FACULTY OF SCIENCES

SYLLABUS
of
Master of Science (Physics)
(Semester: I -IV)

(Under Continuous Evaluation System)

Session: 2020-21

The Heritage Institution

KANYA MAHA VIDYALAYA
JALANDHAR
(Autonomous)

Kanya Maha Vidyalaya, Jalandhar (Autonomous)

SCHEME AND CURRICULUM OF EXAMINATIONS OF TWO YEAR DEGREE PROGRAMME

M.Sc. (Physics)

Session-2020-21

M.Sc. (Physics) SEMESTER-I							
Course Code	Course Name	Course Type	Marks				Examination time (in Hours)
			Total	Ext.		CA	
				L	P		
MPHL-1391	Analog and Digital Electronics	C	100	80	-	20	3
MPHL-1392	Mathematical Physics	C	100	80	-	20	3
MPHL-1393	Classical Mechanics	C	100	80	-	20	3
MPHL-1394	Computational Techniques	C	100	80	-	20	3
MPHP-1395	Electronics Lab	C	100	-	80	20	3
MPHP-1396	Computer Lab	C	100	-	80	20	3
Total			600				

SEMESTER-II							
Course Code	Course Name	Course Type	Total	Ext.		CA	Examination time (in Hours)
				L	P		
MPHL-2391	Quantum Mechanics-I	C	100	80	-	20	3
MPHL-2392	Electrodynamics-I	C	100	80	-	20	3
MPHL-2393	Condensed Matter Physics-I	C	100	80	-	20	3
MPHL-2394	Atomic & Molecular Spectroscopy	C	100	80	-	20	3
MPHP-2395	Condensed Matter Physics Lab -I	C	100	-	80	20	3
MPHP-2396	Spectroscopy Lab	C	100	-	80	20	3
Total			600				

M.Sc. (Physics) Semester-III							
Course Code	Course Name	Course Type	Marks				Examination Time (in Hours)
			Total	External		CA	
				L	P		
MPHL-3391	Quantum Mechanics-II	C	100	80	--	20	3
MPHL-3392	Electrodynamics-II	C	100	80	--	20	3
MPHL-3393	Condensed Matter Physics-I	C	100	80	--	20	3
MPHL-3394	Nuclear Physics	C	100	80	--	20	3
MPHP-3395	Condensed Matter Physics Lab-II	C	100	--	80	20	3
MPHP-3396	Nuclear Physics Lab	C	100	--	80	20	3
M.Sc. (Physics) Semester-IV							
MPHL-4391	Particle Physics	C	100	80	--	20	3
MPHL-4392	Condensed Matter Physics-II	C	100	80	--	20	3
MPHL-4393 (OPT-_)	Student may choose any two subjects from the following list of options	C	100	80	--	20	3
MPHL-4394(OPT-_)		C	100	80	--	20	3
MPHD-4395	Assignment/ Project		50	-	40	10	

OPT-I	Physics of Materials
OPT-II	Radiation Physics
OPT-III	Reactor Physics
OPT-IV	Plasma Physics
OPT-V	Geophysics
OPT-VI	Nano Technology
OPT-VII	Space Science & Astronomy

Program Specific Outcomes: M.Sc. (Physics)

After the successful completion of the program, the student will be able to do the following

PSO 1. The Master of Science in Physics program provides the detailed functional knowledge of the fundamental theoretical concepts and experimental methods of physics. It will help the candidate to enhance her general competence, and analytical skills on an advanced level, and will prepare her according to the jobs needed in education, research or public administration.

PSO 2. The student will have the knowledge of the topics of the research conducted by researchers at the Department of Physics, and knowledge of a well-defined area of research within physics.

PSO 3. The student will have the understanding of the basic concepts of classical mechanics, quantum mechanics, statistical mechanics and electricity and magnetism to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws through logical and mathematical reasoning.

PSO 4. The student will learn to carry out experiments in basic as well as certain advanced areas of physics such as nuclear physics, condensed matter physics, spectroscopy, lasers and electronics.

PSO 5. The work course of project and assignment will give the students special expertise within one of the research areas represented at the Department of Physics which will result in some research experience within a specific field of physics, through a supervised project.

PSO 6. The student will be able to critically apply the knowledge gained during the course to scientific models and solve problems in the areas of electrodynamics, quantum mechanics, classical mechanics, statistical mechanics, and advanced mathematical methods.

PSO 7. **General competence**

The candidate will be able to

- Understand the role of physics in society and know the historical development of physics, its possibilities and limitations, and understands the value of lifelong learning.
- Gather, assess, and make use of new information.

M.SC. PHYSICS SEMESTER-I

COURSE CODE: MPHL-1391
ANALOG AND DIGITAL ELECTRONICS

COURSE OUTCOMES

After passing this course the student will be able to:

CO 1. Understand the concept of Electronic devices (MOSFET, UJT, SCR) and their applications.
CO 2. Demonstrate the concept of Electronic circuits: Operational Amplifier and its applications
CO 3. Use concept of Digital Principles for electronic conversions.
CO 4. Demonstrate application of sequential circuits.

SEMESTER-I

COURSE CODE: MPHL-1391

ANALOG AND DIGITAL ELECTRONICS

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters:

Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

UNIT-I: Electronic Devices and semiconductor Memories

MOSFETs, construction and working of U.J.T. and SCR and their application in wave generation and power control. Types of Memories, Read/Write Memory, ROM, EPROM, EEPROM, static dynamic memory, memory cell: static RAM Memory cells, NMOS static cells.

Lectures 15

UNIT-II: Electronic Circuits:

Amplifier, Operational amplifier (OP-AMP), OP-AMP as inverting and non-inverting, scalar, summer, integrator, differentiator. Schmitt trigger and logarithmic amplifier, Electronic analog computation circuits

Lectures 15

UNIT-III: Digital Principles:

Binary and Hexadecimal number system, Binary arithmetic, Logic gates, Boolean equation of logic circuits, Karnaugh map simplifications for digital circuit analysis, and design, Encoders & Decoders, Multiplexers and Demultiplexers, Parity generators and checkers, Adder-Subractor circuits.

Lectures 15

UNIT-IV: Sequential Circuits:

Flip Flops, Registers, Up/Down counters, D/A conversion using binary weighted resistor network, Ladder, D/A converter, A/D converter using counter, Successive approximation A/D converter.

Lectures 15

Text and Reference Books

1. Electronic Devices and Circuits by Millman and Halkias-Tata McGraw Hill, 1983.
2. Digital Principles and Applications by A.P.Malvino and D.P.Leach-Tata McGraw Hill, New Delhi, 1986.
3. Digital Computer Electronics by A P Malvino-Tata McGraw Hill, New Delhi, 1986
4. Electronic Devices and Circuit Theory 10e by Robert L. Boylestad; Louis Nashelsky 2009.

SEMESTER-I

COURSE CODE: MPHL-1392

MATHEMATICAL PHYSICS

COURSE OUTCOMES OF MATHEMATICAL PHYSICS

On completion of this course a student will be able to:

CO 1. Understand and use, advanced mathematical methods and theories on various mathematical and physical problems.

CO 2. Identify different special mathematical functions.

CO 3. Understand Cartesian (X, Y, Z), Spherical polar (r, θ, φ) and Cylindrical (ρ, φ, z) co-ordinate systems and their transformation equations.

CO 4. Solve partial differential equations with appropriate initial or boundary conditions with Green function techniques

CO 5. Have confidence in solving mathematical problems arising in physics by a variety of mathematical techniques

SEMESTER-I

COURSE CODE: MPHL-1392

MATHEMATICAL PHYSICS

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**

Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters:

Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

UNIT-I: Coordinates systems, Fourier and Laplace transform.

Curvillinear coordinates, Differential vector operators in curvilinear coordinates, spherical and cylindrical systems, General coordinate transformation, Tensors: covariant, contra variant and Mixed, Algebraic operations on tensors, Illustrative applications.

Fourier decomposition, Fourier series and convolution theorem, Fourier transforms and its applications to wave theory. Laplace Transform, Laplace transform of derivatives and integrals, Inverse Laplace transform, Application of Laplace Transform.

20Lectures

UNIT-II: Complex analysis.

Function of a complex variables, Analytical functions and Cauchy–Riemann conditions, Cauchy integral theorem, Cauchy integral formula, Taylor and Laurent series, singularities and residues, Cauchy residue theorem, calculations of real integrals.

10Lectures

Unit –III: Differential equations and Special Functions.

Second order differential equations, Frobenions method, wronskian and a second solution, the Strum Liouville theorem, one dimensional Green's function. Gamma functions. The exponential integral and related functions, Bessel functions of the first and second kind, Legendre polynomials, associated Legendre polynomials and spherical harmonics, Generating functions for Bessel, Legendre and associated Legendre functions, Hermite Functions.

20Lectures

UNIT-IV: Group theory:

Definition of a group, multiplication table, conjugate elements and classes of groups, direct product Isomorphism, homomorphism, permutation group, definition of the three dimensional rotation groups and SU(2)

10Lectures

Text and Reference Books

1. MathematicalMethodsforPhysicist by GeorgeArfken-NewYorkAcademy,1970.
2. MathematicalPhysics by P.K.Chattopadhyay,NewAgeInternational1990.

M.Sc. (Physics) (Session 2019-20)

Semester-1

COURSE CODE: MPHL-1393

CLASSICAL MECHANICS

COURSE OUTCOMES

CO 1. After the students complete this course they will be familiar with aspects of Classical Mechanics such as Lagrangian and Hamiltonian formulation, particle in central potentials, rigid body motion. These will form the essential background for other courses such as Quantum Mechanics, Electrodynamics and High Energy Physics that students would learn in the subsequent semesters.

CO 2. Students will learn the importance of Lagrangian and Hamiltonian mechanics over the Newtonian mechanics and be able to solve the complex problems on the equations of motion by applying these two techniques.

CO 3. Having successfully completed this course, students will be able to demonstrate knowledge and understanding of orbit problems using the conservation of angular momentum and total energy.

CO 4. Students will also be able to demonstrate understanding of rigid body motion using Euler theorem and Euler angles, which will help them to solve advanced problems pertaining to celestial mechanics.

M.Sc. (Physics) (Session 2019-20)

SEMESTER-I

COURSE CODE: MPHL-1393

CLASSICAL MECHANICS

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**

Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the PaperSetters:

Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

UNIT-I: Lagrangian Mechanics

Newton's laws of motion, mechanics of a system of particles, constraints, generalized coordinates D'Alembert's principle and Lagrange equations of motion for conservative systems, simple applications of Lagrangian formulation.**Variational Principles:**Hamiltons principle, some techniques of the Calculus of variations, derivation of Lagrange equations from Hamilton's principle, conservation theorems and symmetry properties.

Lectures 15

UNIT-II: Central Force Problem

Two body central force problem, reduction to equivalent one body problem, the equation of motion and first integrals, the equivalent one dimensional problem, and
classification of orbits, the Virial theorem, the differential equation for the orbit, conditions for closed orbits, the Kepler problem, scattering in a central force field (Rutherford scattering cross section formula).

Lectures 15

UNIT-III: Hamiltonian Mechanics

Legendre transformation and Hamilton equations of motion, cyclic coordinates and conservation theorems, derivation of Hamiltons equations from a variational principle, the principle of least action, simple applications of Hamiltonian formulation.

Canonical Transformations: The equations of canonical transformation, examples of canonical transformations, Poisson brackets, equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, Hamilton-Jacoby theory.

Lectures 15

UNIT-IV: Rigid Body Dynamics

The independent coordinates of a rigid body, orthogonal transformation,
the Euler angles, Euler's theorem on the motion of rigid body, finite and infinitesimal rotations, rate of change of a vector, angular momentum and kinetic energy about a point for a rigid body, the inertia tensor and moment of inertia, the eigen values of the inertia tensor and the principal axis transformation. Euler's equations of motion, torque free motion of a rigid body.

Small Oscillations: Eigen value equation, Free vibrations, Normal Coordinates, vibrations of a triatomic molecule.

Lectures 15

Books:

1. Classical Mechanics by Herbert Goldstein-Narosa Pub. House, New Delhi, 1970.
2. Mechanics by L.D. Landau-Pergamon Press, Oxford, 1982.
3. Classical Mechanics by Rana and Joag-Tata McGraw Hill, New Delhi, 1995.

SEMESTER-I

COURSE CODE: MPHL-1394

COMPUTATIONAL TECHNIQUES

COURSE OUTCOMES

On completion of this course a student will be able to:

CO 1. The very first outcome of the course is having knowledge about various programming languages, their need in research and development.

CO 2. The introduction to MATLAB gives a basic knowledge about syntaxes and procedures used in MATLAB to solve various mathematical problems.

CO 3. Understanding of interpolation of data from an experimental data with equal and unequal intervals.

CO 4. The students will be able to solve integration and differentiation numerically by using various methods.

CO 5. Understanding of various numerical methods to solve polynomial and transcendental equations gives an insight of working of these methods.

SEMESTER-I

COURSE CODE: MPHL-1394

COMPUTATIONAL TECHNIQUES

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters:

Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

UNIT-I: Introduction of MATLAB

Introduction: Basics of MATLAB, working with arrays, creating and printing plots, Interacting Computations: Matrices and Vectors, Matrices and Array Operations, built in functions, saving and loading data, plotting simple graphs Programming in MATLAB: Scriptfiles, function files, Compiled files, p-code, variables, loops, branches, and control flow, Input/Output, Advanced data objects, structures, cells

Lectures18

UNIT-II: Interpolation

Interpolation, Newton's formula for forward and backward interpolation, Divided differences, Symmetry of divided differences, Newton's general interpolation formula, Lagranges interpolation formula

Lectures12

UNIT-III: Numerical Differentiation and integration

Numerical integration, A general quadrature formula for equidistant ordinates, Simpson, Weddle and Trapezoidal rules, Monte- Carlo Method, Euler's method, Modified Euler's method, Runge Kutta Method.

Lectures15

UNIT-IV: Roots of Equation

Approximate values of roots, Bisection Method, Regula-Falsi Method, Newton-Raphsonmethod,Bairstowmethod.SimultaneousLinearAlgebraicEquations:SolutionofSimultaneous Linearequations,Gausseliminationmethod,Gauss-Jordonmethod,Matrixinversion, finding eigen values and eigen vectors, matrix factorization, Curve fitting and Interpolation; polynomial curve fitting, least square curve fitting

Lectures15

Text and Reference Books

1. Getting started with MATLAB by RudraPratap-OxfordUniversityPress-2005.
2. A concise introduction to MATLAB by William JPalm III-McGrawHill-2008.
3. Numerical Mathematical Analysis by James Scarborough (Oxford and IBH),1966.
4. Elementary Numerical Analysis by S.D.Conte (McGrawHill),1965.
5. Numerical Methods for Mathematics by John.H.Methews Science and Engineering(Prentice Hall of India).

SEMESTER-I

COURSE CODE: MPHP-1395

ELECTRONICS LAB

COURSE OUTCOMES

After successfully completion of this lab student will be able to

CO1: Characterise and understand the applications of DIAC, TRIAC, UJT and SCR.

CO2: Investigate characteristics of MOSFET and Multivibrators.

CO3: understand experimentally working of Operational Amplifier and its applications

CO4: basics about Digital Logic circuits from logic gates to ALU.

M.Sc. (Physics) (Session 2019-20)

SEMESTER-I

COURSE CODE: MPHP-1395

ELECTRONICS LAB

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**

Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Practical Examiners:

Question paper is to be set on the spot jointly by the external and internal examiners. Two copies of the same to be submitted for the record to COE office, KanyaMahaVidyalaya, Jalandhar

LIST OF EXPERIMENTS

1. To Study the DC characteristics and applications of DIAC.
2. T o study the DC characteristics and applications of SCR.
3. To study the DC characteristics and applicationsofTRIAC.
4. Investigation of the DC characteristics and applicationso of UJT.
5. Investigation of the DC characteristics of MOSFET.
6. Study of bi-stable, mono-stable and astable, multivibrators.
7. Study of Op-Amps and their applications such as an amplifier(inverting, non-inverting), scalar, summer, differentiator and integrator.
8. Study of logic gates using discrete elements and universal gates.
9. Study of encoder, decoder circuit.
10. Study of arithmetic logic unit(ALU)circuit.
11. Study of shift registers.
12. Study of half and full adder circuits.
13. Study of A/D and D/A circuits.

SEMESTER-I

COURSE CODE: MPHP-1396

COMPUTER LAB

After completion of this lab Student will be

CO1: familiar with various MATLAB syntaxes and techniques to carryout simple calculations.

CO2: able to develop MATLAB programs to find roots of equations.

CO3: able to apply MATLAB commands to plot simple graphs in 2D.

CO4: able to write MATLAB programs to solve numerical integration, numerical differentiation and interpolation.

SEMESTER-I

COURSE CODE: MPHP-1396

COMPUTER LAB

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Practical Examiners:
Question paper is to be set on the spot jointly by the external and internal examiners. Two copies of the same to be submitted for the record to COE office, KanyaMahaVidyalaya, Jalandhar

LIST OF EXPERIMENTS
1.Determination of Roots

a) Bisection Method
b) Newton Raphson Method
c) Secant Method
2.Integration

a) Trapezoidal rule
b) Simpson1/3andSimpson3/8rules
c) Gaussian Quadrature
3.Differential Equations

a) Euler's Method
b) Runge Kutta Method

4.Interpolation

a) Forward interpolation, Backward interpolation.
b) Lagrange's interpolation.
5.Applications

a) Chaotic Dynamics, logistic map
b) One dimensional Schrondinger Equation
c) Time period calculation for a potential
d) Luminous intensity of a perfectly blackbody vs. temperature

M.Sc. (Physics) (Session 2019-20)

SEMESTER-II

COURSE CODE: MPHL-2391

QUANTUM MECHANICS-I

COURSE OUTCOMES OF QUANTUM MECHANICS

This course develops concepts in quantum mechanics such that the behavior of the physical universe could be understood from a fundamental point of view. It provides a basis for further study of quantum mechanics

CO 1. The very first outcome of the course is that the student will learn the mathematical tools needed to solve quantum mechanics problems. This will include complex functions and Hilbert spaces, and the theory of operator algebra and the concept that quantum states could be described in a vector space. Solutions of ordinary and partial differential equations that arise in quantum mechanics will also be studied.

CO 2. The student will be able to build connections between mathematical development and conceptual understanding.

CO 3. The student will be able to apply the concepts of quantum mechanics to solve the one and three dimensional problems of quantum mechanics to understand the basics of atomic structures and the wave mechanics of these atoms.

CO 4. The student will learn the basic concepts of spin and angular momentum and the role of spherical harmonics in determining the shape of electronic clouds around the nucleus. They will also learn about the utilization of simple harmonic oscillator and the role of Hilbert space in developing simple harmonic oscillator.

M.Sc. (Physics) (Session 2019-20)

SEMESTER-II

COURSE CODE: MPHL-2391

QUANTUM MECHANICS-I

Maximum Marks: 100 (External 80 + Internal 20) Examination Time: 3 Hours

Pass Marks: 40 Total Teaching hours: 60

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

NoteforthePaperSetters:

Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

UNIT-I:*Basic Formulation and quantum Kinematics:* Stern Gerlach experiment as a tool to introduce quantum ideas, analogy of two level quantum systems with polarisation states of light. Complex linear vector spaces, ket space, bra space and inner product, operators and properties of operators .Eigen kets of an observable, eigen kets as base kets, matrix representations. Measurement of observable, compatible vs incompatible observable, commutators and uncertainty relations. Change of basis and unitary transformations. Diagonalisation of operators. Position, momentum and translation, momentum as a generator of translations, canonical commutation relations. Wave functions as position representation of ket vectors. Momentum operator in position representation, momentum Space wave function.

Lectures18

UNIT-II: *Quantum Dynamics:*Time evolution operator and Schrödinger equation, special role of the Hamiltonian operator, energy eigen kets, time dependence of expectation values, spin precession. Schrodinger vs. Heisenberg picture, unitary operators, state kets and observable in Schrodinger and Heisenberg pictures, Heisenberg equations of motion, Ehrenfest's theorem. Simple harmonic oscillator Energy eigen values and eigen vectors of SHO, Matrix representation of creation and annihilation operators, Zero-point energy; Coherent states.

Lectures12

UNIT-III: Symmetry Principles: Symmetry and conservation laws, Space time translation and rotations. Conservation of linear momentum, energy and angular momentum. Unitary transformation, Symmetry and Degeneracy, space inversion and parity. Time reversal invariance.

Lectures12

UNIT-IV: Spherical Symmetric Systems and Angular momentum *:*Schrodinger equation for a spherically symmetric potential. Orbital angular momentum commutation relations. Eigen value problem for L^2, spherical harmonics. Three dimensional harmonic oscillator, three dimensional potential well and the hydrogen atom. Angular momentum algebra, commutation relations. Introduction to the concept of representation of the commutation relations in different dimensions. Eigen vectors and eigen functions of J^2 and Jz. Addition of angular momentum and C.G. coefficients.

Lectures18

Text and Reference Books

1. Modern Quantum Mechnics by J.J.Sakurai-PearsonEducatonPvt.Ltd.,New Delhi,2002.
2. A textbook of Quantum Mechanics by P M Mathews, K Venkatesan, MccGraw Hill Education
3. Quantum Mechanics: Concepts and Applications by N. Zettili, John Wiley & Sons.
4. Quantum Mechanics: Merzbacher by JohnWiley&Sons,NewYork,1970.
5. Quantum Mechanics (2^{nd} Ed.) by V.K. Thankappan, New Age International Publications, New Delhi, 1996

SEMESTER-II

COURSE CODE: MPHL-2392

ELECTRODYNAMICS-I

COURSE OUTCOMES

After passing this course the students will be able to:

CO1: understand the basic concepts of electrostatics and magnetism and related quantities and their calculations for different charge distribution as well as the behaviour of electric and magnetic field inside matter. The students will have the ability to solve the electrostatic problems by method of images helps.

CO2: demonstrate knowledge about the time-varying magnetic and electric fields and their effects by

CO3: understand the propagation of electromagnetic waves in conducting and insulating media.

SEMESTER-II

COURSE CODE: MPHL-2392

ELECTRODYNAMICS-I

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters:

Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

UNIT-I: Electrostatics: Coulomb's law, Gauss's law and its applications, Scalar potential, Poisson's equation, Laplace equation. method of images, multipole expansion, Solution of boundary value problems: Green's function and its calculation for the image charge problem in the case of a sphere, uniqueness theorem. Electrostatics of dielectric media, Boundary value problems in dielectrics; molecular polarizability, electrostatic energy in dielectric media.

Lectures 18

UNIT-II: Magnetostatics: Biot and Savart's law. The differential equation of Magnetostatics and Ampere's law, magnetic vector potential and magnetic fields of a localized current distribution. Magnetic moment, force and torque on a magnetic dipole in an external field. Dynamics of charged particles in static and uniform electromagnetic fields. Magnetic materials, Magnetization and microscopic equations.

Lectures 12

UNIT-III: Time-varying fields: Electromagnetic induction. Faraday's law of induction, Energy in a magnetic field. Maxwell's displacement current, Maxwell's equations in free space and linear isotropic media; vector and scalar potential, General Expression for the electromagnetic fields energy, Gauge transformations; Lorentz gauge and Coulomb gauge. Poynting theorem, conservation laws for a system of charged particles and electromagnetic field, Equation of continuity

Lectures 15

UNIT-IV: Electromagnetic Waves: Plane wave like solutions of the Maxwell equations. Polarization, linear and circular polarization. Superposition of waves in one dimension. Group velocity. Illustration of propagation of a pulse in dispersive medium. Reflection and refraction of electromagnetic waves at a plane surface between dielectrics. Polarization by reflection and total internal reflection. Interference, coherence, and diffraction. Waves in conductive medium, Simple model for conductivity.

Lectures 15

Text and ReferenceBooks

1. Introduction to Electrodynamics - D.J. Griffiths-Pearson Education Ltd., New Delhi,1991.
2. Classical Electrodynamics - J.D. Jackson-John & Wiley Sons Pvt. Ltd. New York, 2004.
3. Classical Electromagnetic Radiation - J.B. Marion-Academic Press, New Delhi, 1995.
4. Classical Electrodynamics: S.P. Puri, (Tata McGraw Hill, New Delhi)

SEMESTER-II

COURSE CODE: MPHL-2393

Condensed Matter Physics-I

Course Outcome of Condensed Matter Physics-I

After studying this course, the students will be able to understand:

CO1: Various structures of crystal. The students will be able to draw crystal planes through the knowledge of Miller indices.

CO2: Students have learned about crystal diffraction. How the diffraction takes place and the various methods through which it can be observed.

CO3: The students have learned about lattice vibrations through the concept of phonons. Different models of specific heat, i.e. Einstein model and hence Debye model of specific heat.

CO4: Students have studied about the Fermi Dirac statistics and its applications. Students will be able to find the distinction between metals and insulators, semiconductors.

M.Sc. (Physics) (Session 2019-20)

SEMESTER II

COURSE CODE: MPHL-2393

Condensed Matter Physics-I

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters: Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

Unit-I

Lattice Specific Heat and Elastic Constants:

Different theories of lattice specific heat of solids, Einstein model of the Lattice Specific heat, Density of modes of vibration, Debye model of Lattice specific heat, Born cut-off procedure, Specific heat of metals.Elastic strain and stress components, Elastic compliance and stiffness constants, Elastic constants of cubic crystals, Elastic waves in cubic crystals.

Unit-II

Defects and Diffusion in Solids:

Point defects: Impurities, Vacancies-Schottky and Frankel vacancies, Diffusion, Fick's law, Self diffusion in metals, Color centers and coloration of crystals, F-centres, V-centres, Line defects, Edge and screw dislocations, Burgers vectors, Stress field of dislocations, Grain boundaries, Low angle grain boundaries, dislocation densities, Dislocation multiplication and slips, dislocation and crystal growth.

Unit-III

Conductivity of metals and ionic crystals

Electrical conductivity of metals, Drift velocity and relaxation time, The Boltzmann transport, equation, The Sommerfield theory of conductivity, Mean free path in metals, Qualitative, discussion of the features of the resistivity, Mathiesson's rule.Thermal conductivity of metals, Wiedemann-Franz law. Hydration energy of ions, Activation energy for formation of defects in ionic crystals, Ionic conductivity in pure alkali halides.

Unit-IV

Dielectrics and Ferro Electrics:

Macroscopic field, The local field, Lorentz field, The Claussius-Mossotti relations, Different contribution to polarization: dipolar, electronic and ionic polarizabilities, Ferroelectric crystals: Classifications and their general properties, Structure and properties of $BaTiO_3$, The dipole theory of ferroelectricity, objection against dipole theory, Thermodynamics of ferroelectric transitions.

Books:

1. Solid State Physics by A.J. Dekker-Prentice Hall, 1965.

2. An Introduction to Solid State Physics by C. Kittle-Wiley, 1958

3. Elementary Solid State Physics by Omar, Addison Welly, 1975.

4. Principles of Solid State Physics by R.A. Levey-Academic Press, 1968

5. Introduction of Solid State Physics by Ashroft-Cengage Learning, 1999

M.Sc. (Physics) (Session 2019-20)

SEMESTER-II

COURSE CODE: MPHL-2394

ATOMIC AND MOLECULAR SPECTROSCOPY

COURSE OUTCOMES

Students will have achieved the ability to

CO 1. Describe the atomic spectra of one and two valance electron atoms. the student will understand the relativistic corrections for the energy levels of the hydrogen atom and their effect on optical spectra and the key properties of many electron atoms

CO 2. Explain the change in behaviour of atoms in external applied electric and magnetic field.

CO 3. Explain rotational, vibrational, electronic and Raman spectra of molecules.

CO 4. Explain the role of Frank Condon principle in determining electronic spectra of the molecule. The student will also learn about the dissociation and pre-dissociation energies.

CO 5. state and justify the selection rules for various optical spectroscopies in terms of the symmetries of molecular vibrations

M.Sc. (Physics) (Session 2019-20)

SEMESTER-II

COURSE CODE: MPHL-2394

ATOMIC AND MOLECULAR SPECTROSCOPY

Maximum Marks: 100 (External 80 + Internal 20) Examination Time: 3 Hours

Pass Marks: 40 Total Teaching hours: 60

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters:

Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

UNIT-I: Spectra of one and two valance electron systems

Magnetic dipole moments, Larmor's theorem, Space quantization of orbital, spin and total angular momenta, Vector model for one and two valance electron atoms, Spin-orbit interaction and fine structure of hydrogen, Lamb shift, Spectroscopic terminology, Spectroscopic notations for L-S and J-J couplings, Spectra of alkali and alkaline earth metals, Interaction energy in L-S and J-J coupling for two electron systems, Selection and Intensity rules for doublets and triplets.

15Lectures

UNIT-II: Breadth of spectral line and effects of external fields

The Doppler effect, Natural breadth from classical theory, natural breadth and quantum mechanics, External effects like collision damping, asymmetry and pressure shift and stark broadening, The Zeeman Effect for two electron systems, Intensity rules for the Zeeman effect, The calculations of Zeeman patterns, Paschen-Back effect, LS coupling and Paschen–Back effect, Lande's factor in LS coupling, Stark effect.

15Lectures

UNIT-III: Microwave and Infra-Red Spectroscopy - rigid rotator, Intensity of rotational lines, Effect of isotopic substitution, Microwave spectrum of polyatomic molecules, Microwave oven, the vibrating diatomic molecule as a simple harmonic and anharmonic oscillator, Diatomic vibrating rotator, The vibration-rotation spectrum of carbon monoxide, The interaction of rotation and vibrations, Outline of technique and instrumentation, Fourier transform Spectroscopy.

15Lectures

UNIT-IV: Raman and Electronic Spectroscopy

Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrational Raman spectra, Structure determination from Raman and infra-red spectroscopy, Electronic structure of diatomic molecule, Electronic spectra of diatomic molecules, Born Oppenheimer approximation, The Franck Condon principle, Dissociation and pre-dissociation energy, The Fortrat diagram, Example of spectrum of molecular hydrogen.

15Lectures

Text and Reference Books

1. Atomic and molecular Spectra: Laser by Raj Kumar, Kedarnath Ram Nath
2. Fundamentals of molecular spectroscopy by C.B.Banwell-TataMcGrawHill,1986.
3. Spectroscopy Vol. I,II&III by Walker&Straughen,Chapman&Hall1976
4. Introduction to Molecular spectroscopy by G.M.Barrow-TokyoMcGrawHill,1962.
5. Spectra of diatomic molecules by Herzberg-NewYork,1944.

SEMESTER-II

COURSE CODE: MPHP-2395

CONDENSED MATTER PHYSICS LAB-I

COURSE OUTCOMES

Student upon completion of this course will be able to

CO 1. successfully apply the theoretical techniques presented in the course to practical problems

CO 2. Understand Hall Effect and demonstrate concept of Pn junction g-factor using ESR, formation and analysis of Hysteresis loop.

CO 3. Demonstrate experimental determination of Energy gap using Four Probe Method and characteristics of photovoltaic cell.

SEMESTER-II

COURSE CODE: MPHP-2395

CONDENSED MATTER PHYSICS LAB-I

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**

Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Practical Examiners:

Question paper is to be set on the spot jointly by the external and internal examiners. Two copies of the same to be submitted for the record to COE office, Kanya Maha Vidyalaya, Jalandhar

LIST OF EXPERIMENTS

1. To determine Hall coefficient by Hall Effect.
2. To determine the band gap of a semiconductor using p-n junction diode.
3. To determine the magnetic susceptibility of a material using Quink's method.
4. To determine the g-factor using ESR spectrometer.
5. To determine the energy gap and resistivity of the semiconductor using four probe method.
6. To trace hysteresis loop and calculate retentivity, coercivity and saturation magnetization.
7. To determine dielectric constant of a dielectric material.
8. To study the series and parallel characteristics of a photovoltaic cell.
9. To study the spectral characteristics of a photovoltaic cell.

SEMESTER-II

COURSE CODE: MPHP-2396

SPECTROSCOPY LAB

Course Outcomes

On successful completion of the course students will be able to:

CO 1. develop analytical, laboratory skills through laboratory which involve the application of physics to various spectroscopy systems.

CO 2. successfully apply the theoretical techniques presented in the course to practical problems

CO 3. set up the Fabry Parot interferometer, Michelson Morley interferometer, Zeeman experimental instrument and constant deviation spectrometer.

SEMESTER-II

COURSE CODE: MPHP-2396

SPECTROSCOPY LAB

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**

Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Practical Examiners:

Question paper is to be set on the spot jointly by the external and internal examiners. Two copies of the same to be submitted for the record to COE office, Kanya Maha Vidyalaya, Jalandhar

LIST OF EXPERIMENTS

1. To find the wavelength of monochromatic light using Febry Perot interferometer.
2. To find the wavelength of monochromatic light using Michelson interferometer.
3. To calibrate the constant deviation spectrometer with white light and to find the wavelength of unknown monochromatic light.
4. To find the wavelength of He-Ne Laser using Vernier Calliper and the grating element of the given grating.
6. To verify the existence of Bohr's energy levels with Frank-Hertz experiment.
7. To determine the charge to mass ratio (e/m) of an electron with normal Zeeman Effect
8. To determine the velocity of ultrasonic waves in a liquid using ultrasonic interferometer
9. Particle size determination by diode laser

SEMESTER III

COURSE CODE: MPHL-3391

QUANTUM MECHANICS-II

Course outcomes

CO 1. Quantum mechanics-II aim at the applications of quantum mechanics. The course should give deeper knowledge about the foundations of quantum mechanics and skills in problem solving in quantum mechanics.

CO 2. Make students familiar with various approximation methods applied to atomic, nuclear and solid-state physics, and to scattering.

CO 3. The students will learn the applications of Time-independent and time-dependent perturbation theory in quantum mechanics and will develop a knowledge and understanding of perturbation theory, level splitting, and radiative transitions;

CO 4. Develop a knowledge and understanding of the scattering matrix and partial wave analysis; and to solve quantum mechanics problems;

SEMESTER III

COURSE CODE: MPHL-3391
QUANTUM MECHANICS-II

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters: Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. **Each question carries 16 marks.**

Unit-I: Perturbation Theory

First and second order perturbation theory for non degenerate and degenerate systems. Perturbation of an oscillator and anharmonic oscillator, the variation method. First order time dependent perturbation theory, constant perturbation, Calculation of transition probability per unit time for harmonic perturbation. The Helium atom problem, Stark effect.

Unit-II: Scattering Theory

Born approximation, extend to higher orders. Validity of Born approximation for a square well potential, Optical theorem. Partial wave analysis, unitarity and phase shifts. Determination of phase shift, applications to hard sphere scattering. Low energy scattering in case of bound states. Resonance scattering.

Unit-III: Relativistic Quantum Mechanics

Klein Gordon equation. Dirac Equation, Lorentz covariance of Dirac equation. Positive and negative energy solutions of Dirac equation, positrons. Properties of gamma matrices. Parity operator and its action on states. Magnetic moments and spin orbit energy.

Unit-IV: Identical Particles

Brief introduction to identical particles in quantum mechanics, Fermions and Bosons, wave function of n-identical particles and Slater's determinant, symmetrisation postulates, Exchange operators and exchange degeneracy, Application to 2 and 3 electron systems. Pauli Exclusion Principle,

References :

1. Quantum Mechanics by L I Schiff-Tokyo McGraw Hill, 1968.
2. A textbook of quantum mechanics by P.M. Methews and K. Venktasen Mcgraw Hill Education, 2017

3. Introduction to Quantum Mechanics by David J. Griffiths, pearson, 2015

SEMESTER III

COURSE CODE: MPHL-3392

Electrodynamics-II

Course outcomes

After passing this course the students will be able to:

CO1: Understand different types of waveguides. The transmission of electromagnetic signals through waveguide. The attenuation and loss of signal in waveguides

CO2: Correlate Einstein’s special theory of relativity with classical mechanics and electrodynamics in terms of tensor notation.

CO3: Study the fields around electric dipole, magnetic dipole and electric quadruple. The transition of signal from full wave and half wave antennas.

CO4: Understand fields due to moving charges in terms of vectors and in terms of relativistic mechanics.

SEMESTER III

COURSE CODE: MPHL-3392

Electrodynamics-II

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters: Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

UNIT-I

Wave Guides: Field at the surface of and within a conductor. Cylindrical cavities and waveguides, modes in a rectangular wave guide, energy flow and attenuation in wave guides. Perturbation of boundary conditions, resonant cavities, power loss in cavity and quality factor.

UNIT-II

Relativistic Formulation of Electrodynamics: Special theory of relativity, simultaneity, length contraction, time dilation and Lorentz's transformations, Structure of space-time, four scalars, four vectors and tensors, relativistic mechanics: proper time and proper velocity, relativistic energy and momentum. Relativistic electrodynamics: Magnetism as a relativistic phenomenon and field transformations. Field tensor. Recasting Maxwell equations in the language of special relativity, covariance and manifest covariance.

UNIT-III

Radiating Systems: In **h**omogenous Wave Equation for potentials: Retarded Potentials ,Fields of radiation of localized oscillating sources, electric dipole fields and radiation, magnetic dipole and electric quadrupole fields, central fed antenna, brief introduction to radiation damping and radiation reaction.

UNIT-IV

Fields of Moving Charges: Lienard Wiechert potential, field of a moving charge. Radiated power from an accelerated charge at low velocities, Larmour's power formula and its relativistic generalization; Angular distribution of radiation emitted by an accelerated charge.

Text and Reference Books:

1. Classical Electrodynamics by J.D. Jackson-John Wiley & Sons Pvt. Ltd., New York.
2. Introduction to Electrodynamics by D.J. Griffiths-Pearson Education Ltd.
3. Classical Electromagnetic Radiation by J.B. Marion-Academic Press, New Delhi.

SEMESTER III

COURSE CODE: MPHL-3393

Condensed Matter Physics-I

Course Outcome of Condensed Matter Physics-I

After studying this course, the students will be able to understand:

CO1: Various structures of crystal. The students will be able to draw crystal planes through the knowledge of Miller indices.

CO2: Students have learned about crystal diffraction. How the diffraction takes place and the various methods through which it can be observed.

CO3: The students have learned about lattice vibrations through the concept of phonons. Different models of specific heat, i.e. Einstein model and hence Debye model of specific heat.

CO4: Students have studied about the Fermi Dirac statistics and its applications. Students will be able to find the distinction between metals and insulators, semiconductors.

SEMESTER III

COURSE CODE: MPHL-3393

Condensed Matter Physics-I

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters: Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

Unit-I

Lattice Specific Heat and Elastic Constants:

Different theories of lattice specific heat of solids, Einstein model of the Lattice Specific heat, Density of modes of vibration, Debye model of Lattice specific heat, Born cut-off procedure, Specific heat of metals. Elastic strain and stress components, Elastic compliance and stiffness constants, Elastic constants of cubic crystals, Elastic waves in cubic crystals.

Unit-II

Defects and Diffusion in Solids:

Point defects: Impurities, Vacancies-Schottky and Frankel vacancies, Diffusion, Fick's law, Self diffusion in metals, Color centers and coloration of crystals, F-centres, V-centres, Line defects, Edge and screw dislocations, Burgers vectors, Stress field of dislocations, Grain boundaries, Low angle grain boundaries, dislocation densities, Dislocation multiplication and slips, dislocation and crystal growth.

Unit-III

Conductivity of metals and ionic crystals

Electrical conductivity of metals, Drift velocity and relaxation time, The Boltzmann transport equation, The Sommerfield theory of conductivity, Mean free path in metals, Qualitative discussion of the features of the resistivity, Mathiesson's rule. Thermal conductivity of metals, Wiedemann-Franz law. Hydration energy of ions, Activation energy for formation of defects in ionic crystals, Ionic conductivity in pure alkali halides.

Unit-IV

Dielectrics and Ferro Electrics:

Macroscopic field, The local field, Lorentz field, The Claussius-Mossotti relations, Different contribution to polarization: dipolar, electronic and ionic polarizabilities, Ferroelectric crystals: Classifications and their general properties, Structure and properties of BaTiO3, The dipole theory of ferroelectricity, objection against dipole theory, Thermodynamics of ferroelectric transitions.

Books:

1. Solid State Physics by A.J. Dekker-Prentice Hall, 1965.

2. An Introduction to Solid State Physics by C. Kittle-Wiley, 1958

3. Elementary Solid State Physics by Omar, Addison Welly, 1975.

4. Principles of Solid State Physics by R.A. Levey-Academic Press, 1968

5. Introduction of Solid State Physics by Ashroft-Cengage Learning, 1999

SEMESTER III

COURSE CODE: MPHL-3394

NUCLEAR PHYSICS

Course Outcomes

Upon completion of this course, the student will be able to:

CO 1. Identify basic nuclear properties and outline their theoretical descriptions.

CO 2. Understand the nature of nuclear forces that bind atomic nuclei together and the structure and dynamics of nuclei.

CO 3. Apply the semi-empirical mass formula to evaluate the binding energy of a nucleus and other binding energy related properties.

CO 4. Describe the role of spin-orbit coupling in the shell structure of atomic nuclei, and predict the properties of nuclear ground and excited states based on the shell model.

CO 5. Understand the various decay properties of unstable nuclei such as beta decay, gamma decay, and parity violation.

CO 6. Compare different nuclear reaction mechanisms in relation to cross-sections, excitation functions and angular distributions.

SEMESTER III

COURSE CODE: MPHL-3394

NUCLEAR PHYSICS

Syllabus

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on mid-semester test/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters for final examination: Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. **Each question carries 16 marks.**

Unit-I

Properties of nucleus and nuclear forces: size, spin, parity, magnetic moment, quadrupole moment and binding energy of a nucleus. Two nucleon system, deuteron problem, tensor forces, pp and pn scattering experiments at low energy, scattering length, effective range theory, spin dependence of nuclear forces, charge independence and charge symmetry of nuclear forces, exchanges forces: Bartlett, Heisenberg, Majorana forces and potentials, meson theory of nuclear forces.

Unit-II

Nuclear Models: Liquid drop model, semi-empirical mass formula, Bohr-Wheeler theory of fission, experimental evidence for shell structure of nucleus, shell model, spin-orbit coupling, applications of shell model like angular momenta, parities, magnetic moments (Schmidt lines) of nuclear ground states, collective model, nuclear vibrations spectra and rotational spectra, Nilsson model.

Unit-III

Nuclear Decay: Beta decay: Types of beta decay, neutrino hypothesis, Fermi theory of beta decay, detection of neutrino, total decay rate, comparative half-lives, angular momentum and parity selection rules in beta decay, allowed and forbidden transitions, parity violation in beta decay. Gamma decay: Multipole transitions in nuclei, angular momentum and parity selection rules in gamma decay, internal conversion, nuclear isomerism.

Unit-IV

Nuclear Reactions: Introduction to nuclear reactions, conservations laws, cross sections in terms of partial wave amplitudes, compound and direct nuclear reaction mechanisms, Breit Winger one level formula, Resonance scattering. Nuclear fission, nuclear fusion.

Reference books:

1. Nuclear Physics by R.R. Roy and B.P. Nigam-New Age International Publishers
2. Introductory Nuclear Physics by K.S. Krane-Wiley, New York
3. Nuclear Physics by G.N. Ghoshal-S. Chand and Co.

SEMESTER III

COURSE CODE: MPHL-3395
CONDERNSED MATTER LAB-II

Course Outcomes

Upon completion of this course, the student will be able to:

CO 1. Understand the mechanism of domain formation in ferromagnetic materials and to

CO 2. find the energy losses in various ferromagnetic materials

CO 3. Understand the concept of Curie temperature.

CO 4. Understand the concept of charge storage mechanism in p-n junction diodes

CO 5. Understand the phonon and photon interactions in materials

CO 6. Will learn to work with the travelling, transmission and reflection of microwaves.

SEMESTER III

COURSE CODE: MPHL-3395
CONDERNSED MATTER LAB-II
Syllabus

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on mid-semester test/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

1. To determine the energy loss in transformer and ferrite cores using B-H curve.
2. To determine Curie temperature of ferrites.
3. To determine Stefan's constant using Boltzmann's Law.
4. To study the depletion capacitance and its variation with reverse bias in a p-n junction.
5. To determine the lattice dynamics and dispersion relation for the monatomic and diatomic lattices.
6. To find the Young's modulus of a material using ultrasonic interferometer for solids
7. Experiments with Microwaves set up.

SEMESTER III

COURSE CODE: MPHL-3396
NUCLEAR PHYSICS LAB
Course Outcomes

Upon completion of this course, the student will be able to:

CO 1. Carry out experimental work using NaI (Tl) scintillation detector and GM counter in the field of radiation shielding and radioactive analysis of various materials.

CO 2. Understand the interaction of beta particles, alpha particles and gamma ray with matter.

CO 3. Understand the importance of statistical nature of radioactivity in the field of radioactive analysis.

CO 4. Investigate the attenuation power of various materials for alpha, beta and gamma radiation.

SEMESTER III

COURSE CODE: MPHL-3396
NUCLEAR PHYSICS LAB
Syllabus

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**
Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on mid-semester test/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

1. Pulse-Height Analysis of Gamma Ray Spectra.
2. Energy calibration of Scintillation Spectrometer.
3. Least square fitting of a straight line.
4. Study of absorption of gamma rays in matter.
5. Study of the characteristics of a G.M. Counter.
6. Study of the Dead time of a G.M. Counter.
7. Study of absorptions of Beta Particles in Matter.
8. Window thickness of a G.M. Tube.
9. Investigation of the statistics of radioactive measurements.
10. Study of Poisson Distribution.
11. Study of Gaussian Distribution.
12. Study of absorption alpha-particles in matter.

SEMESTER IV

COURSE CODE: MPHL-4391

PARTICLE PHYSICS

Course Outcomes

CO1: After completing this course the students will understand the fundamental principles and concepts governing particle physics. The students will learn various experimental techniques used in discovering the elementary particles and their various properties such as mass, lifetime, parity and spin.

CO2: Students will be able to understand the role of symmetries in particle physics. They will acquire basic knowledge on the fundamental forces of universe and various conservation laws followed in these forces (interactions).

CO3: Students will also learn the concept of CP violation in detail which will lead them to their knowledge about current area of research on the missing antimatter of universe.

CO4: The students will learn the Feynman rules and their application in calculating the cross sections for various particle interactions.

CO5: They will also be able to understand the theory of spontaneous breaking symmetry and its application to Higgs mechanism. Students will also have a broad overview of the standard model of particle physics and its predictions.

SEMESTER IV

COURSE CODE: MPHL-4391

PARTICLE PHYSICS

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**

Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on mid-semester test/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters for final examination: Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. **Each question carries 16 marks.**

Unit-I

Elementary Particles and Their Properties: Historical survey of elementary particles and their classification, fundamental forces of nature, determination of mass, life time, decay mode, spin and parity of muons, pions, kaons and hadrons, introduction to antiparticles, relativistic kinematics.

Unit-II

Symmetries and Conservation Laws: Conserved quantities and symmetries, the electric charge, baryon number, lepton number, hypercharge (strangeness), the nucleon isospin, isospin invariance, isospin of particles, Gellmann-Nishijima formula, parity operation, charge conjugation, positronium decay, CP violation and $K^o - \overline{K^o}$ doublet, time reversal invariance, CPT theorem, Gellmann's eightfold way of hadrons, quark model.

Unit-III

Week Interactions: Classification of weak interactions, τ-θ puzzle, parity violation in beta decay, parity violation in Λ-decay, the two component neutrino theory, measurement of neutrino helicity (Goldhaber's experiment), the V-A interaction, weak decays of strange-particles and Cabibbo's theory, GIM mechanism, CKM matrix.

Unit-IV

Gauge theory and neutrino oscillation: Gauge symmetry, field equations for scalar (spin 0), spinor (spin ½), vector (spin-1) and fields, global gauge invariance, local gauge invariance, Feynmann rules, spontaneously broken symmetries in the field theory, Higgs mechanism, neutrino mass, neutrino oscillations.

Reference books:

1 Nuclear Physics by S.N. Ghoshal-S. Chand and Co.

2 Introduction to Elementary Particles by D. Griffiths-Wiley-VCH.

3 Introduction to High Energy Physics by D.H Perkins-Cambridge University Press.

SEMESTER IV

COURSE CODE: MPHL-4392
CONDENSED MATTER PHYSICS-II

Course outcomes

- CO 1. Condensed Matter Physics-II aim at the applications of Solid state Physics. The course should give deeper knowledge about magnetic materials.
- CO 2. Make students familiar with various concepts like curie's temperature, super exchange interaction and properties of hysteresis loop.
- CO 3. The students will have knowledge of superconductors and its types and how its properties can be applicable in the research field.
- CO 4. Develop a knowledge and understanding of the optical properties and students will get the knowledge how these properties are beneficial in the field of research.

SEMESTER IV

COURSE CODE: MPHL-4392

CONDENSED MATTER PHYSICS-II

Syllabus

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**

Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters: Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. **Each question carries 16 marks.**

Unit- I

Classification of magnetic materials, Origin of permanent magnetic dipoles, Diamagnetic susceptibility, Langevin diamagnetic equation, Classical theory of paramagnetism, Quantum theory of paramagnetism, Quenching of orbital angular momentum, Cooling by adiabatic demagnetization, Paramagnetic susceptibility of conduction electrons, Determination of susceptibilities of para and diamagnetic materials: Theory, Gouy method and Quincke's method

Unit - II

Ferromagnetism, Curie point and the exchange integral, Weiss molecular field, the interpretation of the Weiss field, Temperature dependence of spontaneous magnetization, Saturation magnetization at absolute zero, Ferromagnetic domains, Anisotropy energy, Transition region between domains: Bloch wall, Origin of domains, Coercivity and hysteresis, Spin waves, Quantization of spin waves, Thermal excitations of magnons, Neutron Magnetic Scattering, Ferrimagnetic Order, Curie temperature and susceptibility of ferrimagnets, Antiferromagnetism, Two sublattice model.

Unit – III

Superconductivity, zero resistivity, critical temperature, Meissner effect, Type I and Type II superconductors, specific heat and thermal conductivity,Thermodynamics of superconducting transition, London's equation, Coherence length, BCS theory of conventional superconductors, BCS ground states, Flux quantization on a superconducting ring, Duration of persistent current, Josephson effect: dc Josephson effect, ac Josephson effect, macroscopic quantum interference, Superconducting magnet and SQUID, High temperature superconductors: Structure and properties.

Unit - IV

Interaction of light with solids, Atomic and electronic interactions, Optical properties of metals and non-metals: Reflection, Refraction, Absorption, Transmission, Fundamentals of direct and indirect band gap, Exciton absorption, Free carrier absorption, Absorption process involving impurities, Photoconductivity, Luminescence, excitation and emission, Decay mechanisms, Thallium activated alkali halides, Sulphide phosphors.

Books Recommended:

1. An Introduction to Solid State Physics by C. Kittel-WielyEstem Ltd., New Delhi.
2. Solid State Physics by A.J. Dekkar-Maemillan India Ltd., New Delhi.
3. Material Science and Engineering by William D. Callister JR, Wiley
4. Elementary Solid State Physics by Omar, Addison Wesly.
5. Principles of Solid State Physics by R.A. Levy-New York Academy.
6. Solid State Physics by Aschroft and Mermin-New York Holt.

SEMESTER IV

COURSE CODE: MPHL- 4393 (OPT-II)

COURSE TITLE: RADIATION PHYSICS

Course outcomes

CO 1. Radiation Physics aim at study the knowledge of ionizing Radiation and Radiation Quantities.

CO 2. Make students familiar with various types of dosimeters.

CO 3. The students will have knowledge of Radiation effects and its protection.

CO 4. Develop a knowledge and understanding of the radiation shielding.

SEMESTER IV

COURSE CODE: MPHL- 4393 (OPT-II)

COURSE TITLE: RADIATION PHYSICS

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**

Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters: Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. **Each question carries 16 marks.**

Unit – 1

Ionizing Radiations and Radiation Quantities:

Types and sources of ionizing radiation, fluence, energy fluence, kerma, exposure rate and its measurement - The free air chamber and air wall chamber, Absorbed dose and its measurement ; Bragg Gray Principle, Radiation dose units - rem, rad, Gray and sievert dose commitment, dose equivalent and quality factor.

Unit- II

Dosimeters:

Pocket dosimeter, films, solid state dosimeters such as TLD, SSNTD, chemical detectors and neutron detectors. Simple numerical problems on dose estimation.

Unit- III

Radiation Effects and Protection:

Biological effects of radiation at molecular level, acute and delayed effects, stochastic and nonstochastic effects, Relative Biological Effectiveness (RBE), Linear energy transformation (LET), Dose response characteristics. Permissible dose to occupational and non-occupational workers, maximum permissible concentration in air and water, safe handling of radioactive materials, The ALARA, ALI and MIRD concepts, single target, multitarget and multihit theories, Rad waste and its disposal, simple numerical problems.

Unit - IV

Radiation Shielding:

Thermal and biological shields, shielding requirement for medical, industrial and accelerator facilities, shielding materials, radiation attenuation calculations-The point kernal technique, radiation attenuation from a uniform plane source. The exponential point-Kernal. Radiation attenuation from a line and plane source. Practical applications of some simple numerical problems.

Books :

1. Nuclear Reactor Engineering by . S. Glasstone and A. Sesonke ,Van Nostrand Reinhold.
2. Radiation Theory by Alison. P. Casart
3. Radiation Biology-Radiation Bio by A. Edward Profio /Prentice Hall.
4. Introduction to Radiological Physics and Radiation Dosimetry by F.H. Attix -Wiley-VCH.

SEMESTER IV

COURSE CODE: MPHL- 4394 (OPT-III)

COURSE TITLE: REACTOR PHYSICS

Course Outcomes-

CO1. Reactor Physics aims to give an insight on functioning of Reactors.
CO2. To learn about Reactor safety and control
CO3.Types of reactors and detailed working of Indian nuclear reactors

SEMESTER IV

COURSE CODE: MPHL- 4394 (OPT-III)

COURSE TITLE: REACTOR PHYSICS

Syllabus

Maximum Marks: 100 (External 80 + Internal 20) **Examination Time: 3 Hours**

Pass Marks: 40 **Total Teaching hours: 60**

Out of 100 Marks, internal assessment (based on one mid-semester tests/ internal examinations, written assignment/project work etc. and attendance) carries 20 marks, and the final examination at the end of the semester carries 80 marks.

Note for the Paper Setters: Eight questions of equal marks are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. **Each question carries 16 marks.**

Interaction of Neutrons with Matter in Bulk:

Thermal neutron diffusion, Transport and diffusion equations, transport mean free path, solution of diffusion equation for a point source in an infinite medium and for an infinite plane source in a finite medium, extrapolation length and diffusion length-the albedo concept.

Lectures 15

Moderation of Neutron:

Mechanics of elastic scattering, energy distribution of thermal neutrons, average logarithmic energy decrement, slowing down power and moderating ration of a medium. Slowing down density, slowing down time, Fast neutron diffusion and Fermi age theory, solution of age equation for a point source of fast neutrons in an infinite medium, slowing down length and Fermi age.

Lectures 15

Theory of Homogeneous Bare Thermal and Heterogeneous Natural Uranium Reactors

Neutron cycle and multiplication factor, four factor formula, neutron leakage, typical calculations of critical size and composition in simple cases, The critical equation, material and geometrical bucklings, effect of reflector, Advantages and disadvantages of heterogeneous assemblies, various types of reactors with special reference to Indian reactors and a brief discussion of their design feature.

Lectures 15

Power Reactors Problems of Reactor Control

Breeding ratio, breading gain, doubling time, Fast breeder reactors, dual purpose reactors, concept of fusion reactors, Role of delayed neutrons and reactor period, In hour formula, excess reactivity, temperature effects, fission product poisoning, use of coolants and control rods.

Lectures 15

Books:

1. The elements of Nuclear reactor Theory by Glasstone&Edlund-VamNostrand, 1952.
2. Introductions of Nuclear Engineering by Murray-Prentice Hall, 1961.

SEMESTER IV

ASSIGNMENT/PROJECT

Course No. MPHD-4395

Maximum Marks: 50 (External 40 + Internal 10) **Examination Time: 3 Hours**
Pass Marks: 20 **Total Teaching hours: 90**

Assignment and Project should be based on following techniques in:
1. Material Science
2. Computational Physics
3. Nuclear Physics
4. Advanced Theoretical Physics
5. Radiation Physics
6. Electronics

Note:
Evaluation committee will consist of following members:
1. External examiner
2. HOD, College/ Internal Examiner