CHAITANYA SCIENCE AND ARTS COLLEGE

(AUTONOMOUS)

PAMGARH, JANJGIR-CHAMPA (C.G.)

ACCREDITED "A" GRADE BY NAAC

DEPARTMENT
OF
PHYSICS

COURSE CURRICULUM & MARKING SCHEME
POSTGRADUATE PROGRAMME

M.SC. PHYSICS

PROGRAM CODE: CCMS02

FIRST & SECOND SEMESTER, III & IV

Approved By	Board of Studies	Academic Council
Date	16/08/26	

ACADEMIC YEAR 2026-27

Website: https://chaitanyacg.ac.in/ **Email:** principalchaitanya417@gmail.com

16.08.26 16.08.2026 16.08.26

SESSION ~~2025-26~~ 2026-27

Proposed Scheme For 2-Year Postgraduate Program

PROGRAMME STRUCTURE: PART	YEAR	SEMESTER	SEMESTER
Part-I	First Year	Semester-I	Semester-II
Part-II	Second Year	Semester-III	Semester-IV

COURSE STRUCTURE:

The syllabus with the paper combination is as under:

SEMESTER-I

SR. NO.	COURSE CODE	TITLE OF COURSE
01.	MPHT101	Mathematical Methods -I
02.	MPHT102	Classical Mechanics
03.	MPHT103	Numerical Methods and Python
04.	MPHT104	Electronics -1
05.	MPHP105	Lab-1 Optics and Electronics
06	MPHP106	Lab-II Python Programming

SEMESTER -II

SR. NO.	COURSE CODE	TITLE OF COURSE
01.	MPHT201	Mathematical Methods -II
02.	MPHT202	Quantum Mechanics-I
03.	MPHT203	Electrodynamics
04.	MPHT204	Electronics -II
05.	MPHP205	Lab-1 Electronics
06	MPHP206	Lab-II General

SYLLABUS AND MARKING SCHEME FOR THE FIRST & SECOND SEMESTER
SESSION-~~2025-26~~ 2026 - 27
SEMESTER I

Sr. No.	Subject Code	Title	Marks		Total
			External	Internal	
1	MPHT101	Mathematical Methods -1	70	30	100
2	MPHT102	Classical Mechanics	70	30	100
3	MPHT103	Numerical Methods and Python	70	30	100
4	MPHT104	Electronics -1	70	30	100
5	MPHP105	Lab-1 Optics and Electronics	-	-	100
6	MPHP106	Lab-II Python Programming	-	-	100
	Total				600

SEMESTER-II

SR. No.	Subject Code	Title	Marks		Total
			External	Internal	
1	MPHT201	Mathematical Methods -II	70	30	100
2	MPHT202	Quantum Mechanics-I	70	30	100
3	MPHT203	Electrodynamics	70	30	100
4	MPHT204	Electronics -II	70	30	100
5	MPHP205	Lab-1 Electronics	-	-	100
6	MPHP206	Lab-II General	-	-	100
	Total				600

SEMESTER-III

SR. No.	Subject Code	Title	Marks		Total
			External	Internal	
1	MPHT301	Quantum Mechanics II	70	30	100
2	MPHT302	Statistical Mechanics	70	30	100
3	MPHT303	Condensed Matter Physics I	70	30	100
4	MPHT304	Electronics III	70	30	100
5	MPHP305	Lab A: Digital Electronics I	-	-	100
6	MPHP306	Lab B: Digital Electronics II	-	-	100
		Total			**600**

SEMESTER-IV

SR. No.	Subject Code	Title	Marks		Total
			External	Internal	
1	MPHT401	Condensed Matter Physics II	70	30	100
2	MPHT402	Nuclear Physics	70	30	100
3	MPHT403	Atomics and Molecular physics	70	30	100
4	MPHT404	Electronics IV	70	30	100
5	MPHP405	Project Or Dissertation Seminar, viva	-	-	200
		Total			600
		GRAND TOTAL [SEMESTER I (600) + SEMESTER II (600)] [SEMESTER III (600) + SEMESTER IV (600)]			**2400**

SEMESTER I

PROGRAMME	**M.SC. PHYSICS**
CORE COURSE	**COURSE CODE: MPHT101**
TITLE	**Mathematical Methods -1**
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**
Course Objective	• To develop a strong understanding of vector spaces, matrices, eigenvalues, eigenvectors, and their applications in solving linear algebraic problems. • To study and apply special functions (Legendre, Laguerre, Bessel, Hermite) with their generating functions, recurrence relations, and orthogonality properties in mathematical physics. • To gain proficiency in integral transforms such as Laplace and Fourier transforms for solving differential equations and analyzing physical systems.
Course Outcomes	**CO1:** To understand mathematical concepts used for solving physics problems. **CO2:** Understand special function, Laplace transform (LT), Fourier Series. **CO3:** Master vector spaces, matrices, linear algebra, eigenvalues, eigenvectors, and their applications. **CO4:** Master orthogonal functions: Legendre, Bessel, Hermite, Laguerre, properties, solutions, orthogonality. **CO5:** Use Mathematical methods that will be used in many of the other courses in the M.Sc. Syllabus.

UNIT	Description	No. of Lectures / Hours
I	**Vector Spaces and Matrices:** Definition of Vector Space, basis of a vector space, Dimensionality of a vector space, Inner Product, Linear Independence of a vector, Linear Transformation of a vector, Inverse of a matrix, Orthogonal, Unitary matrix, Eigen values and eigenvectors, Cayley Hamilton theorem, Diagonalization, Complete orthonormal sets of functions.	15
II	**Special Function:** Solution by series expansion, Legendre Polynomial, Generating function, recursion relation, Rodrigue formula, Orthogonal properties, recurrence formulae and orthogonal properties. Laguerre polynomial generating function, recursion relations, Rodrigue formula, associated Laguerre differential equation and polynomial.	15
III	**Bessel's Function**: Bessel's differential equations, first and second kind, recurrence formulae and generating function for J (x), Jacobi series, Bessel's orthogonality of Bessel's function. Integrals, Hermit differential equation and polynomials, generating function, recurrence relation, Rodrigue formula, orthogonality.	15
IV	**Integral transform:** Laplace transform, first and second shifting theorem, inverse LT by partial fraction, LT of derivative and integral of a function. Fourier series, arbitrary period, half-wave expansion partial sums, Fourier integral and transform, Dirac delta function.	15

Text Books and Reference Books:

1. Mathematical Methods or Physics, by g Arfken
2. Matrices and Tensors for Physicists, by AW Joshi
3. Advanced Engineering Mathematics, by E Kreyszig
4. Special Functions, by ED Rainville
5. Special Functions, by WW Bell
6. Mathematical Method, by H.K. Das
7. Mathematical Method for Physicists and Engineers. By KF Relliy, M P Hobson and SJ Bence
8. Mathematica for Physicists, by Mary L. Boas

E -Resources:

1. https://nptel.ac.in/courses/115103036
2. https://nptel.ac.in/courses/115105097
3. https://nptel.ac.in/courses/115106086
4. https://nptel.ac.in/courses/111106152

SEMESTER I

PROGRAMME	**M.SC. PHYSICS**
CORE COURSE	**COURSE CODE: MPHT102**
TITLE	**CLASSICAL MECHANICS**
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**
Course Objective	• To understand conservation principles, generalized coordinates, and formulate equations of motion for diverse systems. • To apply variational principles, Lagrangian and Hamiltonian formulations for analyzing conservative and non-conservative mechanical systems. • To explore Poisson brackets, canonical transformations, and Hamilton–Jacobi theory for solving complex dynamical problems.
Course Outcomes	**CO1:** To analyze the motion of particles and systems of particles. **CO2:** To Formulate and solve equations of motion using D'Alembert's principle, Lagrange's equations, and their applications to various mechanical systems. **CO3:** Have a deep understanding of Newtons law **CO4:** Analyze Poisson and Lagrange brackets, their properties, and their role in understanding the dynamics of physical systems.

UNIT	Description	No. of Lectures / Hours
I	**Conservation Principles:** Mechanics of particle conservation Principles for system of particles. Constrained motion constraints and degrees of freedom generalized coordinates, Generalized Notations (1) · Generalized Displacement velocity, Acceleration, momentum force and potential, [Imitations of Newton's laws. D'Alembert's Principle, Lagrange's equations form D'Alembert principal Application of Lagrange's equation of motion (1) Linear Harmonic oscillator (II) Simple pendulum (III) spherical pendulum (iv) Isotropic oscillator (v) Atwood's Machine.	15
II	**Variational Principle:** calculus of variation, some techniques of calculus of variables, Euler Lagrange differential equation. Hamilton variational principal Deduction of Hamilton's Principle from D'Alembert's principle. Deduction of Newton's second law of motion from Hamilton's Principle. Deduction of Lagrange's equations of motion from Hamilton's Principle for conservation and for non-conservative systems Non conservative forces. Dissipative system, Rayleigh's Dissipation function, Lagrangian for a charged particle in an electromagnetic field.	15
III	**Hamiltonian formulation of mechanics:** Phase space and the motion of the system, Hamiltonian function, Hamilton's canonical equation of motion. Physical significance of H Deduction of Canonical equation from variational principle. Hamilton's canonical equations of motion in different coordinate systems. Application of Hamilton equation of motion (i) Simple pendulum (II) compound pendulum (iii) Two-dimensional Isotropic Harmonic oscillator (iv) Linear Harmonic oscillator (v) Particle in central field of force. Hamiltonian for a charged particle in an electromagnetic field, Principle of	15

	least action statement and its proof.	
IV	**Canonical or constant transformation:** its advantage example of canonical transformation, necessary and sufficient condition for a trans formation to be canonical Infinitesimal contact transformations. Hamilton-Jacobi partial differential equation for Hamilton's Principal function. Solution of Harmonic oscillator problem by Hamilton-Jacobi method. Hamilton- Jacoby theory. Poisson Bracket: Definition and properties. Invariance of Poisson-Brackets with respect to canonical transformation, Equations of motion in Poisson bracket form Jacoby Identity. Infinitesimal contact transformations Interpretation in terms of Poisson Brackets. The angular momentum and Poisson Bracket Lagrange's Brackets definition and properties, relation with Poisson Brackets.	15

Text Books and Reference Books:

1. Classical mechanics. H. Goldstein
2. Classical mechanics Gupta Kumar, Sharma
3. Classical mechanics of particle and rigid body- Kiran C. Gupta
4. Principal of mechanics Synge and Griffith

E -Resources:

1. https://archive.nptel.ac.in/courses/115105098/
2. https://youtu.be/rk0rp2Jpidc
3. https://youtu.be/941RpKWr2qo
4. https://youtu.be/c10eRk9aUBs
5. https://youtu.be/YXk-mcS2np4

SEMESTER I

PROGRAMME	**M.SC. PHYSICS**	
CORE COURSE	**COURSE CODE: MPHT103**	
TITLE	**NUMERICAL METHOD AND PYTHON**	
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**	
Course Objective	• To introduce Python programming concepts, decision-making structures, loops, functions, modules, and basic plotting techniques. • To develop computational skills for solving equations, curve fitting, interpolation, differentiation, integration, and ODEs numerically. • To apply numerical methods and Python libraries for analyzing mathematical problems in scientific and engineering applications.	
Course Outcomes	**CO1:** Find roots of different types of equations and obtain the eigenvalues of matrices and understand its applicability in various physics aspects. **CO2:** Understand experimental data, its behavior and various interpolating techniques. **CO3:** Understand techniques to evaluate integrals bounded in a range and solve initial value and boundary value problems of ordinary differential equation. **CO4:** To know about Various Control statements of Python. **CO5:** To know about Functions and Module structures in Python.	
UNIT	**Description**	**No. of Lectures / Hours**
I	**(With Programming)** **Introduction Of Python and Decision Making:** keywords and Identifiers, Statements and comments, variables data types and type conversion Output Input. Operator's expression, hierarchy of operators, scope and namespace. Flow control statements, if, if else and nested if else, Loops (for, do while, while), break and continue	15
II	**Functions, Module and Plotting:** Built in and user defined functions, function definition and calling the function, function with argument and return, Variable scope. Python module, import, module, packages, library (SciPy, NumPy, math, Matplotlib), python array. Basic plotting using matplotlib: polynomial (linear, quadratic), sine and cosine function.	15
III	**(Without Programming)** **Roots Of Simultaneous Equation & Non – Linear algebraic & Transcendental Equations**: Solution of simultaneous linear equations using Gaussian elimination method, Concept of Pivoting, Matrix inversion method, Iterative Methods: False position method, Bisection Method, & Newton Raphson method & their convergence. Determination of Eigen values & Eigen vectors of a matrix by Power & Jacobi Method	15
IV	**Calculus of finite difference**: Forward, Backward Central difference and Relation between the operators. **Interpolation:** Newtons forward interpolation formula & backward interpolations, Lagranges interpolation unequally spaced data points. **Curve Fitting:** Method of curve fitting by least square curve fitting, straight line and polynomial fits.	15

	Numerical Integration & Differentiation: Newton-Cotes method, Trapezoidal ruler, Simpson's Method.	

Text Books and Reference Books:

(a) For Numerical Methods

1. B.S. Grewal, Numerical Methods in Engineering & Science with Programs in C, C++ & MATLAB, Khanna Publishers
2. S. S. Sastry, Introductory methods of numerical analysis, Prentice Hall of India

(b) For Python Programming

1. Fundamentals of Python: First Programs, Course Technology, Kenneth Lambert. Cengage Learning.
2. Dr Pooja Sharma, Programming in Python 2017, BPB
3. Numerical Recipes, Teukolsky, Vetterling and Flannery, Cambridge University Press
4. Numerical Mathematical Analysis, J. B. Scarborough, Oxford Publishing, 6th Edition, 1990
5. Numerical methods for mathematics, science and engineering. John H. Matthews, Prentice Hall of India, 2nd Edition, 2000 4. Making Use of Python, Rashi Gupta, Wiley Publishing

E -Resources:

1. https://nptel.ac.in/courses/115104095
2. www.python.org
3. https://wiki.python.org/moin/BeginnersGuide
4. https://www.w3schools.com/python/

SEMESTER I

PROGRAMME	**M.SC. PHYSICS**	
CORE COURSE	**COURSE CODE: MPHT104**	
TITLE	**ELECTRONICS I**	
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**	
Course Objective	• To understand working principles, characteristics, and applications of FET, MOSFET, BJT, and UJT devices. • To study semiconductor devices, MIS and MOS diodes, and charge-coupled device operations comprehensively. • To analyze modulation techniques, demodulation processes, and multiplexing methods for efficient communication systems.	
Course Outcomes	**CO1:** Understand principle of transistors and its application. **CO2:** Understand working principle of MIS, MOS diode. **CO3:** Understand concept of Modulation. **CO4:** Understand concept of multiplexing.	
UNIT	**Description**	**No. of Lectures / Hours**
I	**Transistors: FET and MOSFET:** Junction Field Effect Transistor (FET) N channel and P channel FET, working principle, static and dynamic characteristic curves, pinched off voltage, Coefficient of FET, and Relation between different coefficients. Metal Oxide Field Effect Transistor (MOSFET) DE MOSFET and E-MOSFET, construction and working principle, static and dynamic characteristics.	**15**
II	**BJT and UJT:** Bipolar Junction transistor (BJT) Different methods of biasing. Thermal stabilization stability factor, h parameters. Feedback in amplifiers Advantages of negative feedback, Principle of oscillators. Uni-junction transistor (UJT) basis structure, working principle. Voltage Current characteristics and important parameters.	**15**
III	**Semiconductor Devices and Charge-Coupled Devices:** MIS Diode: Introduction, Energy band diagram, accumulation, depletion and inversion condition concept of surface space charge, surface potential, surface capacitance, Ideal MIS curves. MOS diode: structure, Ideal MOS, surface depletion region, Ideal MOS curves, Si-S10 MOS diode- (real case) interface trapped charge, oxide charges. Charged Couple Device (CCD): Basic structure, working principle, charge transfer with clock voltage.	**15**
IV	**Modulation and Multiplexing:** Modulation: Definition, Types of Modulation Mathematical expression of modulation Percentage of modulation, Amplitude modulation, Generation of Amplitude modulation, Demodulation, Demodulation of Amplitude modulated wave, side bands, band width DSBSC modulation, Generation of DSBSC waves, SSB modulation, Generation and Detection of Multiplexing: Frequency division multiplexing (FDM). SSB waves.	**15**

Text Books and Reference Books:

1. Principles of Electronics, V.K. Mehta, Rohit Mehta, S. Chand
2. Hand Book of Electronics, Gupta Kumar Pragati Prakashan
3. Physics of semiconductor Devices, S.M. Sze. Wiley Eastern Ltd.
4. Foundation of Electronics, D. Chattopadhyay, P.C. Rakshit, B. Saha, N. N. Purkait, New Age International Pvt. Ltd.
5. Electronic Devices and Circuits, Jacob Millman, Christos C. Halkias, Tata McGraw Hill

E -Resources:

1. https://nptel.ac.in/courses/108101091
2. https://nptel.ac.in/courses/115102014
3. https://nptel.ac.in/courses/117103063
4. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+4mIqRALksfwQH9v8YSMrw==

MPHP105 (LAB-1) Optics and Electronics

List of Experiments

1	To study the diffraction pattern by using single slit.
2	To study light spread when passes through a narrow aperture by using laser kit.
3	To determine the separation between the plates of a Fabry Perot Etalon.
4	To study the prismatic spectrum by using Cauchy's relation.
5	Calibration of constant deviation spectrometer and determination of unknown wavelength.
6	To Determine Young modulus of glass by Cornu's method.
7	To Verify the Brewster law of reflection for polarized light.
8	To study the characteristic of NPN transistor in CE mode.
9	To study the characteristic of UJT.
10	To study characteristics of FET.
11	To study the characteristic of MOSFET.
12	To study the energy band gap & diffusion of P-N junction.
13	To study Zener regulated and IC regulated power supply.

MPHP106 **(LAB-2) Python Programming**

List of Experiments

1	Python program to find roots of quadratic equation.
2	Python program to add and subtract matrices.
3	Python program to multiply matrices.
4	Python program to short number in ascending order.
5	Python program to find largest of N number.
6	Write a program to print factors of a given number.
7	Write a function that takes an integer input and calculates the factorial of that number.
8	Using while loop, produce a table of sins, cosines and tangents. Make a variable x in range from 0 to 10 m steps of 0.2. For each value of x. print the value of sin(x), cos(x) and tan(x).
9	Write a function that takes an integer 'n' as input and calculates the value of (1+1/1! +1/2! +......+1/n!).
10	Using for loop, print a table of Celsius/Fahrenheit equivalences (Let C be the Celsius temperatures ranging from 0 to 100, for each value of e, print the corresponding Fahrenheit temperature.)
11	Python program to find result, relative error, percentage error of an experiment.
12	Python program to plot straight line. (In which user enters slope and y- intercept of straight line)
13	Python program to plot potential and wavefunction of one-dimensional harmonic oscillator. (potential and wavefunction for ground state)
14	Python program to plot y = Asin (Bs +C)
15	Python program to find roots of cubic polynomial using bisection method.
16	Python program to perform integration using Simpson's 13td rule.

SEMESTER -II

PROGRAMME	**M.SC. PHYSICS**	
CORE COURSE	**COURSE CODE: MPHT201**	
TITLE	**Mathematical Methods -II**	
JTotal Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**	
Course Objective	• To study complex differentiability, analytic functions, Cauchy theorems, residues, and contour integration techniques. • To solve boundary value problems using Fourier, Laplace transforms, and Green's function methods effectively. • To understand tensor algebra, transformations, covariant differentiation, and their applications in physics and mathematics.	
Course Outcomes	**CO1:** Basic knowledge about the complex variable function. **CO2:** Uses of partial differential equation to solve boundary value problem. **CO3:** Basic knowledge about Tensor. **CO4:** Use concept of Green's function to solve Differential Equation.	
UNIT	**Description**	**No. of Lectures / Hours**
I	**Complex differentiability. Analysis:** Function of Complex Variables, limit, continuity and function to be analytic, Analytic function, the necessary and sufficient condition for a Cauchy-Riemann condition, Cauchy integral theorem, Taylor's Residues, series and Laurent's series expansion, Zeros and singular points, Residue theorem. Evaluation of line integral by indefinite integration, Singularities Cauchy's integral formula, Derivatives of an analytic function. of analytic functions, Contour integration.	**15**
II	**Boundary value problems:** Transverse vibration of a stretched sting. D'Alembert solution. Two-dimensional heat flow, rectangular membrane. Poisson's Fourier and Laplace equations, Solution of partial differential equation by and Laplace transform methods	**15**
III	**Green's function:** non-homogeneous boundary value problem, Greens function for one dimensional problem, eigen function expansion of Green's function, method of constructing Green's function, Green's function for electrostatic boundary value problems and quantum mechanical scattering problem.	**15**
IV	**Tensors:** Definition of Tensor, contra variant and covariant tensors, the algebra of-tensor, Quotient low, Symmetric & antisymmetric tensors, invariant tensors, associate tensors, conjugate tensors, metric tensors; length of a vector, angle. Between tensors, Christophers symbol and their transformation law, equation of geodesies, Covariant differentiation of vectors and tensors of higher rank.	**15**

TEXT AND REFERENCE BOOK:

1. Advance Engineering Mathematics, H.K Das, S. Chand Publishing
2. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, 44 Edition
3. Mathematical Methods for Physicists (60): G.B. Arikan und H.J. Weber, Elsevier Academic Press
4.Applied Mathematics for Engineers and Physicists, L.A. Pipes and L.R. Harvill. McGraw-Hil
5. Complex variables and applications,R. V. Churchill and J.W. Brown,
6.Advanced Engineering Mathematics, E. Kreyzig (2nd Ed., Pearson, 2002) McGraw-Hill, Edition 5th Edition

7. Group Theory in Physies, Wi-K.Tung, World Scientific

E -Resources:

1. https://nptel.ac.in/courses/115106086
2. https://nptel.ac.in/courses/115105097
3. https://nptel.ac.in/courses/115103036
4. https://nptel.ac.in/courses/111107119

SEMESTER -II

PROGRAMME	**M.SC. PHYSICS**	
CORE COURSE	**COURSE CODE: MPHT202**	
TITLE	**Quantum Mechanics-I**	
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**	
Course Objective	• To understand quantum mechanics fundamentals, wave-particle duality, Schrödinger equation, and interpretation of acceptable wavefunctions. • To analyze angular momentum, spin, and their matrix representations using operator methods and commutation relations. • To solve one- and three-dimensional quantum problems including potential wells, barriers, and hydrogen atom systems.	
Course Outcomes	**CO1:** Understand general formalism and quantum mechanics. **CO2:** Master the applications of quantum mechanics in one dimensional and three-dimensional physics problems. **CO3:** Apply angular momentum algebra to find out C G coefficients. **CO4:** Apply Quantum mechanics to solve hydrogen atom problem. **CO5:** Understand Heisenberg and Dirac formalism of Quantum mechanics.	
UNIT	**Description**	**No. of Lectures / Hours**
I	**Review of concepts:** Limitations of Classical Mechanics, Wave-particle duality, Schrodinger equation, Acceptable wavefunctions, Probability interpretation, Continuity equation, Ehrenfest theorem, Stationary states.	**15**
II	**Postulates of quantum mechanics:** Basic postulates, Superposition principle, observables and operators. Measurements, expectation value, symmetries and conservation laws. ~~15~~ 01 General properties of one-dimensional motion, One dimensional problems, Problems, potential wells and barriers, Harmonic oscillator operator method.	**15**
III	**Angular momentum:** Commutation relations of angular momentum operators, Eigenvalues, eigenvectors. Ladder operators and their matrix representations. Spin angular momentum and Pauli matrices, addition of angular momentum rotation in quantum mechanics, Clebsch-Gordan coefficients.	**15**
IV	**Three-Dimensional problem:** Central force problem, Solution of Schrodinger equation for spherically, symmetric potentials, Hydrogen atom, Three-dimensional Square Well Potential and Energy levels, degeneracy.	**15**

Text and Reference Books:

1. Quantum Mechanics-Concepts and Applications, N. Zettili,(2009), Wiley
2. Quantum Mechanics, E.Merzbacher,(2011)
3. Quantum Mechanics. Theory and Applications, Ajoy Glansk and 3 Lokanathan, 5th edition, Macmillan India Ltd
4. A Textbook of Quantum Mechanics, K. Venkatesan, (2010). P.M. Mathews, Dorling Kindersley (India) Pvt. Ltd

E -Resources:

1. https://nptel.ac.in/courses/115101107
2. https://nptel.ac.in/courses/115106066
3. https://nptel.ac.in/courses/115102023
4. https://hcverma.in/QuantumMechanics
5. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+4mIqRALksfwQH9v8YSMrw==
6. https://ocw.mit.edu/courses/8-04-quantum-physics-i-spring-2016/

SEMESTER -II

PROGRAMME	**M.SC. PHYSICS**
CORE COURSE	**COURSE CODE: MPHT203**
TITLE	**Electrodynamics**
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**
Course Objective	• To study electrostatics, magnetostatics, and Maxwell's equations for understanding electromagnetic field behavior. • To analyze electromagnetic wave propagation, reflection, refraction, and interactions across different media and boundaries. • To explore electromagnetic radiation principles, emission mechanisms, and radiation from various sources and antennas.
Course Outcomes	**CO1:** Solve problems involving electrostatics and magnetostatics. **CO2:** Solve problems involving electrostatics and magnetostatics wave behavior. **CO3:** Predict and explain the reflection, refraction, and transmission of electromagnetic waves. **CO4:** Comprehend the characteristics and sources of electromagnetic radiation.

UNIT	Description	No. of Lectures / Hours
I	**Electrostatics:** Gauss's law and its applications, Laplace and Poisson equations, boundary value problems, dielectrics, polarization of a medium, electrostatic **Magnetostatics:** Biet Savart law, differential equation for static magnetic field, vector potential, examples of magnetostatic problems, Faraday's law of induction, magnetic energy of steady current distributions.	**15**
II	**Maxwell's Equations:** Maxwell's Equation of continuity, Maxwell's equations (S1 Unit) and its derivation, Integral form of equation, Maxwell's equations in some particular cases, Electromagnetic energy Poynting Theorem. The wave equation, electromagnetic waves in free space. Plane electromagnetic waves in a Non conducting isotropic medium (i.e. isotropic dielectrics). Plane electromagnetic waves in Anisotropic Non-conducting medium (Anisotropic dielectric), Plane electromagnetic waves in conducting medium, Propagation of electromagnetic waves in ionized gases. Gauge symmetry. Coulomb and Lorentz gauges.	**15**
III	**Interaction of EM Waves:** Boundary conditions at the interface two media, Reflection and Refraction of electromagnetic waves at the interface conducting media, Reflection and transmission coefficients at the interface between two non-conducting media. Brewster's law and degree of polarization, Total-internal reflection. Propagation of Electromagnetic waves between parallel conducting planes Wave guides. TM modes and TE modes.	**15**

IV	**Electromagnetic Radiation:** Electromagnetic vector and scalar potential, Lorenz Gauge, Lienard Wichert potentials, the electromagnetic field of a uniformly moving point charge, Radiation from an accelerated charge at low velocity Larmor's formula. Angular distribution of radiation emitted by an accelerated charge, Radiation damping, Cherenkov radiation. Radiation due to an oscillating electric dipole electric quadra pole radiation, Radiation due to small current element. Radiation from linear antenna.	15

Text and Reference Books:

1. Classical Electrodynamics; J.D. Jackson, Wiley
2. Introduction to Electrodynamics; D.J. Griffiths, Pearson
3. Electrodynamics, Gupta,Kumar, Sharma, Pragati Prakashan
4. Modern Electrodynamics, A. Zangwil: Cambridge University Press,Cambridge, U.K.
5. Principles of Electrodynamics, Melvin Schwartz (Dover Publications, 1987)

E -Resources:

1. https://nptel.ac.in/courses/115101004
2. https://nptel.ac.in/courses/115105132
3. https://nptel.ac.in/courses/115101005
4. https://nptel.ac.in/courses/115104134
5. https://nptel.ac.in/courses/115106122

SEMESTER -II

PROGRAMME	**M.SC. PHYSICS**	
CORE COURSE	**COURSE CODE: MPHT204**	
TITLE	**Electronics -II**	
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**	
Course Objective	• To understand fundamentals of optoelectronic devices, radiative transitions, LEDs, and diode laser operation principles. • To study photodetectors, phototransistors, and solar cells with their characteristics and conversion efficiencies. • To analyze operational amplifiers, configurations, feedback mechanisms, and their applications in electronic circuits.	
Course Outcomes	**CO1:** Understand radiative and nonradiative transitions in electronic devices. **CO2:** Analyze performance of photoconductive devices and emission spectra. **CO3:** Design and analyze light-emitting diodes (LEDs) and photodetectors. **CO4:** Apply operational amplifier principles in differential amplifier circuits. **CO5:** Gain practical skills in analyzing and designing Op-amp circuits, including oscillators and comparators	
UNIT	**Description**	**No. of Lectures / Hours**
I	**Fundamental of Optoelectronics Devices:** Radiative and nonradiative transitions Optical-Absorption, bulk and thin film, photoconductive devices (LDL). Emission spectra. Luminescent efficiency, method of excitation. Light emitting diode (LED): high frequency limit, effect of surface and indirect combination current, operation of LED, Visible LEDs, and infrared LEDs. Diode Laser Condition for population inversion in active region light confinement Factor, optical gun and threshold current for lasing, Fabry Perrot Cavity Length for losing and the separation	**15**
UNIT - II	**Photodetectors, Phototransistors, and Solar Cells:** Photoconductor, equivalent circuit of photoconductor Phototransistor Bipolar phototransistor photo Darlington transistor, V-1 characteristic of bilateral hetero structure phototransistor, Solar cells. Solar radiation, solar-spectrum, ideal conversion efficiency. Energy band diagram of solar cell, I-V characteristics of solar cell, PN junction solar cells, Hetero junction, and Interface thin fin solar cells.	**15**
UNIT - III	**Introduction in Op-amp:** Basic Op-amp, Differential amplifies circuit configurations, dual input, balanced output, differential amplifier -DC analysis, Block diagram of a typical Op-amp, Analysis open loop configuration, inverting Block diagram of a typical Op-amp, Analysis open loop configuration, inverting and non-inverting amplifier. Op-amp with negative feedback Voltage series feedback, effect of feedback un closed loop gain input persistence output resistance bandwidth and output offset voltage, voltage follower.	**15**
UNIT - IV	**Oscillators, Comparators, and Waveform Generators:** Oscillator's principles, oscillator types, frequency, stability response, the phase shin oscillator. Wein bridge oscillator, Multivibrators, Monostable and A stable Comparators, square wave and triangle wave generators.	**15**

Text and Reference Books

1. Hand Book of electronics gupta Kumar (Pragati Prakashan)
2. Electronic Devices and circuit theory-Robert Baylested and Iquis Nashdaky, PHI, New Delhi
3. Semiconductor Devices - Physics and Technology S.M. Sze, Wiley, 1985
4. Introduction to Semiconductor Devices M.S.Tyagi, John Wiley & sons
5. Electronic Fundamentals and applications-John D. Ryder PHI, New Delhi
6. Operational Amplifier and their applications Subir Kumar Sarker, S.Chand & Son

E -Resources:

1. https://nptel.ac.in/courses/108101091
2. https://nptel.ac.in/courses/115102014
3. https://nptel.ac.in/courses/117103063

MPHP205 **(LAB-1) Electronics**

List of Experiments

1	To study the characteristic of LDR
2	To study the characteristic of LED
3	To study the characteristic of Photo transistor
4	To study the characteristic of Photodiode.
5	To design an inverting amplifier using Op-amp (741,351) for de voltage of given gain.
6	To design an inverting amplifier using Op-amp (741,351) and study its frequency response.
7	To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
8	To add two de voltages using Op-amp in inverting and non-inverting mode.
9	To design a precision Differential amplifier of given I/O specification using Op-amp.
10	To investigate the use of an op-amp as an Integrator
11	To investigate the use of an op-amp as a Differentiator
12	To design a Wien bridge oscillator for given frequency using an op-amp
13	To design a phase shift oscillator of given specifications using BJT
14	To study the Colpitis oscillator,

MPHP206 **(LAB-2) General**

List of Experiments

1	To verify Title the law of Malas for plane polarized light.
2	To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
3	To verify the Stefan's law of radiation and to determine Stefan's constant.
4	To determine Curie temperature of Monel metal by using a transformer.
5	To Determination of Planck's constant and work function of Materials by photoelectric effect.
6	Study of Electron spin resonance- determine magnetic field as a function ofthe resonance frequency.
7	Study of Zeeman effect with external magnetic field, Hyperfine splitting.
8	To determine the e/m of electron by Thomson method
9	Plot Planck's law for Black Body radiation and compare it with Wein'sLaw and Kali Law at high temperature (room temperature) and low temperature.)
10	Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Emstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases.
11	Plot Maxwell-Boltzmann distribution function versus temperature.
12	Plot Fermi-Dirac distribution function versus temperature.
13	Plot Bose-Einstein distribution function versus temperature.

SEMESTER -III

PROGRAMME	**M.SC. PHYSICS**
CORE COURSE	**COURSE CODE: MPHT301**
TITLE	**Quantum Mechanics – II**
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**
Course Objective	• Develop understanding of variational and WKB approximation methods for obtaining approximate solutions of complex quantum mechanical systems. • Explain time-dependent perturbations, quantum transitions, and scattering phenomena to analyze interactions between particles and external fields. • Introduce identical particles and relativistic quantum mechanics concepts for understanding spin, statistics, antiparticles, and particle dynamics.
Course Outcomes	**CO1:** Apply variational and WKB methods to solve quantum mechanical problems and analyze tunneling and bound-state phenomena. **CO2:** Evaluate transition probabilities using time-dependent perturbation theory and explain selection rules governing quantum transitions accurately. **CO3:** Analyze scattering processes using Born approximation and partial wave methods to determine scattering amplitudes and cross-sections. **CO4:** Explain identical particle behavior and apply Dirac theory to describe relativistic particles, spin, and positrons.

UNIT	**Description**	**No. of Lectures / Hours**
UNIT - I	**Variational Method and WKB Approximation:** Variational principle and variational method. Applications to ground state problems: hydrogen atom, helium atom and harmonic oscillator using suitable trial wave functions. WKB approximation, validity and limitations of WKB method, connection formulae, quantization condition, tunneling through potential barrier, application to alpha decay.	**15**
UNIT - II	**Time Dependent Perturbation Theory:** Time-dependent perturbation theory, constant and harmonic perturbations, transition probabilities, Fermi's Golden Rule, absorption and induced emission, selection rules and forbidden transitions. Sudden approximation and adiabatic approximation (elementary treatment and applications).	**15**
UNIT - III	**Quantum Scattering Theory:** Scattering in three dimensions, scattering amplitude, differential and total scattering cross sections. Born approximation and its validity. Scattering by spherically symmetric potentials. Applications to screened Coulomb potential and square well potential. Partial wave analysis, phase shifts, scattering by rigid sphere and square well. Optical theorem (qualitative treatment).	**15**
UNIT - IV	**Identical Particles and Relativistic Quantum Mechanics:** Identical particles, symmetric and antisymmetric wave functions, Pauli exclusion principle, spin angular momentum. Relativistic quantum mechanics, Klein-Gordon equation and its limitations, Dirac equation for free particle, α and J3 ~~β~~ matrices, charge and current densities, free particle solutions, existence of spin and magnetic moment, theory of positron, γ matrices and covariant formulation of Dirac equation.	**15**

Text and Reference Books:

1. Davidow: Quantum Mechanics.
2. L.I. Schiff: Quantum Mechanics.
3. Powerll and Craseman: Quantum Mechanics.
4. Ghatak and loknathan: Quantum Mechanics.

E -Resources:

1. **https://nptel.ac.in/courses/115104096?utm**
2. **https://nptel.ac.in/courses/115106122?utm**
3. **https://nptel.ac.in/courses/115104096?utm**
4. **https://ocw.mit.edu/courses/8-05-quantum-physics-ii-fall-2013/?utm**
5. **https://nptel.ac.in/courses/115101107?utm**
6. **https://nptel.ac.in/courses/115104096?utm**
7. **https://nptel.ac.in/courses/115106122?utm**
8. **https://ocw.mit.edu/courses/8-251-relativistic-quantum-physics-i-fall-2007/?utm**
9. **https://nptel.ac.in/courses/115104096?utm**

SEMESTER -III

PROGRAMME	**M.SC. PHYSICS**
CORE COURSE	**COURSE CODE: MPHT302**
TITLE	**Statistical Mechanics**
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**
Course Objective	• Develop understanding of fundamental statistical mechanics principles, ensembles, thermodynamic laws, and their applications to physical systems. • Explain classical and quantum statistics governing particle distributions and thermodynamic properties of ideal quantum gases. • Introduce phase transitions, critical phenomena, fluctuations, and non-equilibrium processes for analyzing complex many-particle systems.
Course Outcomes	**CO1:** Apply statistical mechanics principles and ensemble methods to derive thermodynamic properties of macroscopic physical systems. **CO2:** Analyze Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics and evaluate properties of ideal quantum gases. **CO3:** Explain phase transitions, critical phenomena, and Ising models using mean-field and exact theoretical approaches. **CO4:** Investigate fluctuations, Brownian motion, diffusion, and non-equilibrium processes using stochastic and statistical methods.

UNIT	Description	No. of Lectures / Hours
UNIT - I	**Foundations of Statistical Mechanics:** Foundation of statistical mechanics, postulate of equal a priori probability, ergodic hypothesis (elementary treatment), specification of states of a system, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibbs paradox. Microcanonical ensemble, phase space, trajectories and density of states, Liouville theorem. Canonical and grand canonical ensembles, partition function, calculation of ~~thermodynamic~~ statistical quantities, energy and density fluctuations.	**15**
UNIT - II	**Quantum Statistics:** Statistics of ensembles, statistics of indistinguishable particles, density matrix. Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Properties of ideal Bose gas and Bose-Einstein condensation. Properties of ideal Fermi gas, Fermi energy and Fermi temperature, electron gas in metals, degeneracy pressure (qualitative treatment). Boltzmann transport equation.	**15**
UNIT - III	**Interacting Systems and Phase Transitions:** Cluster expansion for a classical gas, virial equation of state. Phase transitions and critical phenomena (introductory concepts). Mean field theory of Ising model in one, two and three dimensions. Exact solution of one-dimensional Ising model.	**15**
UNIT - IV	**Fluctuations and Non-equilibrium Statistical Mechanics:** Thermodynamic fluctuations, fluctuations in energy, pressure, volume and enthalpy. One-dimensional random walk and diffusion equation. Brownian motion, Langevin theory, fluctuation-dissipation theorem, Fokker-Planck equation and Onsager reciprocity relations.	**15**

Text and Reference Books:

1. Fundamentals of Statistical Mechanics- B.B.Laud
2. Statistical Mechanics- B.K.Agrawal and Melvin Eisner
3. Statistical Mechanics- Gupta and Kumar
4. Statistical Mechanics- K.T. Thorpe

E -Resources:

1. **https://nptel.ac.in/courses/115104046?utm**
2. **https://nptel.ac.in/courses/115106120?utm**
3. **https://nptel.ac.in/courses/115104046?utm**
4. **https://nptel.ac.in/courses/115106056?utm**
5. **https://nptel.ac.in/courses/115104088?utm**
6. **https://nptel.ac.in/courses/115106064?utm**
7. **https://nptel.ac.in/courses/115106054?utm**
8. **https://nptel.ac.in/courses/111106144?utm**

SEMESTER -III

PROGRAMME	**M.SC. PHYSICS**	
CORE COURSE	**COURSE CODE: MPHT303**	
TITLE	**Condensed Matter Physics – I**	
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**	
Course Objective	• Examine crystal symmetry, lattice geometry, and diffraction principles for characterization and determination of crystal structures. • Investigate the influence of defects, dislocations, and electronic energy bands on the physical behavior of solids. • Explore magnetic interactions, ordering phenomena, and collective excitations responsible for diverse magnetic properties of materials.	
Course Outcomes	**CO1:** Analyze crystal structures using symmetry concepts, reciprocal lattices, and diffraction methods for structure determination. **CO2:** Explain crystal defects, dislocations, and their influence on mechanical properties, crystal growth, and material behavior. **CO3:** Apply band theory concepts to describe electronic properties, Fermi surfaces, and transport phenomena in solids. **CO4:** Interpret magnetic ordering and evaluate magnetic properties using Weiss theory, Heisenberg model, and spin-wave concepts.	
UNIT	**Description**	**No. of Lectures / Hours**
UNIT - I	**Crystal Structure and Diffraction:** Crystalline and amorphous solids, unit cells and direct lattice. Two- and three-dimensional Bravais lattices, fundamental elements of symmetry, point groups and space groups, crystal planes and Miller indices, close packed structures. Interaction of X-rays, electrons and neutrons with matter. Elastic scattering from a perfect lattice, Laue equations, Bragg law, reciprocal lattice, Ewald construction, Brillouin zones and introductory concepts of crystal structure determination using diffraction techniques.	**15**
UNIT - II	**Crystal Defects and Dislocations:** Defects and imperfections in crystals and their classification. Point defects, Schottky and Frenkel defects, vacancies, interstitials and colour centres in ionic crystals, their types and production. Surface defects and grain boundaries (elementary treatment). Line defects or dislocations, edge and screw dislocations, Burgers vectors, role of dislocations in plastic deformation and crystal growth.	**15**
UNIT - III	**Band Theory and Electronic Properties of Solids:** Electrons in a periodic lattice, Bloch theorem, Kronig-Penney model, nearly free electron model, band theory of solids, classification of solids, effective mass, tight binding approximation, cellular and pseudopotential methods. Fermi surface and its construction, de Haas–van Alphen effect, cyclotron resonance, magnetoresistance and quantum Hall effect.	**15**
UNIT - IV	**Magnetic Properties of Solids:** Exchange interaction and its significance. Weiss theory of ferromagnetism, Heisenberg model and molecular field theory, Curie-Weiss law for susceptibility. Ferro-, ferri- and antiferromagnetic ordering, domains and Bloch wall energy. Spin waves and magnons, susceptibility below Néel temperature.	**15**

Text and Reference Books:

1. Kittel: solid state physics
2. Azroff: Introduction to solids
3. Varma and Shrivastava: Crystallography for solid state Physics
4. Singhal: solid state physics
5. Ziman: Principal of theory of solids
6. Ascrroff and mermin: solid state physics
7. Madelung: Introduction to solid state theory
8. Huong: Theoretical solid-state physics
9. Omar: Elementary solid-state physics
10. Kittel: Quantum theory of solids

E -Resources:

1. **https://nptel.ac.in/courses/115103030?utm**
2. **https://nptel.ac.in/courses/115106061?utm**
3. **https://nptel.ac.in/courses/113108051?utm**
4. **https://nptel.ac.in/courses/113106032?utm**
5. **https://nptel.ac.in/courses/113106065?utm**
6. **https://nptel.ac.in/courses/115102025?utm**
7. **https://nptel.ac.in/courses/115106061?utm**
8. **https://nptel.ac.in/courses/115106061?utm**

SEMESTER -III

PROGRAMME	**M.SC. PHYSICS**	
CORE COURSE	**COURSE CODE: MPHT304**	
TITLE	**Electronics – III**	
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**	
Course Objective	• Acquire proficiency in number systems, Boolean algebra, and logic minimization techniques for efficient digital circuit design. • Examine the architecture and operation of combinational and sequential circuits used in digital electronic systems. • Explore data conversion techniques and integrated circuit technologies underlying modern electronic and computing devices.	
Course Outcomes	**CO1:** Perform number system conversions, Boolean simplifications, and design optimized logic circuits using Karnaugh maps. **CO2:** Design and analyze combinational circuits including adders, subtractors, encoders, decoders, multiplexers, and demultiplexers. **CO3:** Construct and evaluate sequential circuits using flip-flops, counters, registers, and timing analysis techniques. **CO4:** Compare ADC and DAC architectures and explain fabrication, packaging, and integration levels of integrated circuits.	
UNIT	**Description**	**No. of Lectures / Hours**
UNIT - I	**Number Systems and Boolean Algebra:** Decimal, Binary, Octal and Hexadecimal number systems and mutual conversions. Binary arithmetic, BCD addition and subtraction, 1's and 2's complements, multiplication and division. BCD code (8421), Excess-3 code, Gray code, binary-to-Gray and Gray-to-binary conversion, applications of Gray code. Concept of arithmetic overflow. Positive and negative logic, basic logic gates, universal gates. Basic laws of Boolean algebra, De Morgan's theorems. Two, three and four variable Karnaugh maps, minimization of SOP and POS expressions, pairs, quads, octets, overlapping, rolling and don't-care conditions.	**15**
UNIT - II	**Combinational Logic Circuits:** Exclusive-OR and Exclusive-NOR gates. Half adder, full adder, binary parallel adder, serial adder, half subtractor, full subtractor, 1's complement subtractor and 2's complement subtractor. Digital logic families: basic concepts of RTL, DTL, TTL, ECL and CMOS logic. Characteristics of logic families: fan-in, fan-out, noise margin and propagation delay. Decoders: 2-to-4 decoder, 4-to-16 decoder, BCD-to-decimal decoder, BCD-to-seven segment decoder. Encoders: Decimal-to-BCD encoder. Multiplexers and Demultiplexers: 2-input, 4-input and 16-input multiplexers; 1-to-2, 1-to-4 and 1-to-16 demultiplexers.	**15**

UNIT - III	**Sequential Logic Circuits:** Flip-flops and timing diagrams. RS flip-flop using NOR and NAND gates, clocked RS flip-flop, D-latch, preset and clear operations, JK flip-flop, positive and negative edge-triggered flip-flops, JK master-slave flip-flop. Counters: Binary ripple counter, up counter, down counter, synchronous and asynchronous counters, decade counter, ring counter and timing diagrams. Registers: Parallel and shift registers, PIPO, SIPO, PISO, SISO and bidirectional shift registers. Applications of shift registers and counters.	**15**
UNIT - IV	**Data Converters and Integrated Circuits:** Digital-to-Analog Converters (DAC): Binary weighted resistor DAC and R–2R ladder DAC. Analog-to-Digital Converters (ADC): Counter-type ADC, successive approximation ADC and dual slope ADC. Applications of DACs and ADCs. Integrated Circuits: Introduction, IC technology, advantages and limitations, monolithic IC technology, basic fabrication processes, fabrication of components in monolithic ICs, IC packaging, symbols and scale of integration (SSI, MSI, LSI, VLSI and ULSI).	**15**

Text and Reference Books:

1. Digital Principles and applications - Malvino and Leach, Tata McGraw Hills, New Delhi,
2. Digital and Analogue Technique- Navneet Gokhale and Kale, Kitab Mahal
3. Hand Book of Electronics - Gupta and Kumar, Pragati Prakashan, Meerut, 2008
4. Digital integrated Electronics _Taub and Schilling, McGraw International Edition,
5. Fundamentals of Digital Circuits - A.Anand Kumar, Prentice Hall of India, New Delhi.

E -Resources:

1. **https://nptel.ac.in/courses/108105132?utm**
2. **https://archive.nptel.ac.in/content/storage2/courses/106108099/Digital%20Systems.pdf?utm**
3. **https://nptel.ac.in/courses/108105113?utm**
4. **https://nptel.ac.in/courses/106105185?utm**
5. **https://nptel.ac.in/courses/117105080?utm**

SEMESTER – III

LAB – I

Time: 5 Hrs. **Total Marks: 100**

Experiment	**60**
Viva Voce	**20**
Sessional	**20**

LAB – II

Time: 5 Hrs. **Total Marks: 100**

Experiment	**60**
Viva Voce	**20**
Sessional	**20**

SEMESTER -IV

PROGRAMME	**M.SC. PHYSICS**	
CORE COURSE	**Course Code: MPHT401**	
TITLE	**Condensed Matter Physics – II**	
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**	
Course Objective	• Investigate superconducting phenomena and dielectric behavior to understand collective electronic responses in condensed matter systems. • Examine ferroelectric materials, phase transitions, and polarization mechanisms governing functional properties of advanced materials. • Explore semiconductor physics, nanostructures, and lattice vibrations underlying modern electronic and nanoscale technologies.	
Course Outcomes	**CO1:** Explain superconducting properties, BCS theory, Josephson effects, and the role of electron-phonon interactions in superconductors. **CO2:** Analyze dielectric polarization, ferroelectric behavior, and phase transition mechanisms in electrically active materials. **CO3:** Evaluate charge transport phenomena in semiconductors and describe quantum confinement effects in nanostructured systems. **CO4:** Interpret lattice dynamics, phonon behavior, and thermal properties of solids using classical and quantum models.	
UNIT	**Description**	**No. of Lectures / Hours**
UNIT - I	**Superconductivity:** Superconductivity, critical temperature, persistent current, Meissner effect and flux penetration, Type-I and Type-II superconductors, thermodynamics of superconducting transition, London equations, coherence length and penetration depth (elementary treatment). Interaction of electrons with acoustic and optical phonons, Cooper pairing due to phonons, BCS theory of superconductivity (qualitative). Manifestation of energy gap in superconductors, superconducting tunneling, AC and DC Josephson effects, high temperature superconductivity (elementary).	**15**
UNIT - II	**Dielectrics and Ferroelectrics:** Polarization, depolarization field, local electric field at an atom, Lorentz field, dielectric constant and polarizability. Electronic, ionic and orientational polarizability. Debye equation for gases, complex dielectric constant, dielectric relaxation time, normal and anomalous dispersion, classical theory of electronic polarizability. Ferroelectric crystals, classification, ferroelectric domains, piezoelectricity and pyroelectricity (elementary concepts), structural phase transitions, Landau theory of phase transitions, first and second order phase transitions, antiferroelectricity.	**15**
UNIT - III	**Semiconductors and Nanostructures:** Energy bands in semiconductors, intrinsic and extrinsic semiconductors, drift velocity, mobility, carrier concentration and Fermi level in intrinsic and extrinsic semiconductors. Electrical conductivity of semiconductors and semimetals. Hall effect in semiconductors and its applications. Elementary ideas of nanostructures: definition, properties, methods of preparation and applications. Quantum confinement in low-dimensional systems (quantum wells, quantum wires and quantum dots) – elementary	**15**

	concepts.	
UNIT - IV	**Lattice Dynamics and Phonons:** Interatomic forces and lattice dynamics of simple metals, ionic and covalent crystals. Lattice dynamics of linear monoatomic and diatomic lattices, acoustic and optical modes. Quantization of elastic waves (phonons), momentum of phonons, Debye model of lattice heat capacity, inelastic neutron scattering by phonons, anharmonicity, thermal expansion and lattice thermal conductivity.	**15**

Text and Reference Books:

1. Kittel: solid state physics
2. Azroff: Introduction to solids
3. Varma and Shrivastava: Crystallography for solid state Physics
4. Singhal: solid state physics
5. Ziman: Principal of theory of solids
6. Ascrroff and mermin: solid state physics
7. Madelung: Introduction to solid state theory
8. Huong: Theoretical solid-state physics
9. Omar: Elementary solid-state physics
10. Kittel: Quantum theory of solids

E -Resources:

1. **https://nptel.ac.in/courses/115102025?utm**
2. **https://nptel.ac.in/courses/113104005?utm**
3. **https://nptel.ac.in/courses/113104081?utm**
4. **https://nptel.ac.in/courses/115102025?utm**
5. **https://nptel.ac.in/courses/118106018?utm**
6. **https://nptel.ac.in/courses/115106061?utm**
7. **https://nptel.ac.in/courses/115102025?utm**
8. **https://nptel.ac.in/courses/115106061?utm**

SEMESTER -IV

PROGRAMME	M.SC. PHYSICS
CORE COURSE	COURSE CODE: MPHT402
TITLE	Nuclear Physics
Total Marks	Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40
Course Objective	• Investigate nuclear decay processes and reaction mechanisms to understand the stability, transformation, and energetics of nuclei. • Examine radiation detection techniques, particle accelerators, and their significance in nuclear science and applications. • Explore elementary particles, fundamental interactions, symmetry principles, and theoretical frameworks describing subatomic phenomena.
Course Outcomes	**CO1:** Analyze alpha, beta, and gamma decay processes using quantum and statistical models of radioactive transformations. **CO2:** Apply conservation laws and reaction theories to evaluate nuclear reactions, fission, fusion, and reactor operations. **CO3:** Compare radiation detectors and particle accelerators based on their principles, performance characteristics, and applications. **CO4:** Classify elementary particles and explain fundamental interactions, symmetries, quark structure, and Standard Model concepts.

UNIT	Description	No. of Lectures / Hours
I	**Nuclear Decay:** Alpha decay: Measurement of α-particle energies, α-particle spectra, Geiger-Nuttall law, barrier penetration theory of α-decay. Beta decay: Shape of β-spectrum, neutrino hypothesis, detection of neutrinos, Fermi theory of β-decay (Kurie plot, neutrino mass, half-life), allowed and forbidden transitions, selection rules. Gamma decay and nuclear isomerism (elementary treatment), multipole radiation and selection rules (qualitative).	15
II	**Nuclear Reactions and Nuclear Energy:** Conservation laws in nuclear reactions, Q-equation, theories of nuclear reactions, partial wave analysis, compound nucleus formation and decay, resonance scattering and reactions. Liquid drop model and its role in understanding nuclear fission (elementary treatment). Neutrons released in fission, cross-sections, nuclear chain reactions, nuclear reactor, four-factor formula, critical size of reactor, general aspects of reactor design. Fusion, thermonuclear energy and prospects of controlled fusion energy.	15
III	**Radiation Detectors and Accelerators:** Gas-filled counters including Geiger-Müller counter, scintillation counters, solid-state detectors, neutron detection, detector efficiency and energy resolution (elementary concepts). Accelerators: Cyclotron, linear accelerator, betatron, electron synchrotron and proton synchrotron.	15
IV	**Elementary Particle Physics:** Classification of elementary particles, fundamental interactions, conservation laws, invariance under parity (P), charge conjugation (C), time reversal (T) and CPT transformations.	15

	Electron and positron, proton and antiproton, neutrino and antineutrino, mesons and hyperons (masses, decay modes and reactions). Elementary particle symmetries SU(2) and SU(3), quark model, quark flavours and colour charge, introductory concepts of the Standard Model.	

Text and Reference Books:

1. Nuclear Physics, Ray and Nigam (Wiley Eastern ltd)
2. Nuclear Physics, I Kaplan (Narosa)
3. Introduction to nuclear Physics, H.A. Enge (Addison Wesley)
4. Concepts of Nuclear Physics, B.L.Cohen (TMGH)

E -Resources:

1. **https://nptel.ac.in/courses/115101107?utm**
2. **https://nptel.ac.in/courses/115104043?utm**
3. **https://nptel.ac.in/courses/115101107?utm**
4. **https://nptel.ac.in/courses/112101007?utm**
5. **https://nptel.ac.in/courses/115103101?utm**
6. **https://nptel.ac.in/courses/115101005?utm**
7. **https://nptel.ac.in/courses/115104043?utm**
8. **https://nptel.ac.in/courses/115106123?utm**
9. **https://nptel.ac.in/courses/115104043?utm**

SEMESTER -IV

PROGRAMME	**M.SC. PHYSICS**
CORE COURSE	**Course Code: MPHT403**
TITLE	**Atomic And Molecular Physics**
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**
Course Objective	• Investigate superconducting phenomena and dielectric behavior to understand collective electronic responses in condensed matter systems. • Examine ferroelectric materials, phase transitions, and polarization mechanisms governing functional properties of advanced materials. • Explore semiconductor physics, nanostructures, and lattice vibrations underlying modern electronic and nanoscale technologies.
Course Outcomes	**CO1:** Explain superconducting properties, BCS theory, Josephson effects, and the role of electron-phonon interactions in superconductors. **CO2:** Analyze dielectric polarization, ferroelectric behavior, and phase transition mechanisms in electrically active materials. **CO3:** Evaluate charge transport phenomena in semiconductors and describe quantum confinement effects in nanostructured systems. **CO4:** Interpret lattice dynamics, phonon behavior, and thermal properties of solids using classical and quantum models.

UNIT	Description	No. of Lectures / Hours
I	**Atomic Structure and Spectra:** Spectra of hydrogen and hydrogen-like atoms, reduced mass correction and variation of Rydberg constant. Sommerfeld`s elliptic orbit theory, relativistic corrections to hydrogen atom energy levels, space quantization, Pauli's vector atom model, four quantum numbers. Spectral terms arising from LS coupling, spectroscopic notation (s, p, d, f), term symbols and selection rules. Spectra of alkali atoms, spin-orbit interaction and fine structure in alkali spectra, screening constant, penetrating and non-penetrating orbits.	15
II	**Multi-electron Atoms and X-ray Spectroscopy:** Spectra of helium and alkaline earth atoms, singlet and triplet series, LS and JJ coupling, interaction energy and selection rules. Continuous X-ray spectrum, Duane-Hunt law, characteristic X-rays, Moseley's law, doublet fine structure of X-ray spectra. Effect of magnetic field on energy levels of monovalent atoms, gyromagnetic ratio for orbital and spin motion, vector model, Lande g-factor, Larmor precession (elementary), weak and strong magnetic field effects, normal and anomalous Zeeman effects, Paschen-Back effect and Stark effect.	15
III	**Rotational Spectroscopy and Resonance Techniques:** Energy bands in semiconductors, intrinsic and extrinsic semiconductors, drift velocity, mobility, carrier concentration and Fermi level in intrinsic and extrinsic semiconductors. Electrical conductivity of semiconductors and semimetals. Hall effect in semiconductors and its applications. Elementary ideas of nanostructures: definition, properties, methods of preparation and applications. Quantum confinement in low-dimensional systems	15

	(quantum wells, quantum wires and quantum dots) – elementary concepts.	
IV	**Vibrational and Electronic Spectroscopy:** Vibrational energy of diatomic molecules, energy levels and spectra. Anharmonicity of molecular vibrations, Morse potential energy curve, force constant, dissociation energy and isotope effect. Molecule as vibrating rotator, vibration-rotation spectra of diatomic molecules and selection rules. Electronic band systems, sequences and progressions, Franck-Condon principle, Born-Oppenheimer approximation, P, Q and R branches, infrared spectrometer. Elementary concepts of Raman spectroscopy and Raman shift.	**15**

Text and Reference Books:

1. H.E. White Introduction to atomic physics
2. Barrow Introduction to molecular physics
3. G.Herz berg Molecular spectra and molecular structure
4. H.Kuhn Atomic spectra
5. Walker and straugh Spectroscopy Vol I,II,III.

E -Resources:

1. https://nptel.ac.in/courses/115104096?utm_source=
2. https://nptel.ac.in/courses/122101001?utm_source=
3. https://nptel.ac.in/courses/115102025?utm_source=
4. https://nptel.ac.in/courses/118106018?utm_source=
5. https://ocw.mit.edu/courses/8-421-atomic-and-optical-physics-i-spring-2014/?utm_source=
6. https://ocw.mit.edu/courses/8-231-physics-of-solids-i-fall-2009/?utm_source=

SEMESTER -IV

PROGRAMME	**M.SC. PHYSICS**
CORE COURSE	**Course Code: MPHT404**
TITLE	**Electronics – IV**
Total Marks	**Internal Assessment: 30 Marks Maximum Marks: 70 Minimum Passing Marks: 40**
Course Objective	• Develop understanding of microprocessors, computer architecture, memory organization, and networking concepts for modern digital system applications effectively. • Provide knowledge of Intel 8085 architecture, instruction sets, addressing modes, and assembly language programming for embedded systems. • Introduce optical fiber communication principles, transmission characteristics, and networking applications for advanced electronic communication technologies effectively.
Course Outcomes	**CO1:** Apply microprocessor architecture, memory organization, and networking concepts to analyze digital computer systems effectively and accurately. **CO2:** Analyze Intel 8085 architecture, instruction cycles, addressing modes, and timing diagrams for microprocessor-based system design successfully. **CO3:** Develop assembly language programs using 8085 instructions for arithmetic, sorting, looping, and data processing applications efficiently. **CO4:** Evaluate optical fiber communication systems, transmission characteristics, losses, and dispersion for efficient modern communication network applications effectively.

UNIT	**Description**	**No. of Lectures / Hours**
I	**Microprocessors and Microcomputers:** Evolution of microprocessors, architecture of microprocessors, architecture of digital computers, Von Neumann architecture, memory organization. **Semiconductor memories:** RAM, ROM, PROM, EPROM, shift registers, cache memory (introductory). **Magnetic memories:** Floppy disk, hard disk, optical disk, magnetic bubble memory. Computer networking: Local Area Network (LAN), LAN topologies (Bus, Star and Ring).	15
II	**Intel 8085 microprocessor:** ALU, timing and control unit, registers, data and address buses, pin configuration, stack and stack pointer, interrupts in 8085 (introductory). **Instruction cycle:** Opcode and operands, fetch cycle, execute cycle, machine cycle, instruction and data flow. **Timing diagrams:** Opcode fetch, memory read, memory write, I/O read and I/O write.	15
III	**Addressing modes:** Direct, register, register indirect, immediate and implicit addressing. **Instruction set of 8085:** Data transfer, arithmetic and logical groups. **Assembly language programming:** Addition of 8-bit and 16-bit numbers, subtraction, largest and smallest number in an array, ascending and descending sorting, bit shifting, looping techniques, subroutines, delay programs (elementary).	15

IV	**Optical fibers:** Introduction, structure, classification, refraction, Snell's law, total internal reflection, light propagation, acceptance angle, numerical aperture, modes, cut-off parameter, single-mode propagation, comparison of step-index and graded-index fibers. **Types of optical fibers:** HPSUU, HPSIR and halide fibers. **Optical fiber cables:** Multifiber cable, splicing and connectors. Optical fiber losses (attenuation), dispersion in optical fibers, basic optical communication system (block diagram), advantages and disadvantages of optical fibers.	**15**

<u>Text and Reference Books:</u>

1. Fundamental of microprocessor and microcomputer- B. Ram, Dhanpat Rai Publication, New Delhi
2. Introduction to microprocessor- Aditya Mathur, Tata McGraw Hills, New Delhi
3. Microprocessor Architecture, programming and application with 8085/8086- Ramesh S. Gaonkar Wiley Eastern Ltd. 1987.
4. Optical Fibres and Fibre Optic Communication Systems- Subir Kumar Sarkar (S.Chand & company Ltd.)
5. Optical Fiber Communications (Principle and Practice) John M. Senior Prentice Hall of India Pvt. Ltd.

<u>E -Resources:</u>

1. https://nptel.ac.in/courses/108105102?utm_source=
2. https://nptel.ac.in/courses/106105163?utm_source=
3. https://nptel.ac.in/courses/117101054?utm_source=
4. https://nptel.ac.in/courses/108106168?utm_source=
5. https://ocw.mit.edu/courses/6-004-computation-structures-spring-2017/?utm_source=

SEMESTER IV

PROJECT WORK

TOTAL MARKS – 200

The project work should be related to the field of the physics. This may be either theoretical or experimental. In the theoretical project work, the student should submit dissertation on any scientific/natural event, contemporary development in the field of physics or any new idea for research work. The project report should include declaration by the candidate, certificate by supervisor, Acknowledgement, title and introduction along with the following points.

1. Introduction
2. Review of literature
3. Materials/content and methods
4. Results and discussion
5. Summary
6. Bibliography

Last date of submission of project report : as per ordinance.

Evaluation of project : Evaluation of the project work of semester system of all the candidates of colleges will be held at EXAMINTATION CENTER.