Scheme and Syllabus

(For academic session 2022-2023 & onwards)

M.Sc. Physics

IEC School of Basic Sciences

IEC UNIVERSITY
THE KNOWLEDGE EXPERTS

Atal Shiksha Nagar (Kallujhanda), P.O.
Mandhala, Village- Nanakpura,
Pinjore-Nalagarh highway, District - Solan,
Himachal Pradesh - 174103

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Table of Content

SECTION 1

Program Outcomes and Program Specific Outcomes

Program Outcomes

PO1: ***Knowledge:*** Apply knowledge of the basic and advanced sciences and the ability to acquire, manage and use current information for problem solving.
PO2: ***Research/Project Orientation:*** Know the experimental processes, material synthesis for desired properties, problem formulation, analytical techniques for a variety of applications.
PO3: ***Entrepreneurship Capability:*** Understand scientific and social requirements and provide innovative solutions.
PO4: ***Conformist:***
PO5: ***Critical Thinking Mindset:*** Observe record, analyze, criticize, organize, improvise and manage documents, data and information.
PO6: ***Leadership and Teamwork:*** Demonstrate the ability to plan and implement academic and professional activities.
PO7: ***Professional Ethics:*** Possess personal & universal values and apply ethical principles in professional and social contexts.
PO8: ***Empowerment:*** Apply the knowledge and skills gained through education to gain recognition in academics, professional circle and society.
PO9: ***Communication:*** Develop graduates with effective professional communication skills.
PO10: ***Social Responsibility and Environmental Conservation:*** Develop capable professionals to serve the society with best and environmental friendly practices.
PO11: ***Modern Analytical Knowledge:*** Solve problems by keen observation, understanding and rational thinking.
PO12: ***Life Long Skills:*** Recognize the need, troubleshooting the problems and offering new approaches**.**

Program Specific Outcomes

PSO1: To prepare graduates to success in academic, scientific or professional careers.
PSO2: To prepare graduates to learn and adapt in a globe of constantly developing trends with sound knowledge and practices.
PSO3: To prepare the graduate to have strong foundation in science and technology to analyse and solve problems.
PSO4: Overall scientific temper, ability of quantitative analysis, effective communication skills, logical thinking and capability of working in the interdisciplinary domains.

SECTION 2

Semester wise Scheme

Sr. No.	Course Code	Course Title	L	T	P	CH	CP	Int. A	ESE	Total Marks
SEMESTER I										
1	MPH 101	MATHEMATICAL PHYSICS	4	1	0	5	4.5	60	40	100
2	MPH 102	CLASSICAL MECHANICS	4	1	0	5	4.5	60	40	100
3	MPH 103	QUANTUM MECHANICS-I	4	1	0	5	4.5	60	40	100
4	MPH 104	PHOTONICS & ELECTRONIC DEVICES	4	1	0	5	4.5	60	40	100
5	MPHP 105	PHYSICS LAB I	0	0	4	4	2	30	20	50
6	MPHP 106	MINOR PROJECT-I	0	0	4	4	2	30	20	50
Total			**16**	**4**	**8**	**28**	**22**	**300**	**200**	**500**
SEMESTER II										
1	MPH 201	NUCLEAR AND PARTICLE PHYSICS	4	1	0	5	4.5	60	40	100
2	MPH 202	CONDENSED MATTER PHYSICS-I	4	1	0	5	4.5	60	40	100
3	MPH 203	COMPUTATIONAL PHYSICS	4	1	0	5	4.5	60	40	100
4	MPH 204	QUANTUM MECHANICS-II	4	1	0	5	4.5	60	40	100
5	MPHP 205	PHYSICS LAB II	0	0	4	4	2	30	20	50
6	MPHP 206	COMPUTATIONAL LAB	0	0	4	4	2	30	20	50
Total			**16**	**4**	**8**	**28**	**22**	**300**	**200**	**500**
SEMESTER III										
1	MPH 301	THERMODYNAMICS AND STATISTICAL MECHANICS	4	1	0	5	4.5	60	40	100
2	MPH 302	ELECTRODYNAMICS	4	1	0	5	4.5	60	40	100
3	MPH 303	PHYSICS OF NANOMATERIALS-I	4	0	0	5	4.5	60	40	100
4	MPH 304	CONDENSED MATTER PHYSICS-II	4	1	0	5	4.5	60	40	100
5	MPHP 305	PHYSICS LAB III	0	0	4	4	2	30	20	50
6	MPHP 306	MINOR PROJECT II	0	0	4	4	2	30	20	50
Total			**16**	**4**	**8**	**28**	**22**	**300**	**200**	**500**
SEMESTER IV										
1	MPH 401	ATOMIC AND MOLECULAR PHYSICS	4	1	0	5	4.5	60	40	100
2	MPH 402	PHYSICS OF NANOMATERIALS-II	4	1	0	5	4.5	60	40	100
3	MPH 403A **or** MPH 403B	MICROWAVE AND POWER ELECTRONICS **OR** VACUUM AND ION BEAM SPECTROSCOPIC TECHNIQUES	4	1	0	5	4.5	60	40	100
4	MPHP 404	RESEARCH PROJECT	-	-	-		6.5	60	40	100
Total			**12**	**3**	**0**	**15**	**20**	**240**	**160**	**400**

L – Lecture
T – Tutorial
P – Practical
CH – Contact hour
CP – Credits points
Int. A – Internal assessment
ESE – End-semester exam

SECTION 3

Semester wise Syllabus

Program: M.Sc. Physics	**Semester:** I
Course Title: Mathematical Physics	**Course Code:** MPH-101

Course Description:

The course introduces students to basic and advanced mathematical methods and techniques most widely used in physics. It allows the students to solve various physics problems. An additional goal of the course is to expose the students to the use of mathematics in contemporary physics research.

Course Outcomes

Student on completion of the course will be able to:

CO1: Identify system properties based on impulse response and various techniques.
CO2: Solve first order ordinary differential equation.
CO3: Solve higher order linear ordinary differential equation with constant coefficients.
CO4: Solve linear differential equations using Laplace transforms.

Unit	Topic	Hours
1	Vector algebra & Vector Calculus: Introduction to vector algebra, Scalar Field Gradient and geometrical interpretation, Divergence and Curl of Vector Field, Line, Surface and Volume integrals, Gauss's Divergence Theorem, Stoke's & Green's Theorem, simple problems . Integral transforms: Laplace transform, some simple properties of Laplace transforms such as first and second shifting property, Inverse Laplace Transform by partial fraction method, Laplace transform of derivatives, Laplace Transform of integrals, Fourier series, Evaluation of coefficients of Fourier series (Euler's formulae), Fourier Transforms, Fourier sine & cosine Transforms.	18
2	Complex variables: Elements Complex analysis, Limit and continuity, Cauchy's Riemann equations, Complex integrations, Cauchy's theorem for simply and multiply connected regions, Cauchy's integral formula, Taylor and Laurents series, Poles and singularities, Cauchy's residue theorem. Evaluation of definite integrals (around 4 unit circle, infinite semi-circle using Jordan's lemma with poles lying on real axis and integration involving multiple valued function-branch point).	18
3	Gamma and beta functions: Definition of beta and gamma functions, Evaluation of Γ (1/2), Relation between beta and gamma functions, Evaluation of integrals using beta & gamma function.	6
4	Legendre differential equation: Solution of Legendre differential equation, Legendre polynomials, Rodrigue's formula, Generating function for Legendre polynomials and recurrence relations, Orthogonality of Legendre polynomials. Associated Legendre polynomials and their properties.	10

5	Bessel functions: Definition of Bessel functions of 1st and 2nd kind, Generating function of Jn(x) and their recurrence relations and orthogonality, Definition of spherical Bessel functions and their asymptotic form.	8

Textbooks

1. Mathematical Physics by Satyaprakash, S Chand Publishers New Delhi.

Reference Books

1. Mathematical Methods for Physicists by George Arfken, Academic Press, U.S.A.
2. Mathematical Methods for Physicists and Engineers by Harvil and Pipes L.A,Tata McGraw-Hill Publishing Company, New Delhi.
3. Mathematical Physics by Rajput B.S. Pragati Prakashan, Meerut.
4. Laplace Transforms by Speigal M.R., Schaum Series Tata McGraw-Hill Publishing Company, New Delhi.
5. Advanced Engineering Mathematics by Kreyszig E., John Wiley & Sons, New York.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** I
Course Title: Classical Mechanics	**Course Code:** MPH-102

Course Description:

This course includes concepts of basic Newtonian mechanics and advanced mechanics. It allows the students to understand the physical phenomenon occurring in nature and planetary motions. The course is suitable for students preparing for advanced study of physics and related fields, such as astronomy and many of the applied engineering sciences.

Course Outcomes

Student on completion of the course will be able to:

CO1: Explain the various physical phenomenon’s occurring in nature.
CO2: Understand the concepts of Newtonian and advanced mechanics.
CO3: Implement the concepts to validate heavy body motion on earth and in universe.
CO4: Solve various problems of physics.

Unit	Topic	Hours
1	Lagrangian formulation: Conservation laws of linear, angular momentum and energy for a single particle and system of particles, Constraints and generalized coordinates, Principle of virtual work, D'Alembert principle, Lagrange's equations of motion, Velocity dependent potential and dissipation function. Problem based on Lagrangian formulation, Hamilton's principle, Calculus of variations, Lagrange's equations from Hamilton. Problem based on Hamilton's principle including variations for geodesics of a plane and sphere, Minimum surface of revolution, Branchistochrone problem and harmonic oscillator.	18
2	Kinematics and Dynamics of Rigid Bodies: Generalized coordinates of a rigid body, orthogonal transformations and the transformation matrix. The Euler's angles and Euler's 5 theorem on motion of rigid bodies, Coriolis force. Angular momentum and Kinetic energy of motion about a point. Moment of inertia tensor, Euler's equation of motion. Applications: Torque free motion of a rigid body. Heavy symmetric top with one point fixed.	12
3	Hamilton-Jacobi Theory: The Hamilton-Jacobi equation for (i) Hamilton's principle function, and (ii) Characteristics function. Separation of variables in Hamilton- Jacobi equation. Action angle variables. Applications: Harmonic oscillator with Hamilton-Jacobi and action angle variable methods. Kepler's problem.	10
4	Hamiltonian formulation: Legendre transformation, Hamilton's equations of motion, Hamilton's equation from variational principle, Principle of least action. Problems based on Hamiltonian formulation.	10
5	Canonical transformation: Generating function, Poisson brackets and their canonical invariance, Equations of motion in Poisson bracket formulation, Poisson bracket relations between components of linear and angular momenta. Problems based on Canonical transformation.	10

Textbooks

1. H. Goldstein, Classical Mechanics 2nd ed. (Indian Student Edition, Addison-Wesley/ Narosa).

Reference Books

1. Mechanics- L.D. Landau and E.M. Lifschz (Pergamon, 1976).
2. J. B. Marion, Classical Mechanics (Academic Press).
3. Classical Mechanics – J.W.Mullar- Kirsten (World Scientific, 2008)
4. R. G. Takwale & P. S. Puranik, Introduction to Classical Mechanics (Tata McGraw – Hill).

Assessment Process (Internal)

Internal assessment = 60 Marks

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CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** I
Course Title: Quantum Mechanics I	**Course Code:** MPH-103

Course Description:

The course introduces students to non-relativistic Quantum Mechanics, supplying the basic concepts and tools needed to understand the physics of atoms, molecules, and the solid state. The postulates and rules of quantum mechanics are introduced. Dirac notation, angular momentum and spin are shown to be quantized and the corresponding wave-function symmetries are discussed. The Schrodinger equation is solved for a number of important cases, including harmonic oscillator and Hydrogen atom. Approximate methods of solution are studied, including time-independent perturbation theory, with application to atomic structure.

Course Outcomes

Student on completion of the course will be able to:

CO1: Understand the need of quantum mechanics and its basic postulates.
CO2: Solve first order ordinary differential equation.
CO3: Identify the right method or technique to solve a particular problem
CO4: Solve various problems of physics.

Unit	Topic	Hours
1	Schrodinger Equation: Wave particle duality. Schrodinger equation (time-dependent and time-independent). Eigen value problems (particle in a box, harmonic oscillator, square well potential etc.). Stern-Gerlach Experiment, Motions in a central Potential, Tunnelling effect, Spherical harmonics, Radial solutions, Hydrogen atom energy spectra. Rigid rotator, Solution for three dimensional square well potential.	15
2	Linear vector spaces: State vectors, Orthonormality, Hilbert spaces, Linear manifolds and subspaces, Hermitian, unitary and projection operators and commutators; Dirac Bra and Ket Notation: Matrix representations of bras and kets and operators; Continuous basis, Change of basis-Representation theory. Coordinate and momentum representations. Fundamental postulates of quantum mechanics.	15

3	Symmetry in Quantum Mechanics: Unitary operators for space and time translations. Symmetry and degeneracy. Rotation and angular momentum; Commutation relations, eigen value spectrum, angular momentum matrices of J +, J-, Jz, J2. Concepts of spin, Pauli spin matrices. Addition of angular momenta, Clebsch-Gordon coefficients and their properties, irreducible tensor operator, Wigner Eckart theorem.	14
4	Approximation Methods for Bound State: Time independent perturbation theory for nondegenerate and degenerate systems upto second order perturbation. Application to a harmonic oscillator, first order Stark effect in hydrogen atom, Zeeman effect without electron spin.	10
5	Variation principle, application to ground state of helium atom, electron interaction energy and extension of variational principle to excited states. WKB approximation: energy levels of a potential well, quantization rules.	6

Textbooks

1. Satya Prakash "Advanced Quantum Mechanics", Kedar Nath Ram Nath Publishing House, Meerut, 2009.

Reference Books

2. Modern Quantum Mechanics: J. J. Sakurai, Addison Wesley Pub.,USA,1999, Ist ISE Rep.
3. A. K. Ghatak and S. Lokanathan, Quantum Mechanics 3rd ed. (MacMillan).
4. Advanced Quantum Mechanics: Satya Prakash, Pragati Prakashan Ltd.
5. Quantum Mechanics: N. Zettili, John Willey and Sons. Ltd.
6. Quantum Mechanics: L. I. Schiff (Int. Student Ed.)

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** I
Course Title: Photonics and Electronics Devices	**Course Code:** MPH-104

Course Description:

This course includes concepts of basic principles of semiconductor physics and electronic components. The course is suitable for students preparing for advanced studies of semiconductor physics and related fields, such as electronic circuits and many of the applied engineering & technological areas. It also introduces students to various number systems, digital electronics and microprocessors. The provides complete information of various logic gates, adder, subtractors, flip flops, multiplexer, de-multiplexers, resisters, counters, A/D and D/A converters and microprocessors.

Course Outcomes

Upon successful completion of the course, the students will be able to:
CO1: Identify and Characterize semiconductors, diodes, transistors and operational amplifiers.
CO2: Bias the transistors and FETs for amplifier applications.
CO3: Design op-amp circuits to perform arithmetic operations.
CO4: Design simple analog circuits.
CO5: Understand fundamental principles of communication system

Unit	Topic	Hours
1	Lasers and optical Fibres: Spontaneous and Stimulated Emission, Einstein's coefficients, Population Inversion and Optical Pumping, Three-level and Four-level Lasers, Ruby, He-Ne, CO2, Semiconductor Lasers, Application of Lasers, Basic theory of fiber optics, acceptance angle, numerical aperture modes of propagation, material and pulse dispersion, application of optical fibers.	15
2	Semiconductor Devices: FET, JFET, and its operation, Characteristics, Pinch off voltage, MOSFET, Enhancement and depletion mode, comparison of JFETs and MOSFETs. Thermistor, Barretters, Gunn diode, Zener diode, IMPATT and TRAPATT devices, Pin diode, Tunnel diode. Thyristor, SCR, TRIAC, DIAC, UJT, Photo-conductive devices, Photo-conductive cell, Photodiode, Solar Cell, LED, LCD	15
3	Number Systems: Binary, octal and hexadecimal number system, Arithmetic operations: Logic Gates: AND, OR, NOT, Operations: Boolean identities, Demorgan's theorem: Simplification of Boolean function, NAND NOR gates.	10
4	Flip flops and registers: RS, JK-, D- and T-Flip flops set up and hold times, preset and clear operations, BJT, FET, CCD, IIL switching devices, Major logic families Astable, Monostable and Bi-stable multivibrator, Types of registers, serial-in-serial out, Serial-in-parallel, parallel-in-serial out, parallel-in-parallel out.	10
5	Counters and Converters: Asynchronous and synchronous counters, Mod-3 and Mod-5 counters, shift counters, variable register network, Binary ladder, D/A Converter, Ladder network, A/D Converters. Semiconductors memories: Memory organization and operation, Expanding memory size, Classification and characteristics of memories, Sequential memory, Read only memory, Read and write memory.	10

Textbooks

1. Electric Devices by B. G. Streetman and Banerjee, TMH Publishers. .

Reference Books

1. Electronic Fundamentals and Applications: J.D. Ryder, Prentice Hall of India (5th Ed.).
2. S.M. Size; Semiconductor Devices: Physics and Technology, 2nd edition, John Wiley, New York, 2002.28
3. Electronic Devices and Circuits: G.K. Mithal, Khanna Publishers.
4. Jasprit Singh; Semiconductor Devices : Basic Principals, John Wiley, New York, 2001
5. Digital Principles and Applications: A.P. Malvino & D.P. Leach, tata McGraw-Hill, New Delhi.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** I
Course Title: Physics Lab I	**Course Code:** MPHP-105

Course Description:

The course will describe the experimental part related to electronic devices and their characteristics. In this course students will perform experiments to determine parameters like pinch off voltage, cut-off voltage, breakdown voltage, resonance frequency, power factor, etc.

Course Outcomes:

Students' on completion of the course will be able to:

CO1: understand the apparatus of various experiments.

CO2: understand the physical working procedure of apparatus.

CO3: learn to perform experiments and make record by taking readings.

CO4: understand the physical concept behind the experiment, which will strengthen their theoretical knowledge.

Sr No.	Experiment Title
1.	To perform an experiment (a) to determine DIAC characteristics and (b) to observe the voltage wave form across it
2.	To perform an experiment to identify modes of operation for TRIAC
3.	To perform an experiment to determine UJT characteristics
4.	To obtain V-I characteristics of zener diode
5.	To obtain V-I characteristic of P-N junction diode
6.	To measure the Beam Spot size and Beam *Divergence of a Laser beam* using a detector
7.	Study of Series R-L-C Resonance and to determine its Resonance Frequency.
8.	Study of Parallel R-L-C Resonance and to determine its Resonance Frequency.
9.	To study the I-V characteristics of the solar cell and find its spectral response.
10.	Study of logic circuits TTL, NAND and NOR gates

Textbooks

1. Printed Manuals of the experiment are given to students.

Reference books

2. Practical Physics by C. L. Arora, S. Chand publishers, New Delhi.
3. Practical Physics by P. R. Sasi Kumar, Prentice-Hall of India Pvt.Ltd

Assessment Process (Internal)

Internal assessment = 30 Marks

- **Practical work Performance = 20 Marks. (Practical File = 10 Marks, Viva-Voce = 10 Marks)**
- **Attendance = 10 Marks**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** II
Course Title: Nuclear and Particle Physics	**Course Code:** MPH-201

Course Description:

This course includes historical developments in structure of nucleus and its basic properties, nuclear forces and various nuclear models, decay and half-life reactions of various particles. This course also includes the various radiation detectors and basic introduction of various elementary particles and their quantum numbers.

Course Outcomes

Upon successful completion of the course, the students will be able to:
CO1: Understand the nuclear structure and its properties.
CO2: Solve various problems based on nuclear reactions (fission or fusion).
CO3: Identify the nuclear phenomenon and their importance
CO4: Knowledge about elementary particles and their quantum numbers

Unit	Topic	Hours
1	Nuclear Properties: Nuclear Radius, Mass and Abundance of Nuclides, Nuclear Binding Energy, Semi-empirical Mass Formula, Nuclear Angular Momentum and Parity, Nuclear Electromagnetic Moments, Nuclear Excited States Nuclear Spin and Moments: Nuclear Spin, Nuclear Moments, Hyperfine Structure, Measuring Nuclear Moments	15
2	Forces between Nucleons: Deuteron problem, Nucleon-Nucleon scattering, Proton-Proton and Neutron-Neutron interactions, Properties of Nuclear Forces, Exchange Force Model Nuclear Models: Liquid drop model, Shell Model, Even-Z Even-N Nuclei and Collective Structure, Many-Particle Shell Model, Single Particle States in Deformed Nuclei	15
3	Neutron Physics: Neutron Sources, prompt and delayed neutrons, Absorption and Moderation of Neutrons, Thermal neutron diffusion and diffusion equation, Thermal diffusion length, Fast neutron diffusion and the Fermi-Age equation, Neutron Detectors	10
4	Detection of radiation: Ionization chamber, Proportional counter, GM counters, quenching and dead time of GM counter, Semiconductor detector, Scintillation detectors and photomultiplier tubes.	8
5	Particle Physics: Properties and origin, Elementary particles, Properties, classification, 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.	12

Textbooks

1. Introductory Nuclear Physics: K.S. Krane, John Wiley & Sons, New York

Reference Books

2. Nuclear Physics: R.R.Roy and B.P.Nigam, New Age Pub., N. Delhi
3. Nuclear Physics: W.E. Burcham and M. Jobes (Ind. Ed.), Addison Wesley
4. Introduction to nuclear Physics by H. Enge
5. Theoretical Nuclear Physics by J.M. Blatt and V.F. Weisskopf
6. Theoretical nuclear and Subnuclear Physics by J.D. Walecka
7. Particle Physics An introduction by M.Leon
8. Group Theory in Subnuclear Physics by F.I. Stancu
9. Introduction to Particle Physics by R. Ones.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
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  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** II
Course Title: Condensed Matter Physics-I	**Course Code:** MPH-202

Course Description:

The course introduces students to Crystal lattices and reciprocal lattices, electronic states, lattice vibrations and elastic waves, and thermal properties of solids. phonons, and excitons; the coulomb gas and fermi electron gas theory; magnetism, ferromagnetism, paramagnetism, dielectrics etc.. The phenomena of superconductivity, the BCS theory of superconductivity, Cooper pair problem, the electron-phonon interaction.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify different concepts of crystallography, different theories of heat and electric conduction, dielectrics, semiconductors.

CO2: Describe problems like basic crystals, dependence of heat capacity and thermal conductivity with temperature, Fermi surfaces in description of electric and magnetic properties of solids, conduction in semiconductors.

CO3: Apply principles to determine crystal structure, thermal behavior of solids, dielectric, magnetic and electric behavior of solids.

CO4: Assess the results obtained by solving above problems.

Unit	Topic	Hours
1	Crystal structure: periodic arrays, lattice types, Diffraction of waves, Laue's and Bragg's condition for diffraction, reciprocal lattice (geometrical and vector algebraic discussion) Fourier analysis: Atomic scattering and structure factor for scc, bcc, fcc, Effect of pseudo-symmetry on structure factor.	15
2	Lattice Vibrations and Phonons: Introduction, lattice modes, phase and group velocity, Brillouin zone, concept of phonons: momentum and inelastic scattering of photons by phonons.	15
3	Thermal Properties: heat capacity of gases, specific heat (Einstein's and Debye model)	8
4	Free electron Theory and Transport Properties: Drude–Lorentz theory, electrical conductivity and Ohm's law, motion in magnetic field: Hall Effect, thermal conductivity.	10
5	Band theory of solids: Bloch theorem - The Kronig Penney Model - construction of one, two and three dimensional Brillouin zones - Extended, Reduced and Periodic zone schemes - Effective mass of an electron - The nearly free electron model - Tight binding model – The Pseudo-potential method.	12

Textbooks

1. Elements of Solid State Physics 2nd Ed, J.P.Srivastava, Printice Hall of India, New Delhi, 2001.

Reference Books

1. Solid State Physics: Structure and Properties of Materials, 2nd Ed. A. M. Wahab, Narosa Publishing house, New Delhi, India, 2007.
2. Introduction to Solid State Physics, 7th Ed, C. Kittel, John –Wiley & Sons (Asia) Pvt. Ltd., New Delhi, 1996.
3. Solid State Physics, 4th Ed. S. O. Pillai, New Age International Publishers, New Delhi, 2001.
4. Introductory to Solid State Physics 2nd Ed, H. P. Myers, Taylors and Francis Ltd, London, 1998.
5. Elementary Solid State Physics: Principles and Applications, 4th Ed., M. A .Omar, Pearson Education Pvt. Ltd., Delhi, India, 2004.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
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  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		

CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** II
Course Title: Computational Physics	**Course Code:** MPH-203

Course Description:

This course gives an introduction to the computer architecture, software and concepts of programming language. This course will discuss about basic methods in computational physics and broad range of numerical methods that are commonly employed to solve problems in physics with the emphasis on the ways to evaluate their accuracy and effectiveness.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Understand working of computers and its architecture.
CO2: Solve physical problems using concepts of programming.
CO3: Apply numerical methods to solve scientific and technological problems.
CO4: Assess the results obtained by solving above problems.

Unit	Topic	Hours
1	Computer Algorithms: Introduction, The structure of computer, Computer Arithmetic: Introduction, floating point representation of numbers, Arithmetic operations, some pitfalls in computing, errors in numbers, binary representations of numbers, Basic knowledge of computer systems software and programming language i.e. Machine language. Assembly language and higher level language. Brief recapitulation of FORTRAN, C, C++.	15
2	Iterative methods: Introduction, the method of successive bisection, the method of false position, Newton Raphson iterative method, secant method, the method of successive approximations, comparison of iterative methods. The Gauss elimination method, pivoting, the Gauss- Seidel iterative method.	15
3	Interpolation: Introduction, Lagrange interpolation, Truncation errors in interpolation, Difference tables, Differentiation: Forward Difference, Central Difference, unstable nature of differentiation. Numerical integration, Simpson’s rule, errors in integration formula.	15
4	Numerical solutions of Differential Equations: Introduction, Euler’s method, Taylors series method, Runge- Kutta methods, Predictor corrector method.	15

Textbooks

1. P. L. DeVries and Hasbun, A first course in Computational Physics, Ed. 2nd, Jones & Bartlett Learning, 2010.

Reference Books

1. Rubin Landau, M Paez: Computational Physics (John Wiley).
2. V.Rajaraman, Computer oriented Numerical Methods, PHI ed.

3. Gupta: Computer Concepts & C Programming, Comdex.
4. The ANSI C Programming Language, Keringhan and Ritchie, Prentice Hall of India Ltd.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** II
Course Title: Quantum Mechanics-II	**Course Code:** MPH-204

Course Description:

The course introduces students to non-relativistic Quantum Mechanics, supplying the basic concepts and tools needed to understand the physics of atoms, molecules, and the solid state. The postulates and rules of quantum mechanics are introduced. Dirac notation, angular momentum and spin are shown to be quantized and the corresponding wave-function symmetries are discussed. Identical particles and spin. Pauli's spin, spin orbit coupling. Scattering theory, Yukawa potential, optical theorem, K G equation and relativistic Quantum mechanics. Approximate methods of solution are studied, including time-independent perturbation theory, with application to atomic structure.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Solve problems using perturbation theory.

CO2: Describe the principles of scattering theory.

CO3: Describe the fundamental of the quantum computing.

CO4: Solve conceptual and mathematical problems associated with the topics covered in Quantum Mechanics.

Unit	Topic	Hours
1	Time independent perturbation theory: degenerate and non-degenerate case, hydrogen like atoms, variational methods.	15
2	Time-dependent perturbation theory; transition probability (Fermi Golden Rule), application to constant perturbation and harmonic perturbation. Semi classical treatment of radiation. Einstein coefficients; radiative transitions.	15

3	Relativistic quantum mechanics and quantization of fields: Symmetric and antisymmetric wave functions; Klein- Gordon equation' Charge and current densities; Interaction with electromagnetic field; Dirac's equation; Dirac equation; Plane wave solution; Covariant Formulation of Dirac equation; Probability density and current densities; electron spin; Negative energy of Electron; A relativistic approach to Lagrangian and Hamiltonian of a particle on Electromagnetic field; Lagrangian and Hamiltonian Formulations.	15
4	Scattering theory: Laboratory and centre of mass frames, differential and total scattering cross sections, scattering amplitude; scattering by spherically symmetric potentials; partial wave analysis and phase shifts ; Ramsauer – Townsend effect: Relation between sign of phase shift and attractive or repulsive nature of the potential ; Scattering by a rigid sphere and square well; coulomb scattering.	15

Textbooks

1. Introduction to Quantum Mechanics by Griffiths, D. J., Pearson India Education Pvt. Ltd.

Reference Books

1. Quantum Mechanics: L.I.Schiff (Int. Student Ed.)
2. Modern Quantum Mechanics: J.J.Sakurai, Addison Wesley Pub.,USA,1999, Ist ISE Rep.
3. A. K. Ghatak and S. Lokanathan, Quantum Mechanics 3rd ed. (MacMillan).
4. Advanced Quantum Mechanics: Satya Prakash, Pragati Prakashan Ltd.
5. Quantum Mechanics: N.Zettili, John Willey and Sons. Ltd.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** II
Course Title: Physics Lab II	**Course Code:** MPHP-205

Course Description:

The course will describe the experimental part related to materials science and their Laser. In this course students will perform experiments to determine parameters like resistivity, charge carrier density, mobility, Laser wavelength, Lande's g factor, etc.

Course Outcomes:

Students' on completion of the course will be able to:

CO1: understand the apparatus of various experiments.

CO2: understand the physical working procedure of apparatus.

CO3: learn to perform experiments and make record by taking readings.

CO4: understand the physical concept behind the experiment, which will strengthen their theoretical knowledge.

Sr No.	Experiment Title
1.	To find the dc resistivity of given crystal using Four Probe set-up.
2.	To determine charge carrier density: Hall Effect Experiment
3.	To determine the mobility: Hall Effect Experiment
4.	Study of the characteristics of a GM tube and determination of its operating voltage, plateau length / slope etc
5.	Determination of Planck's constant using photo vacuum tube
6.	Study of He-Ne laser- measurement of Divergence and wavelength.
7.	To determine the wavelength of a laser using the Michelson interferometer
8.	Determination of Lande's factor of DPPH using ESR spectrometer

Textbooks

1. Printed Manuals of the experiment are given to students.

Reference books

2. Practical Physics by C. L. Arora, S. Chand publishers, New Delhi.
3. Practical Physics by P. R. Sasi Kumar, Prentice-Hall of India Pvt.Ltd

Assessment Process (Internal)

Internal assessment = 30 Marks

- **Practical work Performance = 20 Marks. (Practical File = 10 Marks, Viva-Voce = 10 Marks)**
- **Attendance = 10 Marks**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** II
Course Title: Computational Lab	**Course Code:** MPHP-206

Course Description:

The course will describe the experimental part related to computational physics and programming. In this course students will develop computer programmes for addition, subtraction, division, multiplication, integration, differentiation, iteration, etc.

Course Outcomes:

Students' on completion of the course will be able to:

CO1: understand the basics of programming language experimentally.

CO2: understand the flow chart of code building.

CO3: learn to run and execute the program and also record the output.

CO4: understand the concept behind the experiment, which will strengthen their theoretical knowledge.

Sr No.	Experiment Title
1.	program for Addition, Subtraction, Multiplication, Dividing etc.
2.	program for Simpson 1/3 rule.
3.	Program for Euler's Method
4.	Program for Lagrange Interpolation
5.	Program for Secant Method
6.	Program for Regula Falsi Method
7.	Program for Newton Raphson Method
8.	Program for Trapezoidal Method

Textbooks

4. Printed Manuals of the experiment are given to students.

Reference books

5. Practical Physics by C. L. Arora, S. Chand publishers, New Delhi.
6. Practical Physics by P. R. Sasi Kumar, Prentice-Hall of India Pvt.Ltd

Assessment Process (Internal)

Internal assessment = 30 Marks

- **Practical work Performance = 20 Marks. (Practical File = 10 Marks, Viva-Voce = 10 Marks)**
- **Attendance = 10 Marks**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** III
Course Title: Thermodynamics and statistical Physics	**Course Code:** MPH-301

Course Description:

The course introduces students to the fundamentals of thermodynamics and statistical mechanics. It describes the fundamental concepts relevant to thermodynamic potentials, probability, classical and quantum statistics. It enable the students to understand the statistical basis of thermodynamics and its applications to magnetism, black body radiation and phase transition.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify the link between statistics and thermodynamics, classical and quantum statistics and its applications.

CO2: Describe problems like ideal gas, transport phenomenon, critical phenomenon and black body radiation.

CO3: Apply principles to explain Gibbs' paradox, magnetism and phase transitions.

CO4: Assess the results obtained by solving above problems.

Unit	Topic	Hours
1	Thermodynamics: Introduction, thermodynamic variables, thermodynamic limit, transformations, laws of thermodynamics, ideal gas, entropy, limits of thermodynamics, Entropy and Carnot's Engine: Review of terms used in thermodynamics and of Carnot's eat engine.	15
2	Entropy changes in Carnot's cycle, Carnot's theorem, Thermodynamic temperature scale, Thermoelectric effect and its thermodynamical analysis, change of entropy along a reversible path in P-V diagram, entropy of a perfect gas, equation of state of an ideal gas. Thermodynamic potentials and Maxwell's relations, Chemical potential phase equilibrium.	10
3	The statistical basis of thermodynamics: macroscopic and microscopic states, phase space of classical system, Liouville's theorem, the micro canonical ensemble, equilibrium between a heat system and reservoir, partition function, two theorems, equi-partion and virial theorem, thermodynamics of magnetic systems, Grand Canonical Ensemble, partition functions, Statistical Quantities: Calculation of statistical quantities.	15
4	Energy and density, fluctuations, Entropy of an ideal gas using microcanonical Ensemble, Gibb's paradox, Sackur- Tetrode Equation, Postulates of quantum statistical mechanics, Density matrix, Statistics of indistinguishable particles, Maxwell-Boltzmann, Fermi- Dirac and Bose- Einstein Statistics, properties of ideal Bose and Fermi gases, Bose- Einstein condensation.	10
5	Cluster expansion for a classical gas, virial equation of state, ising model, mean-field theories of the ising model in three, two and one dimentions, Exact solutions in one-dimension. Landau theory of phase transition, critical indices, scale transformation and dimensional analysis.	10

Textbooks

1. Statistical Physics, Thermodynamics and Kinetic Theory : V.S. Bhatia (Vishal Pub. Co., Jalandhar) (2003).

Reference Books

1. A Treatise on Heat: M.N. Saha and B.N. Srivastava (Indian Press, Allahabad, 1972).
2. Thermal Physics: C. Kittel & H. Kroemer (CBS Pub.) (1987).
3. Thermal Physics: S.C. Garg, R.M.Bansal & C.K.Ghosh (Tata McGraw Hill) (2000). 27
4. Statistical Mechanics by K. Huang.
5. Statistical Mechanics by R. K. Pathria.
6. Statistical Mechanics by R. Kubo.
7. Statistical Physics by Landau and Lifshitz.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** III
Course Title: Electrodynamics	**Course Code:** MPH-302

Course Description:

The course provides an introduction to basic and advanced electromagnetic theory and techniques most widely used in Physics. First and second unit describe basic theory of electrostatics and magnetostatics and their unification concept; Maxwell equations. Third unit describes the transmission of electromagnetic waves in various media. The fourth unit explains the concepts of transformations and behavior of accelerated charge particles acting as dipoles and multipoles.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Gain understanding of Maxwell’s equations & electromagnetic boundary conditions.

CO2: Understanding the phenomenon of reflection, refraction and polarization.

CO3: Distinguish between a good metal and a good dielectric.

CO4: Grasp idea of electromagnetic wave propagation through space and wave guides.

Unit	Topic	Hours
1	Thermodynamics: Introduction, thermodynamic variables, thermodynamic limit, transformations, laws of thermodynamics, ideal gas, entropy, limits of	15

	thermodynamics, Entropy and Carnot's Engine: Review of terms used in thermodynamics and of Carnot's eat engine.	
2	Entropy changes in Carnot's cycle, Carnot's theorem, Thermodynamic temperature scale, Thermoelectric effect and its thermodynamical analysis, change of entropy along a reversible path in P-V diagram, entropy of a perfect gas, equation of state of an ideal gas. Thermodynamic potentials and Maxwell's relations, Chemical potential phase equilibrium.	10
3	The statistical basis of thermodynamics: macroscopic and microscopic states, phase space of classical system, Liouville's theorem, the micro canonical ensemble, equilibrium between a heat system and reservoir, partition function, two theorems, equi-partion and virial theorem, thermodynamics of magnetic systems, Grand Canonical Ensemble, partition functions, Statistical Quantities: Calculation of statistical quantities.	15
4	Energy and density, fluctuations, Entropy of an ideal gas using microcanonical Ensemble, Gibb's paradox, Sackur- Tetrode Equation, Postulates of quantum statistical mechanics, Density matrix, Statistics of indistinguishable particles, Maxwell-Boltzmann, Fermi- Dirac and Bose- Einstein Statistics, properties of ideal Bose and Fermi gases, Bose- Einstein condensation.	10
5	Cluster expansion for a classical gas, virial equation of state, ising model, mean-field theories of the ising model in three, two and one dimentions, Exact solutions in one-dimension. Landau theory of phase transition, critical indices, scale transformation and dimensional analysis.	10

Textbooks

1. Griffiths D. J. "Introduction to Electrodynamics", Pearson Education Pvt. Ltd., New Delhi, 2002.

Reference Books

1. Puri S. P. "Classical Electrodynamics", Tata McGraw-Hill Publishing Company, New Delhi, 2010.
2. Jackson J. D. "Classical Electrodynamics", John Wiley & Sons Pvt. Ltd., New York, 2004.
3. Marian J. B and Heald M. A. "Classical Electromagnetic Radiation", Academic Press, New Delhi, 2008.
4. Jordon E. C. and Balmain K. G. "Electromagnetic Waves and Radiating Systems", Prentice Hall of India, New Delhi, 1995.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** III
Course Title: Physics of Nano-materials-I	**Course Code:** MPH-304

Course Description:

The course is designed to introduce important concepts of nanomaterials. The course will enable a student to follow and take an active role in research in nanomaterials and understand their application in devices and also physical and chemical sciences.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the need of advanced nanotechnology concepts in physics and their consequences.

CO2: Solve various problems and its central importance to the physics.

CO3: Identify the right method or technique to characterize the materials.

CO4: Implement concepts to solve various physics problems especially in quantum regime.

Unit	**Topic**	**Hours**
1	Introduction to Nanotechnology, Materials science and quantum confinement at nanoscale, classification of nanostructures, bonding in solids, imperfections in solids, size dependent properties, Grain and grain boundaries, Different types of Conduction Mechanisms.	15
2	Quantum Confinement, Quantum wells, quantum wires and quantum dots, ferrites, classification of Ferrites, Spintronics materials, Dilute magnetic semiconductors and applications. Magnetic properties: Magnetic Interactions, Effect of particles size on magnetic properties	15
3	Sinetering process, sintering mechanism and parameters, Electrical properties of metal oxides:	15
4	DC Resistivity-Two/Four probe, Dielectric constant and loss factor, magnetic properties: Curie temperature, Mossbauer Study: Isomer shift, Quadrupole splitting, hyperfine interactions, Line width and line shape, relaxation effects.	15

Textbooks

1. A text of book Nanoscience and Nanotechnology by T.Pradeep.

Reference Books

1. Nanophysics and nanotechnology, by Edward L. Wolf, Willey-VCH 2004
2. An Introduction to Nanophysics and Nanotechnology, by Avinashi Kapoor, Alpha Science International, Ltd (May 2011)
3. An introduction to the physics at low dimensional semiconductors, by J.H. Davies, Cambridge Press, 1998.

4. Nanomaterials: synthesis, properties and applications, by A. S. Edelstein and R. C. Cammarata (Institute of Physics Pub, 1998).
5. Nanostructures and nanomaterials, by G. Cao, Imperial College Press, 2004.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** III
Course Title: Condensed Matter Physics-II	**Course Code:** MPH-304

Course Description:

The course introduces students to magnetism, ferromagnetism, paramagnetism, dielectrics etc.. The phenomena of superconductivity, the BCS theory of superconductivity, Cooper pair problem, the electron-phonon interactions, dielectrics and ferroelectrics.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Identify different concepts of magnetism and magnetic materials.
CO2: Describe fundamentals behind superconductivity and superconducting materials.
CO3: Apply principles to determine magnetic and dielectric behavior of solids.
CO4: Assess the results obtained by solving above problems.

Unit	**Topic**	**Hours**
1	Super conductivity: Historical introduction, Survey of superconductivity, Super conducting systems, Microwave and infrared properties, Isotopic Effect, Critical Magnetic Field, Meissner Effect, London Theory and Pippards' equation, Classification of Superconductors (type I and Type II), BCS Theory of Superconductivity, Flux quantization, Ginzburg's Landau theory, Single particle tunnelling, Josephson Effect (AC and DC), Practical Applications of superconductivity and their limitations, High Tc Super conductors.	15
2	Diamagnetism and para-magnetism: Langevin theory of diamagnetism, Quantum theory of diamagnetism, Paramagnetism, Quantum theory of Paramagnetism.	15

3	Ferromagnetism and antiferromagnetism: ferromagnetic order, curie point and exchange integral, temperature dependence of saturation magnetization, quantum theory of ferromagnetism, antiferromagnetic order, ferromagnetic domains, domain wall theory, single domain particles, ferrites and their applications.	15
4	Dielectrics and ferroelectrics: Maxwell equations, polarisation, local electric field of an atom, dielectric constant and polarizabilty, classical theory of polarizabilty, structural phase transitions, ferroelectric crystals and their classification, displacive transitions, antiferroelctricity, ferroelectric domains, Piezoelectricity, Point defects.	15

Textbooks

1. Elements of Solid State Physics 2nd Ed, J.P.Srivastava, Printice Hall of India, New Delhi, 2001..

Reference Books

1. Solid State Physics: Structure and Properties of Materials, 2nd Ed. A. M. Wahab, Narosa Publishing house, New Delhi, India, 2007.
2. Introduction to Solid State Physics, 7th Ed, C. Kittel, John –Wiley & Sons (Asia) Pvt. Ltd., New Delhi, 1996.
3. Solid State Physics, 4th Ed. S. O. Pillai, New Age International Publishers, New Delhi, 2001.
4. Introductory to Solid State Physics 2nd Ed, H. P. Myers, Taylors and Francis Ltd, London, 1998.
5. Elementary Solid State Physics: Principles and Applications, 4th Ed., M. A .Omar, Pearson Education Pvt. Ltd., Delhi, India, 2004.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** III
Course Title: Physics Lab III	**Course Code:** MPHP-305

Course Description:

The course will describe the experimental part related to condensed matter physics. In this course students will perform experiments to determine parameters like crystallite size, lattice constants, Zeeman parameters, dielectric properties, coercivity, retentivity, etc.

Course Outcomes:

Students' on completion of the course will be able to:

CO1: understand the apparatus of various experiments.

CO2: understand the physical working procedure of apparatus.

CO3: learn to perform experiments and make record by taking readings.

CO4: understand the physical concept behind the experiment, which will strengthen their theoretical knowledge.

Sr No.	Experiment Title
1.	Verification of Inverse Square Law.
2.	To determine the crystallite size using FWHM: X-Ray Diffraction
3.	To determine the lattice constant using XRD data
4.	To study the normal Zeeman Effect
5.	To study dielectric properties of liquids & Solids
6.	Interpretation of transmission Laue photographs.
7.	To study magnetic susceptibility.
8.	To study B-H curve.

Textbooks

1. Printed Manuals of the experiment are given to students.

Reference books

2. Practical Physics by C. L. Arora, S. Chand publishers, New Delhi.
3. Practical Physics by P. R. Sasi Kumar, Prentice-Hall of India Pvt.Ltd

Assessment Process (Internal)

Internal assessment = 30 Marks

- **Practical work Performance = 20 Marks. (Practical File = 10 Marks, Viva-Voce = 10 Marks)**
- **Attendance = 10 Marks**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** IV
Course Title: Atomic and Molecular Physics	**Course Code:** MPH-401

Course Description:

The course introduces students to basic and advanced atomic & molecular Physics and techniques most widely used in physics. The theories of development and understanding of atomic structure for single and multi-electron atoms are explained in this course. The course also discusses molecular spectroscopy, construction and working of X-rays and various types of Lasers. It allows the students to solve various Physics problems.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Describe the atomic spectra of one and two valance electron atoms.
CO2: Explain the change in behavior of atoms in external applied electric and magnetic field.
CO3: Explain rotational, vibrational, electronic and Raman spectra of molecules.
CO4: Apply these concepts to understand the structure of molecules.

Unit	**Topic**	**Hours**
1	Quantum Mechanical Treatment of one-electron Atom: Spin-Orbit interaction and fine structure of hydrogen atom, Spectra of alkali elements. Singlet and triplet States of Helium, Many electron atoms: Central field approximation, Thomas-Fermi field, Atomic wave function, Hartree and Hartree –Fock approximations, Spectroscopic Terms: L S and J J coupling schemes for many electron atoms, wavefunctions and energies of multiplets., Electric dipole and Electric Quadrupole.	15
2	Born - Oppenheimer approximation, Heitler-London theory of H2, Classification of Molecules,Types of Molecular Spectra and Molecular Energy States: Pure Rotational Spectra, Vibrational-Rotational Spectra,	12
3	Raman Scattering, Selection rules , Nuclear spin and intensity alternation , Isotope effect, Classification of electronic states , Coupling of rotational and electronic motions, Electronic spectra: Franck-Condon principle.	13
4	Infrared Spectroscopy, Raman spectroscopy, Photoelectron Spectroscopy, Nuclear Magnetic Resonace , Chemical Shift, and Electron Spin Resonance (Introduction and their principles only).	12
5	General description and working of infra-red Spectrophotometer, Photoelectron Spectrometer, Simple Raman Spectrometer, NMR Spectrometer and ESR Spectrometer.	8

Textbooks

1. Atomic and Molecular Spectra by Raj Kumar, New Delhi.

Reference Books

1. Introduction to Atomic Spectra by H.E. White, Tata Mcgraw Hill.
2. Fundamentals of molecular spectroscopy by C.B. Banwell & E. M. McCash, Tata Mcgraw Hill.
3. Spectroscopy Vol. I, II & III by Walker & Straughen, Springer.
4. Introduction to Molecular spectroscopy by G.M. Barrow, Tata Mcgraw Hill.

5. Molecular spectroscopy by J.M.Brown.
6. Spectra of atoms and molecules by P.F. Bemath.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** IV
Course Title: Physics of Nanomaterials-II	**Course Code:** MPH-402

Course Description:

The course is designed to introduce important concepts of nanomagnetism. The course will enable a student to follow and take an active role in research in nanomaterials and understand their application in devices and also physical and chemical sciences.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Understand the need of advanced nanotechnology concepts in physics and their consequences.
CO2: Solve various problems and its central importance to the physics.
CO3: Identify the right method or technique to characterize the materials.
CO4: Implement concepts to solve various physics problems especially in quantum regime.

Unit	Topic	Hours
1	Nano-Magnetism: Introduction, single domain particles and nanoscale magnetism, Electrical and Mechanical Properties: Introduction- Energy Storage Basics- General Information: Electrical Energy Storage Devices and Impact of Nanomaterials- Batteries –Capacitors. Introduction – Mechanical properties- Density Considered as an Example.	15
2	The Elasticity of Nanomaterials – Elasticity of Bulk Nanomaterials – Plastic Deformation of Nanomaterials – the Physical Basis of Yield Strength – Crystals and Crystal Plastically – From Crystal Plastically to Polycrystal Plasticity.	13
3	Characterization Methods: X-ray diffraction technique and its uses, Raman Spectroscopy and its application. Scanning electron microscope (SEM),	10

	Scanning tunnelling microscope (STM), XPS, Impedance Analysis, vibrating force sample magnetometer.	
4	Nuclear Magnetic (NMR) , Differential scanning calorimeter (DSC) Thermogravimetric/Differential Thermal Analyzer (TG/DTA) UV, Visible Spectrophotometer, FTIR.	12
5	Preparation Methods: Molecular assembler concept, ball mailing, Co-precipitation, Citrate precursor, Electro-deposition, Pulsed Laser Deposition (PLD), DC/RF Magnetron Sputtering, Molecular Beam Epitaxy (MBE), Sol-Gel Process, Photochemical Synthesis, Reverse Micelles and Micro emulsions – Combustion Methods – Template Process – Chemical Vapor Deposition (CVD) – Metal Oxide Chemical Vapor Deposition (MOCVD)	10

Textbooks

1. Nano: The Essentials: Understanding Nanoscience and Nanotechnology by T. Pradeep.

Reference Books

1. Nanomaterials: Mechanics and Mechanisms, K.T.Ramesh, Springer 2009.
2. Nanoscale materials in chemistry, Edited by Kenneth J.Klabunde, John wiley & Sons 2009.
3. Nanoscale materials in chemistry, Edited by Kenneth J.Klabunde, John wiley & Sons 2001.
4. Nanoscopic materials; Size dependent phenomena, Emil Roduner, RSC Publishing, 2006.
5. Optical properties and spectroscopy of Nanomaterials, Jin Zhong Zhang, World Sceintific 2009.
6. Nanoelectronics and nanosystems- K.Goser, P. Glosekotter and J.Dienstuhl, Springer 2008.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** IV
Course Title: Microwave and power electronics	**Course Code:** MPH-403A

Course Description:

The course is designed to introduce important concepts of microwave. The course will enable a student to follow and take an active role in understanding the microwave principles and their application in devices. It will allow the students to learn microwave measurement techniques.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Understand the need of microwave physics and their consequences.
CO2: Solve various problems and understand its central importance to the physics.
CO3: Identify the right method or technique to solve the complex problems.
CO4: Understand the working principles behind various microwave devices.

Unit	Topic	Hours
1	Introduction, definition of Microwave, Characteristic features, application of Microwave, Generation of Microwave by vacuum tube – limitation of conventional tubes klystron amplifier reflex klystron oscillate, magnetrons – travelling wave tubes, Generation of microwave by solid state devices, bipolar transistor field effect transistors, gunn oscillator, avalanche diode, oscillator, IMPATT & TRPATT mode of operation parametric amplifiers.	15
2	Microwave integrated circuit design, introduction, hybrid microwave integrated circuits (HMIC), monolithic microwave integrated circuit (MMIC), MIC Materials, Substrate material, conductor material, dielectric materials, resistive films, types of mics, microwave monolithic integrated circuits (MMIC`s).	13
3	Waveguide dimensions, impedance matching elements, waveguide short circuit, tees and magic tee, Phase shiftless, attenuators, matched terminators, waveguide slotted section, PIN diodes, PIN diode switches.	10
4	Microwave measurement techniques, standing wave measurements, impedance measurement, cavity resonator, cavity q frequency measurements and calibration techniques, dielectric measurements.	10
5	Thyristor control circuits : Temperature control, illumination control, Application of TRIAC as a three position static switch, Light activated turn off circuit using DIAC-TRIAC an LDR, OFF at dark circuit Automatic street lighting circuit using LDR and SCR, emergency Light using SCR, automatic water level indicator using SCR, automatic battery chargers using SCR.	12

Textbooks

1. Microwave devices and circuits; S.Y. Liao (Prentice hall of India).

Reference Books

1. Introduction to Microwave Theory and Measurements L.A Lance (Tata Mcgraw Hill)
2. Radio Frequency and Microwave Electronics M.M Radmanesh (Pearson).
3. Industrial electronics and control by Bhattacharya, Chatterjee, TMH, New Delhi.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	

Program: M.Sc. Physics	**Semester:** IV
Course Title: Vacuum and ion beam spectroscopic techniques	**Course Code:** MPH-403B

Course Description:

The course is designed to introduce important concepts of microwave. The course will enable a student to follow and take an active role in understanding the microwave principles and their application in devices. It will allow the students to learn microwave measurement techniques.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the need of microwave physics and their consequences.

CO2: Solve various problems and understand its central importance to the physics.

CO3: Identify the right method or technique to solve the complex problems.

CO4: Understand the working principles behind various microwave devices.

Unit	**Topic**	**Hours**
1	Basics of Vacuum Techniques: Introduction, classification of vacuum ranges, throughput, Pump speed, speed of exhaust, conductance, ultimate pressure, viscous flow, molecular flow.	12
2	Production of Low Pressures: Pump types, Gaede oil-sealed rotating vane pump, Diffusion pump, sputtering pumps, Gettering, types of getters, Cryogenic pumps.	13
3	Measurement of Low Pressures: Types of gauges, Mcleod gauge, Pirani gauge, Measurement of ultrahigh vacuum. Methodology of Vacuum systems: Materials for vacuum system, cleaning and sealing of vacuum system, Leak detection and its location. Production and Measurement of Low Temperatures: Adiabatic throttling of gases, liquefaction of H2 and He.	15
4	Ion-Beam Techniques-I: Activation Analysis (NAA), Particle Induced X-ray Emission Analysis (PIXE), Particle Induced Gamma-ray Emission Analysis (PIGE)	10

5	Ion-Beam Techniques-II: Rutherford Backscattering Analysis (RBS), Elastic Recoil Detection (ERD), Nuclear Reaction Analysis (NRA).	10

Textbooks

1. Vacuum Technology: A. Roth (North Holland)

Reference Books

2. Handbook of High Vacuum Techniques: H.A. Steinherz (Reinhold Pub.)
3. A Treatise on Heat: M.N. Saha and B.N. Srivastava (Indian Press)
4. Low Temperature Physics: C. Dewitt, B. Dreyfus and P.G. de Gennes (Gordon & Breach)
5. Bose-Einstein Condensation in Dilute Gases: C.J. Pethick and H. Smith (Cambridge Univ. Press).
6. Atomic and Nuclear Analytical Methods: H.R.Verma (Springer-Verlag 2007)

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) =** 40 Marks
- **Continuous Assessment (CA) =** 20 Marks in the form of

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3			2		2		2	2		
CO2	3				3				2		3		3	2		3
CO3	3				3				2		3		3	2		3
CO4	3				3				2		3	3	3	2	3	