SWAMI VIVEKANAND SUBHARTI UNIVERSITY
UGC Approved Meerut

ACCREDITED WITH GRADE A NAAC

Ordinance No. :- V-141-B-3

(Approved in Academic Council meeting held on 11.03.2026

Proposed to be ratified in forthcoming executive council)

Evaluation Scheme and Syllabus

of

M.Sc. PHYSICS

TWO – YEAR POST GRADUATE

PROGRAM

(AS PER NEP-2020)

Keral Verma Subharti College of Science

Swami Vivekanand

SUBHARTI UNIVERSITY

Meerut

Effective from 2025-2026

K. V. Subharti College of Science
S. V. Subharti University
NH-58. Byepass Road, Meerut

Programme Objectives (POs):

The main aim of the M.Sc. in Physics NEP course is to have enriched syllabus based on the recent scientific developments in physics and its interdisciplinary areas and to meet out the requirements of today's academic, research and industry requirements. To teach core subjects of physics to students to acquire knowledge and to have in-depth understanding about the laws of physics, concepts, principles and solve analytical problems. To teach practical courses that is to attain knowledge in advanced physics experiments by independently performing the same, and to clarify the theory learned in core subjects. Introducing skill-based courses training the students to handle advanced equipment and computational knowledge. To provide and teach certain popular courses which are not in conventional core courses considered as elective subjects essential for students to take up their research after completion of the postgraduate course. To provide training to students to perform research in physics and interdisciplinary areas, the course has a room that student to carry out research projects and enable the students to obtain research careers in R & D labs and industry.

Programme Outcome (POs):

PO1. The students will obtain good knowledge in Physical Sciences. They will be trained to compete national level tests like UGC-CSIR NET, JEST, GATE, etc., successfully.

PO2. They will be prepared to take up challenges as globally competitive physicists/researchers in diverse areas of theoretical and experimental physics.

PO3. They will be technically and analytically skilled enough to pursue their further studies.

PO4. They will have a sense of academic and social ethics.

PO5. They will be capable of taking up higher studies of interdisciplinary nature.

PO6. They will be able to recognize the need for continuous learning and develop throughout for the professional career.

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<table>
<tr><th colspan="8">SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT</th></tr>
<tr><th colspan="8">KERAL VERMA SUBHARTI COLLEGE OF SCIENCE</th></tr>
<tr><th colspan="8">Department of Physics</th></tr>
<tr><th colspan="8">Credit distribution of M.Sc. Physics (Session 2025-26 onwards)</th></tr>
<tr><th></th><th></th><th>I</th><th>II</th><th>Internship after II Sem</th><th>III</th><th>IV</th><th>Total</th></tr>
<tr><td>1</td><td>Core Course</td><td>16</td><td>16</td><td rowspan="5">4</td><td>8</td><td>0</td><td>40</td></tr>
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<tr><td>4</td><td>SEMINAR/VAC/OEC/EEC/CHM</td><td>2
(SEMINAR)</td><td>2
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<tr><td></td><td>Total</td><td>26</td><td>26</td><td>26</td><td>26</td><td>108</td></tr>
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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Physics													
Course Name -M.Sc.													
Batch:2025-26							**SEM:I**						
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**	**Internal Assessment**				**External Assessment**	**Total**
				L	**T**	**P**							
THEORY and PRACTICAL SUBJECTS								**CLASS PARTICIPATION**	**Quiz/PPT/ Assignment (10)**	**Mid Sem Test (15)**	**TOTAL**	**End Sem Exam (70)**	
1	CORE COURSE-1	MSPY-101	MATHEMATICAL PHYSICS	4	0	0	4	5	10	15	30	70	100
2	CORE COURSE-2	MSPY-102	CLASSICAL MECHANICS	4	0	0	4	5	10	15	30	70	100
3	CORE COURSE-3	MSPY-103	QUANTUM MECHANICS -I	4	0	0	4	5	10	15	30	70	100
4	CORE COURSE-4	MSPY-104	ELECTRONIC DEVICES	4	0	0	4	5	10	15	30	70	100
5	PRACTICAL COURSE-1	MSPY-105P	PRACTICAL-1	0	0	8	4	5	10	15	30	70	100
6	PRACTICAL COURSE-2	MSPY-106P	PRACTICAL-2	0	0	8	4	5	10	15	30	70	100
7	SEMINAR	MSPY-107S		0	0	4	2	4	4	7	15	35	50
TOTAL CREDITS / ASSESSMENT							**26**	34	64	97	195	455	**650**

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Physics													
Course Name -M.Sc.													
Batch:2025-26							**SEM:II**						
S. No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**	**Internal Assessment**				**External Assessment**	**Total**
				L	**T**	**P**							
THEORY and PRACTICAL SUBJECTS								**CLASS PARTICIPATION**	**Quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**TOTAL**	**End Sem Exam (70)**	
1	CORE COURSE-5	MSPY-201	QUANTUM MECHANICS-II	4	0	0	4	5	10	15	30	70	100
2	CORE COURSE-6	MSPY-202	STATISTICAL MECHANICS	4	0	0	4	5	10	15	30	70	100
3	CORE COURSE-7	MSPY-203	ATOMIC & MOLECULAR PHYSICS	4	0	0	4	5	10	15	30	70	100
4	CORE COURSE-8	MSPY-204	ELECTRODYNAMIC & PLASMA PHYSICS	4	0	0	4	5	10	15	30	70	100
5	PRACTICAL COURSE-3	MSPY-205P	PRACTICAL-3	0	0	8	4	5	10	15	30	70	100
6	PRACTICAL COURSE-4	MSPY-206P	PRACTICAL-4	0	0	8	4	5	10	15	30	70	100
7	CHM	CHM	Constitution of India and IPR	2	0	0	2	4	4	7	15	35	50
TOTAL CREDITS / ASSESSMENT							**26**	34	64	97	195	455	**650**

1. **AN INTERNSHIP COURSE OF 4 CREDITSOF 4-6 WEEKS DURATION DURING SUMMER VACATION AFTER IIND SEMSTER TO BE COPLETED BY EVERY STUDENTS. INTERNSHIP CAN BE EITHER FOR ENHANCING THE EMPLOYAILITY OR AN DEVELOPING THE RESEACH APTITUDE.**

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PO1. The students will obtain good knowledge in Physical Sciences. They will be trained to compete national level tests like UGC-CSIR NET, JEST, GATE, etc., successfully.

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PO3. They will be technically and analytically skilled enough to pursue their further studies.

PO4. They will have a sense of academic and social ethics.

PO5. They will be capable of taking up higher studies of interdisciplinary nature.

PO6. They will be able to recognize the need for continuous learning and develop throughout for the professional career.

Course Learning Outcomes:

1. To impart high quality education in Physical Sciences.
2. To prepare students to take up challenges as globally competitive physicists/researchers in diverse areas of theoretical and experimental physics.
3. To make the students technically and analytically skilled.
4. To provide an opportunity of pursuing high end research as project work.
5. To give exposure to a vibrant academic ambience.
6. To create a sense of academic and social ethics among the students.
7. To prepare them to take up higher studies of interdisciplinary nature.

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Semester- I **PAPER-I** **Core Course-1**

Course Name: MATHEMATICAL PHYSICS	**Course Code: MSPY-101**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives:

- To understand the various important mathematical methods in physics.
- To provide basic skills necessary for the application of mathematical methods in physics.
- To understand the mathematical methods in order to analyses theories, methods and
- interpretations.
- To develop understanding among the students how to use mathematical methods in their field
- of study of research and in the field of scientific knowledge to work independently

Course Content:

Unit 1. Special functions and polynomials: Graphical representation of basic mathematics functions. Solution of Legendre, Hermite and Laguerre differential equations. Generating function, Rodrigues's formula, recurrence relations, and orthogonality for Legendre, Hermite and
Laguerre functions. Introduction of Associated Legendre polynomials. Solution of Bessel differential equation, Bessel functions of first kind. Generating function, recurrence relations and
orthogonality for Bessel function. Expansion and integral of Bessel functions, Applications of special functions.
Unit 2. Complex Variables: Brief overview of complex numbers. Functions of a complex variable. Derivative and Cauchy Reimann equations. Analytic and harmonic function, Integration in the Complex plane, Line integrals of complex functions. Cauchy's integral theorem, Cauchy's Integral Formula. Laurent expansion, Classification of Singularities, Principal value of an integral. Cauchy's Residue theorem and evaluation of some typical real integrals using this theorem.
Unit 3. Laplace Transforms: Laplace Transform, Laplace transform of elementary Functions. First and second shifting theorems, Inverse Laplace transforms, Solutions of simple differential equations. Laplace transforms derivatives and integral of a function. Applications of Laplace Transform.
Unit 4. Fourier Series and Fourier Transform: Fourier series, Fourier series of even and odd functions. Half range expansion, Arbitrary period. Fourier integral and its complex form. Fourier
transforms, Fourier sine and cosine transform. Application of Fourier series and transformation.

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Text and References Books:

1. Mathematical method for Physics by G. Arfken
2. Advanced Engineering Mathematics by E.Kreyszig
3. Special Functions by E.D Rainville
4. Special Functions by W.W Bell
5. Functions of complex variable by R.V.Churchill
6. Mathematical Method for Physicists and Engineers by K.F.Reily, M.P.Hobson and S.J.Bence

Course Outcomes:

- After completion of the course, students will have a wide knowledge of Legendre, Hermite, Laguerre and Bessel polynomials, and their applications in physics and engineering.
- Students will be able to solve research problems based on complex variables, integral of complex functions, Students will earn the solution of various mathematical equations using Laplace transformation.
- Students will be able to use the Fourier series and transformation into some spectroscopic
  analysis.
- Students will understand the use of mathematical methods in their various branches of physics and engineering.
- The content given in 'Special functions and polynomials' of this course will impart skills for direct employability.

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Semester- I **PAPER-II** **Core Course-2**

Course Name: CLASSICAL MECHANICS	**Course Code: MSPY-102**

Credit = L + T + P =(4 + 0 + 0)	**Total Hours = 60**

Course Objectives:

The primary objectives of the classical mechanics course are:

- To study the mechanics of dynamical systems using Lagrange's equations of motion for
- conservative and non-conservative systems through Lagrangian formulation.
- To study variational principle and solve basic problems using calculus of variations.
- To understand the problem of two bodies moving under the influence of a mutual central
- force motion of the Lagrangian formulation.
- To understand the theory of small oscillations applied in many physical applications with
- the concept of stable and unstable equilibrium.
- To study and understand the Hamiltonian formulation for solving mechanical problems
- using Hamilto

Course Content:

Unit 1. Review of Elementary Principles and Lagrange’s Equations of Motion: Overview of mechanics of a particle and system of particles, Types of Constraints on dynamical systems with suitable examples, Conservation theorems, D’Alembert’s principle, generalized coordinates and generalized force, Derivation of Lagrange's equations, Velocity-Dependent potentials and the Dissipation function, Applications of Lagrangian formulation: single particle in space, Simple pendulum with rigid support, Atwood’s machine, Time-dependent constraint-bead sliding on rotating wire.

Unit 2. Variational Principles and Lagrange's Equations: Hamilton’s principle, Some techniques of the calculus of variations: Shortest distance between two points in a plane, Minimum surface of revolution and the brachistochrone problem, Derivation of Lagrange’s equation from Hamilton’s principle, advantages of variational principle formulation, Canonical or Conjugate momentum, Cyclic coordinates and conservation of conjugate momentum.

Unit 3. Two Body Central Force Problem and Small Oscillations: Reduction to the equivalent one-body problem, Equations of motion and first integrals, Equivalent one-dimensional problem and classifications of orbits, Virial theorem, The inverse square law of force, Kepler problem, Concept of small oscillations: stable and unstable equilibrium, Formulation of the problem: Expression of kinetic energy and potential energy for small oscillations.

Unit 4. Hamiltonian equations of motion:Legendre transformations and Hamilton equations of motion, Representation of Hamilton's equations of motion in matrix notation, Cyclic coordinates and conservation theorems, Derivation of Hamilton's equations from a variational principle, Principle of least action, Equations of canonical transformation, generating functions, Poisson brackets and canonical invariants, Relation of Poisson brackets, Hamilton-Jacobi Theory: Hamilton-Jacobi equation for Hamilton's Principle functions.

Text and Reference Books:

1. H. Goldstein : Classical Mechanics
2. N.C. Rana and P.S. Joag : Classical Mechanics
3. A. Sommerfiel : Mechanics
4. Perceival and D. Richards: Introduction to Dynamics

Course Outcomes:

On the successful completion of classical mechanics, the students will able to learn and understand the fundamental concepts of dynamics of system of particles, related conservation theorems, and equations of motion for mechanical systems using the Lagrangian and Hamiltonian formulation. The main course outcomes are as follows:

- Able to solve the mechanics of dynamical systems using Lagrange's equations of motion for conservative and non-conservative systems through Lagrangian formulation.
- Able to understand the variational principle and its application to solve mechanical problems using Lagrangian formulation.
- Able to deal with the problem of two bodies moving under the influence of mutual central force motion.
- Able to understand the theory of small oscillations applied in many physical applications.
- Able to solve mechanical problems using Hamilton's equations of motion by Hamiltonian form

Semester- I **PAPER-III** **Core Course-3**

Course Name: QUANTUM MECHANICS- I	**Course Code: MSPY-103**
Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives:

The primary objectives are:

- To study time-independent and time-dependent Schrodinger wave approach.
- To solve a one-dimensional Schrodinger equation for simple problems.
- To develop the theory of angular momenta and addition of angular momenta
- To understand the applicability of angular momenta in several branches of physics

Course Content:

Unit 1. Fundamental Concepts:

Wave packets, Commutator algebra and uncertainty relation, Motion of wave packets, Wave functions in position and momentum space. Operators, Hermitian operators, Degeneracy, Orthonormality and Completeness. Linear operators, Dirac notation, Matrix representations, Change of basis, Three-dimensional potential well and Hydrogen atom, vector and Hilbert Spaces, Bases, Dimension, Subspaces, Dual spaces, Inner product of spaces, Dirac notations, matrix representation of operators, Linear harmonic oscillator in matrix formulation, Rotation generators, Transformations of dynamical variables, Symmetry and conservation laws. Symmetric and anti-symmetric wave-functions and Pauli Exclusion Principle.

Unit 2. Quantum Dynamics and Approximate Methods: Time independent first and second order perturbation theory for non-degenerate and degenerate levels, Variational method, and its application for Helium atom, WKB Approximation. Application of electric field (Stark effect), Dipole Polarizability of ground state Hydrogen atom, normal and anomalous Zeeman Effect.

Unit 3. Theory of Angular momentum: Commutation relations involving angular momentum operators, the eigenvalue spectrum, Matrix representation of J, Addition of angular momentum, Clebsch- Gordon coefficients, Spin angular momentum, Spin wave functions, Addition of spin and orbital angular momentum.

Unit 4. Scattering Theory: Laboratory and center-of-mass systems, scattering by potential field, scattering amplitude, differential and total cross sections, phase shift, Lippmann-Schwinger equation, and first-born approximation

Text and References Books:

1. A text book of Quantum Mechanics by P.M. Mathews and K. Venkatesan
2. Introduction to Quantum Mechanics by E. Merzbacher
3. Quantum Mechanics by S. Gasiorowicz
4. Quantum Mechanics by L.I. Schiff
5. Modern Physics by S.P. Khare

Course Outcomes:

After completing this course, students will be able to:

- Understand the foundational principles of quantum mechanics, including its physical and mathematical basis for non-relativistic systems.
- Apply essential mathematical tools to formulate and develop the formal structure of quantum mechanics.
- Comprehend the quantum measurement process and its implications on system behavior.
- Explain the uncertainty principle and its relation to the measurement of physical observables.
- Analyze quantum systems using wave function theory, interpreting their physical meaning and evolution.
- Solve standard quantum problems, such as the free particle and particles in various potentials, appreciating the non-intuitive outcomes.
- Understand angular momentum in quantum systems and its applications across different branches of physics.
- Employ approximation methods such as perturbation theory to solve complex quantum problems, including Stark and Zeeman effects.
- Interpret and analyze scattering phenomena in atomic, subatomic, and molecular systems.

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Semester- I

PAPER-IV Core Course-4

Course Name: ELECTRONIC DEVICES	Course Code: MSPY-104

Credit = L + T + P = (4 + 0+ 0)	Total Hours = 60

Course Objectives:

The primary objectives are:

- To study the transport mechanism of elemental and compound Semiconductors.
- To study the effect of dopant concentration and temperature on devices performance.
- To studythe junction characteristics of pn- and metal-semiconductor diodes.
- To learn and understand the FET transfer characteristics.
- To learn and understand the role of metal oxide layer in MOSFETs.

Course Content:

Unit 1. Conduction Mechanism in Semiconductors

Basic carrier transport mechanisms in semiconductors; Direct and indirect bandgap, Electron and hole concentrations in bands for degenerate and nondegenerate states, Elemental and compound, Amorphous and crystalline phase in Semiconductors; Carrier concentrations, Conductivity, mobility in Semiconductors; Fermi Level, electron and hole concentrations at equilibrium; Temperature dependence of carrier concentrations, drift and diffusion of charge carriers; Effect of dopant concentration and temperature on the mobility, The continuity equation.

Unit 2. P-N junction & Metal-semiconductor diode

Qualitative theory of P-N junction, Space charge at a junction, Capacitance of p-n junctions; Generation and recombination charge carriers, Diffusion capacitance; Breakdown mechanisms: Thermal instability, Tunneling and avalanche multiplication; Transient and noise behavior, device performance as the rectifier, voltage regulator; Device structure and energy band diagram, Schottky effect, Barrier height; Voltage dependence of semiconductor surface potential, Current transport mechanisms, Device capacitance, Ohmic contact.

Unit 3. Field Effect Transistors

JFETs: Drain, source and Gate, Transfer characteristics, Current equations, Pinch off voltage and its significance; The FET small signal model, Measurement of gm and rd, JFET fixed bias, Self- bias and voltage divider configurations, JFET source follower (common-Drain) configuration. JFET Common Gate configuration; MOSFET- Characteristics, Threshold voltage, Channel length modulation, D-MOSFET, E-MOSFET Characteristics, Comparison of MOSFET with JFET; Depletion and enhancement type MOSFETs.

Unit 4. Feedback Amplifiers: The transistor as an Amplifier, Analysis of a Transistor amplifier circuit using h parameters, Hybrid π model, Ebers-Moll model, Transistor biasing and thermal stabilization; Classification of Amplifiers, Feedback concept, Ways to introduce negative feedback in Amplifiers, Effect of negative feedback, Method of analysis of a feedback amplifier, Voltage-series feedback, Current-series feedback, Voltage-shunt feedback, Current-shunt feedback.

Text and Reference Books:

1. Solid State Electronic Devices by B.G. Streetman
2. Electronic Devices and Circuit Theory by R.L. Boylested and L. Nashelsky
3. Integrated Electronics by J. Millman and C.C. Halkias
4. Introduction to Semiconductor Devices by M. S. Tyagi
5. Electronic Devices and Circuits by Balbir Kumar and S.B. Jain

Course Outcomes:

- To understand the conduction mechanism of elemental and compound semiconductors for designing the electronic components and circuits.
- Understanding the basic phenomenon of semiconductors, it can be used for the fabrication of modern devices.
- Having knowledge of semiconductors, junction diodes, diode and transistor biasing, and amplifies, students can have the job in semiconductor and microelectronic Industries, communication and telecom.

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Semester- I **PRACTICAL COURSE-1**

Course Name: PHYSICS PRACTICAL-1	**Course Code: MSPY-105P**

Credit = L + T + P = (0 + 0 + 8)	**Total Hours = 60**

1. Design of a Regulated Power Supply.
2. To study the RC coupled amplifier.
3. Study of common Emitter Follower.
4. Study and Verification of Basic Logic gates.
5. To study the negative and positive clipping and clamping.

Semester- I **PRACTICAL COURSE-2**

Course Name: PHYSICS PRACTICAL-2	**Course Code: MSPY-106P**
Credit = L + T + P = (0 + 0 + 8)	**Total Hours = 60**

1. To measure the value of energy band gap in Germanium material by four probe methods.
2. To plot the V-I characteristics of a MOSFET.
3. To plot forward and reverse characteristics of SCR
4. To plot the V-I characteristics of FET
5. To study of the Hall coefficient and its applications

Semester- II **PAPER-I** **Core Course-5**

Course Name: QUANTUM MECHANICS- II	**Course Code: MSPY-201**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives:

- To teach the students various approximation methods in quantum mechanics.
- To teach Klein-Gordon and Dirac approaches to under Relativistic quantum theory
- To teach the importance of quantization of electromagnetic radiation in science
- To make the students understand introductory quantum field theory.

Course Content:

Unit 1. Approximation Methods (Time Evolution): First order perturbation, Interaction of an atom with an electromagnetic field, Transition probabilities, Fermi Golden rule, Dipole approximation. Einstein's coefficients based on quantum mechanics, Induced and spontaneous emissions of radiations, Applications of transition quantum theory in gas and solid-state lasers, adiabatic approximation.

Unit 2. Quantum Theory of Radiation: Classical radiation field, Fourier decomposition and electromagnetic radiation field, dipole approximation, Second Quantization, Creation, annihilation and number operators, Photon states, Basic matrix elements for emission and absorption, explanation of stimulated and Spontaneous emission on the bases of quantum mechanics, Importance of second quantization, Plank's radiation law.

Unit 3. Relativistic Quantum Theory: Klein-Gordon equation and its plane wave solution, Probability density in KG theory, Difficulties in KG equation, Dirac equation for a free electron, Dirac matrices and spinors, Plane wave solutions, Charge and current densities, Existence of spin and magnetic moment from Dirac equation of electron in an electromagnetic field. Dirac equation for central field with spin orbit interaction, Energy levels of Hydrogen atom from the solution of Dirac equation, covariant form of Dirac equation.

Unit:4 Introduction of Quantum Field theory:

Lagrangian density and equation of motion for field, Symmetries and conservation laws, Noether's theorem, canonical quantization of scalar field, Complex scalar field, electromagnetic field and Dirac field, Problem in quantizing electromagnetic field, Gupta & Bleuler method.

Text and Reference Books

1. Quantum Mechanics by L.I. Schiff
2. Modern Quantum Mechanics by J.J. Sakurai
3. A Text Book of Quantum Mechanics by P.M. Mathews and K.Venkatesan
4. Quantum Mechanics by A. P. Messiah

Course Outcomes:

After completing this course, students will be able to

- Understand the time-dependent Schrodinger wave approach and its applications in real life
- Understand the importance of second quantization connection between symmetries, degeneracies, and conservation laws.
- Understand the importance of second quantization Differentiate between classical and quantum identical particles.
- Get basic information needed for advanced courses like quantum field theory.
- The course contents like quantum transitions process for solid-state and gas lasers, the process of second quantization and part of field theory are directly useful for employment.

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Semester- II **PAPER-II** **Core Course-6**

Course Name: STATISTICAL MECHANICS	**Course Code: MSPY-202**
Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives:

- To understand the analysis of the statistical macroscopic quantities of various systems in terms of constituents.
- To learn the ensemble theory and their macroscopic parameters.
- The application of Bose Einstein statistics and Fermi-Dirac statistics to analysis the properties of ideal Bose gas and Fermi-Dirac gas.
- To understand the various models of cluster expansion and fluctuations of thermodynamic variables.
- To learn the theoretical aspect of order-disorder phase transition of various phases.

Course Content:

Unit 1. Ensembles and Statistics of Ideal Gas System. Scope and objective of statistical mechanics. Analysis of phase space, phase points, Mu and Gamma space, Ensemble. Density of phase points, Microstates and Macrostates, Number of accessible microstates. Detailed analysis of micro canonical, canonical and grand canonical ensembles and their properties. Partition function formulation. Fluctuation in energy and particle. Equilibrium properties of ideal systems: classical ideal gas, Harmonic oscillators, Para magnetism, concept of negative temperature. The entropy of mixing of ideal gas and Gibbs paradox, Sackur-Tetrode equation.

Unit 2. Quantum Statistical Mechanics: Transition from classical statistical mechanics to quantum statistical mechanics. Postulates of quantum statistical mechanics, Density matrix, Indistinguishability and quantum statistics, identical particles and symmetry requirements. Basic postulate and particle distribution function of Bose Einstein statistics. Energy, number of particles and pressure of B.E. gas. Bose Einstein Condensation, Thermal properties of B.E. gas, Transition in liquid He4, Superfluidity in He4. Basic postulate and particle distribution function of Fermi Dirac statistics. Energy, number of particles, temperature and pressure of F.D. gas. Properties of ideal electron gas, Thermionic Emission.

Unit 3. Statistical models for order-disorder phase transition: Cluster expansion for a classical gas, virial equation of state, ising model, mean-field and Heigenburg theories of Ising model, Exact solutions in one-dimension. Thermodynamic phase diagrams, Order parameter, Landau theory of phase transition, Landau theory of liquid He-II, critical exponents, Scale invariance, Critical dimensionality.

Unit 4. Fluctuations: Introduction to non-equilibrium processes, fluctuations and transport phenomena, Random walk and Brownian motion, Langevin theory of Brownian motion and relation with diffusion equation.

Text and Reference Books

1. Statistical and Thermal Physics by F. Reif
2. Statistical Mechanics by

K. Huang
3. Statistical Mechanics by R. K. Pathria
4. Statistical Mechanics by R. Kubo
5. Statistical Physics by Landau and Lifshitz
6. Statistical Mechanics and properties of matter, theory and application by E.S.R. Gopal

Course Outcomes:

- After completion of the course, the students will have the basic knowledge of statistical
- mechanics.
- Students will be able to calculate the statistical quantities of various systems.
- Students will be able to eexplain the ensemble theory required for macroscopic properties of the matter in bulk in terms of its constituents.
- Students will understand the analysis of properties of ideal Bose gas, Bose- Einstein condensation, liquid helium and electron gas.
- Students will be able to understand the various theories and models of cluster expansion and fluctuations of thermodynamic variables.
- Students will have the knowledge to explain the theoretical aspect of order-disorder phase
  transition in various systems.

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Semester- II **PAPER-III**

Core Course-7

Course Name: ATOMIC AND MOLECULAR PHYSICS	**Course Code: MSPY-203**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives:

The study of atoms and molecules has played a major role in the development of physics and in
the development of our understanding of the structures and properties of matter as it is encountered in everyday life. The main objectives of this course are

- To develop an understanding of the atomic emission/ absorption spectra of one electron and many electrons atoms.
- To understand the concept of molecular spectroscopy of diatomic molecules which includes Rotational, Vibrational and Electronic energy levels.
- To gain insight of important characterization techniques such as IR/FTIR, Raman, PES,
NMR,

Course Content:

Atomic Physics:

Unit 1. Introduction to Atomic spectra, Quantum states of an electron in Hydrogen atom. Relativistic corrections for energy levels of hydrogen atom. Concept of spin and fine structure of hydrogen atom. Singlet and triplet States of Helium. Broad features of spectra of alkali elements. Fine structure in Alkali Spectra.

Unit 2. Many electron atoms: Central field approximation, Atomic wave function, Hartree and
Hartree–Fock approximations, Results of Hartree's theory, Spectroscopic Terms: LS coupling,
Lande Interval rule, determination of spectral terms for atoms; with two or more Non-equivalent optical electrons, and two or more equivalent optical electrons. Breit's scheme. JJ coupling for many electron atoms. Atom in external field, Zeeman, Paschen-Bach & Stark effects.

Molecular Physics:

Unit 3. Born-Oppenheimer approximation, Classification of Molecules, Types of Molecular Spectra and Molecular Energy States: Pure Rotational Spectra, Vibrational-Rotational Spectra,
Raman Scattering, Classical and Quantum theory of Raman effect. Selection rules, Isotope effect, Formation of electronic spectra, fine structure of electronic bands. Intensity distribution in electronic bands: Franck-Condon principle. Explanation of intensity distribution in absorption and emission bands from Franck-Condon principle.

Characterization Techniques:

Unit 4. Infrared/FTIR Spectroscopy, General description and working of dispersive and FTIR instrument. Interpretation of FTIR spectra. Raman spectroscopy. Nuclear Magnetic Resonance,

Chemical Shift, NMR Spectrometer. NMR spectrum analysis.

Text and Reference Books

1. Introduction to atomic spectra by H.E. White
2. Spectra of diatomic molecules by Herzberg
3. Atoms and molecules by M. Weissbluth
4. Quantum theory of Atomic Structure Vol I by Slater
5. Quantum theory of molecules and Solids by Slater
6. Fundamentals of molecular spectroscopy by C.B.Banwell
7. Introduction to molecular spectroscopy by G.M.Barrow
8. Molecular spectroscopy by Jeanne L.McHale
9. Molecular spectroscopy by J.M.Brown
10. Spectra of atoms and molecules by P.F. Bemath

Course Outcomes:

On successful completion of this course, the students will:

- Develop the ability to conceptually understand the atomic spectra of Hydrogen atom and similar a valance electron atoms.
- Be able to understand and interpret the atomic spectra for many electron atoms.
- Also can also explain the change in behavior of atoms in external applied electric and magnetic field and corresponding changes in observed spectra.
- Gain sufficient understanding of rotational, vibrational, electronic and Raman spectra of molecules.
- Develop skill in important material characterization techniques like IR/FTIR, Raman, etc.
- Acquire ability to apply Nuclear Magnetic Resonance (NMR) for structure elucidation of Synthesiz.

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Semester- II **PAPER-IV** **Core Course-8**

Course Name: ELECTRODYNAMICS & PLASMA PHYSICS	**Course Code: MSPY-204**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives:

- To teach the students about the basic phenomenon of electrostatics and magnetostatics for
  the application of electromagnetism.
- To study the transfer of energy in terms of electro-magnetic waves.
- To learn about the formation of plane electromagnetic waves for transmitting and receiving data in terms of photons.
- To learn about the work-energy theorem for data transfer mechanism.

Course Content:

Unit 1. Electrostatics

Physical significance of Vector algebra and Calculus: divergence, gradient, and Curl; Electrostatic fields in matter, Dielectrics, Polarization; Field inside a dielectric, Electric displacement, Linear dielectrics;Gauss's divergence theorem and symmetry: planner (pillbox),
co-axial (cylindrical), spherical (concentric); Laplace's and Poisson Equations, Methods of images, point charge near an infinite conducting plane, Point charge in the presence of grounded conducting sphere, Point charge in presence of charged insulated sphere.

Unit 2. Magnetostatics

Magnetic vector potential, Magnetostatic fields in Matter: Magnetization, Ampere's circuital law; field of a magnetized object, magnetic field inside matter, linear and nonlinear magnetic media.

Unit 3. Plane Electromagnetic Wave

Basic phenomenon of electromagnetic waves: Reflection, Refraction at an interface between dielectrics, transmission, absorption; Plane electromagnetic waves in free space, dielectrics and
conducting media; Fresnel's relation of polarization by reflection and total internal reflection; Maxwell's displacement current, Maxwell's equations, Maxwell's equations in terms of vector
and scalar potentials, Poynting theorem, Lienard- Wiechert potentials due to a point charge, Fields of a point charge in motion, Power radiated by an accelerated charge, Larmor's formula and its relativistic generalization.

Unit 4. Plasma

Definition of plasma, Concept of temperature, Debye shielding, Criteria for plasma, Single-particle motions in E and B fields, Magnetic mirrors and plasma confinement, Plasma as fluid,
the fluid equation of motion, Equation of continuity and equation of state, Waves in plasmas, Plasma oscillations, Plasma

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frequency ωp, Electron plasma waves, ion waves, Electron and ion
oscillations perpendicular to B and parallel to B.

Text and Reference Books:

1.Classical Electrodynamics by J.D. Jackson

2. Foundations of Electromagnetic theory by J.R. Reitz, F.J.Milford and R.W.Christy

3. Introduction to Electromagnetics by David J. Griffiths

4. Intriduction to Plasma Physics and Controlled Fusion, Vol-1: Plasma Physics by Francis F. Chen

5. Plasma Physics by S.N. Sen.

Course Outcomes:

After completing this course, students will

- Understand the electromagnetic phenomenon used for the wireless communication in terms of photons.
- Understand the importance of reflection, transmission, and absorption of electromagnetic
waves.
- Understand the importance of work-energy phenomenon used for transmission of data by
using plane electromagnetic waves.
- Studying this syllabus, the students can get a chance to utilize their skills in wireless and
telecom industries for propagation/receiving signals/data/energy.

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Semester- II **PRACTICAL COURSE-3**

Course Name: PHYSICS PRACTICAL-3	**Course Code: MSPY-205P**
Credit = L + T + P = (0 + 0 + 8)	**Total Hours = 60**

1. Determination of Lande g- factor by ESR spectroscopy.
2. Wavelength of laser by diffraction method (Transmission grating).
3. To determine the Coefficient of Thermal Conductivity of a metal by Searle's Method.
4. To find the Wavelength of laser and thickness of wire.
5. To find the operating voltage and count at various distances between the radioactive sources and the tube.

Semester- II **PRACTICAL COURSE-4**

Course Name: PHYSICS PRACTICAL-4	**Course Code: MSPY-206P**
Credit = L + T + P = (0 + 0 + 8)	**Total Hours = 60**

1. To study the characteristics of active filter.
2. To study the wave shape and frequency generated by phase shift oscillator.
3. To determine the value of a electronic charge by Millikan's method.
4. To determine the value of Planck's constant.
5. Measurement of absorption coefficient of a material (supplied) using laser light.

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Physics													
Course Name -M.Sc.													
Batch:2025-26								**SEM:III**					
S.No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load**			**Credits**	**Internal Assessment**				**External Assessment**	**Total**
				L	**T**	**P**							
THEORY and PRACTICAL SUBJECTS								**CLASS PARTICIPATION**	**Quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**TOTAL**	**End Sem Exam (70)**	
1	CORE COURSE-9	MSPY-301	CONDENSED MATTER PHYSICS	4	0	0	4	5	10	15	30	70	100
2	CORE COURSE-10	MSPY-302	NUCLEAR & PARICLE PHYSICS	4	0	0	4	5	10	15	30	70	100
3	DISCIPLINE ELECTIVE COURSE -1	MSPY-303 A OR MSPY-303 B	SPECIAL PAPER-I ELECTRONICS **OR** LASER & MODERN OPTICS	4	0	0	4	5	10	15	30	70	100
4	DISCIPLINE ELECTIVE COURSE -2	MSPY-304 A OR MSPY-304 B	SPECIAL PAPER-II ELECTRONICS **OR** SPECTROSCOPY	4	0	0	4	5	10	15	30	70	100
5	PRACTICAL COURSE- 5	MSPY-305P	PRACTICLA-5	0	0	8	4	5	10	15	30	70	100
6	PRACTICAL COURSE-6	MSPY-306P	PRACTICLA-6	0	0	8	4	5	10	15	30	70	100
7	OEC	OEC	MATLAB	2	0	0	2	4	4	7	15	35	50
TOTAL CREDITS / ASSESSMENT							**26**	34	64	97	195	455	**650**

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Physics

Course Name -M.Sc.

Batch:2025-26							**SEM:IV**						
S. No.	**Course Type**	**Course Code**	**Course Name**	**Teaching Load L**	**T**	**P**	**Credits**	**Internal Assessment**			**TOTAL**	**External Assessment**	**Total**
THEORY and PRACTICAL SUBJECTS								**CLASS PARTICIPATION**	**Quiz/ PPT/ Assignment (10)**	**Mid Sem Test (15)**		**End Sem Exam (70)**	
1	DISCIPLINE ELECTIVE COURSE - 3	MSPY-401A OR MSPY-401B	SPECIAL PAPER-III ELECTRONICS **OR** PHYSICS OF NANOMATERIALS	4	0	0	4	5	10	15	30	70	100
3	DISCIPLINE ELECTIVE COURSE - 4	MSPY-402A OR MSPY-402B	SPECIAL PAPER-IV ELECTRONICS **OR** MODERN PHYSICS	4	0	0	4	5	10	15	30	70	100
4	DISCIPLINE ELECTIVE COURSE - 5	MSPY-403A OR MSPY-403B	EXPERIMENTAL TECHNIQUES IN PHYSICS **OR** ELECTROMAGNETIC THEORY	4	0	0	4	5	10	15	30	70	100
5	DISSERTATION	MSPY-404R		4	0	8	12	20	30	50	100	200	300
7	EEC	EEC-1	Density Functional Theory	2	0	0	2	4	4	7	15	35	50
TOTAL CREDITS / ASSESSMENT							26	39	64	102	205	445	650

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Semester- III **PAPER-I** **Core Course-9**

Course Name: CONDENSED MATTER PHYSICS	**Course Code: MSPY-301**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives: To study some of the basic properties of the condensed phase of matter, especially solids. Condensed matter Physics is the study of the structure and behavior of the matter that makes up most of the usual stuff that surrounds us every day. Condensed Matter Physics is the fundamental science of solids and liquids. It has the greatest impact on our daily lives by providing foundations for technology.

Course Content:

Unit 1. Bravais lattice, primitive vectors, primitive unit cell, conventional unit cell, Wigner-Seitz cell; Sym- metry operations and classification of 2- and 3-dimensional Bravais lattices; point group and space group (information only); Common crystal structures: NaCl and CsCl structure, close-packed structure, Zinc blende and Wurtzite structure, tetrahedral and octahedral interstitial sites, Spinel structure. X-ray diffraction, The Laue, powder and rotating crystal methods, Reciprocal lattice and Brillouin zone; Ewald construction; Explanation of experimental methods on the basis of Ewald construction. Anomalous scattering; Atomic and geometric structure factors; systematic absences. Point defects (Schottky & Frankel Defects) Imperfections, Line defects (Edge& Screw dislocations), Burger vector & Burger Circuit Planer (stacking) faults.

Unit 2. Different types of bonding in solids, covalent, metallic, Vander Waal, hydrogen bonding & ionic bonding, Madelung constant of ionic crystals, cohesive energy. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power.

Unit 3. Electronics Properties of Solids: Electrons in a periodic lattice: Bloch theorem, The Kronig-Penny Model, Effective mass of an electron, Tight-binding approximation, Cellular and pseudopotential methods.

Superconductivity: Review of basic properties, Meissner effect, Type-I and Type-II superconductors, thermodynamics of superconductors, London's phenomenological theory, Flux quantization. Elements of BCS theory. Josephson junction and applications.

Unit 4. Magnetic Properties of Solids: Weiss theory of ferromagnetism, Heisenberg model and molecular field theory, Ferromagnetic domains, The Bloch-wall, Spin waves and Magnons, Curie- Weiss law for susceptibility, Ferri and antiferro-magnetic order.

Text and References Books

1. Verma and Srivastava: Crystallography for Solid State Physics
2. Azaroff: Introduction to Solids
3. Omar: Elementary Solid State Physics
4. Aschroff & Mermin: Solid State Physics
5. Kittel: Solid State Physics

Course outcomes:

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- After completing this course, students will
- Be able to correlate real and virtual lattice which is the key of structure property relationship of any solid.
- Develop skill in X-ray diffraction techniques and its applications.
- Gain knowledge of various crystal imperfections and their impact of properties of the material.
- Also be able to explain electronic and magnetic properties. The knowledge may help them to design new materials with desired electronic and magnetic properties.
- Learn about the basic concept of super conductivity and its applications.

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Semester- III **PAPER-II** **Core Course-10**

Course Name: NUCLEAR AND PARTICLE PHYSICS	**Course Code: MSPY-302**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives:

- To impart knowledge about nuclear properties.
- To understand the nuclear decay, inter-nucleon forces and related facts.
- To understand the Nuclear reactions.
- To understand the different nuclear detectors.
- To understand the different nuclear modals to know fundamental principles and concepts governing nuclear structures.
- To understand particle physics to construct nuclear reactions.

Course Content:

Unit 1. Nuclear Structure and Nuclear force: Nuclear structure and properties. Binding energy per nucleon, Proton and neutron separation energy. Analysis of nuclear angular momentum, nuclear magnetic dipole moment and nuclear electric quadruple moment, Parity quantum number. Overview of Deuteron properties. Theory of Deuteron ground state and excited states. Two-nucleon scattering at low energy, neutron-proton scattering, partial wave analysis, phase-shift, scattering length, proton- proton scattering (qualitative discussion). Charge symmetry and charge independence of nuclear forces, exchange nature of nuclear forces, saturation of nuclear forces.

Unit 2. Nuclear Models: Fermi gas model, Experimental evidence for shell structure in nuclei, Basic postulates of shell model, Single- particle energy levels in central potential, Spin-orbit potential and prediction of magic numbers, Extreme single- particle model, Prediction of angular momenta, Parities and magnetic moment of nuclear ground states, Semi- empirical mass formula, The Unified Model.

Unit 3. Nuclear Decay, Reactions and Nuclear detectors: Overview of alpha, beta and gamma- decay, Parity violation in beta decay, Neutrino, Wu's experiment in beta decay, Internal conversion. Introduction and types of nuclear reactions, conserved quantities of nuclear reaction, energies of nuclear reaction, Q value, exoergic & endoergic reactions, nuclear fusion and fission reactions. Interaction of radiation with matter, Ge and Si solid state detectors. Calorimeters and their use for measuring jet energies. Scintillation and Cerenkov counters, hybrid detectors.

Unit 4. Particle Physics: Overview of properties, origin and classification of Elementary particles, type of interactions and conservation laws, Properties of mesons, Resonance particles, Strange particles and Strangeness quantum number, Simple ideas of group theory, Symmetry and conservation laws, CP and CPT invariance, Special symmetry groups SU (2) and SU (3) classification of hadrons, Quarks, Gell- Mann- Okubu mass formula.

Text and Reference Books:

1. Nuclear Physics by Roy & Nigam

2.Introduction to nuclear Physics by H. Enge
3. Theoretical Nuclear Physics by J.M. Blatt and V.F. Weisskopf
4. Theoretical nuclear and Subnuclear Physics by J.D. Walecka
5. Particle Physics An introduction by M.Leon
6. Group Theory in Subnuclear Physics by F.I. Stancu
7. Introduction to Particle Physics by R. Ones.

Course outcomes:

- After completion of the course, students will learn about the nuclear angular momentum and dipole moment of nuclei.
- They will understand the concept of inter nucleon forces and related facts.
- Students will understand the parity violation in beta-decay.
- Students will understand nuclear reactions and detectors.
- Students will obtain knowledge of the nuclear structure and various important Nuclear models.
- They will be able to construct nuclear reactions using the conservation laws for elementary particles.
- The knowledge of various detectors will impart skills for direct employability.

Semester- III **PAPER-III** **DISCIPLINE ELECTIVE COURSE (DEC) -1**

Course Name: SPECIAL PAPER- I: ELECTRONICS	**Course Code: MSPY-303A**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives:

- To learn about the basic and advanced knowledge of amplifier, operational amplifiers.
- To study voltage and current controlled Source, rectifiers, and gains.
- To study the CMOS technology and logic families.
- To study the digital numbers system, logic gates for mathematical operations and memories.
- To design the arithmetic logic circuits and storage data systems: flip-flop, registers. Counters

Course Content:

Unit I: Operational Amplifier and their Application

Characteristics of an ideal operational amplifier, Op-Amp Specifications, DC Off-set parameter, Frequency parameters, Applications of operational amplifiers: Inverting and Non-inverting amplifiers, Unity follower, Voltage summing and subtraction, Integrator, Differentiator, multiple stage gain, Current controlled voltage source, Voltage controlled current source, Rectifiers and Limiters, Comparators and Schmitt Triggers, Active filters.

Unit II: Logic Families

Logic gate symbols and truth tables, Classes of digital integrated circuits (Diode logic, DTL, TTL, ECL, MOSFET, CMOS), Transistor- Transistor Logic (TTL), Single Input TTL Inverter (transfer characteristic), multi-collector transistors, Propagation delays, Diode Logic, DTL NAND Gate (transfer characteristic, noise immunity, fan out), Emitter Coupled Logic (transfer characteristic of OR/NOR gate, practical implementation, MOSFET Logic, MOSFET Inverter, MOSFET NOR and NAND gates, Complementary MOS (CMOS)- CMOS inverter, CMOS NOR and NAND, Power dissipation in CMOS, Advantages/Disadvantages of CMOS.

Unit 3: Digital Electronics and Logic Gate Number systems: Binary, Octal, Decimal and Hexadecimal, Base conversion systems, Basic logic gates: OR, AND and NOT, Bubbled gate, Boolean Algebra, De-Morgan’s theorems, Boolean equations of Logic circuits, Combinational logic circuits, NOR and NAND Gates, Sum of Product (SOP) and Product of Sum (POS) methods, Karnaugh map (K-map), pairs, quads and octets, K- map simplifications, don’t care conditions, Product of Sum simplifications, Min-terms and Max- terms, Converting a truth table to an Equations, Exclusive-OR gate, BCD to decimal decoders, Excess-3 code, gray code,.

Unit 4: Application of Digital Logic Gates Arithmetic circuits:

binary addition and subtraction, 1’s and 2’s complement arithmetic and representation; Arithmetic building blocks, Half adder and Full adder circuits; Multiplexers and Demultiplexer, RS Flip-Flops: NOR and NAND gate latch, Clocked RF Flip-Flops, Edge- triggered D Flip-Flop, T-Flip Flop, JK Flip-Flop, Flip-Flop timing, JK Master-Slave Flip-Flops; Registers, Types of registers, Serial-in-serial out,

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Serial-in-parallel out, Parallel-in-serial out, Parallel-in parallel out; Counters: Asynchronous and synchronous counters, Mod-3 and Mod-5 counters, Shift counters; Digital-to-Analog and Analog-to-Digital Converters; Microprocessor- 8085 microprocessor architecture, interfacing devices, BUS timing, Basic terms and ideas of memory.

Text and Reference Books:

1. Electronic Device and Circuit: R. Boylested and L. Nashdsky
2. Analysis and Design of Digital Integrated Circuit: Hodges, Jackson and Saleh
3. Digital Principles and Implementation: A.P. Malvino and D.P. Leach
4. Op- Amp and Linear Integrated Circuit: Ramakant A. Gayakwad

Course outcomes:
At the completion of the course students will be able to:

- To learn for designing amplifiers, operational amplifiers for various applications.
- To learn for CMOS technology, ICs designing for digital circuit operations.
- Having the knowledge of number systems and logic gates, students can develop the mathematical operations.
- To learn the actual role of Transistors for making ICs and data storage systems.
- After studying and practical learning of logic families, gates, and circuits, the students can
  get the job in microelectronic component industries, telecommunication industries for designing circuits.

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Semester- III **PAPER-IV** **DISCIPLINE ELECTIVE COURSE (DEC) - 1**

Course Name: Lasers and Modern Optics	**Course Code: MSPY-303B**

Credit = L + T + P = (4 + 0+ 0)	**Total Hours = 60**

Course Objectives: Students should develop a basic understanding and awareness of the physics of lasers is subsequently developed. A central theme is a description of phase and coherence that enables a discussion of applications of modern optics including interference, diffraction and polarization.

Course Content:

Unit – I Laser: Einstein coefficients, Light amplification; Population inversion; pumping processes; rate equation for three and four level systems; Cavity modes, polarization of cavity media; Quality factor of cavity and ultimate line width, Characteristic properties, Basic principles of Ruby, He-Ne, CO2.

Unit – II Holography: Basic principle of holography, Method of hologram Recording and Reconstruction; Basic theory of plane hologram; practical consideration of holography and its application.

Unit – III Non- Linear: Non-linear polarizability tensors, Coupled amplitude equation; Manely-Rowe relationship; Parametric amplification and oscillation, Phase matching, Second harmonic generation.

Unit – IV Fibre Optics: Types of fibres, Single mode and multi-mode fibres; dispersion and loss in fibre; Principles of optical communication, Optical elements. Spatial and temporal coherence, classical and quantum coherence function; Glauber's theory of optical coherence, Over completeness of coherent states and its properties; Quasi phase distribution function.

References:

1. Optical Coherence and Quantum Optics, L.Mandel and E.Wolf (Cambridge University Press, Cambridge, 1995)
2. Quantum Optics by M.O. Scully and M. Suhail Zubairy (Cambridge University Press, Cambridge, 1997)
3. Physics of Non-Linear Optics by Guang S. He and Song H. Liu(World Scientific Press, Singapore, 2003)
4. Laser and holographic Data processing by N. G. Bosov (Mir Publisher, Moscow)

Course outcomes:

After completion of this course students would be able to

- Determine a general formula for laser gain in a generalised four-level laser.

- Describe the operation of helium-neon and carbon dioxide lasers.
- Understand principle of diffraction grating;
- Determine diffraction patterns, resolving power, and spectrums by diffraction gratings.

Semester- III **PAPER-V DISCIPLINE ELECTIVE COURSE -2**

Course Name: SPECIAL PAPER- II: ELECTRONICS	**Course Code: MSPY-304A**

Credit = L + T + P = (4 + 0+ 0)	**Total Hours = 60**

Course Objectives: Students should develop a basic understanding and awareness about the digital communication, modulation techniques and signal transmission.

Course Content:

Unit 1. Digital Communication: Pulse Modulation system, Sampling Theorem, low pass and band pass signals, PAM, Channel BW for a PAM signal Natural sampling, Fat- top sampling. Signal Recovery, through Holding, Quantization of signals, Quantum error, Differential PCM, Data modeling, Adaptive data Modulation, CVSD

Digital Modulation Techniques: BPSK, DPSK, QPSK, PSK, QASK, BFSK, FSK, MSK

Unit 2. Amplitude Modulated Systems: Frequency translation, method of frequency translation, recovery of the base band signal, Amplitude modulation, Maximum allowed modulation, The square law demodulation, Spectrum of an amplitude modulated signal, Modulators and Balanced modulators, Single side band modulation, Methods of generating as SSB signal, Vestigial side band modulation, Multiplexing.

Unit 3. Frequency Modulated Systems: Angle modulation, Phase and frequency modulation, Relationship between phase and frequency modulation, Phase and frequency deviation, Spectrum of an FM signal, Sinusoidal modulation, Bandwidth of a sinusoidally modulated FM signal, FM generation, Parameter variation method, Armstrog system.

Unit 4. Transmission and Radiation of signals: Primary line constants, phase velocity and line wavelength, Characteristic impedance, Propagation Coefficient, Phase and group velocities, Standing waves, Lossless line at radio frequencies, Voltage standing wave ratio, Slotted line measurements at radio frequencies, Transmission lines as circuit elements, Smith chart, Single and double Stub matching, Time domain reflectometry, Telephone lines and cables, Radio frequency lines. Principles of light transmission in a fiber, Propagation within a fiber, Effect of index profile on propagation, Modes of propagation, Single mode propagation, Losses in fibres, Dispersion, Fiber optic communication systems.

Text and Reference Books

1. Electronic Devices and circuit Theory by R. Boylested and L. Nashdsky
2. Principles of Communication Systems by H. Taub and Donald L. Schilling
3. Optoelectronics: Theory and Practice, Edited by Alien Chappal
4. Microwaves by K.L. Gupta
5. Electronic communications by Dennis Roddy and John Coolen

Course **Outcome**s: After completion of this course students would be able to

- Recognize a variety of exciting high-tech products and systems enabled by electronics.
- Manipulate voltages, currents and resistances in electronic circuits.
- Demonstrate familiarity with basic electronic components and use them to design simple electronic circuits.

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Semester- III **PAPER-VI** **DISCIPLINE ELECTIVE COURSE -2**

Course Name: Spectroscopy	**Course Code: MSPY-304B**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives: Course objectives: Students should develop a basic understanding on spectroscopy, coordinate analysis, different types of spectra and study about vibration and electronics motion

Course Content:

Unit – I Vector model for two and three valence electrons, Lande interval rule, Inverted terms and Hund's rule, Lande 'g' factor, spectral terms by magnetic quantum numbers. Breadth of spectral lines, Intensity of spectral lines, Nuclear spin, Isotope effect and Hyperfine structure, Lamb shift.

Unit – II

Normal coordinate analysis: classical and quantum mechanical treatment of normal modes of vibration, vibrational selection rules, Fermi resonance, Vibrational and electronic spectra of benzene.

Unit – III

Rotational spectra of linear molecules like CO2 and HCN, Rotational Raman spectra, Microwave spectra of ammonia. Rotational structure of vibrational bands, Parallel and perpendicular bands of linear molecules like CO2 and HCN and symmetric top molecules like NH3, Coriolis interaction.

Unit – IV

Classification of electronic states, interaction of vibration and electronic motion, Renner-Teller effect, Coupling of rotation with vibration and electronic motion for linear molecules. Allowed and forbidden electronic transitions, Isotope effect, Teller and Redlich product rule.

Text and Reference Books:

1. Atomic spectra: H.E. White
2. Molecular spectra and Molecular structure Vol. I, II, III: G. Herzberg

Course Outcomes: After completion of this course students would be able to

- Interpret UV-Visible spectroscopy.
- Explain basic principles of UV-Visible spectroscopy
- Explain working principle, taking spectra and outline of UV spectroscopy device.
- Explain basic principles of IR spectroscopy.

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Semester- III **PRACTICAL COURSE- 5**

Course Name: PHYSICS PRACTICAL-5	**Course Code: MSPY-305P**

Credit = L + T + P = (0+ 0 + 8)	**Total Hours = 60**

1. To study the characteristics of active filter.
2. To study the wave shape and frequency generated by phase shift oscillator.
3. To study the Operational Amplifier.
4. To determine the value of Planck’s constant.
5. To determine the resistivity of given semiconductor crystal and hence the energy band gap using Four probe Method.

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Semester- III **PRACTICAL COURSE- 6**

Course Name: PHYSICS PRACTICAL-6	Course Code: MSPY-306P

Credit = L + T + P = (0+ 0 + 8)	Total Hours = 60

1. To study and verify the outputs of 4/8 Bit Analog to Digital converter.

2. Study of 8085 microprocessor.

3. To study the Dual DAC Interface.

4. To study of Half and Full adder.

5. To verify the Truth Table of Universal Logic Gates.

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Semester- III **OEC- 1**

Course Name: MATLAB	Course Code:

Credit = L + T + P = (2+ 0 + 0)	Total Hours = 30

Objectives:

The students should be made to:

- Be familiar with the MATLAB GUI and basic toolboxes.
- Be familiar with arithmetic, logic and relational operations on matrix
- Aware about to find the roots of nonlinear equations by numerical methods
- Learn various methods to solve the matrices
- Learn about interpolation, least square fitting, Numerical differentiation, Integrations,
- ordinary and partial differential equations.

Course Content:

Unit 1. MATLAB:

MATLAB environment, M-Files, Basic syntax and scalar arithmetic operations, variables, Working with formula, MATLAB control flow: if and loops, Functions, structured data types, file input output, defining functions, Graphics, 2D & 3D plotting in MATLAB, Linear algebra with MATLAB, solving a system of linear equations.

Unit 2. Roots of nonlinear equations:

Linear and nonlinear algebraic and transcendental equations, Roots of functions, Bracketing and open end methods: Bisection method, Newton-Raphson method. Matrices and solution of linear equations: Eigen values and eigenvectors of matrices, Power and Jacobi method, consistency of a system of linear equation, Gaussian elimination, LU decomposition method, matrix inversion, Jacobi iterative method, Gauss-Seidel method.

Unit 3. Interpolation and least square fitting: Finite differences, Newton's formula for interpolation, Gauss, Stirling, Divided differences, Newton's general interpolation formula, Lagrange's interpolation formula. Method of Least square curve fitting, straight line and quadratic equation fitting, curve fitting of curves $y = ax^b$, $y = ae^{bx}$, $xy^a = b$ and $y = ab^x$, curve fitting by sum of exponentials.

Unit 4. Numerical differentiation, integration and solution of ordinary differential equations: Differentiation of continuous functions, Trapezoidal rule, Simpson 1/3 and 3/8 rules, Boole's and waddles rules, Euler, Picard and Runge-Kutta methods, Finite element method (solve wave and heat equations).

Text and References Books

1. MATLAB programming for engineers, 4th edition by Stephen J. Chapman.
2. Introductory Methods of Numerical analysis by S.S. Shastri
3. Numerical Analysis by Rajaraman
4. Computational method in physics and engineering by Wong
5. Numerical Methods by E. Balagurusamy
6. ATLAB for Engineers, 3rd edition by Holly Moore

Outcomes:

At the completion of the course students will be able to:

- Perform data handling in MATLAB environment.
- Write arithmetic programs in MATLAB environment.
- Solve the linear and non-linear algebraic equations, Eigen value problems, curve fitting and numerical solution of ordinary differential equations.
- Solve numerical integration & differentiation, curve fitting, Numerical solution of ordinary equations.

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Semester- IV **PAPER-I** **DISCIPLINE ELECTIVE COURSE -3**

Course Name: **SPECIAL PAPER -III- ELECTRONICS**	**Course Code: MSPY-401A**
Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives: The objective of the course is to develop specialization skills with advanced knowledge in the subject.

- To introduce 8085 microprocessors and assembly language programming.
- To learn about 8086 connection timings, Interrupts, Digital and Analog interfacing.

Course Content:

Unit 1. Basic Microprocessor System, Address Bus, Data Bus, Control Bus, Architecture of 8085 Microprocessor, Register Section, Address Buffer and Address Data Buffer, Arithmetic and Logical Unit (ALU), Timing and Control Unit, Interrupt Control, Pin Description of 8085, Instruction Set of 8085 Microprocessor, Timing Diagram for 8085 Instructions.

Unit 2. Methods of I/O Operations, Memory mapped I/O, I/O Mapped I/O or Isolated I/O, Data Transfer Scheme, Programmed I/O Data Transfer, Interrupt Driven I/O Data Transfer, Direct Memory access (DMA) Data Transfer, The 8085 Interrupts, Software Interrupts, Hardware Interrupts, Interrupt Control Circuit, Interrupt Interactions, Serial Inputs and Output Data Transfer,.

Unit 3. Programmable Interval, Trimmer/ Counter 8253, INTEL Programmable Interval, Trimmer 8253, Block Diagram of 8253, Logics for Counters, Control Word Format of 8253, Interfacing and programming of 8253, programming of 8253 in Mode 0: Interrupt of Terminal Count.

Unit 4. Interfacing Data converter: A/D and D/A Converters, Digital to Analog Converter, Resistive Divider D/A Converter, Binary Ladder D/A Converter, Performance Criteria for D/A Converter, D/A Converter IC 0808, Interfacing of D/A Converter, Microprocessor Compatible D/A Converter, Analog to Digital Converter, Simultaneous A/D Converter. Programming of 8085, Simple Programs, Programs on Code Conversion, BCD to Binary Conversion, Programs on addition and subtraction, Programs on multiplication, Program on 8- Bit Division.

Text and Reference Books

1. Principles of Communication Systems, second Edition by Taub and Schilling Communication Systems, third edition, by Simon Haykin.
2. Fundament of Microprocessor and Microcomputer: B Ram
3. Introdution to Moicroprocessor 8085 by DK Kaushik, Dhanpat Rai Publishing comp., New Delhi
4. Microprocessor architecture programming and application with the 8085 by R

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Course Outcomes: At the end of Course, students will be able to:

- Understand 8086 architecture and functioning, its assembly language programming, 8086 connection timings, Interrupts, digital and analog interfacing, elementary idea of Pentium processors.

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Semester- IV **PAPER-II DISCIPLINE ELECTIVE COURSE -3**

Course Name: PHYSICS OF NONOMATERIALS,	**Course Code: MSPY-401B**
Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives: The aim and objective of the course on Physics of Nanomaterials is to familiarize with the various aspects related to preparation, characterization and study of different properties of nanomaterials.

Course Content:

Unit 1. Introduction to Nanostructure Materials: Nanoscience & nanotechnology, Size dependence of properties, Moor's law, Surface energy and Melting point (quasi melting) of nanoparticles,

Unit 2. Band structure of solids: Free electron theory (qualitative idea) and its features, Idea of band structure, insulators, semiconductors and conductors, Energy band gaps of semiconductors, Effective masses and Fermi surfaces, Localized particles, Donors, Acceptors and Deep traps, Mobility, Excitons, Density of states, Variation of density of states with energy and Size of crystal.

Unit 3. Quantum Size Effect: Quantum confinement, Nanomaterials structures, Two-dimensional quantum system, Quantum well, Quantum wire and Quantum dot, Fabrication techniques.

Unit 4. Characterization techniques of Nanomaterials: Determination of particle size, XRD (Scherrer's formula), Increase in width of XRD peaks of nanoparticles, Shift in absorption spectra peak of nanoparticles, Shift in photoluminescence peaks, Electron Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe Microscopy (SPM), Scanning Tunneling Electron Microscopy (STEM), and Atomic Force Microscopy (AFM).

Synthesis of Nanomaterials: Key issue in the synthesis of Nanomaterials, Different approaches of synthesis, Top down and bottom-up approaches, Cluster beam evaporation, Ball Milling, Chemical bath deposition with capping agent, Carbon nanotubes (CNT)- Synthesis, Properties and Applications.

Text and References Books

1. Nanostructures & Nanomaterials, Synthesis, Properties & Applications by Guozhong Cao, Imperial College Press.
2. Introduction to Nanotechnology, by Charles P. Poole, Jr. Frank J. Owens, John Wiley & Sons Inc. Publication.
3. Quantum Wells, Wires and Dots by Paul Harrison, John Wiley & Sons Ltd.
4. Quantum Dot Hetrostructures, by D. Bimberg, M. Grundman, N.N. Ledenstov.

Course Outcomes: At the end of Course students will able to

- Understand concept of quantum confinement, electron confinement in deep square well and two and three dimensions, idea of quantum well, dot and wires.
- Understand quantum well and super lattices, techniques of fabrication of MQW and SL structures.
- Acquire knowledge of basic approaches like Bottom up and Top down to synthesize inorganic colloidal nanoparticles and their self-assembly in solution and surfaces, Physical properties of nanoparticles.
- Understand and describe the use of unique optical properties of nanoscale metallic structures using Luminescence and Raman scattering.

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Semester- IV **PAPER-III DISCIPLINE ELECTIVE COURSE -4**

Course Name: SPECIAL PAPER -IV- ELECTRONICS	**Course Code: MSPY-402A**
Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives: The aim and objective of the course on advance electronics for the specialization in electronics is to familiarize with the various aspects related to integrated circuits, wafer preparation, characterization and study of different properties of the electronics circuits.

Course Content:

Unit 1. Materials for Integrated Circuits Classification of IC, CMOS Process Overview , Electronic grade silicon , Crystal growth, Czeehralski and float zone crystal growing methods, Silicon shaping lapping , Polishing and wafer preparation.

Unit 2. Hot Processes-I: Oxidation and Diffusion Oxidation of silicon, oxide deposition by thermal dry oxidation and wet oxidation method Diffusion Process, Diffusion Coefficient, Fick's 1st and 2nd Laws of Diffusion, Vacancy –Impurity interactions, Dopants and Dopant Sources, Doping by Diffusion, ion implantation, Diffusion Process Control,

Unit 3. Thin Films: Metals and Nonmetals Vacuum Science and Technology, Evaporation theory and electron beam evaporation, evaporation system, idea of DC and R.F. sputtering system, Physical vapor deposition methods, Design construction of vacuum coating units, Chemicals Vapor Deposition, Reactors for Chemical Vapor Deposition, CVD Applications, Epitaxy methods for thin film deposition, Vapor-Phase Epitaxy,

Unit 4. Photolithography, Photoresist Processing and Etching Vapor HMDS Treatment for adhesion improvement of photoresist, photoresist coating methods, soft backing of photo resist, post exposure backing of photo resist, Negative photoresist, Positive photoresist, Contrast and sensitivity of photoresist, Chemical Modulus Transfer Function (CMTF) of Photoresist Exposure and Resist Development, Hard Baking and Resist curing, Photolithographic Process Control.

Photolithography: An Overview, lithography, Raleigh criterion for resolution, Photolithography source, Resolution and numerical aperture, Photolithographic methods: Contact, proximity and projection and their resolution limit, Photo mask and mask Alignment, Limitations of optical lithography,

Text and Refernece Books:

1. Integrated Electronics- Milliman and Taub
2. Microelectronics –Milliman and Gros
3. Thin Film Phenomena- K.L. Chopra
4. Hand Book of Thin Film- Marshel and Glang

5. VLSI Technology- S.M. Sze.

Course Outcomes: At the end of Course, students will be able to: Understand

- IC and fabrication
- Oxidation, masking, diffusion systems
- photolithograph

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Semester- IV **PAPER-IV DISCIPLINE ELECTIVE COURSE -4**

Course Name: MODERN PHYSICS	**Course Code: MSPY-402B**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives: Objective of this course is to learn the fundamentals of atomic and molecular spectroscopy key for Physics problems.

Course Content:

Unit 1: Blackbody Radiation: Nature of Blackbody spectrum; classical radiation laws and their limitations; Planck's radiation law and quantum hypothesis. **The Photoelectric Effect:** Experimental arrangement of the Photoelectric Effect; laws of Photoelectric Effect; Einstein Photoelectric Equation.

Unit 2: X-Rays: Nature and production of X-rays; the Bragg law; Bragg X-ray crystal spectrometer. The Compton Effect: X-ray Compton scattering from an electron; experimental set-up for Compton scattering.

Unit 2: Atomic Structure: Hydrogen spectrum; the Bohr model; experimental measurement of the Rydberg constant; Franck-Hertz experiment. **Matter Waves:** The de Broglie wavelength and its relationship with the Bohr model; Davisson-Germer experiment. Heisenberg Uncertainty principle: Momentum-position and Energy-time relations.

Unit 3: Molecular Structure: Bonding mechanisms: Ionic bonds; Covalent bonds; the Hydrogen bond; Van der Waals bonds. Molecular vibration and rotation spectra. Molecular orbitals: Hydrogen molecular ion and molecule. **Solid State Physics:** Ionic solids; covalent solids; metallic solids; molecular crystals; amorphous solids. Classical models of electrical and heat conductivities in solids; Ohm's Law; Wiedemann- Franz law; the quantum view point.

Unit 4: Magnetism; Magnetic moment; Hysteresis and Magnetization. Magnetic materials: Diamagnetic, paramagnetic and ferromagnetic materials. **Nuclear Structure: Nuclear properties:** Charge, Mass, Size and Structure; Nuclear spin and magnetic moment; Nuclear Magnetic Resonance (NMR) phenomenon. Binding energy and nuclear forces. The liquid drop model. Radioactivity: Decay constant, Half-life.

Text and Refernece Books:

1. Modern Physics (2nd Ed) Serway, Moses and Moyer, Saunders College Pub, 1997.

2. Fundamentals of Physics extended with Modern Physics (4th Ed) Halliday, Resnick and Walker, John Wiley, 1993.

3. Concepts of Modern Physics by Arthur Beiser, Mcgraw- Hill Higher education, 2003

Course Outcomes: At the end of the course, the student will be

1. Able to deal with problems related to Hydrogen-like atomic spectra and alkali

metals. Understand coupling schemes and hyperfine structures.

2. Able to understand the basics of Black Body Radiation, Photoelectric Effect, Compton Effect.

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Semester- IV **PAPER-V DISCIPLINE ELECTIVE COURSE -5**

Course Name: EXPERIMENTAL TECHNIQUES IN PHYSICS	**Course Code: MSPY-403A**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives: This course provides a detailed account of some common experimental techniques in physics research. It introduces the basic working principles, the operational knowhow, and the strength and limitations of the techniques

Course Content:

Unit-I Experimental Techniques to observe the defects in Lattice: Electron Microscopy: Transmission Electron Microscope (TEM) and X-ray Diffraction Technique, Experimental methods of observing dislocations and stacking faults.

Unit-II Electron microscopy: Kinematical theory of diffraction contrast and lattice imaging, Optical Techniques: Photo Luminescence, FTIR and Raman Spectroscopic techniques.

Unit-III Surface Analytical Techniques: Electron Spectroscopies-Auger, XPS (ESCA), UV-photo emission, X ray absorption techniques: EXAFS, NEAFS, Secondary Ion Mass Spectroscopy (SIMS), Rutherford Back Scattering (RBS) and low Energy electron diffraction techniques

Unit-IV Opto-Electronic Devices: Solar Cells, Photo Diodes, Photo-detectors, LEDs; Data Interpretation and Analysis. Precision and Accuracy, Error Analysis, Propagation of Errors, Least Squares fitting. Linear and Non-linear curve fitting, Chi-square test, Modulation Techniques: Amplitude Modulation, Frequency Modulation

Spectroscopic and Scanning Probe Techniques: Detailed study of spectroscopic techniques: ESR(electron spin resonance) and NMR; Scanning Probe Techniques: STM (Scanning Tunneling Microscopy), AFM (Atomic Force Microscopy), STS (Scanning Tunneling Spectroscopy)

Text and Refernece Books:

1. Crystal Growth and Characterization by R. Ueda and J.B. Mullin
2. Experimental Techniques of Surface Science by Woodruff and Delchar
3. Solid State Physics by Ibach and Luth
4. Solid Surfaces by Ibach
5. Solid Surfaces by Prutton

Course Outcomes: Upon completion, students should be able to:

1. describe and explain the working principles of the various techniques
2. identify the strength and limitation of each technique, therefore, choose the right technique for characterization of properties
3. know the operational details and interpret the data obtained by the techniques.

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Semester- IV **PAPER-VI** **DISCIPLINE ELECTIVE COURSE -5**

Course Name: Electro-Magnetic Theory	**Course Code: MSPY-403B**

Credit = L + T + P = (4 + 0 + 0)	**Total Hours = 60**

Course Objectives: To acquire basic knowledge about Maxwell Equations, EM Wave Propagation in Unbounded & bound Media, waveguides and Radiation from time varying sources. Introducing the mathematical tools used in electrodynamics & Review of electrostatics and magneto statics in matter including Dielectrics.

Course Content:

UNIT I Electrostatics Coulomb's Law– Charge distributions– Lines of force and flux–Gauss's Law and its applications –The potential function– Poisson's equation and Laplace equation– Equipotential surfaces– Field due to continues charge distribution– Energy associated to an electrostatic field– Electrostatic uniqueness theorem.

UNIT II Magnetostatics Lorentz force – Faraday's law – Magnetic field strength and Ampere's circuital law– Biot-Savart's law – Ampere's force law – Magnetic vector potential – Equation of continuity–The far magnetic field of a current distribution– Magnetic field due to volume distribution of current

UNIT III Dielectrics; Polarization – the electric field inside a dielectric medium – Gauss law in dielectric and the electric displacement – Electric susceptibility and dielectric constant – Boundary conditions on the field vectors – Dielectric sphere in a uniform electric field– Force on a point charge embedded in a dielectric

UNIT IV Maxwell's equation and propagation of EM waves: Maxwell's equations and their physical significance – Plane wave equation in homogeneous medium and in free space – relation between E and H vectors in a uniform plane wave– The wave equation for a conducting medium – Skin depth – Wave propagation in dielectric– Poynting vector – Poynting's theorem

UNIT V Waves in bounded region and Radiation Reflection and refraction of EM waves at the boundary of two conducting media – Normal incidence and oblique incidence – Brewster's angle– Wave guides – Rectangular wave guide – Cavity resonators – Radiation from and oscillating dipole –Transmission line theory – Transmission line as distribution circuit– Basic transmission line equations Books for Study and

Text and Reference Books:

1. Foundation of EMT – Third edition –John R. Reity, Frederick J. Milford and Robert W. Christy.
2. Electromagnetic theory – Prabir K. Basu and Hrishikesh Dhasmana.
3. Introduction to Electrodynamics– David J Griffiths.
4. Electromagnetic fields and

waves– P.Lorrain and D.Corson.

5. Electrodynamics– B.P.Laud.

Course Outcomes: At the end of the course, the student will be able to

1. Understand and apply the laws of electromagnetism and Maxwell's equations. Basics of electrostatics and magneto statics Solve the electric and magnetic fields problems for different configurations.

2. Have sufficient Knowledge about Dielectrics and its applications.

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Semester- IV **PC-1**

Course Name: DISSERTATION	**Course Code: MSPY-404R**
Credit = L + T + P = (4+ 0 + 8)	**Total Hours = 120**

Semester- IV **EEC-1**

Course Name: Density Functional Theory	**Course Code:EEC-1**
Credit = L + T + P = (2+ 0 + 0)	**Total Hours = 30**

Course Objective:

The objective of this course is to provide students with a fundamental understanding of Density Functional Theory (DFT) and its application to the electronic structure of atoms, molecules, and solids. The course will build a theoretical foundation, introduce computational aspects, and emphasize the importance of DFT in modern materials research.

Course Content:

Unit 1: Foundations of Quantum Many-Body Systems

The many-electron Schrödinger equation, Hartree and Hartree–Fock approximations, Exchange and correlation, Failure of wavefunction-based methods for large systems.

Unit 2: Principles of Density Functional Theory

Hohenberg–Kohn theorems, Kohn–Sham equations, Exchange-correlation functionals: LDA, GGA, Concept of self-consistency.

Unit 3: Computational Methods and DFT Implementations

Plane-wave basis sets and pseudopotentials, Real-space methods and numerical grids, Introduction to software packages (e.g., VASP, Quantum ESPRESSO, WIEN2k), Convergence, k-point sampling, and energy cut-offs.

Unit 4: Applications of DFT in Physics and Materials Science

Electronic band structure and density of states, Magnetic, optical, and mechanical properties, Case studies: Semiconductors, metals, insulators, Heusler alloys, perovskites, Limitations of DFT and beyond-DFT methods (e.g., DFT+U, hybrid functionals, GW).

Text and Refernece Books:

1-Density Functional Theory: A Practical Introduction" – David Sholl and Janice A. Steckel *(Focus on practical application and hands-on use)*

2-Electronic Structure: Basic Theory and Practical Methods" – Richard M. Martin *(Strong theoretical foundation and computational details)*

3-Computational Materials Science: An Introduction" – Richard LeSar *(Combines DFT with broader computational techniques)*

4-Introduction to Computational Materials Science" – Richard Catlow *(Good reference for DFT applications in solids and molecules)*

Course Outcomes.

After successful completion of this course, students will be able to:

- Understand the complexities of many-electron systems and the limitations of traditional quantum mechanical approaches.
- Appreciate the motivation behind the development of Density Functional Theory (DFT) as a computational alternative.
- Explain the Hohenberg–Kohn theorems and derive the Kohn–Sham equations.
- Identify and analyze different exchange-correlation functionals such as LDA and GGA.
- Understand the self-consistent field (SCF) process in solving Kohn–Sham equations.
- Gain hands-on experience with DFT software packages (e.g., WIEN2k, VASP, Quantum ESPRESSO).
- Understand key computational parameters like k-point sampling, pseudopotentials, and convergence testing.
- Perform basic DFT calculations for molecular and solid-state systems.
- Analyze electronic structure, magnetic properties, and optical behavior of materials using DFT.
- Apply DFT to interpret band structure, density of states, and charge density.
- Recognize the strengths and limitations of DFT and the need for beyond-DFT corrections in complex systems (e.g., DFT+U, hybrid functionals).

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