Memory Interfaing :

Reference:

1. Digital principle & Application by Malvino Leach.
2. Modern digital electronics by R.P. Jain.
3. Microprocessor by Goyan kar.
4. Microprocessor & Interfacing by Douglas Hall (TMH).

M.Sc. Final (Practical)

Group – A

General :

1. Linear Characteristics of op-Amp
2. Non-Liner Characteristics of op-Amp
3. Active filter using op-Amp
4. Sampling theorem
5. PAM & Demodulation
6. Study of series & shunt clamping circuit
7. Study of integrated circuit regulator
8. PWM (Pulse Width Modulation)
9. G.i '. Counter
10. IC 555 Timer

Group – B

Special :

1. Register & Counter
2. Boolean algebra
3. Half & Full Adder
4. Flip – Flop
5. A/D converter
6. D/A converter
7. Encoder & Decoder
8. Multiplexer
9. Microprocessor Application Circuits (I)16*4 bit Random Access Memory (RAM) (II) 8155 simple Programmable interface
10. Microprocessor (8085)