NETAJI SUBHAS UNIVERSITY

Estd. Under Jharkhand State Private University Act, 2018

Department of Physics

M.Sc. (PHYSICS)
Course Curriculum
(with CO, PO Structure)

w.e.f. 2018

Course Curriculum

for

Postgraduate Program in Physics

Netaji Subhas University

Pokhari, Jamshedpur

M.Sc Physics

Effective from Academic Session 2018- 2020

Dinesh
Head
Department of Physics
Netaji Subhas University

NETAJI SUBHAS UNIVERSITY JAMSHEDPUR

Dean Academics
Netaji Subhas University
Jamshedpur, Jharkhand

The M.Sc. Physics program has multifarious objectives which start with imparting students an in-depth understanding and awareness of the various core courses of Physics namely, Classical Mechanics, Mathematical Physics, Quantum Mechanics, Statistical Physics, Electromagnetic Theory, Solid State Physics, Electronics, Nuclear and Particle Physics, Atomic and Molecular Physics. The entire thought and focus is on interest generation, proactive thinking and problem-solving capabilities through theory, labs, assignments and tutorials. The course is designed to instill appreciation in the learners about the set of fundamental laws which govern the nature and natural phenomena through logical and mathematical reasoning.

Some papers namely Nanotechnology, Introduction to Astrophysics and Environmental Physics have been included to cater to the students the various dimensions of Physics and develop enthusiasm and interest in the nature and natural phenomena. The specialization papers on the other hand are aimed at deeper and broader range of concept of some specialized branches of Physics which can open up effective research channels. The core and elective labs are designed to develop a practical mode of understanding for the fundamental concepts and working of devices engaging scientific methods/tools of physics. Computational physics course is included to furnish the students with the training of computers as a tool for scientific investigations/understanding. The dissertation(s) in both theory and experimental stream are expected to inculcate a research orientation and inquisitive approach.

The **Program Outcomes (POs)** for **M.Sc. Physics** as per **UGC guidelines** align with the **Outcome-Based Education (OBE) model** and focus on equipping students with theoretical knowledge, practical skills, research abilities, and professional competencies.

The general **POs** for an M.Sc. in Physics are:

PO1. Fundamental Knowledge

Develop a strong foundation in core areas of physics, including **classical mechanics, quantum mechanics, electromagnetism, statistical mechanics, condensed matter physics, and nuclear physics**.

PO2. Analytical and Problem-Solving Skills

Enhance **mathematical, analytical, and logical reasoning** to solve complex problems in physics using theoretical models and computational techniques.

PO3. Experimental and Computational Proficiency

Gain expertise in **advanced laboratory techniques, instrumentation, and computational tools**, including **numerical methods and simulations** for solving real-world physics problems.

PO4. Research and Innovation

Develop research aptitude by engaging in **literature review, experimentation, data analysis, and scientific inquiry**, leading to innovative solutions in physics and interdisciplinary areas.

PO5. Application of Physics in Technology and Industry

Apply physics principles in **material science, electronics, photonics, nanotechnology, medical physics, renewable energy, space research, and other applied fields**.

PO6. Communication and Scientific Reporting

Develop the ability to **communicate scientific ideas effectively** through research papers, reports, presentations, and discussions.

PO7. Ethics and Professional Responsibility

Understand and uphold **scientific integrity, ethical research practices, and environmental sustainability** in scientific and industrial applications.

PO8. Lifelong Learning and Adaptability

Cultivate a mindset for **continuous learning and skill enhancement** to stay updated with emerging trends in physics and technology.

PO9. Interdisciplinary Approach

Apply physics concepts in **cross-disciplinary domains** such as computational sciences, bio-physics, atmospheric sciences, plasma physics, and material science.

PO10. Employability, Entrepreneurship, and Higher Studies

Prepare students for careers in **academia, research institutes, R&D labs, industries, government sectors, and startups**, and equip them for **higher studies like Ph.D. programs**.

These **POs** align with the **National Education Policy (NEP) 2020** and the **Outcome-Based Education (OBE) framework** set by UGC. They aim to ensure that M.Sc. Physics postgraduates are skilled, knowledgeable, research-oriented, and ready for professional challenges.

Program Specific Outcomes (PSOs)

Program Specific Outcomes (PSOs) for M.Sc. Physics

- **PSO1: Advanced Theoretical and Experimental Physics**

  Develop a deep understanding of core physics concepts such as Quantum Mechanics, Electrodynamics, Statistical Mechanics, and Condensed Matter Physics, along with proficiency in experimental techniques.

- **PSO2: Computational and Analytical Problem-Solving Skills**

  Apply mathematical methods, computational techniques, and simulation tools to solve complex physics problems and analyze real-world phenomena.

- **PSO3: Research and Innovation in Physics**

  Gain expertise in scientific research methodologies, data analysis, and critical thinking to contribute to innovative research and interdisciplinary applications.

- **PSO4: Applications of Physics in Industry and Technology**

  Utilize physics principles in materials science, electronics, nanotechnology, renewable energy, space science, and medical physics to address technological and societal challenges.

- **PSO5: Scientific Communication and Ethics**

  Develop effective scientific communication skills through research papers, reports, and presentations while adhering to ethical research practices and professional integrity.

These PSOs ensure that **M.Sc. Physics graduates** are well-prepared for **research, academia, and industry roles**.

Students may get job opportunities in higher education, research organizations, physics consultancy, radiology, radiation oncology and many others. Some of the institutions where physics students can start their careers are: BARC, DRDO, NPTC, IISc, ISRO, ONGC, BHEL, PRL, NPL, SINP, VECC, IITs, NITs, IIPR

Program Structure

The M. Sc. program is a two-year course divided into four-semesters. The program would make the students competent in a natural science, viz., Physics, and help them understand its role in modern day technology. Overall, the program would enable the students to understand the fundamental concepts and experimental methods of physics which would help them to innovate, apply and generate new devices, applications, insights and knowledge. Knowledge gained through the electives would be an asset in branching out in fields other than physics.

EVALUATION STRUCTURE OF M.Sc. (2YRS) PROGRAM IN PHYSICS

- **Each theory course in each semester has 30 marks for Internal Exam and 70 marks for External Exam.**
- **Lab Courses and Dissertations have 50 marks as internal marking and 50 marks as external viva marks.**

Total marks 100 for each course (Overall marks 2400)

YEAR- I							
Semester- I	**Code No.**	**Marks**	**Credits (L-T-P)**	**Semester -II**	**Code No.**	**Marks**	**Credits (L-T-P)**
Classical Mechanics	MPH101	100	3-1-0	Electromagnetic Theory	MPH201	100	3-1-0
Mathematical Methods	MPH102	100	3-1-0	Solid State Physics	MPH202	100	3-1-0
Quantum Mechanics I	MPH103	100	3-1-0	Scientific Computing	MPH203	100	3-1-0
Electronic Devices	MPH104	100	3-1-0	Quantum Mechanics -II	MPH 204	100	3-1-0
General Physics Lab I	MPH 105P1	100	0-0-4	General Physics Lab -III	MPH 205P1	100	0-0-4
General Physics Lab II	MPH 106P2	100	0-0-4	Scientific Computing Lab	MPH206P2	100	0-0-4
Total Credits			24	Total Credits			24

YEAR- II							
Semester- III	**Code No.**	**Marks**	**Credits (L-T-P)**	**Semester -IV**	**Code No.**	**Marks**	**Credits (L-T-P)**
Atomic and Molecular Physics	**MPH301**	**100**	**3-1-0**	**Nuclear Physics**	**MPH401**	**100**	**3-1-0**
Introduction to Astrophysics	**MPH302**	**100**	**3-1-0**	**Introduction to Nanotechnology**	**MPH402**	**100**	**3-1-0**
Statistical Mechanics	**MPH303**	**100**	**3-1-0**	**Environmental Physics**	**MPH403**	**100**	**3-1-0**
Specialization Paper I (Elective)	**MPH304**	**100**	**3-1-0**	**Specialization PaperII (Elective)**	**MPH404**	**100**	**3-1-0**
Specialization Paper Practical I	**MPH305P1**	**100**	**0-0-4**	**Specialization Paper Practical II**	**MPH405P1**	**100**	**0-0-4**
Dissertation- I	**MPH306P2**	**100**	**0-0-4**	**Dissertation-II**	**MPH 406P2**	**100**	**0-0-4**
Total Credits			**24**	**Total Credits**			**24**

TOTAL CREDITS FOR PG PROGRAM: 96

Specialization (Electives) (Any one of these)

1. **Elective –I Electronics**
2. **Elective -II Condensed Matter Physics**
3. **Elective –III Laser and Spectroscopy**

Year- Ist

Semester- I

Course: Classical Mechanics (Code: MPH101)

Here are the **Course Objectives** for **Classical Mechanics (Course Code: MPH101) – PG Level**:

1. **To develop a strong foundation in classical mechanics** by understanding the principles of Newtonian, Lagrangian, and Hamiltonian mechanics.
2. **To enhance problem-solving skills** by applying analytical and mathematical techniques to study the motion of particles, rigid bodies, and dynamical systems.
3. **To introduce advanced concepts such as central force motion, rigid body dynamics, and small oscillations**, which are essential for higher studies in physics.
4. **To familiarize students with variational principles and Hamiltonian formulations**, leading to a deeper understanding of modern physics, including quantum mechanics and statistical mechanics.
5. **To apply classical mechanics to real-world problems and interdisciplinary areas**, such as celestial mechanics, nonlinear dynamics, and chaos theory

Unit-I **(60 Lectures)**

System of particles: Center of mass, total angular momentum and total kinetic energies of a system of particles, conservation of linear momentum, energy and angular momentum.

Unit-II

Lagrangian Formulation: Constraints and their classification, degrees of freedom, generalized coordinates, virtual displacement, D'Alembert's principle, Simple applications of the Lagrangian formulation , Symmetries of space time: Cyclic coordinate, Conservation of linear momentum, angular momentum and energy.

Unit- III

Central forces: Reduction of two particle equations of motion to the equivalent one-body problem, reduced mass of the system, conservation theorems (First integrals of the motion),equations of motion for the orbit, classification of orbits, conditions for closed orbits, the Kepler problem (inverse square law force). Scattering in a central force field: general description of scattering, cross-section, impact parameter, Rutherford scattering,

Unit- IV

Hamiltonian formulation: Generalized momenta, canonical variables, Hamilton's equations of motion, Hamiltonian of a particle in a central force field, cyclic coordinates and conservation theorems, derivation of Hamilton's equations from variational principle.

Unit- V

Canonical transformation: Generating functions (four basic types), examples of canonical transformations, the harmonic oscillator in one dimension, Poisson brackets, equations of motion in terms of Poisson brackets, properties of Poisson brackets

Reference Books:

1. Classical mechanics, H Goldstein, C Poole, J Safco, III Edition, Pearson Edu
2. Classical mechanics, NC Rana and PS Joag, Tata McGraw-Hill, 1991.
3. Introduction to classical mechanics, Takwale and Puranik, Tata McGraw-Hill, 2006.
4. Classical mechanics, LD Landau and EM Lifshitz, 4th edition, Pergamon press, 1985.
5. Classical Mechanics by Gupta, Kumar& Sharma

Course Outcomes:

This course enables the students to comprehend:
CO1: The Lagrangian and Hamiltonian approaches in classical mechanics.
CO2: The classical background of Quantum mechanics and get familiarized with Poisson brackets and Hamilton -Jacobi equation.
CO3: Basic concepts in Variational principle and Principle of Least Actions
CO4: Central force problems, theory of small oscillations and its applications
CO5: Canonical Transformations and applications of Poisson's Brackets.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	1	1	2	3	3
CO2	3	3	2	2	2	1	1	2	3	3
CO3	3	3	2	2	2	1	1	2	2	3
CO4	3	3	2	2	2	1	1	2	3	3
CO5	3	3	2	2	2	1	1	2	3	3

Course: Mathematical Methods (MPH102)

Here are the **Course Objectives** for **Mathematical Methods (Course Code: MPH102) – PG Level**:

1. **To develop a strong mathematical foundation** required for advanced studies in theoretical and applied physics.
2. **To introduce essential mathematical techniques** such as vector calculus, complex analysis, differential equations, and special functions for solving physics problems.
3. **To familiarize students with linear algebra and tensor analysis**, which are crucial for understanding quantum mechanics, relativity, and field theories.
4. **To enhance problem-solving skills** by applying Fourier and Laplace transforms, integral equations, and Green's functions to physical systems.
5. **To provide computational and analytical tools** for tackling real-world problems in physics, engineering, and interdisciplinary research.

Unit I

Complex Analysis: Functions of complex variables, Analytic functions, Cauchy-Riemann conditions, Multivalued functions, Cauchy's theorem and Cauchy integral formula, Derivatives of analytic functions, Liouville theorem,

Unit-II

Taylor's Series, Laurent's Series , Maclaurin's Series

Unit - III

Fourier series, Fourier integrals, Fourier transform, Inverse Fourier transform, Parseval relations, Convolutions, Laplace Transform

Unit - IV

Matrices: Introduction of matrices through rotation of co-ordinate systems, Orthogonal, Hermitian, Unitary, Null and Unit matrices, Singular and Non-singular matrices, Inverse of a matrix, Trace of a matrix, Eigenvalues and Eigenvectors, Diagonalization. Green's Function

Unit - V

Group Theory: Definition and examples of physically important finite groups, Basic symmetry operations and their matrix representations, Multiplication table, Cyclic groups and subgroups,

Reference Books:

1. Mathematical Methods for Physicists, G.B.Arfken, H.J.Waber, E.E. Harris, 2013, 7th Edn., Elsevier.
2. Boas, M.L., "Mathematical Methods in Physical Sciences", Wiley International Editions.
3. Mathematical Physics : B.D.Gupta
4. Matrices and Tensors: A. W. Joshi
5. Mathematical Physics: Das and Sharma. 6. Mathematical Physics: A.K.Ghatak, I.C.Goyal& S.J. Chua.
6. Mathematical Physics by H.K. Dass

Course Outcomes:

The students studying this course will acquire:

CO1: Knowledge about complex variables and analytic functions

CO2: Concepts of useful theorem's , residues and integral theorems.

CO3: The skills of using Fourier transforms to simplify calculations and their physical significance

CO4: knowledge of matrices and its different properties to simplify calculations and also the idea of Group Theory.

CO5: Mathematical concepts that are widely used in various physics derivations in almost all courses of Physics.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	1	1	3	3	3
CO2	3	3	3	2	2	1	1	3	3	3
CO3	3	3	3	2	2	1	1	3	3	3
CO4	3	3	3	2	2	1	1	3	3	3
CO5	3	3	3	2	2	1	1	3	3	3

Course: Quantum Mechanics I (Code: MPH103)

Here are the **Course Objectives** for **Quantum Mechanics I (Course Code: MPH103)**

1. **To establish a fundamental understanding of quantum mechanics** by exploring the postulates, wave functions, and principles of quantum theory.
2. **To develop mathematical formulations of quantum mechanics**, including the Schrödinger equation, operator formalism, and Dirac notation.
3. **To analyze exactly solvable quantum systems**, such as the particle in a box, harmonic oscillator, and hydrogen atom, to understand their physical significance.
4. **To introduce angular momentum and spin concepts**, emphasizing their role in quantum mechanics and applications in atomic and nuclear physics.
5. **To provide a foundation for advanced quantum mechanics**, preparing students for topics like perturbation theory, quantum field theory, and quantum computation.

Unit-I

Introductory concepts: Wave-particle duality, interpretation of the wave function, Schrodinger equation,

Unit –II

Heisenberg uncertainty principle, operators and expectation values, Ehrenfest theorem, Expectation values

Unit- III

Time-independent Schrodinger equation, stationary states and their properties, energy quantization, properties of energy Eigen functions, general solution of the time dependent Schrodinger equation for a time independent potential.

Unit- IV

One-dimensional problems: Normalization, Eigen values and Eigen functions of particle in a) infinitely deep potential b) finite square well potential, and c) simple harmonic oscillator potential, potential barrier - transmission and reflection coefficients , rectangular potential box. Schrodinger equation in three dimensional box. Central potential, separation of variables in the Schrodinger equation, the radial equation, Hydrogen atom.

Unit-V

Angular momentum: Orbital angular momentum commutation relations, Eigen values and Eigen functions, General operator algebra of angular momentum operators Jx ,Jy , Jz . Ladder operators, eigen values and eigen state of J^2 and Jz , matrix representations of angular momentum operators, Pauli spin matrices, addition of angular momentum, Clebsch-Gordan coefficients for the case j1 = j2 =1/2.

Reference Books:

1. Quantum Mechanics : Concepts and Applications By Nouredine Zettili
2. Introduction to Quantum Mechanics, David J Griffiths, 2nd Edition, Pearson Prentice Hall, 2005.
3. Quantum Mechanics, LI Schiff, 3rd Edition, McGraw Hill Book Company, 1955.
4. Modern Quantum Mechanics, JJ Sakurai, Revised Edition, Addison-Wesley, 1995.
5. Quantum Mechanics by Ghatak & Loknathan,.

Course Outcomes:

After successful completion of this course, the student will be well-versed in:

CO1: Wave particle concepts and Schrodinger's Equation.

CO2: Both Schrödinger and Heisenberg formulations and their applications.

CO3: Applications of Time dependent and independent Schrodinger's equation.

CO4: Space-time symmetries and conservation laws, theory of identical particles.

CO5: Ladder operators and angular momentum operators, Theory of angular momentum and spin matrices, orbital angular momentum and Clebsh Gordan Coefficients.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	1	1	3	2	3
CO2	3	3	2	2	2	1	1	3	2	3
CO3	3	3	2	2	2	1	1	3	2	3
CO4	3	3	2	2	2	1	1	3	2	3
CO5	3	3	2	2	2	1	1	3	2	3

Course: Electronic Devices (Code: MPH104)

Here are the **Course Objectives** for **Electronic Devices (Course Code: MPH104)**

1. **To provide a fundamental understanding of semiconductor physics**, including charge carrier dynamics, energy bands, and transport mechanisms.
2. **To study the working principles of essential electronic devices**, such as diodes, transistors (BJT, FET, MOSFET), and optoelectronic components.
3. **To analyze the characteristics and applications of analog and digital electronic circuits**, including amplifiers, oscillators, and logic gates.
4. **To introduce advanced semiconductor devices**, such as power electronics, MEMS, and nanoelectronic components, for modern technological applications.
5. **To develop practical skills in designing and troubleshooting electronic circuits**, preparing students for research and industry applications in electronics and communication technology.

Unit-1

Transistors: BJT, FET, MOSFET, JFET: Structure, Working, Derivations of the equations for I-V characteristics under different conditions

Unit- 2

Microwave Devices: Tunnel Diode, Transfer Electron Devices (Gunn Diode)

Unit -3

Photonic Devices: Radiative and Non Radiative transitions , Optical Absorption, Photoconductive devices (LDR), diode photo detectors, solar cell (Open circuit voltage and short circuit current), LED : operation of LED, Diode Lasers, Optical gain and threshold current for lasing.

Unit- 4

Electro- optic , Magneto- optic and Acoustic – Optic Effects, Material Properties related to these effects, Piezoelectric, Electrostrictive and Magnetostrictive effects, important materials exhibiting these properties and their applications in sensor and actuator devices.

Unit -5

Satellite communication:Orbital satellites, geostationary satellites, orbital patterns, look angles, orbital spacing, satellite systems, Link modules

Reference Books:

1. Semiconductor Devices- Physics and Technology, S.M.Sze (Wiley)
2. Introduction to semiconductor Devices- M.S.Tyagi, John Wiley & Sons
3. Optical Electronics by Ajay Ghatak and K. Thyagarajan Cambridge Univ. Press
4. Microelectronics by Jacob Milman, McGraw Hill International Book Co, New Delhi, 1990
5. Advanced Electronics Communications Systems by Wayne Tomasi

COURSE OUTCOMES:

At the end of the course the student is expected to assimilate and have the conceptual knowledge of the following:
CO1: N and P- type semiconductors, mobility, drift velocity, fabrication of P-N junctions; forward and reverse biased junctions.
CO2: Application of PN junction for different type of rectifiers and voltage regulators.
CO3: NPN and PNP transistors and basic configurations current and voltage gain.
CO4: To characterize various devices namely PN junction diodes, LEDs, Zener diode, solar cells, photo diodes etc
CO5: PNP and NPN transistors. Acousto –optic , magneto- optic and electro-optic effects

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	1	3	2	3
CO2	3	2	2	2	3	1	1	3	2	3
CO3	3	2	2	2	3	1	1	3	2	3
CO4	3	2	2	2	3	1	1	3	2	3
CO5	3	2	2	2	3	1	1	3	2	3

Course- General Physics Lab I (Code: MPH105P1)

Course Objectives for **General Physics Lab I (Course Code: MPH104P I)**

1. **To provide hands-on experience with fundamental and advanced experimental techniques** in physics.
2. **To develop skills in data collection, analysis, and interpretation** using precise measurement tools and statistical methods.
3. **To reinforce theoretical concepts learned in coursework** by performing experiments in mechanics, optics, electromagnetism, and modern physics.
4. **To train students in the proper handling of laboratory instruments** and experimental error analysis to ensure accuracy and reliability.
5. **To enhance scientific communication skills** by preparing technical reports and presentations based on experimental findings.

Experiments -

1. Studies with Michelson's Interferometer.

(a) Determination of wavelength separation of sodium D-lines.

(b) Determination of thickness of mica sheet.

2. Studies of phenomena with polarized light:

(a) Verification of Brewster's law.

(b) Verification of Fresnel's law of reflection of plane polarized light.

(c) Analysis of elliptically polarized light using λ /4 plate and Babinet's compensator.

3. Verification of Rayleigh's criterion for the limit of resolution of spectral lines using

(a) Prism spectrum and

(b) Grating spectrum.

4. Young's modulus determination by optical method.

5. Experiments using He-Ne laser source:

(a) Determination of laser parameters.

(b) Measurement of the angle of a wedge plate using Haidinger fringes.

(c) Determination of grating pitch using phenomena of self-imaging.

(d) Determination of wavelength with a vernier callipers.

6. Experiment to study the applications of Newton's Ring Method.

Course Outcomes (COs)

- **CO1:** Demonstrate proficiency in using laboratory instruments and techniques for conducting experiments in classical and modern physics.
- **CO2:** Apply theoretical concepts from mechanics, optics, electromagnetism, and modern physics to analyze and interpret experimental data.
- **CO3:** Develop skills in data acquisition, statistical analysis, and error estimation to ensure precision and accuracy in experimental research.
- **CO4:** Work independently and collaboratively in a laboratory setting, following safety protocols and standard experimental procedures.
- **CO5:** Enhance scientific communication skills by preparing detailed lab reports and presenting experimental results effectively.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	2	1	3	3	3
CO2	3	3	3	2	3	2	1	3	3	3
CO3	3	3	3	2	3	2	1	3	3	3
CO4	3	3	3	2	3	2	1	3	3	3
CO5	3	3	3	2	3	2	1	3	3	3

Course- General Physics Lab II (Code: MPH106P2)

Course Objectives (COs) for General Physics Lab II (MPH106P)

1. **To provide hands-on experience in designing and analyzing electronic circuits** using semiconductor devices such as diodes, transistors, and operational amplifiers.
2. **To develop an understanding of analog and digital electronics** by performing experiments on rectifiers, amplifiers, oscillators, and logic gates.
3. **To enhance practical skills in circuit assembly, troubleshooting, and testing** using laboratory equipment like oscilloscopes, function generators, and multimeters.
4. **To apply theoretical concepts of electronics to real-world applications**, such as signal processing, communication circuits, and microcontroller-based systems.
5. **To improve data analysis, error estimation, and technical reporting skills**, ensuring accuracy in experimental results and effective scientific communication.

Experiments-

1. Network Analysis- Thevenin and Norton Equivalent circuits.
2. Basics Of PN Junction – Forward and Reverse Biasing, Significance of Fermi Level.
3. Zener Diode- Characteristics and Voltage Regulation
4. Transistor Characteristics and Biasing
5. Wein's Bridge and Phase shift
6. Solving Boolean expressions
7. Negative Feedback (Voltage series/shunt and current series /shunt)
8. A stable, monostable and bistable multivbrator
9. Characteristics and applications of silicon controlled rectifier.
10. To verify and design AND, OR, NOT and XOR gates using NAND gates.

Course Outcomes (COs)

- **CO1:** Demonstrate proficiency in handling and testing electronic components, circuits, and measuring instruments.
- **CO2:** Analyze the characteristics and functioning of semiconductor devices, including diodes, transistors, and operational amplifiers.
- **CO3:** Design and implement basic analog and digital circuits, such as rectifiers, amplifiers, oscillators, and logic circuits.

- **CO4:** Troubleshoot and optimize electronic circuits, applying systematic methods to identify and correct faults.
- **CO5:** Prepare technical reports and effectively communicate experimental findings, linking theoretical concepts with practical applications in electronics.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	2	1	3	3	3
CO2	3	3	3	2	3	2	1	3	3	3
CO3	3	3	3	2	3	2	1	3	3	3
CO4	3	3	3	2	3	2	1	3	3	3
CO5	3	3	3	2	3	2	1	3	3	3

Year - Ist

Semester - II

Course: Electromagnetic Theory (Code: MPH201)

Course Objectives for Electromagnetic Theory (MPH201)

1. **To develop a strong foundation in classical electromagnetism** by studying Maxwell's equations and their physical significance.
2. **To understand electrostatics and magnetostatics in different media** and apply boundary conditions to solve field equations.
3. **To analyze electromagnetic wave propagation** in free space, dielectrics, conductors, and waveguides.
4. **To explore the principles of radiation and electromagnetic interference**, including dipole radiation, antenna theory, and relativistic electrodynamics.
5. **To apply electromagnetic theory in real-world applications**, such as wireless communication, optical fibers, and plasma physics.

Unit-I

Electrostatics: Coulomb's law, Electric field, Gauss's law, applications of Gauss's law, Electric Potential, Poisson's equation and Laplace's equation, Work and energy in electrostatics, boundary conditions and uniqueness theorems

Unit- II

Magnetostatics: Biot-Savart Law, Divergence and Curl of B, Ampere's law and applications of Ampere's law, Magnetic vector potential, Multipole expansion of the vector potential.

Unit-III

Electrodynamics: Faraday's law, Energy in magnetic fields, Maxwell's equations, Maxwell's displacement current, Maxwell's equations and magnetic charge, Maxwell's equations inside matter, boundary conditions. Scalar and vector potentials, Gauge transformations, Coulomb and Lorentz Gauge; Lorentz force law in potential form, Energy and momentum in electrodynamics, Poynting's theorem Maxwell's stress tensor, Conservation of momentum.

Unit –IV

Electromagnetic waves: Electromagnetic waves in non-conducting media: Monochromatic plane waves in vacuum, propagation through linear media, Reflection and transmission at interfaces. Fresnel's laws;Electromagnetic waves in conductors: Modified wave equation, monochromatic plane waves in conducting media

Unit-V

Electromagnetic radiation: Retarded potentials, Electric dipole radiation, magnetic dipole radiation, Radiation from a point charge: Lienard-Wiechart potentials, fields of a point charge in motion, power radiated by a point charge

Reference Books:

1. Introduction to Electrodynamics, David J Griffiths, 2 nd Edition, Prentice Hall India, 1989.
2. Classical Electrodynamics, JD Jackson, 4 th Edition, John Wiley & Sons, 2005.
3. Electrodynamics, Gupta, Kumar, Singh, Pragati prakashan,18 th edition, 2010.

COURSE OUTCOMES (COs):

After successful completion of this course, the student is expected to :
CO1: Have grasped the idea of electrostatics and Magnetostatics along with time varying fields
CO2:.Have gained a clear understanding of Maxwell's equations.
CO3: Relate about the boundary conditions for various electric and magnetic field vectors.
CO4: Comprehend clearly the reflection and transmission of Electromagnetic waves and the Fresnel's Laws.
CO5: Have learnt about Electromagnetic potentials, Lienard Wiechart Potentials.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	1	1	3	2	3
CO2	3	3	2	3	2	1	1	3	2	3
CO3	3	3	2	3	3	1	1	3	2	3
CO4	3	3	2	3	3	1	1	3	2	3
CO5	3	3	2	3	3	1	1	3	2	3

Course: Solid State Physics (Code: MPH202)

Course Objectives for Solid State Physics (MPH202)

1. **To develop a fundamental understanding of crystal structure and bonding** in solids and their role in determining material properties.
2. **To study lattice dynamics and phonons** and their impact on the thermal properties of solids.
3. **To explore the electronic properties of materials** using band theory, free electron models, and semiconductor physics.
4. **To understand the magnetic, dielectric, and superconducting properties of materials** and their applications in modern technology.
5. **To apply solid-state physics concepts in material science and nanotechnology**, with relevance to device fabrication and industrial applications.

Unit-I

Scattering of x-rays, Laue conditions and Bragg's law, geometrical scattering structure and atmic scattering factor , Reciprocal lattice (Properties).

Unit-II

Free electron theory of metals: Free electron model, Electrical conductivity of metals, relaxation time and mean free path, electrical conductivity and Ohm's law, thermal conductivity, Wiedemann - Franz law, thermionic emission, Hall effect.

Unit-III

Semiconductors: Introduction to semiconductors, band structure of semiconductors, Intrinsic and extrinsic semiconductors, expression for carrier concentration (only for intrinsic), ionization energies, charge neutrality equation, conductivity-mobility and their temperature dependence, Hall effect in semiconductors.

Superconductors: Meissner effect- heat capacity-energy gap-Isotope effect- BCS theory (qualitative)-Josephson tunneling exotic superconductors- high T_c super conductors, AC and DC Josephson effect, London's theory.

Unit IV

Dielectrics: Introduction, Dielectric constant and displacement vector different kinds of polarization-local electric field-Lorentz field- Clausius - Mossotti equation relation- expressions for electronic, ionic and dipolar polarizability, Ferroelectricity and piezo electricity.

Unit – V

Magnetism: Review of basic formulae -classification of magnetic materials-Langevin theory of diamagnetism, para-magnetism and Ferromagnetism, domains-Weiss molecular field theory (classical)-Heisenberg exchange interaction theory-. Antiferro-magnetism and ferrimagnetism.Bloch, wall energy

Reference Books:

1. Solid State Physics, AJ Dekker, Macmillan India Ltd., Bangalore, 1981.
2. Solid State Physics, C Kittel, V Ed., Wiley Eastern Ltd., 1976.
3. Elementary Solid state physics, MA Omar, Addison Wesley, New Delhi, 2000.
4. Solid state Physics, SO Pillai. New Age International Publication, 2002.
5. Solid state Physics, MA Wahab, Narosa Publishing House, New Delhi, 1999.

COURSE OUTCOMES:

Learners after completion of this course will be able to:
CO1: Develop an understanding of the lattice, different types of crystal structures, symmetries, scattering of X-rays and Bragg's Law.
CO2: Gain insight about the free electron theory of metals, its thermal and electrical conductivity
CO3: Comprehend the concepts of energy bands and their origin, effect of superconductivity and their applications.
CO4: Relate with the understanding of dielectric and their properties.
CO5: Understand the concept of various types of magnetism and their classical and quantum explanation of its origin.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	1	1	3	3	3
CO2	3	2	3	2	3	1	1	3	3	3
CO3	3	2	3	2	3	1	1	3	3	3
CO4	3	2	3	2	3	1	1	3	3	3
CO5	3	2	3	2	3	1	1	3	3	3

Course: Scientific Computing (Code: MPH203)

Course Objectives for Scientific Computing (MPH203)

1. **To introduce fundamental numerical methods** for solving mathematical problems in physics, including differentiation, integration, and root-finding techniques.
2. **To develop programming skills in scientific computing languages** such as Python, MATLAB, or C++ for implementing numerical algorithms.
3. **To apply computational techniques to solve complex physical problems**, including differential equations, linear algebra, and Fourier analysis.
4. **To enhance data visualization and analysis skills** using computational tools for interpreting simulation and experimental results.
5. **To provide hands-on experience with simulations and modeling**, preparing students for research and industry applications in computational physics.

Unit – I

Introduction: Role of computers in physics; Numerical analysis, modeling and simulation; Flow charts; Introduction to computer programming in Python/C/C++,

Unit- II

Integer and Floating point arithmetic, Operators and Expressions, While, Do-While, For loops, Arrays and Strings, Functions, I/O with files. Programs:- (1) Roots of a Quadratic Equation, (2) Sum and Average of Numbers, (3) Sum, Difference and Product of Matrices, (4) Largest of Three Numbers, (5) Factorial of an Integer by Normal Method and by Recursion, (6) Largest of a List of Numbers and its Location in the List, (7) Fitting a Straight Line to a Data, (8) Deviations About an Average, (9) Arrange a List of Numbers in Ascending and Descending Order, (10) Binary Search

Unit – III

Solution of Algebraic and Transcendental Equations: (1) Fixed-Point Iteration Method, (2) Bisection Method, (3) Secant Method, (4) Newton-Raphson Method

Unit-IV

Matrices and Linear System of Equations: Solution of Linear Equations :(1) Gauss Elimination Method and (2) Gauss-Seidel Iterative Method, Eigenvalues and Eigenvectors :Computation of Eigenvalues and Eigenvectors of Matrices by using Iterative Methods.

Unit - V

Interpolation: Forward and Backward Differences. Symbolic Relation, Differences of a Polynomial, Newton' Forward and Backward Interpolation Formulas. Divided Differences.

Reference Books:

1. Numerical Methods in Engineering with Python by JaanKiusalaas, Cambridge University Press.
2. Mathews, J. H., Numerical Methods for Mathematics, Science and Engineering, Prentice-Hall, (2000).
3. Introduction to Numerical Analysis, S.S. Sastry, PHI Learning Pvt. Ltd.
4. Schaum's Outline of Programming with C++., J. Hubbard, MCGraw-Hill Pub.
5. Numerical Methods for Scientists & Engineers, R.W. Hamming, Courier Dover Pub.
6. Scilab (A free Software to Matlab): H.Ramchandran, A.S. Nair. 2011, S.Chand& Company.

COURSE OUTCOMES:

The students will have understanding of:

CO1: C++ programming/ Scilab

CO2: Various operations and expressions relating to basic Arithmetics.

CO3: Solutions of algebraic and transcendental equations

CO4: Solutions of Linear Equations by various matrix and other methods.

CO5: Different interpolation and difference techniques utilized in programming

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	1	1	2	3	3
CO2	3	3	3	2	2	1	1	2	3	3
CO3	3	3	3	2	2	1	1	2	3	3
CO4	3	3	3	2	2	1	1	2	3	3
CO5	3	3	3	2	2	1	1	2	3	3

Course: Quantum Mechanics-II (Code: MPH204)

Course Objectives for Quantum Mechanics-II (MPH204)

1. **To deepen the understanding of quantum mechanics** by exploring advanced topics such as approximation methods and scattering theory.
2. **To introduce time-independent and time-dependent perturbation theory**, with applications in atomic and molecular physics.
3. **To study scattering theory and its applications**, including partial wave analysis and the Born approximation.
4. **To explore relativistic quantum mechanics**, covering the Klein-Gordon and Dirac equations for relativistic particles.
5. **To provide a foundation for quantum field theory and modern applications**, such as quantum computing and condensed matter physics.

Unit-I

Approximation Methods for stationary problems: Time independent perturbation theory, Time independent perturbation theory for i) non-degenerate and ii) degenerate energy levels, applications: one dimensional harmonic oscillator subjected to a perturbing potential in x and x^2, the fine structure of the hydrogen atom and Zeeman effect.

Unit –II

Approximation Methods for time dependent problems: Time dependent perturbation theory: Approximate solution of the Schrodinger equation with time dependent Hamiltonian,

Unit- III

WKB approximation and variational method, Born approximation, scattering by a spherically symmetric potential, Fermi Golden Rule.

Unit-IV

Symmetry Principles and Conservation Laws: Continuous symmetries: Spatial translation symmetry and conservation of linear momentum, time translation symmetry and conservation inenergy, Rotations in Space: Conservation of angular momentum scattering of identical particles, Three dimensional problems: Spin 1/2 particles in a box - The Fermi gas.

Unit-V

Relativistic quantum mechanics: Klein-Gordon equation for a free relativistic particle, Properties of Dirac Matrices, Plane wave solutions of Dirac equations, Spin and Magnetic Moment of an electron, Nonrelativistic reduction of Dirac equation

References Books:

1. Introduction to Quantum Mechanics, David J Griffiths, 2nd Edition, Pearson Prentice Hall, 2005.
2. Quantum Mechanics, VK Thankappan, 2nd Edition, Wiley Eastern Limited, 1993.
3. Quantum Mechanics Vol I & II, C Cohen Tannoudji, B Diu and F Laloe, 2nd Edition, Wiley Interscience Publication, 1977.
4. Quantum Mechanics, LI Schiff, 3 rd Edition, McGraw Hill Book Company, 1955

COURSE OUTCOMES

After successful completion of this course, the learners will have a conceptual understanding of:

CO1: Approximate methods for solving stationary and time dependent problems by Time independent & dependent Perturbation Theory.

CO2: Variational Method and WKB Method.

CO3: Born approximation and scattering and Fermi Golden Rule

CO4: Various symmetry principles and conservation laws.

CO5: Relativistic Quantum Mechanics and Klein Gordon Equation

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	1	1	3	2	3
CO2	3	3	2	2	2	1	1	3	2	3
CO3	3	3	2	2	2	1	1	3	2	3
CO4	3	3	2	2	2	1	1	3	2	3
CO5	3	3	2	2	2	1	1	3	2	3

Course: Physics Lab III (Code: MPH205P1)

Course Objectives for Physics Lab III (MPH205P1)

1. **To provide hands-on experience with advanced experimental techniques** in physics, covering optics, electromagnetism, and modern physics.
2. **To develop precision in measurement and data analysis** using sophisticated laboratory instruments.
3. **To reinforce theoretical concepts** by performing experiments that demonstrate key principles of quantum mechanics, spectroscopy, and material science.
4. **To enhance problem-solving and critical-thinking skills** by designing, conducting, and troubleshooting experiments.
5. **To improve scientific communication skills** through detailed lab reports and presentations of experimental findings.

Experiments-

1. 'e/m' measurement by Braun's tube and by Magnetron valve method.
2. 'e' measurement by Millikan oil drop apparatus.
3. Characterization of Photo –resister.
4. Determine the plateau characteristics of the given GM counter.
5. Verification of Inverse Square Law for Gamma-rays.
6. To measure the absorption coefficient of gamma rays in Aluminum or Copper.
7. To plot the Gaussian or normal distribution curve for background radiation.
8. Determination of dead time of the GM Counter.

Course Outcomes

After successful completion of the course students will be able to-

- **CO1:** Perform advanced experiments in optics, electromagnetism, and modern physics using high-precision instruments.
- **CO2:** Analyze and interpret experimental data, applying statistical and error analysis techniques.
- **CO3:** Relate experimental results to theoretical physics concepts, demonstrating a deeper understanding of fundamental principles.

- **CO4:** Develop troubleshooting skills to identify and resolve experimental challenges effectively.
- **CO5:** Communicate scientific findings effectively through structured lab reports and presentations.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	2	1	3	3	3
CO2	3	3	3	2	3	2	1	3	3	3
CO3	3	3	3	2	3	2	1	3	3	3
CO4	3	3	3	2	3	2	1	3	3	3
CO5	3	3	3	2	3	3	1	3	3	3

Course: Scientific Computing Lab (Code: MPH206P2)

Course Objectives for Scientific Computing Lab (MPH206P2)

1. **To provide hands-on experience in implementing numerical methods** using programming languages such as Python, MATLAB, or C++.
2. **To develop computational problem-solving skills** by applying numerical techniques to real-world physics problems.
3. **To enhance proficiency in data analysis and visualization** using computational tools for interpreting simulation results.
4. **To train students in debugging and optimizing code** for efficient and accurate scientific computations.
5. **To prepare students for research and industry applications** by developing skills in simulation, modeling, and algorithm development.

Sample Programming -

1. To evaluate a Polynomial:-

(1) Converting Temperature from Fahrenheit to Celsius,

(2) Area of a Circle

(3) Volume of Sphere etc.

2. To find the Roots of a Quadratic Equation: Real and Distinct, Repeated and Imaginary.

3. To locate a Number in a Given List (linear search).

4. (i) To find the Largest of Three Numbers. (ii) To find the Largest Number in a Given List of Numbers.

5. (i) To check whether a Given Number is a Prime Number. (ii) To calculate the first 100 prime numbers.

6. To rearrange a List of Numbers in Ascending and Descending Order.

7. (i) To calculate Factorial of a Number. (ii) To calculate the first few Factorials.

8. Manipulation of Matrices

(i) To Add and Subtract two Matrices.

(ii) To Multiply two Matrices.

Course Outcomes (COs) for Scientific Computing Lab (MPH206P2)

- **CO1:** Implement numerical methods such as root-finding, differentiation, integration, and solving differential equations using programming languages like Python, MATLAB, or C++.
- **CO2:** Apply computational techniques to solve real-world physics problems, including simulations and data-driven analysis.
- **CO3:** Develop skills in data visualization and interpretation using graphs, plots, and statistical tools.
- **CO4:** Debug, optimize, and enhance code efficiency for accurate and reliable scientific computations.
- **CO5:** Gain practical experience in scientific computing, preparing for research and industry applications in computational physics and engineering.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	2	1	3	3	3
CO2	3	3	3	2	3	2	1	3	3	3
CO3	3	3	3	2	3	2	1	3	3	3
CO4	3	3	3	2	3	2	1	3	3	3
CO5	3	3	3	2	3	2	1	3	3	3

Year - IInd

Semester- III

Course: Atomic and Molecular Physics (Code: MPH301)

Course Objectives for Atomic and Molecular Physics (MPH301)

1. **To develop a fundamental understanding of atomic structure**, quantum states, and spectra based on quantum mechanics principles.
2. **To study the interaction of electromagnetic radiation with atoms and molecules**, including selection rules and transition probabilities.
3. **To explore molecular bonding and spectroscopy**, including rotational, vibrational, and electronic spectra of diatomic and polyatomic molecules.
4. **To introduce advanced concepts such as fine structure, hyperfine structure, and Zeeman & Stark effects** in atomic and molecular systems.
5. **To provide applications of atomic and molecular physics** in astrophysics, laser technology, and material characterization techniques.

Unit –I

Atomic Spectra: Space quantization, Relation between angular momentum and magnetic moment, Bohr magnetron. Fine structure of spectral lines, Term symbols of alkali and alkaline earth atoms. LS and JJ coupling

Unit- II

Quantum theory of Zeeman effect (normal and anamolous), Paschen-Back effect, Stark effect (linear and non-linear). Hyperfine structure of spectral lines, X-ray spectra characteristics and absorption.

Unit- III

Electronic states and electronic transitions in diatomic molecules, Frank Condon principle, Raman Spectra

Unit- IV

Types of Molecular Spectra, Pure Rotational Spectra, Vibrational –Rotational Spectra.

Unit-V

Laser and Holography: Spontaneous and stimulated emission, Einstein A and B coefficients, Basic Principles of Laser, Population Inversion-Two level and Three level Laser system, The CO_2 Laser, Semi-conductor Laser, Principle of Holography,

Reference Books:

1. Atomic and molecular Physics by Rajkumar.
2. Atomic and Molecular Physics by Gupta and Sharma
3. Elements of Spectroscopy: Gupta, Kumar and Sharma, Pragati Prakashan.
4. Fundamentals of Molecular Spectroscopy: Colin and Elaine, TMH.
5. Laser and Non-linear Optics: B.B. Laud, New Age Publications.

COURSE OUTCOMES (COs):

After successful completion of the course, the learner is expected to :

CO1: Know about different atom models and will be able to differentiate different atomic systems, different coupling schemes and their interactions with magnetic and electric fields.

CO2: Have gained ability to apply the techniques of Zeeman effect, Stark effect and Paschen Back effect to elucidate the structure of molecules.

CO3: Be able to apply the principle of Raman spectroscopy and its applications in the different field of science & Technology.

CO4: To become familiar with different resonance spectroscopic techniques and its applications.

CO5: To understand the working of Lasers and Holographic systems.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	3	1	1	3	3	3
CO2	3	2	2	3	3	1	1	3	3	3
CO3	3	2	2	3	3	1	1	3	3	3
CO4	3	2	2	3	3	1	1	3	3	3
CO5	3	2	2	3	3	1	1	3	3	3

Course: Introduction to Astrophysics (Code: MPH302)

Course Objectives for Introduction to Astrophysics (MPH302)

1. **To introduce fundamental concepts of astrophysics**, including celestial mechanics, stellar structure, and galactic dynamics.
2. **To study the physical properties and life cycles of stars**, including nuclear fusion, stellar evolution, and end stages such as white dwarfs, neutron stars, and black holes.
3. **To explore the structure and dynamics of galaxies and the universe**, covering dark matter, cosmology, and the Big Bang theory.
4. **To understand observational techniques in astrophysics**, including telescopes, spectroscopy, and modern space-based observations.
5. **To apply physics principles to astrophysical phenomena**, preparing students for further research in cosmology, space science, and observational astronomy.

Unit- I

Sky coordinates and motions: Earth Rotation - Sky coordinates - seasons - phases of the Moon - the Moon's orbit and eclipses

Unit –II

Planetary motions: Kepler's Laws - Gravity; Light & Energy - Telescopes - Optics - Detectors;

Unit- III

Galaxies: Our Milky Way - Galactic structure - Galactic rotation - Galaxy types - Galaxy formation

Unit- IV

Planets: Formation of Solar System - planet types - planet atmospheres - extrasolar planets; Stars, Black Holes

Unit -V

Expansion of the Universe, redshifts, Supernovae, the Big Bang - history of the Universe, fate of the Universe.

Reference Books:

1. COSMOS by Carl Sagan
2. Black Holes: The Reith Lectures by Stephen Hawking
3. Astrophysics for People in a Hurry by Neil deGrasse Tyson

4. An Introduction to Astrophysics by Basu
5. Space Encyclopedia: A Tour of Our Solar System and Beyond by NAT GEO
6. An Introduction to Modern Astrophysics, BW Carroll & DA OstlieLatest Edition, Addison-Wesley.
7. Frank Shu, The Physical Universe, Latest Edition, University Science Books
8. Martin Harwit, Astrophysical Concepts, Latest Edition, Springer.
9. T. Padmanabhan, Invitation to Astrophysics, Latest Edition, World Scientific Publishing

COURSE OUTCOMES:

The learners covering this course will be able to:

- **CO1: Acquire knowledge of the Physical Universe and its evolution.**
- **CO2: Define fundamental principles and techniques of Astrophysics.**
- **CO3: Attain the knowledge of evolution, classification, formation of stars, planets, satellites, Black holes, solar systems etc.**
- **CO4: Familiarize with the structure and population of Milky Way galaxy, properties of galaxy and its classification.**
- **CO5: Understand red shifts, white dwarfs & neutrons dwarfs**

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	2	1	1	3	3	3
CO2	3	2	2	3	2	1	1	3	3	3
CO3	3	2	2	3	2	1	1	3	3	3
CO4	3	2	2	3	2	1	1	3	3	3
CO5	3	2	2	3	2	1	1	3	3	3

NETAJI SUBHAS UNIVERSITY JAMSHEDPUR

Course: Statistical Mechanics (Code: MPH303)

Course Objectives for Statistical Mechanics (MPH303)

1. **To develop a fundamental understanding of statistical methods** and their applications in describing macroscopic systems using microscopic principles.
2. **To introduce classical and quantum statistical distributions**, including Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics.
3. **To study the principles of ensemble theory**, including microcanonical, canonical, and grand canonical ensembles, and their applications in thermodynamic systems.
4. **To explore phase transitions and critical phenomena**, understanding concepts like order parameters, correlation functions, and mean-field theory.
5. **To apply statistical mechanics to real-world problems**, including applications in condensed matter physics, astrophysics, and biological systems.

Unit-I

Classical statistical description of system of particles: Specification of the state of a classical system, Phase space, Statistical ensemble, Basic postulates, Probability calculations, Behaviour of density of states, Statistical Equilibrium, Liouville theorem, Microcanonical, canonical, grand canonical ensembles.

Unit-II

Partition function of ideal gas and their properties, Calculation of thermodynamic quantities of ideal monoatomic gas, Gibbs' paradox, Equipartition theorem

Unit-III

Quantum statistical mechanics: Basic concepts – Quantum ideal gas, Identical particles and symmetry requirements, Bose - Einstein statistics, Ideal Bose gas, black body radiation, Virial equation of state, Virial coefficients in classical limits.

Unit -IV

Bose - Einstein condensation, Evaluation of α and β and it's thermodynamical interpretation, Thermal properties of Bose-Einstein gas and liquid He, The Lambda transition, two fluid model, Pauli paramagnetism, electronic specific heat, Quantum statistics in the classical limit.

Unit-V

Irreversible processes and fluctuations: Random walk in one dimension, Brownian motion, Langevin equation, Ising Model, Bragg-Wiliams Approximation, White Dwarf, Chandrasekhar's Limit.

Reference Books:

1. Fundamentals of Statistical and Thermal Physics, F Reif, First Indian Edition, Levant Books, 2010.
2. Statistical Mechanics, K Huang, Wiley Eastern Limited, New Delhi, 1963.
8. Statistical Mechanics, RK Pathria and PD Beale,3rd Edition, Academic Press (Oxford), 2011.
9. Introduction to Statistical Physics, Silvio R A Salinas, Springer, 2001.
10. Fundamentals of Statistical Mechanics, BB Laud, 5 th Edition, New Age International Publication

COURSE OUTCOMES:

The students will be able to:

- **CO1: Explain statistical physics and thermodynamics as logical consequences of the postulates of statistical mechanics.**
- **CO2: Apply the principles of statistical mechanics to selected problems.**
- **CO3: Grasp the basis of ensemble approach in statistical mechanics to a range of situations.**
- **CO4: To learn the fundamental differences between classical and quantum statistics and learn about quantum statistical distribution laws.**
- **CO5: Study important examples of ideal Bose systems and Fermi systems**

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	P1O7	PO8	PO9	PO10
CO1	3	2	2	2	2	1	1	3	3	3
CO2	3	2	2	2	2	1	1	3	3	3
CO3	3	2	2	2	2	1	1	3	3	3
CO4	3	2	2	2	2	1	1	3	3	3
CO5	3	2	2	2	2	1	1	3	3	3

SYLLABUS FOR SPECIALIZATION

Code: MPH304 (One to be selected from the three electives)

Paper: ELECTRONICS (ELECTIVE -I)

Course Objectives for Electronics (Elective-I)

1. **To provide a fundamental understanding of semiconductor electronics**, including the physics of diodes, transistors, and integrated circuits.
2. **To study the design and analysis of analog and digital circuits**, including amplifiers, oscillators, and logic gates.
3. **To introduce microprocessors and microcontrollers**, emphasizing their architecture, programming, and applications in automation and embedded systems.
4. **To explore advanced electronic devices and communication systems**, such as optoelectronics, sensors, and wireless communication technologies.
5. **To develop hands-on skills in circuit design, simulation, and troubleshooting**, preparing students for research and industry applications in electronics and embedded systems.

Unit- I

Physics of devices: Calculation of carrier concentration in intrinsic semiconductors; Calculation of carrier concentration in extrinsic semiconductors; Fermi energy level; electrical conductivity; p-n junction; abrupt junction; band structure; Calculation of junction voltage; variation of electric field across the junction; expression for width of the depletion region; expression for junction capacitance; diffusion and drift currents; equilibrium current calculation.

Unit-II

Forward and reverse bias of the diode; current relations under non equilibrium; Derivation of diode equation; V-I characteristics of diode; Junction field effect transistor; band structure; construction and working principle; current – voltage characteristics; Depletion and Enhancement mode MOSFET: Principle and working; calculation of threshold voltage; V-I characteristics.

Unit -III

Operational amplifiers: Operational amplifier as open loop amplifier - Limitations of open loop configuration – Operational amplifier as a feedback amplifier: closed loop gain, input impedance, output impedance of inverting and non-inverting amplifiers - Voltage follower - Differential amplifier: voltage gain. Linear applications – Phase and frequency response of low pass, high pass and band pass filters (first order), summing amplifier – inverting and non-inverting configurations, subtractor, difference summing amplifier, Differentiator, Integrator

Unit –IV

Simplification using Karnaugh Map technique (6 variables) Flip flops: Latch using NAND and NOR gates- RS flip flop, clocked RS flip flop, JK flip flop, JK master slave flip flop - racing – Shift Registers basics - Counters: Ripple / asynchronous counters truth table-timing diagram, Synchronous counters-truth table-timing diagram, Decade counter. Digital to Analog converters, ladder and weighted resistor types. Analog to digital Converters-counter method, successive approximation and dual slope converter.

Unit-V

BJT Logic Families: TTL logic NAND gate circuit, ECL logic OR/NOR gate circuit, analysis and evaluation of logic parameters. MOS Logic Families: NMOS inverter circuit and its analysis with linear and non-linear loads, CMOS inverter.

Reference Books:

1. Semiconductor Devices Physics and Technology, SM Sze, 3 rd Edition, John Wiley and Sons Inc. Asia, 2006.
2. Solid State Electronic Devices, Ben G Streetman, Sanjay Bannerjee, 7 th edition, Pearson, Asia, 2014.
3. Electronic Principles, AP Malvino and J Bates, Eighth Edition, Tata McGraw Hill, Delhi, 2016.
4. Op-Amps and Linear Integrated Circuits, RA Gayakwad, 4 th Edition, Eastern Economy Edition, 2004.
5. Digital principles and applications, DP Leach and AP Malvino, 5 th Edition, Tata McGraw Hill, 2002.
6. Millman&Brabel, "Microelectronics", McGraw-Hill (International Students' Edition).
7. Gayakwad, "Op-Amps and Linear Integrated Circuits",3/e, Prentice-Hall of India
8. Sedra& Smith, "Microelectronic Circuits", 3/e, Sounders College Publishing.

COURSE OUTCOMES:

This specialization course will help the learners to assimilate and comprehend:

- **CO1: Physics of Semiconductor devices and their working principle.**
- **CO2: Working principle of Diodes, transistors and MOSFET**
- **CO3: Detailed operation of OP-AMP and their applications**
- **CO4: Simplification using Karnaugh Map technique (6 variables) and Flip flops**
- **CO5: BJT Logic Families and evaluation of logic parameters.**

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	3	1	1	3	3	3
CO2	3	2	2	3	3	1	1	3	3	3
CO3	3	2	2	3	3	1	1	3	3	3
CO4	3	2	2	3	3	1	1	3	3	3
CO5	3	2	2	3	3	1	1	3	3	3

TO BE SELECTED ACCORDING TO CORRESPONDING SPECIALIZATION THEORY

Practical: Electronics Lab-I (Elective) (Code: MPH305P1)

Course Objectives for Electronics Lab-I (Elective) (MPH305P1)

1. **To provide hands-on experience in designing and analyzing electronic circuits** using semiconductor devices such as diodes, transistors, and operational amplifiers.
2. **To develop practical skills in assembling, testing, and troubleshooting analog and digital circuits** including amplifiers, oscillators, and logic circuits.
3. **To familiarize students with the use of laboratory instruments** such as oscilloscopes, function generators, and multimeters for circuit analysis.
4. **To introduce microcontroller and microprocessor-based experiments**, enhancing understanding of embedded system applications.
5. **To strengthen technical documentation and reporting skills**, ensuring accurate recording and analysis of experimental results.

Experiments

1. p-n junction diodes-clipping and clamping circuits.
2. FET – characteristics, biasing and its applications as an amplifier
3. MOSFET – characteristics, biasing and its applications as an amplifier.
4. UJT – characteristics and its application as a relaxation oscillator.
5. SCR – Characteristics and its application as a switching device.
6. Filters-passive and active, all pass (phase shifters)
7. Power supply-regulation and stabilization
8. Oscillator-design and study
9. Multi stage and tuned amplifiers
10. Multivibrators-astable, monostable and bistable with applications
11. Design and study of a triangular wave generator
12. A/D and D/A converters

Course Outcomes for Electronics Lab-I (Elective) (MPH305P1)

- **CO1:** Demonstrate proficiency in handling and testing electronic components and circuits.
- **CO2:** Analyze the characteristics and functioning of semiconductor devices, including diodes, transistors, and operational amplifiers.
- **CO3:** Design and implement analog and digital circuits, such as amplifiers, oscillators, and logic circuits.
- **CO4:** Utilize laboratory instruments effectively for signal measurement, troubleshooting, and circuit analysis.
- **CO5:** Prepare well-structured lab reports and effectively communicate experimental findings, linking theoretical concepts with practical applications.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	1	3	3	3
CO2	3	3	3	2	3	3	1	3	3	3
CO3	3	3	3	2	3	3	1	3	3	3
CO4	3	3	3	2	3	3	1	3	3	3
CO5	3	3	3	2	3	3	1	3	3	3

Course: Elective II:
Condensed Matter Physics-I (Specialization) (Code: MPH304)

Course Objectives for Condensed Matter Physics-I (Specialization) (MPH304)

1. **To develop a deep understanding of crystal structures and bonding mechanisms** in solids, including lattice dynamics and phonon interactions.
2. **To explore electronic properties of materials**, such as band theory, electrical conductivity, and semiconductor physics.
3. **To study magnetic, dielectric, and optical properties of materials**, with applications in modern technology and device fabrication.
4. **To introduce phase transitions and critical phenomena**, including the role of symmetry, order parameters, and statistical mechanics approaches.
5. **To provide exposure to experimental and computational techniques** used in condensed matter research, preparing students for advanced studies and industrial applications.

Unit-I

Inter-atomic forces and bonding in solids: Forces between atoms, binding energy, cohesion of atoms and cohesive energy, calculation of cohesive energy, bond energy of NaCl molecule, calculation of lattice energy of ionic crystals, calculation of Madelung constant of ionic crystals.

Unit-II

Diffusion in solids: Fick's law of diffusion, determination of diffusion coefficients, diffusion couple, applications based on second law of diffusion, atomic model of diffusion-electrical conductivity of ionic crystals.

Unit-III

Lattice vibrations and phonons: Wave motion of one dimensional atomic lattice, lattice with two atoms with primitive cell, Some facts about diatomic lattice, number of possible normal modes of vibrations in a band, phonons, momentum of phonons

Unit-IV

Thermal properties: Classical calculations of lattice specific heat, Einstein theory of specific heats, Debye's model of lattice specific heat, Debye approximation, An-harmonic crystal interactions, thermal expansion, lattice thermal conductivity of solids- Umklapp process.

Unit- V

Imperfections in crystals: Classification of imperfections, crystallographic imperfections, point defects, concentrations of Schottky and Frenkel defects, line defects, edge dislocations, screw dislocation.

Reference Books:

1. Solid State Physics, A.J. Dekker, MacmillanIndia Ltd, Bangalore, 1981.
2. Solid State Physics, C Kittel, V Ed, Wiley Eastern Ltd, 1976.
3. Elementary Solid state physics,M. A Omar, Addison Wesley, New Delhi, 2000.
4. Solid State Physics, SO Pillai,New Age International Publication, 2002.
5. Solid State Physics, MA Wahab, Narosa Publishing House, New Delhi.

Course Outcomes for Condensed Matter Physics-I (Specialization) (MPH304)

- **CO1:** Explain the fundamental concepts of crystal structures, bonding mechanisms, and lattice dynamics in solid materials.
- **CO2:** Analyze the electronic properties of materials using band theory, Fermi surfaces, and charge transport mechanisms.
- **CO3:** Describe the magnetic, dielectric, and optical properties of materials and their applications in modern technology.
- **CO4:** Understand phase transitions and critical phenomena, applying statistical mechanics principles to condensed matter systems.
- **CO5:** Utilize experimental and computational techniques for investigating the physical properties of condensed matter systems.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	3	1	1	3	3	3
CO2	3	2	3	3	3	1	1	3	3	3
CO3	3	2	3	3	3	1	1	3	3	3
CO4	3	2	3	3	3	1	1	3	3	3
CO5	3	2	3	3	3	1	1	3	3	3

Practical : Condensed Matter Physics Lab-I (Elective)
(Code: MPH305P1)

Course Objectives for Condensed Matter Physics Lab-I (Elective) (MPH305P1)

1. **To provide hands-on experience in experimental techniques** used for studying the structural, electrical, magnetic, and thermal properties of condensed matter systems.
2. **To familiarize students with characterization methods** such as X-ray diffraction (XRD), electrical resistivity measurements, and Hall effect studies.
3. **To analyze phase transitions and critical phenomena** through experimental observation of material properties under different conditions.
4. **To develop skills in data acquisition, analysis, and interpretation** using computational tools and software for condensed matter research.
5. **To prepare students for research and industry applications** by enhancing their ability to design, conduct, and report scientific experiments.

1. Analysis of X-ray powder photographs (NaCl, KCl, Cu)

2. Analysis of single crystal rotation photograph (NaCl)

3. Analysis of a backscattering of powder photograph of copper

4. Estimation of R-factor using X-ray diffractogram.

5. Calibration of electromagnet and magnetic susceptibility determination of magnetic salts

($MnSO_4$, $MnCl_2$) by Quincke's method

6. Experiments with pn-junction

(a) Determination of n, E_g and dV/dt of PN -junction material

(b) Determination of junction capacitance

7. Determination of Curie temp for a ferromagnetic material (Ni-Fe alloy)

8. Study of B-H curve of a Ferromagnetic material (both hard and soft).

9. Electrical resistivity of semiconducting Ge sample using four probe method.

Course Outcomes for Condensed Matter Physics Lab-I (Elective) (MPH305P1)

- **CO1:** Perform experiments to study the structural, electrical, magnetic, and thermal properties of materials.
- **CO2:** Utilize advanced characterization techniques such as XRD, resistivity measurements, and optical analysis for material investigation.
- **CO3:** Analyze phase transitions and critical behavior in condensed matter systems through experimental observations.
- **CO4:** Apply computational tools for data analysis, modeling, and interpretation of experimental results.
- **CO5:** Develop skills in scientific documentation and communication by preparing detailed lab reports and presentations.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	1	1	3	3	3
CO2	3	3	3	3	3	1	1	3	3	3
CO3	3	3	3	3	3	1	1	3	3	3
CO4	3	3	3	3	3	1	1	3	3	3
CO5	3	3	3	3	3	1	1	3	3	3

Elective III- Laser and Spectroscopy – I (Specialization) (Code: MPH304)

Course Objectives for Laser and Spectroscopy – I (Specialization) (MPH304)

1. **To introduce the fundamental principles of lasers**, including spontaneous and stimulated emission, population inversion, and optical amplification.
2. **To study different types of lasers**, such as gas lasers, solid-state lasers, semiconductor lasers, and their working mechanisms.
3. **To explore laser applications in scientific and industrial fields**, including holography, optical communication, and medical diagnostics.
4. **To develop an understanding of spectroscopic techniques**, such as rotational, vibrational, and electronic spectroscopy, for material characterization.
5. **To analyze the interaction of light with matter**, including Raman and fluorescence spectroscopy, and their applications in research and technology.

Unit – I

Interaction of Matter with radiation: Interaction of electromagnetic radiation with matter, Einstein coefficients (2 level system interacting with radiation) Beer's law- attenuation and amplification of light.

Unit - II

Molecular symmetry: Review of definition and properties of a Group. Molecular symmetry elements and symmetry operations, Matrix representation of symmetry operations, geometric transformations.Reducible and Irreducible representation for simple molecules such as NH_3 and H_2O.

Unit-III

Spin resonance spectroscopy-A: Basic principles of NMR, absorption and resonance condition, Relaxation processes: concepts of spin-lattice relaxation and spin-spin relaxation, Line broadening and dipolar interaction, MASS experiment, chemical shift, spin-spin coupling.

Unit-IV

Spin resonance spectroscopy :Electron spin and magnetic moment, Basic concepts of ESR, characteristics of g-factor and its anisotropy, nuclear hyperfine interaction, Spin Hamiltonian, ESR of organic and inorganic radicals: equivalent and non-equivalent sets of nuclei, experimentaltechnique and ESR spectrometer (Block diagram level).

Unit-V

Basic principles of NQR, nuclear quadrupole interaction, fundamental requirements of NQR. Electron Nuclear Double Resonance (ENDOR)-General treatment of an ENDOR experiment in a system with $s = 1/2$ and $I = 1/2$. Advantages of ENDOR over ESR

Reference Books:

1. Physics of atoms and molecules, Bransden and Joachain, 2nd Edition, Pearson Education,
2. Fundamentals of Molecular Spectroscopy, BanwellandMcCash, Tata McGraw Hill
3. Modern Spectroscopy, JM Hollas, John Wiley, 1998.
4. Introduction to Magnetic Resonance Spectroscopy: ESR, NMER, NQR, 2 nd Edition, DN Sathyanarayana, IK International Publishing House Ltd, 2014.

COURSE OUTCOMES:

The learners of this course will be able to develop an understanding of :

CO1: Interaction of Matter with radiation , attenuation and amplification of light
CO2: Molecular symmetry elements and symmetry operations.
CO3: Spin resonance spectroscopy and Basic principles of NMR
CO4: Basic concepts of ESR, characteristics of g-factor and its anisotropy.
CO5: Nuclear quadrupole interaction, fundamental requirements of NQR

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	1	3	2	3
CO2	3	2	2	2	2	1	1	3	2	3
CO3	3	2	2	2	2	1	1	3	2	3
CO4	3	2	2	2	2	1	1	3	2	3
CO5	3	2	2	2	2	1	1	3	2	3

Practical : Spectroscopy & Laser I (Elective)
(Code: MPH305P1)

Course Objectives for Spectroscopy & Laser I (Elective) (MPH305P1)

1. **To provide hands-on experience in laser operation and spectroscopy techniques**, including absorption, emission, and Raman spectroscopy.
2. **To study the characteristics of different types of lasers**, such as He-Ne, diode, and Nd:YAG lasers, and their applications.
3. **To explore the interaction of light with matter** by conducting experiments on fluorescence, Raman scattering, and optical absorption.
4. **To develop skills in using spectrometers and detectors** for precise measurement and analysis of spectral lines.
5. **To enhance data acquisition, analysis, and interpretation abilities**, preparing students for research and industrial applications in optics and photonics.

Experiments-

1. Determination of g-factor for standard ESR sample using portable ESR spectrometer
2. Ion trap (q/m determination) quadrupole AC trap
3. CCD spectrometer to record absorption bands of Iodine molecule
4. CCD spectrometer to record band spectrum of AlO
5. Analysis of band spectrum of PN molecule
6. Analysis of Rotational Raman spectrum of a molecule
7. Twyman-Green interferometer
8. Fabry-Perot interferometer experiments
9. Zeeman effect experiment
10. Numerical aperture and bending loss of optical fiber.
11. Wavelength of laser by diffraction method (Transmission grating).
12. Wavelength of laser by diffraction method (Reflection grating).
13. Wavelength of laser by interference method.
14. Determination of spin coupling constant from NMR spectrum of a molecule

Course Outcomes for Spectroscopy & Laser I (Elective) (MPH305P1)

- **CO1:** Operate and analyze the working principles of different lasers and their emission characteristics.
- **CO2:** Perform spectroscopic experiments, including absorption, fluorescence, and Raman spectroscopy, for material characterization.
- **CO3:** Utilize optical instruments such as monochromators, photodetectors, and interferometers for precise spectral analysis.
- **CO4:** Interpret experimental data and understand the interaction of light with matter in various spectroscopic techniques.
- **CO5:** Develop technical proficiency in spectroscopy and laser experiments, preparing for advanced research and industry applications in photonics.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	1	1	3	3	3
CO2	3	3	3	2	3	1	1	3	3	3
CO3	3	3	3	2	3	1	1	3	3	3
CO4	3	3	3	2	3	1	1	3	3	3
CO5	3	3	3	3	3	1	1	3	3	3

Course- Dissertation – I (MPH 306 P2)

Course Objectives for Dissertation-I

1. **To develop research skills** by engaging in independent study on a specialized topic in physics.
2. **To enhance critical thinking and problem-solving abilities** through literature review, hypothesis formulation, and experimental or theoretical analysis.
3. **To gain proficiency in scientific methodologies** including data collection, computational modeling, or experimental techniques relevant to the research topic.
4. **To improve scientific communication skills** through the preparation of research reports, presentations, and discussions.
5. **To foster innovation and interdisciplinary learning**, encouraging students to apply physics concepts to real-world challenges in academia or industry.

This course aims to facilitate students to create the basic understanding of research, problem identification, report writing and carry out extensive research and development project or technical project at place of work through problem and gap identification, development of methodology for problem solving, interpretation of findings, presentation of results and discussion of findings in context of national and international research. The overall goal of the dissertation is for the student to display the knowledge and capability required for independent work.

Project Allotment:

On the first day of 3rd semester, common guidelines will be provided to the students & within a week the field/ title & supervisor will be decided by the departmental council. It may be theoretical, experimental & computational in nature. The student should work continuously as per the credit hour under the supervision of Guide. The final Master's Dissertation will be uploaded on the Departmental website, archives & on INFLIBNET.

Project Submission & Evaluation

At the end of third semester, the students will submit the soft binding of report in three copies (Dept., Guide & Candidate). The student will prepare a presentation & present it in front of External Examiner, Faculty members of Dept. & students of the Department. The dissertation will be evaluated according to the relevance of topic, intensity of actual work done, conceptual understanding of the work.

The marking guidelines are following:

• Marks Awarded for 2 Reviews (20 + 20) (Guide + External Examiner) = 40 Marks

• Evaluation of the Dissertation (20 + 20) : (Guide + External Examiner) = 40 Marks

• Presentation (15 Min) followed by Viva-voce Examination = 20 Marks
(Guide +External Examiner)

Total : 100 Marks

Course Outcomes :

The learners will be able to:

CO1: gain in-depth knowledge and use adequate methods in the major subject/field of study.

CO2: create, analyze and critically evaluate different technical/research solutions

CO3: clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings

CO4: obtain the primary window of research to each and every student, they get acquainted with basics of research. Ethics and methodology of research are also taught to students.

CO5: become expert during exploring their project about the analytical, mathematical and experimental concepts in the corresponding topic and leads them to choose research or higher education as their career.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	2	3	3
CO2	3	3	3	3	3	3	3	2	3	3
CO3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	2	3	3

Year-IInd

Semester- IV

Course: Nuclear Physics (Code: MPH401)

Course Objective for Nuclear Physics (MPH401)

1. **To understand the fundamental properties and models of the atomic nucleus.**
2. **To study nuclear forces, decay mechanisms, and energy generation in nuclear reactions.**
3. **To explore quantum mechanical aspects of nuclear physics and their applications.**
4. **To analyze nuclear experimental techniques and instrumentation.**
5. **To introduce applications of nuclear physics in energy production, medicine, and industry.**

Unit - I

Basic concepts of General properties of nuclei, mass defect, size and shape, binding energy, angular momentum, magnetic dipole moments and electric quadrupole moments. Nuclear radius

Unit II

Radioactivity, units of radiation, Alpha, Beta and Gamma-Rays decay. Constituents of nuclei : Nature of interactions: Electromagnetic and weak interactions

Unit – III

Nuclear Models: Liquid drop model, Fermi Gas Model, Shell Model Magic numbers, spin-orbit coupling prediction of angular momenta of nuclear ground states, Nuclear Energy levels

Unit - IV

Reaction dynamics, the Q of Nuclear reaction, Compound nucleus formation and breakup, nuclear fission and heavy ion induced reactions, fusion reactions, types of nuclear reactors.

Unit - V

Elementary particle physics, Hadrons and leptons, their masses, spin parity decay structure, quarks and gluons., Conservation Laws, Gell-mann-Nishijima formula, parity non conservation in weak interactions etc.,

Reference Books:

1. Introductory nuclear Physics by Kenneth S. Krane, Wiley India Pvt. Ltd., 2008.
2. Concepts of nuclear physics by Bernard L. Cohen, Tata Mcgraw Hill, 1998
3. Introduction to Elementary Particles by D. Griffith, John Wiley & Sons
4. Introductory Nuclear Physics by S.S.M. Wong, PHI
5. Nuclear Physics by R.R. Roy & B.P.Nigam, John Wiley
6. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP Institute of Physics Publishing, 2004)

COURSE OUTCOMES:

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

CO1: Acquire knowledge about nuclear decay processes and their outcomes.
CO2: Have a wide understanding regarding alpha, beta and gamma decay.
CO3: Get a picture of the various nuclear models which are able to define the nuclear structure.
CO4: Have an understanding of the reaction dynamics and the Q value of the reaction.
CO5: Understand the basic forces in nature and classification of particles and study in detail about conservations laws and quark model.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	1	1	2	3	3
CO2	3	2	2	2	3	1	1	2	3	3
CO3	3	2	2	2	3	1	1	2	3	3
CO4	3	2	2	2	3	1	1	2	3	3
CO5	3	2	2	2	3	1	1	2	3	3

Course: Introduction to Nanotechnology (Code: MPH402)

Course: Introduction to Nanotechnology (MPH402)

Course Objectives:

1. **Introduce the fundamental concepts of nanotechnology and nanoscale science.**
2. **Explain the unique physical, chemical, and mechanical properties of nanomaterials.**
3. **Describe the various synthesis and fabrication techniques used in nanotechnology.**
4. **Familiarize students with key characterization techniques such as SEM, TEM, AFM, and XRD.**
5. **Discuss the applications, environmental impact, and ethical considerations of nanotechnology.**

Unit- I

General Concepts in Nanotechnology, What is nanotechnology, Classification of different areas of nanotechnology, the interdisciplinary nature of nanotechnology, What does nanotechnology offer for our future.

Unit- II

Carbon Nanotubes, Structures of CNTs, Mechanical Properties of CNTs , Electrical and Electronic Properties of CNTs

Unit III

Photonic crystals and Nano photonics, Photons and Electrons: Similarities and differences, Photonic Crystals, Properties and applications of photonic crystals

Unit- IV

Quantum dot structure, Properties of quantum structure, Quantum confinement

Unit- V

Carbon Nanofoam and Graphene , Generation of graphene sheets

Reference Books:

1. Introduction to nanoscience and nanomaterials by Dinesh. C. Agarwal
2. "Nanostructures & Nanomaterials: Synthesis, Properties &Applications" G. Cao, Imperial College Press, 2004.
3. Nanomaterials, Nanotechnologies and Design: An introduction for engineers and Architects, Micheal F. Ashby, P.J. Ferreria, D.L. Schodek,
4. Introduction to Nanoscience and Nanotechnology, Gabor .L et al,
5. Fundamentals of Nanotechnology, Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep, CRC Press, 2009
6. Nanomaterials: An introduction to synthesis, properties and application, Dieter Vollath, WILE-VCH, 2008

Course Outcomes (COs):

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

1. **CO1: Explain the fundamental principles and significance of nanotechnology.**
2. **CO2: Analyze and evaluate the unique properties of nanomaterials at the nanoscale.**
3. **CO3: Demonstrate knowledge of synthesis and fabrication techniques for nanomaterials.**
4. **CO4: Apply advanced characterization tools to investigate nanomaterial structures and properties.**
5. **CO5: Assess real-world applications of nanotechnology and its implications in various industries.**

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	3	1	1	3	3	3
CO2	3	2	3	3	3	1	1	3	3	3
CO3	3	2	3	3	3	1	1	3	3	3
CO4	3	2	3	3	3	1	1	3	3	3
CO5	3	2	3	3	3	1	1	3	3	3

Course: Environmental Physics (Code: MPH403)

Course: Environmental Physics (MPH403)

Course Objectives:

1. Introduce the fundamental principles of environmental physics and their applications in understanding environmental systems.
2. Explain the interaction of solar radiation with the atmosphere and its effects on climate and weather patterns.
3. Study the physical processes governing air, water, and soil pollution, along with their environmental impacts.
4. Explore the physics of renewable energy sources and their role in sustainable development.
5. Familiarize students with environmental monitoring techniques and strategies for pollution control.

Unit -1

Essentials of Environmental Physics

Structure and thermodynamics of the atmosphere, Composition of air, Greenhouse Effect, Transport of matter, energy and momentum in nature. Stratification and stability of atmosphere , General circulation of tropics, Elements of weather and climate.

Unit -2

Solar and Terrestrial Radiation

Physics of radiation, Interaction of light with matter, Rayleigh scattering, Laws of radiation i.e. Kirchoff's law, Planck's law, Wein's Displacement Law etc., UV radiation, Ozone depletion problem, Energy balance of earth 's atmosphere system.

Unit-3

Environmental Pollution and Degradation

Factors governing air, water and noise pollution, Air and water quality standards, waste disposal, Land and sea breeze, Wet and dry deposition, Dispersal mechanism of air and water pollutants, Environmental Degradation.

Unit-4

Environmental Changes and Remote sensing

Energy sources, Renewable sources of Energy: Solar Energy, Wind Energy, Bioenergy, Hydroenergy, Deforestation, Degradation of soils, Remote sensing techniques.

Unit-5

Global and Regional Climate

Elements of weather and climate, Stability and vertical motion of air, Horizontal motion of air and water, Global climate models, Projection of global climate changes, Energy balance- a zero dimensional greenhouse model.

Reference books:

1. J. Twidell and J.Weir : Renewable Energy Resources (Elbs, 1988)
2. J.T. Hougtion: The Physics of Atmosphere (Cambridge University Press, 1977)
3. R.N. Keshavamurthy and M.Shankar Rao: The Physics of Monsoons (Allied Publishers,1992

COURSE OUTCOMES (COs)-

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

1. **CO1:** Explain the fundamental principles of environmental physics and their role in understanding natural and human-made environmental processes.
2. **CO2:** Analyze the interaction of solar radiation with the Earth's atmosphere, including greenhouse effects, climate change, and energy balance.
3. **CO3:** Evaluate the impact of various pollutants on air, water, and soil quality using physics-based approaches.
4. **CO4:** Apply physical principles to study renewable energy sources such as solar, wind, and geothermal energy.
5. **CO5:** Assess environmental monitoring techniques and mitigation strategies for pollution control and sustainable development.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	2	3	3	3	3
CO2	3	2	2	2	3	2	3	3	3	3
CO3	3	2	2	2	3	2	3	3	3	3
CO4	3	2	2	2	3	2	3	3	3	3
CO5	3	2	2	2	3	2	3	3	3	3

Specialization –II (Code- MPH404)

Elective I (Electronics- II)

Course: Specialization – II (MPH404) – Elective I (Electronics-II)

Course Objectives:

1. Provide an in-depth understanding of advanced electronic circuits and semiconductor devices.
2. Explore the principles of analog and digital signal processing in electronic systems.
3. Study microcontrollers, embedded systems, and their applications in automation.
4. Analyze communication systems, including modulation techniques and data transmission.
5. Develop practical skills in circuit design, simulation, and troubleshooting of electronic devices.

Unit-1

Analog circuits: Comparators, Multivibrators, Waveform generators: Square wave, triangle wave and pulse generators.

Unit-2

Digital MOS circuits: NMOS and CMOS gates (AND, NAND and NOT), Dynamic MOS circuits, ratio inverter, two phase inverter; dynamic MOS shift register, static MOS shift registers, four phase shift registers. MemoryDevices; Static and dynamic random access memories (SRAM and DRAM)

Unit -3

Physics of Semiconductor devices: Carrier concentrations in semiconductors; Band structure of p-n junction; Basic semiconductor equations; p-n diode current voltage characteristics; Dynamic diffusion capacitances; Ebers-Moll equation.

Unit- 4

Physics of Semiconductor devices: Metal semiconductor junctions: Schottky barriers; Rectifying contacts; Ohmic contacts; Typical Schottky barriers, Miscellaneous semiconductor devices:

Tunnel diode; Photodiode; Solar cell; LED; LDR; p-n-p-n switch, SCR; Unijunction transistor (UJT); Programmable Unijunction transistor (PUT).

Unit- 5

Experimental design: Scintillation detectors; Solid state detectors (Si and HPGe).

Measurement of energy and time using electronic signals from the detectors and associated instrumentation, Signal processing; Multi channel analyzer; Time of flight technique; Coincidence measurements: true-to-chance ratio.

Reference Books:

1. Integrated Electronics ,J. Millman and C.C.Halkias.
2. Electronic Devices and Circuits, S.Salivahanan & N.S. Kumar
3. Semiconductor Devices: Physics and Technology, S.M.Sze
4. Electronic Devices, ThomasL.Floyd

COURSE OUTCOMES:

The learners of this course will assimilate and comprehend substantial understanding of:
CO1: Comparators and multivibrators.
CO2: Digital MOS circuits and memory devices
CO3: Physics of Semiconductor devices
CO4: Working of miscellaneous semiconductor devices
CO5: Experimental design of Scintillation detectors and Solid state detectors

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	3	2	1	3	3	3
CO2	3	2	2	2	3	2	1	3	3	3
CO3	3	2	2	2	3	2	1	3	3	3
CO4	3	2	2	2	3	2	1	3	3	3
CO5	3	2	2	2	3	2	1	3	3	3

Practical Paper: Electronics Lab-II (Elective) (Code: MPH405P1)

Course: Practical – Electronics Lab-II (Elective) (MPH405P1)

Course Objectives:

1. Develop hands-on experience in designing and analyzing advanced electronic circuits.
2. Understand the working principles of semiconductor devices, including transistors, diodes, and operational amplifiers.
3. Perform experiments on analog and digital signal processing techniques.
4. Gain proficiency in microcontroller programming and interfacing with electronic components.
5. Enhance troubleshooting and debugging skills for electronic circuits and systems.

1. Operational amplifier parameters measurements and their dependence on frequency.
2. Basic operational amplifier configurations: inverting amplifier, non-inverting amplifier, voltage follower, differentiator, integrator and instrumentation amplifier
3. Butterworth second order active low pass and high pass filters.
4. Studies on second order band-pass and band-elimination active filters.
5. Precision rectification: half- and full- wave.
6. Design and study of Wein bridge oscillator circuit.
7. Design and study of op amp based square wave oscillator.
8. To draw the characteristic curve of SCR and to determine its holding voltage, holding current and break-over voltage
9. Use of IC 555 timer.
10. To simulate electronic circuits using Pspice/ MultiSim.
11. BCD adder and subtractor.
12. DIAC and TRIAC characteristics and applications.

Course Outcomes (COs):

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

1. **CO1:** Design and implement electronic circuits using semiconductor devices.
2. **CO2:** Analyze the characteristics and performance of analog and digital circuits.
3. **CO3:** Apply microcontroller-based systems for automation and signal processing applications.
4. **CO4:** Utilize laboratory instruments such as oscilloscopes, signal generators, and multimeters for circuit testing.
5. **CO5:** Demonstrate problem-solving skills in troubleshooting and debugging electronic circuits.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	3	1	1	3	3	3
CO2	3	2	2	3	3	1	1	3	3	3
CO3	3	2	2	3	3	1	1	3	3	3
CO4	3	2	2	3	3	1	1	3	3	3
CO5	3	2	2	3	3	1	1	3	3	3

Course: Elective II

Condensed Matter Physics-II (Code: MPH404)

Course: Elective II – Condensed Matter Physics-II (MPH404)

Course Objectives:

1. Develop an advanced understanding of the physical properties of condensed matter systems.
2. Explore the quantum mechanical foundations of electronic, optical, and magnetic properties of materials.
3. Study superconductivity, semiconductors, and low-dimensional systems such as nanomaterials.
4. Analyze phase transitions, crystal defects, and their impact on material properties.
5. Introduce experimental and computational techniques used in condensed matter physics research.

Unit-I

Crystal Physics: Introduction, symmetry elements of crystals, concept of point groups, derivation of equivalent point position, experimental determination of space groups, expression for structure factor, analytical indexing, Weissenberg and rotating crystal method, Determination of relative structures, amplitudes from measured intensities, Multiplicity factor, Lorentz polarization factor, Reciprocal lattices, concept of reciprocal lattice, geometrical construction, relation between reciprocal lattice vector and inter-planar spacing, properties of reciprocal lattice.

Unit-II

Energy bands in solids: Elementary ideas of formation of energy bands, Bloch function, Kronig Penny model, number of states in a band, Energy gap, Distinction between metals, insulators and intrinsic semiconductors, concept of holes, equation of motion for electrons and holes, effective mass of electrons and holes. Nearly free electron approximation.

Unit-III

Ferroelectrics: General properties of ferroelectric materials, Classification and properties of representative ferroelectrics, The dipole theory of ferroelectricity, objections against the dipole theory, ionic displacements and behaviour of $BaTiO_3$ above the Currie temperature, The theory of spontaneous polarization of $BaTiO_3$, Thermodynamics of ferroelectric transitions, ferroelectric domains.

Unit-IV

Films and surfaces: Preparation - Thermal Vapour Deposition, Chemical Vapour Deposition, laser ablation, Molecular Beam Epitaxy, study of surface topography by multiple beam interferometry, conditions for accurate determination of step height and film thickness Fizeau fringes, Electrical conductivity of thin films, difference of behaviour of thin films from bulk material, expression for electrical conductivity for thin film.

Reference Books:

1. Crystallography Applied to Solid State Physics, A.R. Verma and O.N. Srivastava 2nd edition, New Age International publishers, 2001.
2. Solid State Physics, A.J. Dekker, MacmillanIndia Ltd, Bangalore, 1981.
3. Solid State Physics, C. Kittel, V Ed, Wiley Eastern Ltd, 2013.
4. Elementary Solid state physics, MA Omar, Adison Wesley, New Delhi,2000.
5. Solid state Physics, SO Pillai. New age international publication, 2002.
6. Solid state Physics, MA Wahab, Narosa publishing house, New Delhi., 1999.
7. Introduction to Solid state physics, L Azoroff, Tata McGraw Hill publications,1993.
8. Solid State Physics, H.C. Gupta, Vikas Publishing house, New Delhi,2002.

COURSE OUTCOMES:

The learners of this course will develop a conceptual knowledge of:

CO1: Crystal structure and various lattice parameters
CO2: Energy Bands in solids and Kronig Penny model
CO3: General properties of ferroelectric materials
CO4: Various Films and surfaces preparation methods
CO5: Electrical conductivity of thin films

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	3	1	1	3	3	3
CO2	3	2	2	3	3	1	1	3	3	3
CO3	3	2	2	3	3	1	1	3	3	3
CO4	3	2	2	3	3	1	1	3	3	3
CO5	3	2	2	3	3	1	1	3	3	3

Course: Condensed Matter Physics Lab-II (Elective) (Code: MPH405P1)

Course: Condensed Matter Physics Lab-II (Elective) (MPH405P1)

Course Objectives:

1. Develop hands-on experience in experimental techniques used in condensed matter physics.
2. Study the electrical, thermal, and magnetic properties of materials through laboratory experiments.
3. Analyze crystal structures and defects using X-ray diffraction and other characterization methods.
4. Perform measurements related to superconductivity, semiconductors, and nanomaterials.
5. Enhance data analysis, interpretation, and scientific reporting skills in experimental condensed matter physics.

1. Magnetic susceptibility of Ferrous ammonium sulphate by Gouy's balance method
2. Temperature variation of dielectric constant and determination of Curie point of a Ferro electric solid PZT (Lead Zirconium Titanate)
3. Thermo-stimulated luminescence of F-centre in Alkali halide.
4. Hall effect experiment in semiconductors.
5. Determination of Fermi energy of copper.
6. Determination of Plank's constant using LED's
7. Determination of energy gap of a semiconductor using diode.
8. Determination of Solar cell characteristics
9. Energy band gap of a thermistor
10. Determination of lattice parameter using Bernal Chart

Course Outcomes (COs):

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

1. **CO1: Conduct experiments to investigate the physical properties of various condensed matter systems.**
2. **CO2: Analyze crystal structures and defects using experimental techniques like XRD.**
3. **CO3: Evaluate the electrical, thermal, and magnetic behavior of different materials.**
4. **CO4: Apply computational and data analysis tools for interpreting experimental results.**
5. **CO5: Demonstrate proficiency in laboratory techniques and scientific communication through report writing and presentations.**

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	3	2	1	3	3	3
CO2	3	2	2	3	3	2	1	3	3	3
CO3	3	2	2	3	3	2	1	3	3	3
CO4	3	2	2	3	3	2	1	3	3	3
CO5	3	2	2	3	3	2	1	3	3	3

Elective III- Laser and Spectroscopy – II (Code- MPH404)

Course: Elective III – Laser and Spectroscopy-II (MPH404)

Course Objectives:

1. Provide an advanced understanding of laser physics, including laser-matter interactions and applications.
2. Explore different laser systems, their operational principles, and their role in modern technology.
3. Study various spectroscopic techniques such as Raman, fluorescence, and infrared spectroscopy.
4. Analyze the applications of laser and spectroscopy in material science, medicine, and industry.
5. Develop problem-solving skills related to optical systems and spectroscopic analysis.

Unit-I

Absorption spectroscopy: Basic principles, Beer - Lambert law, Molar extinction coefficient, Intensity of electronic transitions. Types of electronic transitions.Franck - Condon principle, Ground and excited electronic states of diatomic molecules. Electronic spectra of polyatomic molecules, Electronic spectra of conjugated molecules - dissociation and pre-dissociation spectra, UV-Visible spectrophotometer - Principles and Instrumentation, Applications.

Unit-II

Fluorescence spectroscopy: Jablonski diagram; characteristics of fluorescence emission - Stokes shift, mirror image rule; solvent and environmental effects on fluorescence; lifetimes and quantum yields; Fluorescence quenching: mechanism and dynamics; Fluorescence anisotropy; Spectrofluorimeter - Principles and Instrumentation, Applications.

Unit-III

Laser Raman spectroscopy: Review of Raman scattering and Raman spectrum of diatomic and linear polyatomic molecules, molecular polarizability, Polarization of Raman lines, Depolarization ratio and its determination, Resonance Raman scattering. Application of Raman spectroscopy to study phase transitions and proton conduction in solids. Non- linear effects of Raman scattering: General principles. Hyper Raman effect, Inverse Raman effect, stimulated Raman scattering, Principle and experimental technique.

Unit-IV

Mossbauer spectroscopy: Mossbauer effect, recoilless absorption and emission of gamma rays, basic principles of gamma ray fluorescence spectroscopy, hyperfine interaction, chemical isomer formula,Verification of Beer-Lambert law. Iodine absorption spectra using CDS

Reference Books:

1. Fundamental of Photochemistry, KK Rohatgi-Mukherjee, New Age International Ltd, New Delhi, 1986.
2. Principles of Fluorescence Spectroscopy, 3 rd Ed, JR Lakowicz, Springer, New York, 2006.
3. Fundamentals of Molecular Spectroscopy, Banwell and McCash, Tata McGraw Hill, 1998.
4. Modern Spectroscopy, JM Hollas, John Wiley, 1998.
5. Molecular Quantum Mechanics, PW Atkins and RS Friedman, 3 rd Edition, Oxford Press, 2004.
6. Spectra of Atoms and Molecules, P Bernath, Oxford Press, 1999.

COURSE OUTCOMES:

The learners of this course will develop a sufficient understanding of:

CO1: Spectra of molecules and different electronic transitions and their characteristic
CO2: Fluorescence spectroscopy, Fluorescence quenching and its mechanism and dynamics; Fluorescence anisotropy
CO3: Raman spectroscopy and Raman Scattering
CO4: Hyper Raman Effect, Inverse Raman effect, stimulated Raman scattering
CO5: Mossbauer spectroscopy

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	2	1	1	3	3	3
CO2	3	2	1	2	2	1	1	3	3	3
CO3	3	2	2	2	2	1	1	3	3	3
CO4	3	2	2	2	2	1	1	3	3	3
CO5	3	2	1	2	2	1	1	3	3	3

Elective III- Laser and Spectroscopy – II Lab

(Code- MPH405P1)

Course: Elective III – Laser and Spectroscopy-II Lab (MPH405P1)

Course Objectives:

1. Provide an advanced understanding of laser physics, including laser-matter interactions and applications.
2. Explore different types of laser systems, their working principles, and operational characteristics.
3. Study various spectroscopic techniques such as Raman, fluorescence, infrared, and absorption spectroscopy.
4. Analyze the applications of lasers and spectroscopy in material science, medicine, communication, and industry.
5. Develop problem-solving skills in optical systems and spectroscopic data interpretation.

1. Determination of hyper fine coupling constant from ESR spectrum of a molecule
2. Michelson Interferometer:
3. Experiment with CCD: Analysis of the spectrum of aluminium oxide (AlO)
4. Analysis of Mossbauer spectrum
5. Visual mapping of some important sources: Hg, Na, Fe, Cu arc, Brass arc and laser
6. Refractive index of liquid using Hallow prism
7. Experiment and analysis the spectrum of iron and Brass arc using Photograph method
8. Spatial and temporal coherence of He-Ne laser.
9. Experiments with lasers and fibre optics kit.
10. Experiments with lasers and reflection grating

.Course Outcomes (COs):

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

1. **CO1:** Explain the principles and operational mechanisms of different laser systems.
2. **CO2:** Analyze laser-matter interactions and their applications in various fields.

3. **CO3:** Demonstrate knowledge of advanced spectroscopic techniques and their theoretical foundations.

4. **CO4:** Apply spectroscopy for material characterization and investigate molecular structures.
5. **CO5:** Utilize laser and spectroscopic methods in real-world applications, including medical, industrial, and scientific research.

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	2	1	3	3	3
CO2	3	2	3	2	3	2	1	3	3	3
CO3	3	2	3	2	3	2	1	3	3	3
CO4	3	2	3	2	3	2	1	3	3	3
CO5	3	2	3	2	3	2	1	3	3	3

Course: Dissertation-II (Code - MPH 406P2)

Dissertation - II

Course Objectives:

1. Enable students to conduct independent and original research in their chosen area of study.
2. Develop critical thinking, problem-solving, and analytical skills for addressing complex scientific questions.
3. Enhance students' ability to design experiments, collect data, and apply relevant theoretical frameworks.
4. Improve scientific communication skills through report writing, presentations, and research publications.
5. Prepare students for further academic research or professional careers by fostering innovation and technical expertise.

Same project will continue from 3rd semester:

This paper is focused to guide the students and provide them an opportunity to facilitate learning and training to carry out extensive research and development project or technical project identifying different areas of gap, problem identification, application of concepts and methodologies in context of a research quest. The working on a dissertation is aimed at instilling confidence in their minds about a systematic approach, writing skills, creative imaginations, presentation skills and knack of research pursuits.

Final Dissertation Submission & Evaluation

At the end of 4th semester, the students will submit the soft copy and three hard copies in binding of final dissertation report (Dept., Guide & Candidate). The soft copy of final Master's Dissertation will be uploaded on the Departmental website & archives. The student has to prepare a presentation & present it in front of External Examiner, Faculty members of Dept. & students of the Department.

The marking guidelines are following:

- Marks Awarded for 2 Reviews (20 + 20) (Guide + External Examiner) = 40 Marks
- Evaluation of the Dissertation (20 + 20) (Guide + External Examiner) = 40 Marks
- Presentation (15 Min) followed by Viva-voce Examination = 20 Marks
  (Guide+ External Examiner)

Total: 100 Marks

Course Outcomes:

The student will be able to:

- **CO1 -gain in-depth knowledge and use adequate methods in the major subject/field of study.**
- **CO 2 - create, analyze and critically evaluate different technical/research solutions**
- **CO3- Develop confidence for independent research and proceedings.**
- **CO4 -develop appropriate presentation, explanation and communication skills.**
- **CO5- Have complete knowledge of research related procedures and activities. compile the research findings and justifications.**

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	2	3	2	3	3	3
CO2	3	3	3	3	2	3	2	3	3	3
CO3	3	3	3	3	2	3	2	3	3	3
CO4	3	3	3	3	2	3	2	3	3	3
CO5	3	3	3	3	2	3	2	3	3	3

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