DEPARTMENT OF PHYSICS
M. Sc Physics Curriculum

Semester – I

S. No.	Course Code	Title of the Course	Credit Hrs.		
			L	T	P
1	PHY - 631	CLASSICAL MECHANICS	2	1	0
2	PHY - 633	STATISTICAL MECHANICS AND THERMODYNAMICS	3	1	0
3	PHY - 637	MATHEMATICAL PHYSICS	3	1	0
4	PHY - 639	ATOMIC &MOLECULAR SPECTROSCOPY	3	1	0
5	PHY - 630	PHYSICS LAB. - I	0	0	4
TOTAL CREDITS			17		

Semester – II

S.No.	Course Code	Title of the Course	Credit Hrs.		
			L	T	P
1	PHY - 642	ELECTRONICS	3	1	0
2	PHY - 644	CONDENSED MATTER PHYSICS	3	1	0
3	PHY - 646	QUANTUM MECHANICS- I	3	1	0
4	PHY - 662	ASTROPHYSICS	3	1	0
5	PHY - 640	PHYSICS LAB. - II	0	0	4
TOTAL CREDITS			18		

Semester – III

S. No.	Course Code	Title of the Course	Credit Hrs.		
			L	T	P
1	PHY - 731	ELECTROMAGNETIC THEORY & ELECTRODYNAMICS	3	1	0
2	PHY - 733	QUANTUM MECHANICS-II	3	1	0
3	PHY - 735	NUCLEAR & PARTICLE PHYSICS	3	1	0
4	PHY - 737	DIGITAL ELECTRONICS	3	1	0
5	PHY - 730	PHYSICS LAB. - III	0	0	4
TOTAL CREDITS			18		

Semester – IV*

S. No.	Course Code	Title of Course	Credit Hours
1	PHY - 899	PROJECT WORK	30

Optional Paper*

S. No.	Course Code	Title of Course	Credit Hours		
			L	T	P
1	PHY – 842	OPTOELECTRONICS DEVICES & COMMUNICATION ELECTRONICS	3	1	0
2	PHY- 844	THEORETICAL METHODS OF PHYSICS	3	1	0

*One optional paper has to be opted.

M. Sc. Physics

Semester- I

Mathematical Physics

Course Code: PHY-637 Credit Hours: 3-1-0

Unit-I: Ordinary Differential Equations

Power series, solution of second order differential equations, ordinary point and singularities of a linear differential equation, Solutions of Hyper- geometric, Bessel, Legendre, Laguerre and Hermite equations.

Unit II: Special Functions

Basic properties (recurrence and orthogonality relations, series expansion) of Bessel, Legendre, Hermite and Laguerre functions.

Unit-III: Complex Analysis

Analyticity and Cauchy-Reimann Conditions, Cauchy's integral theorem and formula, Taylor's series and Laurent's series expansion, Zeros and singular points, Multivalued functions, Branch Points and Cuts, Reimann Sheets and surfaces, Residues, Cauchy's Residue theorem, Jordan's Lemma; Evaluation of definite integrals, Principal Value, Bromwitch contour integrals.

Unit- IV: Partial Differential Equations

Partial differential equations, Lagrange's linear equation, Method of multipliers,Solutions of Laplace, Poisson, Diffusion and wave equations.

Books Recommended/ Reference Books:

R. W. Churchill : Complex Variables
J. P. Sharma : Discrete Mathematics (Khanna Publishers Delhi)
B. S. Grewal : Higher Engineering Mathematics (Khanna Publisher Delhi)
Margenau & Murphy : The Mathematics of Physics and Chemistry

M. Sc. (Physics)

Semester-I

Statistical Mechanics

Course Code: PHY-633 **Credit Hours: 3-1-0**

Unit I: Macroscopic and Microscopic States & Statistical Ensembles: Macroscopic States, Microscopic States, Phase Space, Density distribution in phase space, Liouville theorem, Micro canonical, Canonical & Grand Canonical Ensembles.

Unit II: Some Applications of Statistical Mechanics: Maxwell- Boltzmann's Statistics-Quantum Statistics Symmetric & Antisymmetric wave function, Gibbs paradox, Bose-Einstein Statistics- Degeneracy and Einstein condensation, Femi-Dirac Statistics- Free Electron theory of Metals, Density of State in 1-D & 3-D, Fermi energy, variation of Fermi energy with Temperature, Variation of specific heat with temperature.

Unit III: Basic Concepts and Laws of thermodynamics: Thermodynamic systems, thermodynamic variables, P-V diagrams, Zeroth Law of thermodynamics, first law of thermodynamics, second law of thermodynamics third Law of thermodynamics (Kelvin-Planck Statement IInd law of thermodynamics), Concept of Entropy, Enthalpy Reversible and in eversible process, Joule's experiment, J-T cooling.

Unit IV: Kinetic theory of gases: Pressure extend by a perfect gas, some deductions for the pressure**,** Expressions for most probable speed ($\bar{v}_{mp}$), average or mean speed ($\bar{v}_{mp}$) and mean square speed ($\bar{v}_{mp}$) of molecules, degrees of freedom, law of equipartition of energy, near free path, Transport phenomena (viscosity, thermal conduction, diffusion). Brownian motion.

Unit V: Thermo dynamical Relationships: Thermodynamic potentials, Deduction of Maxwell's thermo dynamical relations by their corresponding potentials, their applications.

Text Books:

1. Kittle : Elementary Statistical Mechanics
2. Mark W. Zemansky & Richard H. Dittman : Heat and thermodynamics

Reference Books:

1. B.K. Agarwal : Elements of Statistical Mechanics
2. B.B. Laud : Fundamentals of Statistical Mechanics
3. Hung : Statistical Mechanics
4. S. Singhal, J.P. Agarwal & Satya Prakash: Heat Thermodynamics & Statistical Physics
5. Briz Lal Subramanyam: Heat & Thermodynamics
6. Domkundurar : A course in Thermodynamics Arora : Thermodynamics

M. Sc. Physics
Semester-I
Atomic & Molecular Spectroscopy

Course Code: PHY 639 **Credit Hours: 3-1-0**

Unit- I: Types of spectra, Spectrum of H atom & Spectral series, Bohr's theory & Spectrum of H atom, Spin orbit coupling, Relativistic correction for H and H – like atoms, Lamb shift, fine structure of H and He^{+} lines, selection rules, Quantum numbers, space quantization, spectral terms and their notations.

Unit-II: Spin orbit interaction, Transition rules, Intensity rules, Spectra of alkaline earth elements, L-S & J-J coupling, Selection rules, Spectrum of He atom, spectral lines & their splitting, Zeeman effect, anomalous Zeeman effect, Paschen back effect, Stark effect.

Unit-III : Pure rotational spectra, Rigid rotator, Rotational energy levels and selection rules, diatomic molecule as harmonic oscillation, fine structure of vibration- rotation bands. Isotope effect in vibrational bands, Franck Condon principle.

Unit-IV: Raman effect, Raman spectra, Classical & Quantum theory of Raman effect, Pure rotational Raman Spectra, Vibration rotation Raman spectra, X-ray spectra.

References:

1. Introduction to atomic spectra by M,E White, Mc Graw-Hill international edition's
2. Fundamentals of Molecular Spectroscopy by CN Baswell, Tata McGraw Hill
3. Elements of Spectroscopy by Gupta Kumar & Sharma, Pragati Prakashan Meerut

M. Sc. (Physics)

Semester-I

Classical Mechanics

Course Code: 631 **Credit Hours: 2-1-0**

Unit -I
Introduction, Conservation Principles (Laws), Mechanics of a Particle, Mechanics of a system of Particles, Conservation of Linear Momentum, Conservation of Angular Momentum, Newton's Laws and their Limitations (in some details).

Unit- II Techniques of the Calculus of Variations, Hamilton's Variational Principle, D'Alembert's Principle and Lagrange's Equations, Deduction of Lagrange's Equations from Hamilton's Principle, Equivalent One-Body problem, Equivalent One-Dimensional Problem, General Features of the Orbits,, Motion Under Inverse Square Law- Kapler's Problem, Visial Theorem, Rutherford Seattering.

Unit- III The Independent Coordinates of a Rigid Body, Euler Angles, Angular Velocity and Momentum, Equations of Motion for a Rigid Body, Euler's Equations, Torque Free Motion of a Rigid Body-Poinsot Solutions.

Unit- IVTypes of Equilibria, Formulation of the Problem, Lagrange's Equations of Motion for small Oscillations, Normal Coordinates, and Normal Frequencies of Vibrations Free Vibrations of a Linear Triatomic Molecule, Forced Vibrations**.**

Unit-VHamiltonian Formulation of Mechanics, Basic Concepts- View- Pont of the New Development, Phase Space, and the Motion of the system, Hamiltonians, Hamilton's Canonical Equations of Motion Deduction of Canonical Equations from Variational Principle.

Text Books:

1. Classical Mechanics: Herbert Goldstein, Published by Person Education (Singapur) Pvt. Ltd., Indian Branch, 482, P.I.E, Patpargang , Delhi-110092, India.

References:

1. Classical Mechanics: M.C. Ram et al. Tata Mc. Graw-Hill Publishing Company Ltd., New Delhi.
2. Classical Mechanics: Dr. S.L. Gupta et al, Pragati Prakashan (Meerut), India
3. Mechanics: R.S. Gambhir, CBS Publishers and Distributiors; New Delhi-110002

M. Sc. Physics

Physics Lab-I

Semester-I

Course Code: PHY-630 **Credit Hours: 0-0-4**

1. To determine the modulus of rigidity of a given material by statistical method.
2. To determine the Poisson ratio for rubber.
3. To determine the modulus of rigidity using horizontal pattern apparatus.
4. To find thermal conductivity Co-efficient of a bad conductor using Lee's method.
5. To measurement of resistivity of semiconductor by four probe method out deferent temperature and determination of the band gap.
6. To resolve and determine the wavelength of two spectrum lines by Grating Method.
7. To designing and testing of half wave rectifier.
8. To designing and testing of full wave rectifier.
9. To designing and testing Clipper and Clamper circuit.

M. Sc. Physics
Semester-II
ELECTRONICS

Course Code: PHY-642 **Credit Hrs: 3-1-0**

Unit-I: Review of Semiconductor Devices

p- and *n*-type semiconductors, *pn* junction diode and its characteristics, *pnp* and *npn* transistors, feedback amplifiers, FET, comparison of UJT and BJT, MOSFET and JFET transistors. Oscillators: Phase shift and Wien-bridge oscillators.

Unit-II: Power Amplifiers

Difference between voltage & power amplifiers. Terms used in power amplifiers. Class A and Class B power amplifiers. Class A & Class B Push-Pull power amplifiers. Fundamentals about tuned circuits, single and double tuned amplifiers.

Unit-III: Multivibrators

Switching action of a transistor, Multivibrators, astable, mono-stable and bi-stable multivibrators, Emitter-coupled astable & monostable vibrators. Comparison between different multivibrators. Triggering of bistable multivibrator.

Unit-IV: Integrated circuits & Op-Amplifiers

Advantages & limitations. IC classification. Production process of monolithic IC. Fabrication of components on monolithic IC. IC packing. General Integrated Circuit Technology.

Characteristics of an ideal op-amplifiers. Op-Amplifiers stages, Op-Amplifiers parameters. Differential Amplifier, Adder or Summing Amplifier, Subtractor, Integrator, Differentiator. Signal generator: square, pulse, triangular & sawtooth wave generator.

Textbook recommended:

1. Integrated Electronics
   Millman / Halkias

Reference books:

1. Electronic Devices & Circuit Theory
   Bodystead / Nashelsky
2. Electronic Principles
   Malvino
3. Principles of Electronics
   V.K.Mehta
4. Electronic Devices & Circuits
   David A. Bell
5. Electronic Fundamental & Applications
   John K. Ryder
6. Electronic Devices & Circuits
   Sanjeev Gupta

M. Sc. Physics
Semester – II
ASTROPHYSICS

PHY-662 **Credit Hours: 3-1-0**

Unit-1
Photometric Concepts and Magnitudes

Intensity, Flux Density and Luminosity, Apparent Magnitudes, Magnitude Systems, Absolute Magnitudes, Extinction and Optical Thickness.

Unit-2
The Sun

Solar structure - photosphere, chromosphere and corona. Activity in the sun -sunspots, flares, solar oscillations, helioseismology

Unit-3
Stellar Interiors

Hydrostatic equilibrium, Pressure equation of state, Energy sources, Energy transport, Equations of Gravitational Equilibrium, and the Potential Energy, Polytropic Gas Spheres: Polytropic Equation of State, The Equations of Equilibrium. The Lane-Enden Functions for n = 0, 1 and 5, and for General Polytropic Index n.

Unit-4
Star Formation

Interstellar dust and gas, Formation of protostars, Pre-main sequence evolution, Evolution on the main sequence, Late stages of evolution, Fate of massive stars, supernovae

Unit-5
Galaxies

The Classification of Galaxies, Luminosities and Masses, Galactic Structures, Dynamics of Galaxies, Stellar Ages and Element Abundances in Galaxies, Systems of Galaxies, Active Galaxies and Quasars, The Origin and Evolution of Galaxies.

Books Recommended and Reference material:-

1. Shu, F., The Physical Universe, University of California,
2. H. Karttunen, Fundamental Astronomy
3. Stix, M., The Sun: An Introduction,
4. S.Chandrasekhar An Introduction to the Study of Stellar Structures
5. Collins, G. W: Fundamentals of Astrophysics
6. Mihalas, D. and Binney, J: Galactic Astronomy.

M. Sc. Physics

Semester-II

Quantum Mechanics-I

Course Code: PHY-646 **Credit Hours: 3-1-0**

Unit I: Introduction & Review

Schrodinger wave equation- Interpretation 1-D potential problems- Eigenfunctions & Eigenvalues & This properties- Momentum Eigen functions- Motion of a Free Wave Packet in 1-D- Bound States- SHO- Square well potential - H-atom.

Unit II : Continuous Eigenvalues: Collision Theory- 1-D Square potential Barrier– Collisions in 3-D- Scattering by Spherically Symmetric Potentials- Scattering by a Coulomb Field.

Unit III : Matrix Formulation of QM

Transformation Theory- Equations of Motion- Matrix Theory of SHO.
Unit IV: Approximation Methods for Bound States : Stationary Perturbation Theory- Applications -The Variational Method- Applications WKB Approximation.
Methods for Time-dependent Problems.

Text Books:

1. Quantum Mechanics 3rd Edition- L.I. Schiff
   McGraw- Hill International Edition- 1968
2. Quantum Mechanics- Mathews & Venkatesan
   McGraw Hill- New Delhi

Reference Books:

1. Quantum Mechanics, Walton Greiner
   International Springer Group, Fourth Edition-2004
2. Introduction to Quantum Mechanics, Linus Pauling & E. Bright Wilson
   McGraw-Hill Book Co. July, 1935
3. Quantum Mechanics, Robert Eisberg & Robert Resnick
   John Wiley & Sons (Asia) Pte Ltd, IInd Edition, 1985
4. Advanced Quantum Mechanics, B.S. Rajput
   Pragati Prakashan, Meerut- 5th Edition, 2001
5. Quantum Mechanics, B.K. Agarwal & Hari Prakash
   Prentice-Hall of India Pvt.Ltd, 2nd Edition – June, 2001
6. Quantum Mechanics, Ajoy Ghatak & S. Lokanathan
   Macmillan India Ltd., 4th Edition- 1999

M. Sc. Physics

Semester-II

Condensed Matter Physics

Course Code: PHY-644 **Credit Hours:3-1-0**

Unit-1: Crystal Structure

Lattice translation Vectors and Lattices, Symmetry operations, the basis and the crystal structure, unit cell, Primitive lattice cell.

Miller indices, X-ray diffraction, Atomic Scattering factor and Geometric form factor

Simple crystal structure and Reciprocal lattice.

Unit-2: The Specific heat of Solids and Lattice Vibrations

The various theories of the lattice specific heat, breakdown of classical theory, Einstein's theory of specific heat, Debye theory of specific heat, Vibrational modes of a finite one dimensional lattice of identical atoms, the vibrational modes of a diatomic linear lattice.

Unit- 3: Lattice vacancies and lattice defects

Formation of lattice defects in metals**,** Schottky defeet, Frenkel defect's, Color Centers, F Center.

Edge and screw dislocation.

Unit-4: Free electron theory of Metals & band theory of solids

Difficulties of the classical theory, Free electron model, electronic specific heat, paramagnetism of free electrons. Bloch theorem, Kronig Penney model, Distinction between metals, insulators and semi conductors, Diamagnetisim and Paramagnetisim

Unit-5: The Conductivity of Metals

Some features of the electrical conductivity of metals, A simple model leading to a steady state, drift velocity and relaxation time, Boltzmann transport equation. The Sommerfield theory of electrical Conductivity, Superconductivity.

M. Sc. Physics
Physics Lab-II
Semester-II

Course Code: PHY-640 **Credit Hours: 0-0-4**

1. Introduction of the various types of Electronic components.
2. Study and familiarization with CRO and function generator.
3. V-I characteristics of zener diode.
4. V-I characteristics of P-N junction.
5. Transistor characteristics of CE, CB, CC Configuration.
6. Designing and testing of +5V and -5V regulated power supply.
7. Study of FET Characteristics.
8. Designing and testing of Wien Bridge Oscillator using IC-741.
9. Study of Hartley oscillator.
10. Study of Phase Shift Oscillator.
11. Study and testing of soldering and disordering techniques.
12. Study of operational amplifier as voltage follower.
13. Study of LDR Characteristics.
14. Designing and testing of step-up and step-down transformer.
15. Study the Etching and Drilling techniques.
16. Study of class-A amplifier.
17. Study of class-B amplifier.

**MINI PROJECT

M. Sc. Physics
Semester – III
Electromagnetic theory & Electrodynamics

Course Code: PHY-731 **Credit Hrs: 3-1-0**

Unit-I: Electrostatatics and Magnetostatics:-

Gauss' law and its application; Laplace and Poisson equations, boundary valve problems, Biot-Savart law, Ampere's theorem. Electromagnetic Induction.

Unit-II: Maxwell's Equation:-

Maxwell equation in free space and linear isotropic media, Scalar and vector potentials, gauge invariance poynting theorem

Unit-III: Electromagnetic Waves:-

Electromagnetic Waves in free space, dielectric and conductors, Reflection and Refraction, Polarization and dispersion, transmission lines and waves Guided

Unit-IV: Electrodynamics of a radiating System:-

Dynamics of charged particles in static and uniform electromagnetic fields, Radiations from moving charges, dipoles and retarted potentials

Reference books:

1. Introduction to Electrodynamics
David j. Griffiths
2. Electromagnetic Theory and Electrodynamics
Satya Prakash
3. Electrodynamics
Gupta Kumar.

M. Sc. Physics

Semester-III

Quantum Mechanics-II

Course Code: PHY-733 **Credit Hours: 3-1-0**

Unit I : The Scattering Matrix- Born Approximation-
Identical Particles and Spin- Spin Angular Momentum- Density Matrix.

Unit II : Semiclassical Treatment of Radiation: Absorption and Induced Emission-
Spontaneous Emission- Some Application.

Unit III : Atoms, Molecules and Atomic Nuclei: Approximations in Atomic Structure- Alkali Atoms- Molecules

Unit IV : Relativistic Wave Equations- Schrodingers Relativistic Wave Equation- Dirac's
Relativistic Wave Equation- Diracs Equation for a Central Field.

Text Books:-

1. Quantum Mechanics- 3rd Edition – Leonard I. Schiff
   McGraw- Hill International Editions 1968.
2. Quantum Mechanics- Mathews & Venkatesan
   McGraw Hill- New Delhi

Reference Books:

1. Quantum Mechanics, Walton Greiner
   International Springer Group, Fourth Edition-2004
2. Introduction to Quantum Mechanics, Linus Pauling & E. Bright Wilson
   McGraw- Hill Book Co. July, 1935
3. Quantum Mechanics, Robert Eisberg & Robert Resnick
   John Wiley & Sons (Asia) Pte Ltd, IInd Edition, 1985
4. Advanced Quantum Mechanics, B.S. Rajput
   Pragati Prakashan, Meerut- 5th Edition, 2001
5. Quantum Mechanics, B.K. Agarwal & Hari Prakash
   Prentice-Hall of India Pvt.Ltd, 2nd Edition – June, 2001
6. Quantum Mechanics, Ajoy Ghatak & S. Lokanathan
   Macmillan India Ltd., 4th Edition- 1999
7. Quantum Mechanics- Satya Prakash, Swati Saluja,
   Kedar Nath Ram Nath & Co. Meerut- 2004

M. Sc. Physics
Semester – III
Digital Electronics

Course Code: PHY-737 **Credit Hrs: 3-1-0**

Unit – I: Basic Concepts & Boolean Algebra

Number systems- Binary, Octal, Decimal, Hexadecimal, conversion from one to another, Boolean algebra, de-Morgans theorem, meaning of minterms and maxterms, truth table to Karnaugh map and simplification.

Unit – II: Data Processing Circuits

Multiplexers, Demultiplexers, Encoders, Decoders, Parity generators and checkers.

Unit – III: Sequential Circuits

Flip-Flops-RS, JS, D,T.
Registers-Buffer register, Shift register.
Counters-Asynchronous counter, Synchronous counter.

Unit – IV: Semiconductor Memory

ROM, PROM and EPROM, RAM, Static and Dynamic Random Access Memories (SDRAM and DRAM), content memory addressing.

Unit – V: Digital Logic Families

RTL, DTL, TTL, ECL, CMOS, MOS. Circuit diagram, analysis and specifications.

Books:

1. Digital Electronics by Malvino and Leach
2. Digital Logic and Computer Design by Morris Mano
3. Semiconductor Devices: Physics and Technology by S.M. Sze

M. Sc. Physics
Semester – III
NUCLEAR AND PARTICLE PHYSICS

Course Code: PHY-735 **Credit Hrs: 3-1-0**

Unit-I: Nuclear Interaction and Nuclear Reaction:-

Nucleon-Nucleon interaction, exchange forces and tensor forces, Meson theory of Nuclear forces, Nucleon-Nucleon Scattering, Effective Range theory, spin dependence of Nuclear forces, charge independence and charge symmetry of Nuclear forces, iso-spin formalism, Yukawa interaction.

Unit-II: Nuclear Models:-

Liquid drop model, Bohr Wheeler theory of fission, experimental evidence for shell effects, shell model, Spin orbit Coupling, Magic number, Angular momenta and parity of ground of Nuclear ground states, Qualitative discussion and estimates of transition rates, magnetic moments and Schmitt lines- Collective model of Bohr and Mattelson .

Unit-III: Nuclear Decay:-

Beta decay, Fermi theory of beta decay- Shape of the beta spectrum-total decay rate- Angular Momentum and parity selection rules- Comparatives half-lines Allowed and Forbidden transitions- Selection rules parity Violatie. Two Component theory of nutrino decay Detection and properties of Nutrino- Gamma decay- Multipole Transition in nuclei-Angular Momentum and parity selection rules-Internal Conversion Nuclear Isomerism.

Unit-IV: Elementary particle Physics:-

Types of Interaction between elementary particle, Hadrons and leptons- symmetry and Conservation Laws. Elementary ideas of CP and CPT invariance, classification of hadron-Lie algebra, SUC2, SUC3, Multiplats- Quark model-Gell Menn-Okubo Mass formula for octel and decuplet hadron-Charm, bottom and Top quarks.

Reference books:

1. Nuclear Physics
   D.C. Tayal
2. Nuclear Physics
   S.N. Ghoshal
3. Nuclear Physics
   John Lilley
4. Nuclear Physics
   Roy & Nigam
5. Introduction to Particle Physics
   M.P. Khanna

M. Sc. Physics
Physics Lab-III
Semester-III

Course Code: PHY-730 **Credit Hours: 0-0-4**

1. To find out the frequency of sine wave with the help of CRO.
2. To study the 3 to 8 line decoder.
3. To study the logic gates.
4. To study the RC phase shift oscillator.
5. To study astable multivibrator.
6. To study multiplexer and de-multiplexer.
7. To study flip-flop.
8. Designing and testing Transistor as a Switch.
9. To study the Single stage transistor Amplifier.
10. To study the Double stage RC coupled Amplifier.
11. To study the Transistor Biasing circuits.
12. To study the Applications of Op-Amp (amplifier & oscillators).
13. To study the Analog to Digital and Digital to Analog converter.
14. To study the AM, FM, PAM, PCM, PWM sampling method
15. To study and Measurement the Propagation loss in the fiber.
16. To Study the Numerical Aperture of the fiber.
17. To study and Measurement of length of the fiber.