Syllabus & Scheme of Examination for M.Sc. (Previous) Physics
(Annual Pattern)
Master of Science Examination as per Provisions of Ordinance No.39

In **M.Sc. (Previous) Physics**, there shall be 04 Theory Papers & 02 LAB Courses, each of 100 Marks with minimum 36% passing marks in each theory & practical papers separately.

In **M.Sc. (Previous) Physics**, 04 Theory Papers shall be as follows:-

1. MATHEMATICAL PHYSICS & CLASSICAL MECHANICS
2. QUANTUM MECHANICS ATOMIC AND MOLECULAR PHYSICS
3. ELECTRODYNAMICS, PLASMA PHYSICS & STATISTICAL MECHANICS
4. ELECTRONICS

In **M.Sc. (Previous) Physics**, 02 LAB Courses shall be as follows:-

1. LAB COURSE-A (GENERAL)
2. LAB COURSE-B (ELECTRONICS)

PAPER-I
MATHEMATICAL PHYSICS & CLASSICAL MECHANICS

M.M. 100

Vector Spaces and Matrices: Linear Independence of vectors, Bases, Dimensionality Linear transformation, Inner product. Matrices: Orthogonal and Unitary matrices, Independent elements of a matrix, rank of a matrix. Eigen values and Eigen vectors, Diagonalisation, Complete orthogonal state of functions.

Tensors: Definition of tensor, Contra-variant, covariant tensors of higher ranks, the algebra of tensor, addition, substation, multiplication and contraction, Quotient law, Dyadic, Symmetric and anti-symmetric tensors, invariant tensors, associate tensors. Conjugate tensors, metric tensors, length of a vector, angle between tensors. Christophell's symbol and their transformation laws, equation of geodesics, Covariant differentiation of vectors and tensors of higher rank.

Differential equation, second order linear ordinary differential equations with variable coefficient.

Special function, Hermit, Legendre, Bessel's and Laguerre's function, Physical application, generating functions, recurrence relations.

Newtonian mechanics of one and many particle systems, conservation laws, work energy theorem, open system (with variable mass) constraints, their classification D. Alembert's generalized coordinates.

Lagrange's equation, gyroscopic forces, Dissipative systems, Jacobi integral, gauge invariance, generalized coordinate and moments, integral of motion, Symmetries of space and time with conservation Laws.

Principle of least action, derivation of equation of motion, Variation and end points, Hamilton's principles and characteristic functions, Hamilton-Jacobi equation, Canonical transformation, generating functions, properties, group property examples, Infinitesimal generators, Poisson bracket, Poisson theorem, angular momentum.

TEXT AND REFERENCE BOOKS:

1. Mathematical Methods for Physics by G. Arfeken.
2. Matrix and tensors for physicists By A. W. Joshi.
3. Advance Engineering Mathematics by P. Krezing.
4. Special functions by E.D. Rainville.
5. Special functions by W.W. Bell.
6. Mathematical methods for Physicists & Engineers; by K.F. Reily, M.P. Hobson, S.J. Bence
7. Enter Mathematics for Physicists: by Mary L. Bose.
8. Classical Mechanics by N.C. Rana and P.S. Jog.
9. Classical Mechanics by H. Goldstein.
10. Mechanics by A. Somerfield.
11. Introduction to Dynamics: by I Percieval and D. Richards.

PAPER- II

QUANTUM MECHANICS ATOMIC AND MOLECULAR PHYSICS

M.M. 100

Revision: Inadequacy of classical mechanics, Schrödinger equation, Ehrenfest theorem, Admissible wave function, stationary state.

One dimensional problems, wells and barriers, Harmonic oscillator, Uncertainty relation of x and state with minimum uncertainty product, general formalism of wave mechanics commutation relation, representation of state and dynamical variables, Completeness of Eigen functions, Dirac delta function, Bracket notation, Matrix representation of an operator, Unitary transformation.

Angular momentum in quantum mechanics, central force problem, solution of Schrodinger equation for spherically symmetric potentials: example-hydrogen atom

Time independent perturbation theory: non-degenerate and degenerate cases, applications such as Stark effect, variational method, WKB approximation.

Time dependent perturbation theory: harmonic perturbation, Fermi's Golden rule, adiabatic and sudden approximation, Semi-classical theory of radiation, Transition probability for absorption and induced emission, Electric dipole and forbidden transition selection rules.

Identical particles, Symmetric and anti-symmetric wave functions, collision of identical particles, spin angular momentum and spin function for many electron system.

Quantum state of one election atoms, atomic orbits, Hydrogen spectrum, Pauli's principle, spectra of alkali elements, Spin-orbit interaction and fine structure in alkali spectra, equivalent and non-equivalent electron, Normal and anomalous Zeeman effect, Paschen beck effect, Stark effect.

Two electron systems, Interaction energy in L-S and J-J coupling, Hyperfine structure (qualitative), line broadening mechanism (General ideas)

Type of molecules, diatomic linear symmetric top, asymmetric top and spherical top molecules, rotational spectra of diatomic molecules as rigid rotator, energy levels and spectra of non-rigid rotator

TEXT AND REFFERENCE BOOKS:

1. Quantum Mechanics by L.L. Schif
2. Quantum Mechanics by S. Gasforowicz.
3. Quantum Mechanics by Landau & Lufshitz
4. Quantum Mechanics by A.P. Messiah
5. Quantum Mechanics by B.B. Craseman and J.D. Powell.
6. Quantum Mechanics by Matthews and Venkatesan
7. Modern Quantum Mechanics: By J. J. Sakurai.

PAPER-III
ELECTRODYNAMICS, PLASMA PHYSICS & STATISTICAL MECHANICS

M.M. 100

Maxwell equations, displacement current, potential formulations of electrodynamics, scalar and vector potentials, Gauge transformation, Coulomb's gauge and Lorentz gauge, Paynting theorem, conservation momentum for a system of charged particles and electromagnetic fields.

Review of four vector concept, Lorentz transformation in four dimension spaces, covariant form to Maxwell's equation, electromagnetic field tensor, dual field tensor.

Wave equation for vector and scalar potential and their solution, retarded potentials, Leonard Wienchart potentials, electric and magnetic fields due to a uniformly moving charge and accelerated charge, Linear and circular acceleration and angular distribution of power radiated Bremsstrahlung and Cerenkov radiation.

Motion of charged particle in electromagnetic field, Uniform E and B Fields, non-uniform fields, diffusion across magnetic fields, time varying E and B Fields, adiabatic invariants, first, second and third adiabatic variants.

Theory of collision, Townsend's ionization theory, Breakdown potential, Elementary concept of plasma, Electric neutrality of plasma particle, orbits and drift motion in plasma, magnetic mirrors, Hydro-magnetic equations, pinch effect, plasma oscillations and wave motion, probes for plasma measurement.

Connection between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox.

Micro-canonical ensemble, phase space trajectories and density of states. Liouville's theorem, canonical and grand canonical assemblies, partition function, calculation of statistical quantities, energy and density fluctuations

Density matrix statistics of ensemble, Statistics of indistinguishable particles, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics, properties of ideal Bose and Fermi gases, Bose-Einstein condensation.

TEXT AND REFERENCE BOOKS:

1. Classical electricity and magnetism; By Panofsky and Philips
2. Classical electrodynamics; By J.D. Jackson.
3. Plasma- Physics By Bitten court,
4. Plasma Physics by Chen.
5. Plasma Physics by S.N. Sen.
6. Statistical and thermal Physics by F Rolf.
7. Statistical Mechanics by K. Huang.
8. Statistical Mechanics by R. K. Patharia.
9. Statistical Mechanics by R. Kubo.
10. Statistical Physics by Landau and Litshitz.

PAPER- IV
ELECTRONICS

M.M. 100

Different methods of Biasing a transistor, thermal stabilization and stabilizing factor, low frequency parameter for transistor amplifier, Feedback amplifier, different types of feedback in amplifier, condition of oscillation, Hartley Wien-bridge and phase-shift oscillator.

Direct couple amplifier, differential amplifier, C.M.R.R. constant current bias, block diagram of a typical operational amplifier, Op-Amp offset voltage and current, frequency response of Op-Amp, Inverting and non-inverting amplifier, operational amplifier with negative feedback, integrator and differentiator. Use of operational amplifier as function generator, Uni-junction transistor and silicon control rectifier.

Basic logic gates and operations: AND, OR, NOT, NAND, EXOR and EXNOR gates, half and full adder and substractor by stable circuits, RS Flip-Flop using NOR and NAND Gate, JK Flip-flop race around condition, JK Master-slave flip-flop, Up and down counter, shift registers.

Microwave devices: High frequency limitations of transistors, microwaves transistors, MESFET, Tunnel diode, Transferred electron devices, Gun diode, LSA diode, Avalanche/Transit Time Devices – READ diode.

IMPATT Diode, TRAPATT diode, Parametric Devices, varactor diode, Fundamental of MASERS.

Op-to electronic devices: Luminescence radiative and non-radiative recombination, Double hetro junction, Light emitting diode, spontaneous and stimulated emission, Einstein relation, population inversion, optical feedback and LASER oscillations, Threshold condition for LASER oscillation, semi-conductor injection, LASER and its efficiency optical detector, P-N photo diode, – P – i- N photo diode, Avalanche photo diode.

TEXT AND REFERENCE BOOKS:

1. Semi-conductor device- Physics and Technology: by S. M. Sze
2. Introduction to Semi-conductor devices: by M.S. Tyagi.
3. Optical electronics: by Ajay Ghatak and K. Thyangarajan
4. Microwave devices: by Lio.
5. Electronic Communication: by Kesar.
6. Micro-electronics: by Jacob Millman.
7. Electronic device and circuit theory: by Foobert Boylested & Louis Nashdsky.
8. Digital principles and application: by Malvino & Leach
9. Op-Linear Integrated circuit: by Gayakwad.

PAPER- V
LAB COURSE – A (GENERAL)

M.M. 100

Note: Students are required to perform any 10 of the following experiments.

1. Measurement of wave length using Michelson Interferometer.
2. Measurement of e/m.
3. Measurement of ionization potential of mercury.
4. Measurement of conductivity using four probe method.
5. Measurement of susceptibility by Quinck's method.
6. Measurement of magnetic field using Hall effect.
7. Measurement of Planck's constant.
8. Measurement of velocity of ultra-sonic waves liquid.
9. Measurement of light temperature using thermister and thermocouple.
10. Measurement of wave length of mercury light by Hartman formula.
11. Measurement of width of single – slit using LASEP.
12. Study of B – H curve.
13. Verification of Stefen's Law.
14. To study pumping speed of a vacuum pump.
15. Study of electrically polarized light.

PAPER- VI
LAB COURSE – B (ELECTRONICS)

M.M. 100

Note: Students are required to assemble & perform any 10 of the following Experiments:

1. To use Op – amp as
   (i) Adder (ii) Substractor (iii) Multiplier (iv) Differentiation & (v) Integrator.
2. To use Op – amp as (i) Wien – bridge, and (ii) Phase – shift Oscillator.
3. To use Op – amp as (i) Hartley, and (ii) Colpit Oscillator.
4. To use Op amp as a Function generator.
5. To use Op – amp as AC Mill – voltmeter.
6. To study feed-back Amplifier.
7. To study Common-source Amplifier.
8. To study Source Follower.
9. To Study characteristic curve of U.J.T. and S.C.R.
10. To Study different type of Gates and verity their Truth cable.
11. Study of Half-Adder and Full Adder. & verity De Morgan's theorem.
12. Study of up and down counter.
13. Study of RS & JK Flip flop using NAND gate.
14. Study of shift register.
15. Study of Varactor Diode.