Maulana Azad National Institute of Technology Bhopal

Department of Physics

Scheme and Syllabus of M.Sc. Physics

M.Sc. Physics

Scheme of Study (July 2025)

FIRST SEMESTER:

COURSE CODE	Title of the Course	Periods per week			Credit
		L	T	P	
PY MS 1101	Mathematical Physics	3	0	-	3
PY MS 1102	Classical Mechanics	3	0	-	3
PY MS 1103	Quantum Mechanics	3	0	-	3
PY MS 1104	Solid State Physics	3	0	-	3
PY MS 1151-1179	Elective I	3	0	-	3
PY MS 1105	Physics Laboratory-1	-	-	2	1
PY MS 1106	Physics Laboratory-2	-	-	2	1
PY MS 1107	Seminar-1	-	-	2	1
PY MS 1108	Minor Project-1 (Self Learning)	-	-	-	2
* HS PG 1101	Communication Skills (Audit Course)	2	-	-	2
	Total Hours = 21	**15**	**0**	**6**	**20**
Open Audit Course					
*HS PG 1101 Communication Skills 02 Credits (Compulsory Audit Course Not Counted in SGPA/CGPA Calculations)					

SECOND SEMESTER:

COURSE CODE	Title of the Course	Periods per week			Credit
		L	T	P	
PY MS 1201	Advanced Quantum Mechanics	3	-	-	3
PY MS 1202	Electrodynamics	3	-	-	3
PY MS 1203	Statistical Mechanics	3	-	-	3
PY MS 1204	Fundamentals of Electronics	3	-	-	3
PY MS 1251-1279	Elective II	3	-	-	3
PY MS 1205	Physics Laboratory-3	-	-	2	1
PY MS 1206	Physics Laboratory-4	-	-	2	1
PY MS 1207	Seminar-2	-	-	2	1
PY MS 1208	Minor Project-2 (Self Learning)	-	-	-	2
	Total Hours = 21	**15**	**0**	**6**	**20**

THIRD SEMESTER:

COURSE CODE	Title of the Course	Periods per week			Credit
		L	T	P	
PY MS 2101	Digital Electronics	3	-	-	3
PY MS 2102	Atomic & Molecular Spectroscopy	3	-	-	3
PY MS 2103	Nuclear & Particle Physics	3	-	-	3
PY MS 2104	Materials Science	3	-	-	3
PY MS 2151-2179	Elective III	3	-	-	3
PY MS 2105	Physics Laboratory-5	-	-	2	1
PY MS 2106	Physics Laboratory-6	-	-	2	1
PY MS 2107	Seminar-3	-	-	2	1
PY MS 2108	Minor Project-3 (Self Learning)	-	-	-	2
Total Hours = 21		**15**	**0**	**6**	**20**

FOURTH SEMESTER:

COURSE CODE	Title of the Course	Periods per week			Credit
		L	T	P	
PY MS 2201	Major Project Dissertation	-	-	40	20
Total Hours = 40		**0**	**0**	**40**	**20**

Grand Total of Course Credits = 20 + 20 + 20 + 20 = 80

List of Programme Electives

List of Electives (I)	**Semester -I**
PY MS 1151 Nanoelectronics	PY MS 1152 Optoelectronics
PY MS 1153 Photonic Materials	PY MS 1154 Computational Physics
PY MS 1155 Semiconductor devices	
List of Electives (II)	**Semester -II**
PY MS 1251 Thin Film Technology	PY MS 1252 Physics-Informed Machine Learning
PY MS 1253 Molecular Electronics & Biomolecules	PY MS 1254 Solar Photovoltaic Technology
PY MS 1255 Astronomy and Astrophysics	
List of Electives (III)	**Semester -III**
PY MS 2151 Characterization Techniques	PY MS 2152 Advanced Magnetic Materials
PY MS 2153 General Theory of Relativity	PY MS 2154 Plasma Physics
PY MS 2155 Quantum Many-Body Theory	

Name of Program	**M.Sc. Physics**	**Semester-I**	**Year: 2025**
Name of Course	**Mathematical Physics**		
Course Code	**PY MS 1101**		
Core / Elective / Other	**Core**	**Credit: 3**	

Course Objective: The course aims to equip students with the mathematical tools and techniques necessary to solve complex physical problems and develop a deep understanding of theoretical physics.

Course Outcomes:

- CO1: Understand and comprehend Linear vector space and eigenvalue problems
- CO2: Develop the skill to analyze and interpret special functions of polynomials
- CO3: Analyze functions of complex variables, Fourier series, and transform
- CO4: Describe and understand Group theory in various physical systems
- CO5: Formulate Tensor calculus problems

Syllabus:
Linear vector spaces, eigen values and eigen vectors of matrices, linear ordinary differential equations of second order, special functions. Fourier series and transforms, functions of a complex variable and residue calculus. Partial differential equations (Laplace equation in two and three dimensions in rectangular and polar co- ordinates, wave equation). Introduction to tensors and index notation, Introduction to group theory. Elements of numerical techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods

List of Text Books:

1.	Mathematical methods for Physicists, Arfken, Weber and Harris, Academic press
2.	Mathematical Physics, H.K. Dass
3.	Mathematical Methods in the Physical Sciences Mary L. Boas, Wiley.
4.	Advance Engineering Mathematics, Kreyzig Wiley
5.	Introductory Numerical Methods by Sastry.S. S.
6.	Advanced Engineering Mathematics by Dennis G. Zill and Warren S. Wright.

List of Reference Books:

1.	Methods of Mathematical Physics by Richard Courant and David Hilbert
2.	A Course in Mathematical Physics by Walter E. Thirring

URLs:

1.	https://nptel.ac.in/courses/115103036
2	https://archive.nptel.ac.in/courses/111/106/111106148/

Name of Program	**M.Sc. Physics**	**Semester-I**	**Year: 2025**
Name of Course	**Classical Mechanics**		
Course Code	**PY MS 1102**		
Core / Elective / Other	**Core**	**Credit: 3**	

Course Objective: The course aims to provide a deep understanding of advanced classical mechanics through Lagrangian and Hamiltonian formalisms. It also introduces relativistic mechanics and modern applications.

Course Outcomes:

- CO1: Understand and comprehend Lagrangian (L) and Hamiltonian (H) for a mechanical system
- CO2: Develop the skill to analyze, solve and interpret Lagrange's and Hamilton's equations of motion
- CO3: Analyze the vibrations of discrete and continuous mechanical system
- CO4: Describe and understand planar and spatial motion of a rigid body
- CO5: Understand and comprehend special theory of relativity

Syllabus:

Revision of Newtonian mechanics, constraints, Generalized coordinates Lagrange's equations of motion, Noethers theorem. Hamilton's function and Hamilton's equation of motion, Legendre transform, Phase space, Phase trajectories, Principle of least action, Hamiltonian principle. Two body central force problem, Kepler problem, Scattering, Virial theorem. Non-inertial frames of reference and pseudo forces, Elements of rigid body dynamics. Small oscillations, Normal mode analysis, Normal modes of a harmonic chain. Principle and postulate of relativity, Lorentz transformation, Length contraction, Time dilation and the Doppler Effect, Relativistic invariance of physical laws.

List of Text Books:

1.	Classical Mechanics, H. Goldstein, 2nd Edition, Narosa Pub.
2.	Classical Mechanics, N.C. Rana and P.S. Joag, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
3.	Mechanics, L. D Landau and E.M.Lifshitz, Pergamon Press, 1960
4.	Classical mechanics, K. R. Srinivasa Rao, Univesities Press, Delhi
5.	Introduction to Mechanics, D. Kleppner, R.J. Kolenkow, McGraw Hill

List of Reference Books:

1.	Classical Mechanics by John R. Taylor
2.	Introduction to Classical Mechanics by D. J. Morin
3.	Introduction to Special Theory of Relativity - R. Resnick

URLs:

1.	https://nptel.ac.in/courses/115/106/115106123/
2	https://nptel.ac.in/courses/115/106/115106119/
3.	https://nptel.ac.in/courses/115/105/115105098/
4.	https://nptel.ac.in/courses/115/104/115104094/
5.	https://nptel.ac.in/courses/115/101/115101011/, https://nptel.ac.in/courses/115/106/115106068/

Name of Program	**M.Sc. Physics**	**Semester-I**	**Year: 2025**
Name of Course	**Quantum Mechanics**		
Course Code	**PY MS 1103**		
Core / Elective / Other	**Core**	**Credit: 3**	

Course Objective: This course is an introductory level course on quantum mechanics (QM) and aims to provide students with a solid understanding of the fundamental concepts of QM including various applications.

Course Outcomes:

- CO1: Understand the Mathematical formulation of Quantum Mechanics
- CO2: Develop the skill to analyze, solve and interpret Schrodinger wave equation
- CO3: Analyze the Quantum Measurement of observables
- CO4: Describe and understand the Perturbed Hamiltonian in QM
- CO5: Understand and analyze Symmetry and Identical particle Spin angular momentum

Syllabus:

Basic principles of Quantum mechanics, probabilities and probability amplitudes, wave functions, probability density and probability current. Schrödinger equation, application to linear harmonic oscillator, rigid rotor, hydrogen atom. WKB approximation, WKB wave function criterion for validity of approximation, application to bound state. Identical Particles and Spin Angular momentum, Integral and Half-integral angular momentum spin Eigen functions, Conservation rules, Identical particles, Physical meaning of identity, Distinguishability of identical particles, Symmetric and Antisymmetric wave function, Construction from unsymmetrised function, Slater's Determinant, Connection of spin and statistics, Pauli spin matrices, scattering between identical particles, Stern-Gerlach Experiment.

List of Text Books:

1.	Quantum Mechanics, E. Merzbacher, John Wiley (Asia) 1999
2.	Quantum mechanics, G. Aruldhas
3.	A Textbook of Quantum Mechanics, P. M. Mathews and K. Venkatesan, TMH
4.	Principles of Quantum Mechanics, R. Shankar, Springer (Indian edition)
5.	Quantum Mechanics, B.H. Bransden, C.J. Joachain, Longman Publication.

List of Reference Books:

1.	Quantum Mechanics by Stephen Gasiorowicz
2.	Lectures on Quantum Mechanics by Steven Weinberg
3.	Modern Quantum Mechanics by J. J. Sakurai

4.	Quantum Mechanics: Concepts and Applications by N. Zettili
5.	Introduction to Quantum Mechanics by D. J. Griffith
URLs:	
1.	https://nptel.ac.in/courses/115/104/115104096/
2	https://nptel.ac.in/courses/115/106/115106066/
3.	https://nptel.ac.in/courses/115/102/115102023/
4.	https://nptel.ac.in/courses/115/101/115101010/
5.	https://nptel.ac.in/courses/115/101/115101107/

Name of Program	M.Sc. Physics	Semester-I	Year: 2025
Name of Course	Solid State Physics		
Course Code	PY MS 1104		
Core / Elective / Other	Core	Credit: 3	

Course Objective: This is the first course on theoretical treatment of the physics of solids. This course aims to introduce students to the fundamental principles of solid state physics, focusing on crystal structures, electronic properties, magnetism, and superconductivity, enabling them to understand and analyze the physical behavior of solids.

Course Outcomes:

- CO1: Understand and comprehend: Crystal Structure, Bonding in Solids, Free electron Theory, Energy band gaps
- CO2: Develop the skill to analyze and interpret Phonons and Superconductivity
- CO3: Analyze the material properties such as electrical, magnetic, and thermal mechanisms.
- CO4: Describe and understand the Meissner Effect, type-I and type-II superconductors, and London's equations.
- CO5: Describe and understand Theory of superconductivity, BCS theory of superconductivity, Josephson junction

Syllabus:

Crystal structure: Bravais lattices (2D and 3D), Symmetry operations, Point groups, Coordination number, Plane, Interplanar distance/spacing, Miller indices. Crystal diffraction and concept of the reciprocal lattice: X-ray diffraction; Bragg and von Laue diffraction, Methods for obtaining the X-ray diffraction from materials, Reciprocal lattice, Ewald construction; Braggs' law in reciprocal lattices, Wigner-Seitz method, and Brillouin zones, structure factor. Bonding of solids: Interatomic forces and types of bonds, cohesive energy. Imperfection/Defects in solids: Types of defects and their origins; Point, Line, and plane defects. Lattice vibration and thermal properties: Quanta of vibration (Phonon) and its types, Monatomic and diatomic lattices, Phase and group velocities, the density of states, Acoustic and optical modes, Specific heat and relative's theories, Free electron theory: Free electron gas model, Quantum theory, Ohm's law, thermal conductivity, Wiedemann-Franz law. Band theory of solids: Electrons in the periodic lattice, Bloch theorem, Kronig-Penney model, Classification of solids; metal, insulator, and semiconductor. Intrinsic and extrinsic semiconductors, carrier concentration and electron-hole mobility, p-n junction diode. Hall Effect, Effective mass, mobility, Einstein's relation, Generation Recombination, continuity equation. Magnetism: types of magnetism; Diamagnetism, Paramagnetism, Ferromagnetism, Anti-ferromagnetism and Ferrimagnetism. Superconductivity: Critical Magnetic field and critical current density, Meissner Effect, type-I, and type-II superconductors, London's equations, Thermodynamics of the superconducting state, Entropy and Specific heat in the

superconducting state, Ginzburg Landau Theory of superconductivity, BCS theory of superconductivity, Josephson junction.	
List of Text Books:	
1.	Introduction to solid state physics, Charles Kittel, John Wiley and Sons.
2.	Solid State Physics, A. J. Dekkar, Prentice Hall of India.
3.	Solid State Physics, C.M. Srivastava.
4.	Elementary Solid State Physics Principles and Applications: M. Ali Omar
List of Reference Books:	
1.	Solid State Physics by N. W. Ashcroft and N. D. Mermin
2.	Condensed Matter Physics by M. P. Marder
3.	Elements of X-ray Diffraction By B. D. Cullity
4.	Solid State Physics by H. Ibach and H. Lutz
URLs:	
1.	https://nptel.ac.in/courses/115/106/115106127/
2	https://nptel.ac.in/courses/115/104/115104109/
3.	https://nptel.ac.in/courses/122/107/122107035/
4.	https://nptel.ac.in/courses/115/105/115105099/
5.	https://podcasts.ox.ac.uk/series/oxford-solid-state-basics

FIRST SEMESER PY MS 1105 and PY MS 1106: PHYSICS LABORATORY-1 and 2

List of Experiments:

1. Determination of the Hall voltage developed across the sample material and also the Hall coefficient, mobility of charge carriers and carrier concentration of that material.
2. Determination of the resistivity and energy band gap of a semiconducting material using 4-Probe Method.
3. Determination of the excitation potential of Argon using Franck-Hertz apparatus.
4. Magnetic Susceptibility of Liquids – Quincke's Method, Powder-Faraday Method
5. Hysteresis (B–H Curve)
6. Solar-Cell Characteristics
7. Determination of Planck's Constant
8. Characteristics of Photo Diode, Photo Transistor, LDR, LED
9. To determine the wavelength of He- Ne LASER using Michelson interferometer
10. I-V characteristics of photoresistor.

PY MS 1107 SEMINAR-1

PY MS 1108 Minor Project-1 (Self Learning)

Name of Program	**M.Sc. Physics**	**Semester-II**	**Year: 2025**
Name of Course	**Advanced Quantum Mechanics**		
Course Code	**PY MS 1201**		
Core / Elective / Other	**Core**	**Credit: 3**	

Course Objective: This course is the second in the series of quantum mechanics (QM) courses, and will build upon the knowledge of QM-I. The course covers approximation methods used in QM, quantum scattering theory as well as a brief introduction to relativistic quantum mechanics.

Course Outcomes:

- CO1: Understand and comprehend: Schrodinger and Heisenberg interaction picture
- CO2: Develop the skill to analyze and interpret sudden and adiabatic approximation
- CO3: Analyze the time dependent and independent perturbation theory
- CO4: Describe and understand the Relativistic Quantum theory, Dirac theory of electron.
- CO5: Describe and understand Scattering Theory

Syllabus:

Time dependent and independent perturbation theory, quantum theory of radiation- Einstein's A & B coefficients, Sudden approximation, sudden reversal of a magnetic field, Adiabatic approximation. Schrödinger, Heisenberg and Interaction picture, representation of operators and equations of motion. Many Electron Systems-Atoms and Molecules, Thomas-Fermi Statistical Model, Hartree's self-consistent field method, Hartree-Fock method, molecular orbital theory for Hydrogen Ion- LCAO approximation, Heitler-London theory of hydrogen molecule. Scattering Theory Scattering amplitude, Born approximation- Integral equation of scattered waves. Relativistic Wave equations The Klein-Gorden equation for free particle and electromagnetic Potential, The Dirac equation, Properties of Dirac matrices, Free particle solutions, existence of electron spin.

List of Text Books:

1.	Quantum Mechanics: LI Schiff, McGraw Hill
2.	Quantum Mechanics: Mathews and Venkatesan
3.	Quantum Mechanics: A.K Ghatak and S. Lokanathan, MacMillan Publishers
4.	Quantum Mechanics: Eugen Merzbacker, John Wiley & Sons
5.	Quantum Mechanics: DJ Griffith, Pearson Education 8.
6.	Quantum Mechanics VolI & II: Cohen-Tannoudji, John Wiley

List of Reference Books:

1.	Quantum Mechanics by Stephen Gasiorowicz
2.	Lectures on Quantum Mechanics by Steven Weinberg
3.	Modern Quantum Mechanics by J. J. Sakurai

4.	Principles of Quantum Mechanics by R. Shankar
5.	Quantum Mechanics – Non-relativistic Theory, L D. Landau and L M. Lifshitz
6.	Quantum Mechanics: Concepts and Applications by N. Zettili
URLs:	
1.	https://nptel.ac.in/courses/115/103/115103104/
2	https://nptel.ac.in/courses/115/103/115103104/
3.	https://ocw.mit.edu/courses/8-05-quantum-physics-ii-fall-2013/
4.	https://homepages.iitb.ac.in/~shukla/qm2_syllabus.html
5.	https://nptel.ac.in/courses/115/101/115101107/

Name of Program	**M.Sc. Physics**	**Semester-II**	**Year: 2025**
Name of Course	**Electrodynamics**		
Course Code	**PY MS 1202**		
Core / Elective / Other	**Core**	**Credit: 3**	

Course Objective: To understand the nature of electric and magnetic force fields and the intricate connection between them. Derive and apply Maxwell's equations to analyze electric and magnetic fields in different physical situations. Explain the propagation of electromagnetic waves in free space, conductors, and dielectric media.

Course Outcomes:

- CO1: Understand the concept of Charges, Electric fields and Boundary conditions.
- CO2: Develop the skill to analyze, solve and interpret Boundary value problems in electrostatics
- CO3: Analyze the Electric and Magnetic Multipole moments, Analyze the Electric and Magnetic fields in matter.
- CO4: Describe and understand Dynamic fields, Maxwell's equation and Electromagnetic wave propagation in vacuum and medium.
- CO5: Understand and comprehend Wave guide, TE, TM and TEM waves propagation in wave guide. Acceleration of charges.

Syllabus:

Gauss law, Laplace and Poisson's equation, induced charges, Green's theorem, Laplace equation, Boundary conditions and uniqueness theorem, method of images, multipole expansion.
Biot-Savart law, magnetic vector potential, magnetic field in matter.

Faraday's law, Maxwell's equations, conservation laws, electromagnetic wave in free space, wave equation, reflection, refraction and propagation of waves. Dipole radiation, electric and magnetic dipole radiation.

Fields at the surface of and within conductor, cylindrical cavity and wave guide, Modes in rectangular waveguide, Modes in dielectric waveguides.

List of Text Books:

1.	Classical Electrodynamics, J.D. Jackson, 3rd edition., Wiley, 1999.
2.	Introduction to Electrodynamics, D.J. Griffiths, 3rd edition, PHI, 2011
3.	Classical Electricity and Magnetism, W.K.H. Panofsky and M. Phillips, 2nd ed., Addison- Wesley, 1962.
4.	Electricity and magnetism, A. S. Mahajan, A. A. Rangwala, Tata McGraw Hill publishing company limited

List of Reference Books:

1.	The Feynman Lectures on Physics – Vol. II
2.	Berkeley Series Vol II (Electricity and Magnetism) by E.M. Purcell
URLs:	
1.	https://nptel.ac.in/courses/115/103/115103104/
2	https://nptel.ac.in/courses/115/103/115103104/
3.	https://ocw.mit.edu/courses/8-07-electromagnetism-ii-fall-2012/
4.	https://archive.nptel.ac.in/courses/115/106/115106122/

Name of Program	**M.Sc. Physics**	**Semester-II**	**Year: 2025**
Name of Course	**Statistical Mechanics**		
Course Code	**PY MS 1203**		
Core / Elective / Other	**Core**	**Credit: 3**	

Course Objective: This course aims to provide a foundational understanding of statistical mechanics, focusing on the connection between microscopic and macroscopic properties of systems. It covers key concepts such as microstates, macrostates, ensembles, partition functions, and the statistical definitions of thermodynamic quantities. The course also explores classical and quantum statistics, including Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein distributions, with applications to radiation, electron behavior in metals, and astrophysical phenomena like thermal ionization.

Course Outcomes:

- CO1: Understand the concept of Law of Thermodynamics, Thermodynamical potential, Maxwell relation.
- CO2: Develop the skill to analyze, solve and interpret Ensemble, Phase space, Macro and micro state, Partition function, Brownian motion.
- CO3: Analyze the Maxwell-Boltzmann statics, Bose-Einstein and Fermi-Dirac Statistics.
- CO4: Describe and understand First and second order phase transition
- CO5: Understand and Formulate Density matrix, Ising model, Bose condensation.

Syllabus:

First law, second law, entropy, Thermodynamic potential, Maxwell relations, chemical potential , Phase equilibria. Macro & micro state, phase space, density distribution in phase space, micro canonical, canonical and grand canonical ensembles, partition function, free energy, calculation of thermodynamic quantities. Classical statistical mechanics, Postulates, derivation of thermodynamic laws, equipartition theorem, classical ideal gas, Gibbs paradox, statistics of paramagnetism. Quantum Statistics, Postulates, density matrix, ensemble, Third Law of Thermodynamics, Ideal gases, Liovillie's theorem. Equilibrium condition, classification of phase transitions, phase diagram, Claussius-Clapeyron equation, Van-der-Walls equation, second order phase transition, Ginzberg–Landau theory, Ising model, ferromagnetism, law of mass action, diffusion , Brownian motion. Maxwell – Boltzmann, Bose – Einstein, Fermi – Dirac distributions, Bose condensation, and introduction to non-equilibrium processes.

List of Text Books:

1.	Statistical Mechanics, Kerson Huang, Wiley India
2.	Fundamentals of Statistical mechanics, B.B. Laud, New Age International
3.	Statistical Physics, F Reif, Berkley Physics Course, Vol. 5
4.	Statistical Thermodynamics, M. C. Gupta, New Age International

5.	Statistical Mechanics, J. K. Bhattacharya, Narosa publishing house
List of Reference Books:	
1.	Statistical Physics, F. Mandle
2.	Fundamentals of Statistical and Thermal Physics, F. Reif
3.	Statistical Mechanics by R. K. Pathria
4.	Statistical Physics, Part 1 by L.D. Landau and E.M. Lifshitz
5.	Thermal Physics by C. Kittel and H. Kroemer
URLs:	
1.	https://www.nptel.ac.in/courses/115/103/115103028/
2	https://www.nptel.ac.in/courses/115/106/115106126/
3.	https://www.nptel.ac.in/courses/115/103/115103113/
4.	https://www.nptel.ac.in/courses/115/106/115106111/
5.	https://www.nptel.ac.in/courses/115/106/115106091/

Name of Program	**M.Sc. Physics**	**Semester-II**	**Year: 2025**
Name of Course	**Fundamentals of Electronics**		
Course Code	**PY MS 1204**		
Core / Elective / Other	**Core**	**Credit: 3**	

Course Objective: To provide a strong foundation in the basic principles and concepts of electronics, including electrical circuits, semiconductor devices, digital logic, and signal processing. These objectives are designed to ensure that students gain a balanced mix of theoretical knowledge and practical skills, preparing them for successful careers in the evolving field of electronics.

Course Outcomes:
- CO1: Understand about various types of diodes and its characteristics, Transistors (FET and MOSFET) and applications, Concept of h-parameters
- CO2: Develop the skill to analyze, solve and interpret significance of Op Amps and their importance, Verifying the concepts of logic gates.
- CO3: Analyze the real time applications such as integrator, comparator, registers, Counters.
- CO4: Describe and understand the Transducers and A/D and D/A convertors in digital signal processing.
- CO5: Understand and Formulate op amp based, instrumentation amplifier, feedback.

Syllabus:
P-N Junction: Built in potential, width and capacitance of depletion region; Current flow in biased p-n junction, Varactor diode, Zener diode and its characteristics, Photo diode and Solar cell. Transistors: n-p-n and p-n-p transistors, current flow in transistors, h-parameters, FET and MOSFET: Principle of operation, characteristics and parameters. Operational amplifiers: Differential amplifier using transistors, operational amplifier characteristics, negative feedback configuration, application circuits (inverter, non-inverter, adder, integrator, differentiator, waveform generator, comparator and Schmidt trigger). Transistor as a switch, feedback in amplifier. Digital logic gates, combinational circuits, Digital techniques and applications, registers, counters and comparators. A/D and D/A convertors, applications. Transducers (temperature, pressure, magnetic field, vibration, optical and particle detectors), Impedance matching, amplification (op amp based, instrumentation amplifier, feedback) filtering and noise reduction, shielding and grounding.

List of Text Books:

1.	Solid state electronic devices, B.G. Streetman, Prentice Hall of India, New Delhi
2.	Microelectronics, J. Millman, Mc Graw Hill International
3.	Process control and instrumentation, C. D. Johnson, Prentice Hall of India, New Delhi
4.	Integrated Electronics – J. Millman and C. C. Halkias

5.	Electronics Fundamentals and Applications – J. D. Ryder
6.	Electronic Device and Circuit Theory – R. Boylestad and L. Nashelsky
List of Reference Books:	
1.	Digital Principles and Applications, A.P. Malvino, D.P. Leach
2.	Digital Logic and Computer Design – M. Moris Mano
3.	Digital Fundamentals by Thomas L.Floyd
4.	Electronic Principles, S.K.Sahdev, Educational and technical (1998)
5.	R.K. Puri, V.K. Babbar, Solid State Physics and Electronics
6.	Operational amplifiers and Linear Integrated circuits, R. F. Coughlin and F. F. Driscoll, Pearson Education (2001)
URLs:	
1.	https://nptel.ac.in/courses/122/106/122106025/
2	https://onlinecourses.nptel.ac.in/noc21_ee55/
3.	https://nptel.ac.in/courses/117/106/117106086/
4.	https://podcasts.ox.ac.uk/series/oxford-solid-state-basics
5.	https://nptel.ac.in/courses/108/108/108108147/

PY MS 1205 and PY MS 1206: PHYSICS LABORATORY-3 and 4

List of Experiments:

1. To calculate the frequency of oscillations of RC phase shift oscillator
2. Study of RC Coupled CE amplifier – Two stages with feedback – Frequency response and voltage gain
3. Study of Push-pull amplifier using complementary – symmetry transistors power gain and frequency response.
4. Study of Active filters – low pass and high pass-first and second order frequency response and roll off rate.
5. Study of gain of Inverting/ Non-inverting amplifier and also study the frequency response characteristics and find out the bandwidth.
6. Study of frequency response characteristics of differentiator/ integrator.
7. Study of frequency response characteristics of Clipper Clamper circuit.
8. Verification of truth table of OR, AND and NOT gates.
9. To determine the frequency and wavelength in a rectangular waveguide working in TE10 mode
10. Study the drain, transfer; drain resistance, amplification factor, and Trans conductance characteristics of an FET.

PY MS 1207 Seminar-2

PY MS 1208 Minor Project-1 (Self Learning)

Name of Program	**M.Sc. Physics**	**Semester-III**	**Year: 2025**
Name of Course	**Digital Electronics**		
Course Code	**PY MS 2101**		
Core / Elective / Other	**Core**	**Credit: 3**	

Course Objective: To provide a strong foundation in the basic principles and concepts of electronics, including electrical circuits, semiconductor devices, digital logic, and signal processing. These objectives are designed to ensure that students gain a balanced mix of theoretical knowledge and practical skills, preparing them for successful careers in the evolving field of electronics.

Course Outcomes:

- CO1: Understand the Various Binary Number Systems and conversions.
- CO2: Explain principle of operation of digital circuits
- CO3: Describe and design the concepts of gates, flip flop, adder and subtractor.
- CO4: Understand and design digital systems using IC's
- CO5: Understand the concept of Decoder, encoder, multiplexer, de-multiplexer, A/D and D/A conversion techniques .

Syllabus:

Number Systems, Codes (Grey code, ASCII code and BCD code), Logic gates, Half& full adder and subtractor, RTL, DTL, TTL and ECL Logic circuit, Karnaugh (K-) Map, Pairs, Quads and Octets, RS, JK, D, T, JK M/S Flip flops, Race problem, Preset and Clear inputs. Pin out Diagrams, Truth Tables and Working of Decoders: 1-of-4(IC 74AS139) and 1-of-16 (IC 74154), BCD to Decimal Decoder(IC 7445), BCD to Seven Segment Decoder Driver(IC 7446A, 7448), Encoders: Decimal to BCD Encoder (IC 74147), Regulated Power Supply (IC-555, IC-723), Multiplexers: 16-to-1(IC 74150) and Implementation of Boolean Functions, Demultiplexer: 1-of-16 Demultiplexer/ Decoder(IC 74154). Weighted Resistor D/A Converter, Ladder Network D/A Converter, D/A Converter Specifications- Resolution, Accuracy, Linearity, Settling Time, Temperature Sensitivity A/D Conversion, Quantization and Encoding, Parallel-comparator A/D Convertor, Successive. Approximation A/D Converter, Counter method, Single and Dual Slope A/D Converter, Specifications of A/D converters

List of Text Books:

1.	Solid state electronic devices, B.G. Streetman, Prentice Hall of India, New Delhi
2.	Microelectronics, J. Millman, Mc Graw Hill International
3.	Digital Circuit and Design, S. Salivahanan and S. Arivazhagan
4.	Process control and instrumentation, C. D. Johnson, Prentice Hall of India, New Delhi
5.	Integrated Electronics – J. Millman and C. C. Halkias

6.	Electronics Fundamentals and Applications – J. D. Ryder
7.	Electronic Device and Circuit Theory – R. Boylestad and L. Nashelsky
List of Reference Books:	
1.	Digital Principles and Applications, A.P. Malvino, D.P. Leach
2.	Digital Logic and Computer Design – M. Moris Mano
3.	Digital Fundamentals by Thomas L.Floyd
4.	Electronic Principles, S.K.Sahdev, Educational and technical (1998)
5.	R.K. Puri, V.K. Babbar, Solid State Physics and Electronics
6.	Operational amplifiers and Linear Integrated circuits, R. F. Coughlin and F. F. Driscoll, Pearson Education (2001)
URLs:	
1.	https://nptel.ac.in/courses/108/105/108105113/
2	https://nptel.ac.in/courses/108/105/108105132/
3.	https://nptel.ac.in/courses/117/106/117106086/
4.	https://freevideolectures.com/course/4238/nptel-digital-electronic-circuits/18
5.	https://nptel.ac.in/content/storage2/courses/106108099/Digital%20Systems.pdf

Name of Program	**M.Sc. Physics**	**Semester-III**	**Year: 2025**
Name of Course	**Atomic & Molecular Spectroscopy**		
Course Code	**PY MS 2102**		
Core / Elective / Other	**Core**	**Credit: 3**	

Course Objective: The objective of this course is to provide students with a detailed understanding of the principles and techniques used to study the interaction of electromagnetic radiation with atoms and molecules.

Course Outcomes:

- CO1: Recognize the importance of spectroscopy for various day-to-day applications in device fabrication
- CO2: Apply the knowledge of spectroscopy to characterize the materials
- CO3: Examine the behavior of rotational, vibrational, and electronic spectra
- CO4: Implement the knowledge of energy-matter interaction to get information about the symmetry of molecules
- CO5: Describe NMR and ESR spectroscopy

Syllabus:

Vector model of atoms, term for equivalent and non-equivalent electron atoms, Hyperfine structure and width of spectral line, Spectra of alkali metals, Helium Atom Normal and anomalous Zeeman Effect, Paschen –Back effect, Stark effect, line broadening mechanism, rotation and vibrational spectra of molecules. Electronic spectra of molecules, Frank-Condon Principle, dissociation energy, rotational fine structure of electronic vibration transitions, Raman spectra Characterization techniques: NMR spectroscopy, ESR spectroscopy.
Lasers, Theory of optical resonant cavity, Q- switching and mode locking in Lasers, different types of Lasers.

List of Text Books:

1.	Atomic Spectra, H. D. White, Tata McGraw Hill Publication.
2.	Molecular structure & spectroscopy, G.Aruldhas;
3.	Fundamentals of molecular spectroscopy, Colin N.Banwell & Elaine M.McCash,
4.	Quantum Physics of atoms, molecules, solids, nuclei & particles, Robert Eisberg, Robert Resnick, Second edition, John Wiely & Sons (Asia) Ltd (1985)
5.	Physics of atoms and molecules, Bransden, Joachain, Longman publishing group

List of Reference Books:

1.	Atomic and molecular spectroscopy by Svanberg
2.	Atomic and Molecular Spectra by Raj Kumar
3.	Springer handbook of atomic, molecular, and optical physics, Gordon W. F. Drake

URLs:

1.	https://nptel.ac.in/courses/115/105/115105100/
2	https://nptel.ac.in/courses/115/101/115101003/

Name of Program	**M.Sc. Physics**	**Semester-III**	**Year: 2025**
Name of Course	**Nuclear and Particle Physics**		
Course Code	**PY MS 2103**		
Core / Elective / Other	**Core**	**Credit: 3**	

Course Objective: This course aims to provide a comprehensive understanding of nuclear and particle physics, covering fundamental nuclear properties, nuclear forces, models, and decay processes. It also introduces particle classification, quantum numbers, symmetries, fundamental interactions, and the Standard Model, along with topics beyond it.

Course Outcomes:

- CO1: Understand the structure of the nucleus, form factors, and properties of the nucleus
- CO2: Develop the skill to analyze, solve, and interpret nuclear models
- CO3: Analyze the nuclear reaction and reaction mechanism
- CO4: Describe and understand the group symmetry of elementary particles and their conserved quantum numbers, Relativistic kinematics
- CO5: Understand and comprehend the Standard model of elementary particles and forces

Syllabus:

Basic nuclear properties: size, shape and charge distribution, spin and parity, binding energy, semi empirical formula, liquid drop model. Nature of nuclear force, form of nucleon-nucleon potential, Deuteron problem. Evidence of Shell structure, single particle shell model, its validity and limitations, Rotational spectra, elementary ideas of alpha, beta and gamma decays and their selection rules, fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.Classification of fundamental forces , Elementary Particles and their Quantum numbers, Gellmann- Nishijima formula, Quark model, baryons and mesons, C, P, T invariance, Application of symmetry arguments to particle reactions, Parity non-conservation in weak interaction, Relativistic kinematics.

List of Text Books:

1.	Kenneth S. Krane, Introductory Nuclear Physics, Wiley, New York, 1988
2.	Atomic and Nuclear Physics, S. N. Ghoshal , S.Chand publication
3.	Introduction to high Energy Physics, P.H. Perkins, Addison-Wesley, London, 1982.
4.	Introduction to Elementary Particles, D. Griffiths, Harper and Row, New York, 1987.
5.	Introductory nuclear physics, Y.R. Waghmare, Oxford – IBH, Bombay, 1981.

List of Reference Books:

1.	Fundamentals in Nuclear Physics: from Nuclear Structure to Cosmology by J. Basdevant, J. Rich and M. Spiro

2.	Gauge theory of elementary Particles Cheng and Li
3.	Quarks and Leptons by F. Halzen and A. Martin
4.	Concepts of Nuclear Physics – R. Cohen
5.	Nuclear Physics by S. B. Patel
URLs:	
1.	https://nptel.ac.in/courses/115/104/115104043/
2	https://nptel.ac.in/courses/115/103/115103101/
3.	https://nptel.ac.in/courses/115/102/115102017/
4.	https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ph19/
5.	https://onlinecourses.nptel.ac.in/noc20_ph19/preview
6.	https://nptel.ac.in/content/syllabus_pdf/115104043.pdf

Name of Program	**M.Sc. Physics**	**Semester-III**	**Year: 2025**

Name of Course	**Material Science**	
Course Code	**PY MS 2104**	
Core / Elective / Other	**Core**	**Credit: 3**

Course Objective: To provide students with a foundational understanding of material structures, phase transformations, mechanical behavior, and functional properties, enabling them to analyze and apply material science principles in engineering applications.

Course Outcomes:

- CO1: Understand the Binary phase diagram and microstructural changes during cooling.
- CO2: Develop the skill to analyze, solidification, and recrystallization
- CO3: Analyze the polar and non-polar materials
- CO4: Describe and understand the Classification of Magnetic Material and their application
- CO5: Understand Nucleation and kinetics, Crystal Growth, Multiferroics

Syllabus:

Introduction to materials. The phase rule, single component system, Binary Phase diagrams Microstructural changes during cooling, Lever Rule, Some typical phase diagrams, Time scale for phase changes, nucleation and growth, nucleation kinetics, growth kinetics and overall kinetics, Applications, Solidification and crystallization, the glass transition. Fick's laws and their solutions, the Kirkendall effect, mechanisms of diffusion. Types of polarization, complex dielectric constant, polar and non-polar materials, Dielectric breakdown, piezoelectricity, ferroelectricity, electroceramics, multilayer capacitors. Magnetic parameters, classification of magnetic materials, Ferromagnetic materials, ferrites, Applications of magnetic materials, Multiferroics.

List of Text Books:

1.	Materials Science and engineering: a first course, V. Raghavan fifth Edition (Prentice-Hall of India) 2004.
2.	Materials Science and Engineering – An Introduction, W.D. Callister Jr. (John Wiley & Sons,) 1991.
3.	Materials Science, J. C. Anderson, K. D. Leaver, R.D. Rawlings and J.M. Alexander, 4th Edition, Chapman & Hall (1994).
4.	Electrical Properties of Materials, seventh Edition L. Solymar and D. Walsh (Oxford Univ. Press Indian Edition) 2006
5.	Essentials of Materials Science and Engineering, Askeland, Pradeep Phule, Thomson learning (India Edition)
6.	Principles of Materials Science and Engineering, William Smith, McGraw-Hill Publication

List of Reference Books:	
1.	Engineering Material and Metallurgy: RK Rajput
2.	Material Science and Engineering: William F Smith, Javad Hashemi, Ravi Prakash
URLs:	
1.	https://www.nptel.ac.in/courses/113/101/113101003/
2	https://www.nptel.ac.in/courses/113/101/113101002/
3.	https://www.nptel.ac.in/courses/113/108/113108052/
4.	https://www.nptel.ac.in/courses/113/106/113106032/

PY MS 2105 and PY MS 2106 Physics Laboratory-5 and 6

List of Experiments:

1. X-Ray Diffraction – Determination of lattice parameters of a crystalline solid
2. UV-Vis Spectrophotometer – Determination of absorption coefficient and bandgap
3. Measurement of ac and dc Electrical Conductivity of bulk and thin film
4. Measurement of e/m using Geiger Muller Counter
5. Dielectric Constant and Curie Temperature of Ferroelectric Ceramics
6. Study of Electron Spin Resonance spectrum of paramagnetic substance
7. Study of Nuclear Magnetic Resonance spectrum of magnetic substance
8. Study the Magnetoresistance behaviour of deposited sample
9. Regulated Power Supply using IC-555, IC-723
10. Filp flops a. SR flip-flop b. Clocked SR flip-flop c. JK flip-flop d. Master-slave flip-flop e. D- flip-flop f. T- flip-flop
11. Design of full adder/ full subtracter.

PY MS 2107 Seminar-3

PY MS 2108 Minor Project 3 (Self Learning)

List of Programme Electives

List of Electives (I)	**Semester -I**
PY MS 1151 Nanoelectronics	PY MS 1152 Optoelectronics
PY MS 1153 Photonic Materials	PY MS 1154 Computational Physics
PY MS 1155 Semiconductor devices	
List of Electives (II)	**Semester -II**
PY MS 1251 Thin Film Technology	PY MS 1252 Physics-Informed Machine Learning
PY MS 1253 Molecular Electronics & Biomolecules	PY MS 1254 Solar Photovoltaic Technology
PY MS 1255 Astronomy and Astrophysics	
List of Electives (III)	**Semester -III**
PY MS 2151 Characterization Techniques	PY MS 2152 Advanced Magnetic Materials
PY MS 2153 General Theory of Relativity	PY MS 2154 Plasma Physics
PY MS 2155 Quantum Many-Body Theory	

Name of Program	**M.Sc. Physics**	**Semester-I**	**Year: 2025**

Name of Course	**Nanoelectronics**	
Course Code	**PY MS 1151**	
Core / Elective / Other	**Elective**	**Credit: 3**

Course Objective: This course aims to introduce students to the fundamentals and applications of spintronics, nanoscale solid-state devices, nanophotonics, and liquid crystals. It covers key concepts such as spin injection, magnetoresistance effects, quantum confinement, photonic bandgap materials, and nanoscale optical phenomena, along with the unique properties and applications of liquid crystals in modern nanoelectronics and photonics.

Course Outcomes:

- CO1. To study the concept of spin associated with the electron and its usability for various engineering applications and memory devices.
- CO2. To study injection of spin and its transport through the required medium.
- CO3. To understand the phenomenon of Giant Magneto-resistance (GMR) and spin valve effect.
- CO4. To understand quantum confinement effect and to study applications of the structures showing quantum confinement effect.
- CO5. Study of Photonic band gap material and nanoscale photonic devices.

Syllabus:

Spintronic: Spin Injection, GMR & TMR, Spin valve effect, spin valves and MRAM devices

Solid state devices: quantum dots, quantum wires, Photonic bandgap materials, nanoscale photonic devices, Special phenomena in 2D and 3D nano structures.

The basic properties of liquid crystals and their display and non-display applications at the Nanoscale.

List of Text Books:

1.	Nano Electronics and Information Technology: Rainer Waser (John Wiley)
2.	Nanoelectronics Principles and Devices: M. Dragoman & D. Dragoman (Artech House Publishers)
3.	Fundamentals of Nanoelectronics: George W. Hanson (Pearson)
4.	Introduction to Nanoelectronics Science, Nanotechnology, Engineering, and Applications: V. V. Mitin& V. A. Kochelap (Cambridge University Press)
5.	Integrated Electronics Analog and digital Circuit: J Millman & C.C. Halkias (Tata McGraw-Hill)

List of Reference Books:

1.	Nano-Electronic Devices Semiclassical and Quantum Transport Modeling: D. Vasileska& S.M. Goodnick (Springer)
2.	Introduction to quantum mechanics: D. J. Griffiths (Prentice Hall)
3.	Photonics: Nanophotonic Structures and Materials: David L Andrews (Wiley) Liquid Crystals: lam-Choon Khoo (Wiley)

URLs:

1.	https://nptel.ac.in/courses/117/108/117108047/
2.	https://nptel.ac.in/courses/118/104/118104008/
3.	https://www.youtube.com/watch?v=wdNFCWLuC10&list=PLbMVogVj5nJT8RG5Q4 CpsJXi GqXE6t8N1
4.	https://www.youtube.com/watch?v=RnUGSDW-Tfk

Name of Program	**M.Sc. Physics**	**Semester-I**	**Year: 2025**
Name of Course	**Optoelectronics**		

Course Code	**PY MS 1152**	
Core / Elective / Other	**Elective**	**Credit: 3**

Course Objective: This course aims to introduce students to the fundamentals and applications of spintronics, nanoscale solid-state devices, nanophotonic, and liquid crystals.

Course Outcomes:

- CO1. Study the application of electronic devices and systems that produce, detect and control light.
- CO2. Establish the concept of light guidance in optical fibers and discuss types, rays, modes and losses in optical fibers
- CO3. Study the various fabrication techniques and applications of fiber optical cables.
- CO4. Demonstrate the use of optical fiber interconnectors and optical waveguides.
- CO5. Introducing the concept of Nonlinear optics-generation of harmonics-its applications like Kerr effect, Pockel's effect, Faraday effect.
- CO6. Study the concepts, principles and applications of magneto optics.

Syllabus:
Principle of light guidance in optical wave guides. Fabrication and types of Optical fibres, rays and modes, losses in optical fibres and applications. Optical fibre interconnectors, concept of optical waveguides. Nonlinear optics. Second harmonic generation. Birefringence. Electrooptics (Kerr effect, Pockels effect, Faraday effect), Magneto-optics. Optical Integrated Circuits, Light Emitting Diode, Solar Cells.

List of Text Books:

1.	Optical Electronics: A. Ghatak & K. Thyagarajan
2.	Quantum Electronics: A. Yariv
3.	An Introduction to Optical Fibers: A.H. Cherin

URLs:

1.	https://nptel.ac.in/courses/117/108/117108047/
2.	https://nptel.ac.in/courses/118/104/118104008/
3.	https://www.youtube.com/watch?v=wdNFCWLuC10&list=PLbMVogVj5nJT8RG5Q4CpsJXiGqXE6t8N1
4.	https://www.youtube.com/watch?v=RnUGSDW-Tfk

Name of Program	**M.Sc. Physics**	**Semester-I**	**Year: 2025**
Name of Course	**Photonic Materials**		

Course Code	**PY MS 1153**	
Core / Elective / Other	**Elective**	**Credit: 3**

Course Objective:
This course aims to introduce students to the fundamentals and applications of Photonic Materials.

Course Outcomes:
- CO1: Apply the scientific knowledge gained through the subject to attain problems related to engineering
- CO2: Differentiate ferromagnetic, anti-ferromagnetic and ferrimagnetic order on the basis of exchange integral
- CO3: Outline the magnetic excitations in nanoparticles
- CO4: Propose new areas of research in nanotechnology and allied fields of LASER
- CO5: Explain the trapping and cooling of atoms by radiation forces

Syllabus:
Photonic materials: Atomic scale structure of materials, Magnetism: moments, environments and interactions, order and magnetic structure, Scattering theory: Excitations of crystalline materials, magnetic excitations, sources of X-rays and neutrons, Interaction of light with photon: LASER Chaotic light and coherence. Laser spectroscopy. Multiphoton processes. Light scattering by atoms. Electron scattering by atoms. Coherence and cavity effects in atoms. Trapping and cooling

List of Text Books:

1.	Nanoscale Multifunctional Materials: Science and Applications, Sharmila M. Mukhopadhyay, (Wiley)
2.	2. Light and Matter: Electromagnetism, Optics, Spectroscopy and Lasers, Yehuda B. Band, (Wiley)
3.	Nanostructured Films & Coatings, Gang Moog Chow, (Springer)
4.	Solid State Properties: From Bulk to Nano, Mildred Dresselhaus, Gene Dresselhaus, et al., (Springer)

List of Reference Books:

1.	Introduction to Molecular Magnetism: From Transition Metals to Lanthanides, Cristiano Benelli and Dante Gatteschi, (Wiley)
2.	Magnetism in Condensed Matter, Stephen Blundell, (Oxford University Press)
3.	Introduction to Magnetic Materials, By B. D. Cullity and C. D. Graham (Wiley)

URLs:

1.	https://nptel.ac.in/courses/118/106/118106021/
2.	https://swayam.gov.in/nd1_noc20_mm19/preview
3.	https://nptel.ac.in/courses/118/102/118102003/
4.	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=28

5.	https://swayam.gov.in/nd1_noc20_cy23/preview

Name of Program	**M.Sc. Physics**	**Semester-I**	**Year: 2025**
Name of Course	**Computational Physics**		
Course Code	**PY MS 1154**		

Core / Elective / Other	Elective	Credit: 3

Course Objective:
To introduce various numerical and computational techniques useful to handle complex problems

Course Outcomes:

- Use mathematical software (e.g., MATLAB, Python) to model and analyzephysical phenomena numerically.
- Interpret physical laws using advanced computational techniques in classical mechanics, quantum mechanics, and electrodynamics.
- Explain the importance of numerical methods in solving physical problems where analytical solutions are difficult or impossible.
- Model real-world physical phenomena such as projectile motion, harmonic oscillators, and chaotic systems using computational simulations.

Utilize libraries such as NumPy, SciPy, and Matplotlib for numerical analysis and visualization of physical data.

Syllabus:
Introduction to programming (Python/MATLAB/C++/C/Fortran95), Numerical differentiation and integration, Monte Carlo methods, Curve fitting, Linear and nonlinear regression, Roots and optimization of multivariable functions, Solution of nonline ar equations, Numerical matrix computing, Numerical Fourier analysis, Numerical solutions of ordinary and partial differential equations, Numerical solution of Physics problems (Wave equation, Poisson equation, heat equation, Laplace equation, Schrodinger equation, Nonlinear dynamics, Ising model, Statistical mechanics, molecular dynamics).

List of Text Books:

1.	Computational Physics by Tao Pang
2.	Computational Physics by R. H. Landau, M. J. Paez and C. C. Bordeianu
3.	Numerical Recipe by W. T. Vetterling

List of Reference Books:

1.	Computational Physics: Problem Solving with Python by Richard M. Feynman
2.	Computational Methods in Physics by Joel P. Plum and Michael M. Woolfson

URLs:

1.	https://archive.nptel.ac.in/courses/115/106/115106118/#
2.	https://archive.nptel.ac.in/courses/115/106/115106121/

Name of Program	**M.Sc. Physics**	**Semester-I**	**Year: 2025**
Name of Course	**Semiconductor Devices**		
Course Code	**PY MS 1155**		

Core / Elective / Other	Elective	Credit: 3

Course Objective:

In this course, we will study the basics of semiconductor physics and charge transport phenomena in semiconductors via mobility, conductivity, and carrier concentration calculations. The current-voltage characteristic is a basic characterization for all class of applications for these semiconductor devices.

Course Outcomes:

With this course

- We will gain the knowledge about semiconductor device fabrication and their applications for diode, solar cell, FET, MOSFETs and various circuits.
  In addition to analog circuits, the digital electronics will also be used in various switching applications.

Syllabus:

Semiconductor heterostructures, Transport: Diffusion equations, Boltzmann transport equations, scattering mechanisms, calculation of mobility, carrier dynamics under illumination condition, Generation and recombination of carriers, rate equations, different recombination processes. Field-Effect Transistors (FET): JFET- current-voltage characteristics, effects in real devices, high-frequency and high-speed issues. MOSFET: Introduction to MOSFET operation and characteristics. MIS structures, C-V characteristics, Single Electron Transistors: SET structure, Equivalent circuit, coulomb blockade effect, coulomb diamond, Current-Voltage characteristics. Multiplexers, De-multiplexers, Decoders, Encoders. Registers and Counters. Microprocessor and Microcontroller. Integrated Circuits: Principle of Design of monolithic Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and introduction to VLSI. Optoelectronic devices: Semiconductor under EM field, absorption, reflection, refraction, transmission, basic operation principle of Solar cell and LEDs.

List of Text Books:

1.	Integrated Electronics, Millman and Halkias
2.	Physics of Semiconductor devices, Michael Shur
3.	Quantum Heterostructures: Microelectronics and Optoelectronics, V. V. Mitin, V. A. Kochelap and M. A. Stroscio
4.	Physics of Low dimensional Semiconductors: An Introduction. J.H. Davies

List of Reference Books:

1	D. A. Neamen, Semiconductor physics and devices, 3rd Edition, McGraw-Hill
2.	S. M. Sze, Semiconductor Devices, 2nd Edition, Wiley

URLs:

1.	https://www.youtube.com/watch?v=h0Y9jDKqScQ&list=PLgMDNELGJ1CaNcuuQv9xN07ZWkXE-wCGP

	https://www.youtube.com/watch?v=tjUUU9f2Wpc&list=PLDVC8J0Twuc9DCeiUaM0PRakAqa-lYwmP

Name of Program	**M.Sc. Physics**	**Semester-II**	**Year: 2025**
Name of Course	**Thin Film Technology**		

Course Code	**PY MS 1251**	
Core / Elective / Other	**Elective**	**Credit: 3**

Course Objective: To provide a comprehensive understanding of various physical and chemical deposition methods, such as thermal evaporation, sputtering, molecular beam epitaxy, and chemical vapor deposition. These objectives aim to ensure that students gain both theoretical knowledge and practical skills, preparing them for careers in industries and research fields that utilize thin film technology.

Course Outcomes:

- CO1: Explain the basics of thin film techniques.
- CO2: Explain the nucleation and growth mechanism of different thin film deposition techniques.
- CO3: Differentiate the working and principle of different thin film deposition techniques.
- CO4: Apply the knowledge of deposition techniques in the experimental lab to fabricate electronic devices.
- CO5: Apply knowledge of deposition techniques at research as well as in industry.

Syllabus:

Brief introduction regarding different methods for thin film formation (Physical and chemical), nucleation and growth mechanism. Electrochemical deposition: Introduction, principle, Faradays laws of electrolysis, electrode, electrolyte, additives, power supply, substrate, Classification of electrodeposition: potentiostatic, galvanostatic and cyclic voltammetry, Steps involved in electrodeposition process, over potential term, nucleation and growth mechanism, advantages and disadvantages, a case study. Spray Pyrolysis: Principle, preparative parameters: influence of temperature, precursor's solution, Model for films deposition: Atomization of precursor's solution, Aerosol transport, decomposition of precursor, advantages and disadvantages, a case study of SnO_2 deposition. Spin Coating: Modeling spin coating, advantages and disadvantages, a case study. Physical methods: Introduction physical vapor deposition (PVD) and Chemical Vapor deposition (CVD) Evaporation Methods: Thermal Evaporation (vacuum evaporation), Flash evaporation, Laser evaporation, Molecular Beam Epitaxy. Types of CVD: atmospheric pressure, low pressure, plasma enhanced CVD. Sputtering: Basic principle of sputtering process, brief regarding triode sputtering, ion beam sputtering.

List of Text Books:

1.	Thin Film Phenomenon, K. L. Chopra, Mc Graw Hill, 1969.
2.	Hand Book of Thin Film Technology, L. I. Maissel and R. Glang Mc Graw Hill, 1969
3.	Thin Film Processes. J. L. Vossen and W. Kem, (Academic Press, 1978)
4.	The Material Science of Thin Films, M. Ohring (Academic Press, 1972)
5.	Chemical Solution Deposition of semiconductor Films, Gary Hodes, Marcel Dekker Inc

List of Reference Books:

1.	Thin Film Deposition Using Spray Pyrolysis, J. Electroceramics, 14 (2005) 103-111
2.	Handbook of semiconductor electrodeposition, R. K. Pandey, S. N. Sahu, S. Chandra
3.	Spin Coating for rectangular substrates, A Thesis written by G. A. Luurtesema, University of California, Berkeley, 1997
URLs:	
1.	https://www.youtube.com/watch?v=wFVVuHyx200
2.	https://nptel.ac.in/courses/127105531
3.	https://www.youtube.com/@DrPervaizAhmad
4.	https://www.youtube.com/@surfaceengineeringofnanoma4417
5.	https://www.youtube.com/watch?v=ev1EiLWgDIs
6.	https://www.youtube.com/watch?v=RzIa_WGcsRQ

Name of Program	**M.Sc. Physics**	**Semester-II**	**Year: 2025**
Name of Course	**Physics Informed Machine Learning**		

Course Code	PY MS 1252	
Core / Elective / Other	Elective	Credit: 3

Course Objective:
To integrate physics-based models with machine learning techniques to improve predictive accuracy, and generalization in scientific and engineering applications.

Course Outcomes:

- CO1: Understand and implement machine learning models such as neural networks, regression,
- CO2: Understand and implement clustering for physics-based applications.
- CO3: Utilize ML techniques to analyze and predict outcomes in physics-based domains.
- CO4: Use ML to accelerate numerical simulations, reduce computational costs,
- CO5: Enhance the scalability of physics-based modeling.

Syllabus:
Measurement, analysis; Probability distributions; Parameter Estimation; Hypothesis testing; Model Comparison; Confidence Intervals; Bootstrap and Jackknife analysis. Bayesian Analysis; Markov Chain Monte Carlo techniques; Basics of Machine Learning. Supervised Learning; Clustering, Classification and Data Mining; Machine Learning metrics; Multivariate analysis; Hands-on experience in Python with applications to Physics.

List of Text Books:

1.	Statistics, Data Mining and Machine Learning in Astronomy by Z. Ivezic, A Connolly, J. VanderPlas and Alexander Gray
2.	Data Reduction and Error Analysis for Physical Sciences. P.R. Bevington
3.	Data Analysis. A Bayesian tutorial by D.S. Sivia
4.	Introduction to Machine Learning using Python by Andreas Mueller and Sarah Guido
5.	Python Data Science Handbook by Jake Van Der Plas

List of Reference Books:

1.	Data Reduction and Error Analysis for Physical Sciences. P.R. Bevington
2.	Statistics, Data Mining and Machine Learning in Astronomy by Z. Ivezic, A Connolly, J. VanderPlas and Alexander Gray

URLs:

1.	https://www.youtube.com/watch?v=3KqTt7O_rnU
2.	https://nptel.ac.in/courses/106102220

Name of Program	M.Sc. Physics	Semester-II	Year: 2025
Name of Course	Molecular Electronics & Biomolecules		

Course Code	PY MS 1253	
Core / Elective / Other	Elective	Credit: 3

Course Objective:
The objective of the course is to provide students with a comprehensive application of nanomaterials in the field of biotechnology and self-assembly of complex organic molecules and molecular interconnections.

Course Outcomes:

- CO1: Understand the application of nanomaterials in the field of biotechnology
- CO2: Synthesis of some organic semiconductors and understand the role of molecules as switches, biometric components, conducting polymers and light emitting polymers.
- CO3: Detailed knowledge about self-assembly of complex organic molecules and molecular interconnections.
- CO4: Understand the mechanism of integration of molecular components into functional devices.
- CO5: Develop an understanding of structural and functional principles of bio machines, interfacing of bio and non-biomaterials and porous silicon.

Syllabus:
Organic semiconductors, Organic molecules as switches, motor-molecules and biomimetic components, conducting polymers, light emitting polymers, The selfassembly of complex organic molecules, Molecular connections and the integration of molecular components into functional devices, Contact issues, Structure of biomolecules; Biotechnology, recombinant DNA technology, molecular biology. Structural and functional principles of bio nanomachines, Interfacing bio with non-bio materials, Porous silicon

List of Text Books:

1	Molecular Electronics: T. Helgakar (Wiley,VCH)
2	Semiconductor Quantum Dots: MasumotaTakaga (Springer)

List of Reference Books:

1	Nanobiotechnology: Inorganic Nanoparticles vs Organic Nanoparticles- Jesus M. de la Fuente, V. Grazu (Elsevier)
2	Molecular Electronics: Loan Baldea (Jenny Stanford Publishing)
3	Biomolecules: N Arumugam (Saras Publication)
4	

URLs:

1	https://www.weizmann.ac.il/materials/Cahen/research-activities/bio-molecularelectronics
2	https://www.ch.ic.ac.uk/local/organic/tutorial/steinke/4yrPolyConduct2003.pdf
3	https://www.rsc.org/news-events/journals-highlights/2019/apr/molecular-electronics/

Name of Program	M.Sc. Physics	Semester-II	Year: 2025

Name of Course	**Solar Photovoltaic Technology**	
Course Code	**PY MS 1254**	
Core / Elective / Other	**Elective**	**Credit: 3**

Course Objective:
The objective of the course is to provide students with a comprehensive understanding of the principles, technologies, and applications of solar photovoltaic systems.

Course Outcomes:

- CO1: To understand photovoltaic systems, applications for photovoltaic systems
- CO2: Identify practices and protective equipment used for PV systems.
- CO3: Describe Production of single crystal silicon:Czokralski (CZ) and Float Zone (FZ) method
- CO4: Understand the solar cell parameters; I-V curve & L-I-V characteristics
- CO5: Use software tools for simulating and optimizing PV system performance. Design a photovoltaic solar cell

Syllabus:
The Sun Light: World Energy scenario – Advantages and challenges of solar energy harnessing - Source of radiation – solar constant– solar intensity at earth's surface – direct and diffuse radiation – apparent motion of sun-solar insolation data –solar charts – measurement of diffuse, global and direct solar radiation: pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder.
Semiconductors for Solar Cell: Silicon: preparation of metallurgical, electronic and solar grade silicon -Production of single crystal silicon: Czokralski (CZ) and Float Zone (FZ) method– imperfections – carrier doping and lifetime – Germanium –compound semiconductors – growth & characterization– amorphous materials – transparent conducting oxides – anti-reflection principles and coatings – organic materials.
Characterization and Analysis: Device isolation & analysis – ideal cell under illumination – solar cell parameters short circuit current, open circuit voltage, fill factor, efficiency; optical losses, electrical losses, surface recombination velocity, quantum efficiency – measurements of solar cell parameters; I-V curve& L-I-V characteristics, internal quantum yield measurements – effects of series and parallel resistance and temperature.

List of Text Books:

1.	Solar Cells and their Applications by Larry D. Partain
2.	The Physics of Solar Cells by J. Nelson
3.	Handbook of Photovoltaic Science and Engineering by A. Luque and S. Hegedus
4.	Physics of Solar Cells: From Basic Principles to Advanced Concepts by P. Wurfel
5.	J. Nelson, The Physics of Solar Cells, Imperial College Press.

6.	R. H. Bube, Photovoltaic Materials, Imperial College Press
List of Reference Books:	
1.	Solar Cells and their Applications by Larry D. Partain
2.	Photovoltaic Materials by R. H. Bube
3.	Thin Films Solar Cells, K.L. Chopra
URLs:	
1.	https://archive.nptel.ac.in/courses/115/107/115107116/
2.	https://onlinecourses.nptel.ac.in/noc20_mm05/preview

Name of Program	**M.Sc. Physics**	**Semester-II**	**Year: 2025**

Name of Course	Astronomy and Astrophysics	
Course Code	PY MS 1255	
Core / Elective / Other	Core	Credit: 3

Course Objective:
The objective of this course is to understand our composition and universe, the dynamics of stars including our solar system, radiation, and various experimental techniques and astronomical observations.

Course Outcomes:

- CO1: To understand the different coordinated systems to locate the celestial object in space.
- CO2: To explore the parent star, Sun, and its importance for sustaining life on the earth.
- CO3: Basic information about the formation of stars, their magnitudes, and luminosity.
- CO4: To study the importance of stellar magnetic fields, stellar populations, and their classification.
- CO5: Knowledge of astronomical instruments, telescopes, their mountings, and image defects.

Syllabus:
The solar system: Celestial mechanics, Elliptical orbits, Kepler's laws, Virial theorem; Earth-moon system, Tidal forces, Precession of earth's axis, Interiors, Atmospheres; Planets, Terrestrial planets, Jovian planets; Observational tools: Blackbody radiation, Specific intensity and flux density; Stellar parallax, Magnitudes, Colour index; Basic optics and optical telescopes; Radio telescopes; Infrared, ultraviolet and X-ray telescopes; Coordinates and time. Star: Classification, Formation of spectral lines, Hertzsprung-Russell diagram, Atmosphere, Description of the radiation field, Opacities, Radiative transfer. Structure of spectral lines. Sun: Interior, Atmosphere, Solar activity, Helioseismology. Stellar interiors: Hydrostatic equilibrium, Energy transport and convection, Model building, Main sequence. Binary stars: Classification, Mass determination, Accretion disks in close binaries, White dwarfs, neutron stars, and black holes in binaries. Star formation: Interstellar dust and gas, Formation of protostars, pre-main sequence evolution. Post main sequence evolution: Evolution on the main sequence, Late stages of evolution, Fate of massive stars, supernovae. Degenerate remnants of stars: White dwarfs, Chandrasekhar limit, Neutron stars, Pulsars.

List of Text Books:

1.	Modern Astrophysics, B. W. Carroll and D. A. Ostlie, Addison-Wesley Publishing Co.
2.	Introductory Astronomy & Astrophysics, M. Zeilik and S. A. Gregory, 4th Edition, Saunders College Publishing.
3.	Theoretical Astrophysics, Vol II:Stars and Stellar Systems, T. Padmanabhan, Cambridge University Press.
4.	The Physical Universe: An Introduction to Astronomy, F. Shu, Mill Valley : University Science Books.

5.	Fundamental Astronomy, H. Karttunen
6.	An Introduction to Astrophysics, Baidyanath Basu

List of Reference Books:

1.	Astronomy in India: A Historical Perspective, T. Padmanabhan,
2.	Theoretical Astrophysics, Vol II:Stars and Stellar Systems, T. Padmanabhan
3.	Foundation of Astrophysics, B. Ryden and B. M. Peterson

URLs:

1.	https://ocw.mit.edu/courses/8-901-astrophysics-i-spring-2006/
2.	https://www.coursera.org/learn/astro

Name of Program	**M.Sc. Physics**	**Semester-III**	**Year: 2025**

Name of Course	Characterization Techniques	
Course Code	PY MS 2151	
Core / Elective / Other	Elective	Credit: 3

Course Objective:
To provide a comprehensive understanding of various characterization techniques used to analyze the structure, composition, and properties of materials. These objectives aim to ensure that students gain both theoretical knowledge and practical skills in material characterization, preparing them for careers in research, development, and industry.

Course Outcomes:
Upon completion of the course, students will be able to:

- CO1: Understanding fundamental principles: Explain the basic principles and mechanisms behind common characterization techniques like X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), infrared spectroscopy (FTIR), nuclear magnetic resonance (NMR), and differential scanning calorimeter (DSC).
- CO2: Understand the Working principle of the above instruments
- CO3: Analyze and interpret data generated from characterization techniques, including identifying key features, relating them to material properties, and drawing meaningful conclusions.
- CO4: Choose the most suitable characterization technique based on the specific information needed about a material, considering factors like resolution, sensitivity, and sample requirements.
- CO5: Assess the limitations and potential errors associated with each characterization technique.

Syllabus:
Generation of X-rays, Moseley's law, Absorption of X-rays, Absorption edge, structure factor, Powder method, Rotation method, Filter, detectors and counters. X-ray characterization of single crystal, polycrystalline, thin films, super-lattices and nanomaterials. Determination of crystal structure, lattice parameter and strain (Tensile and compressive), XRF Basics electron diffraction. Working principles and construction of Scanning electron microscope, electron gun, field emission, resolution, types of scans: line scan and area scan. Basics of EDS, Sample preparation, Factors influencing image. Working principles and construction of transmission electron microscope, analysis of image. Principles and working of DTA, DSC, TGA and Dilatometry. Basics UV- Visible Spectroscopy, Photoluminiscence, FTIR and Raman Spectroscopy. Resistivity/Sheet Resistance of Semiconductors, Basics of linear four probe and Van der Pauw methods, I- V characteristics of metal – semiconductor, Thermoelectric measurements.

List of Text Books:

1.	Elements of X- ray diffraction, B.D. Cullity

2.	Transmission electron microscopy: A text book of Materials Science, David Williams and C.B. Carter
3.	Scanning Electron Microscopy: Physics of Image Formation and Microanalysis: Ludwig Reimer

List of Reference Books:

1.	Introduction to Thermal Analysis Techniques and Applications, Brown and M Ewert
2.	Electrical characterization of semiconductor materials and devices, M. Deen and F. Pascal
3.	Electrical Properties of Materials, D. Walsh and L. Solymar
4.	Introduction to Thermal Analysis Techniques and Applications, Brown and M Ewert

URLs:

1.	https://www.youtube.com/watch?v=-JEJmGLNL68&list=PLuLbAPvMsV-TrNGW8Yq6kKgc6-yviwwAf
2.	https://nptel.ac.in/courses/105106200
3.	https://nptel.ac.in/courses/105108078
4.	https://nptel.ac.in/courses/113104004
5.	https://nptel.ac.in/courses/113105101
6.	https://nptel.ac.in/courses/115103030
7.	https://nptel.ac.in/courses/113106034
8.	https://nptel.ac.in/courses/118104008

Name of Program	**M.Sc. Physics**	**Semester-III**	**Year: 2025**
Name of Course	**Advanced Magnetic Materials**		

Course Code	PY MS 2152	
Core / Elective / Other	Elective	Credit: 3

Course Objective:
To provide a comprehensive understanding of various characterization techniques used to analyze the structure, composition, and properties of materials. These objectives aim to ensure that students gain both theoretical knowledge and practical skills in material characterization, preparing them for careers in research, development, and industry.

Course Outcomes:
Upon completion of the course, students will be able to:

- CO1: Understanding fundamental principles: Explain the basic principles and mechanisms behind common characterization techniques like X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), infrared spectroscopy (FTIR), nuclear magnetic resonance (NMR), and differential scanning calorimeter (DSC).
- CO2: Understand the Working principle of the above instruments
- CO3: Analyze and interpret data generated from characterization techniques, including identifying key features, relating them to material properties, and drawing meaningful conclusions.
- CO4: Choose the most suitable characterization technique based on the specific information needed about a material, considering factors like resolution, sensitivity, and sample requirements.
- CO5: Assess the limitations and potential errors associated with each characterization technique.

Syllabus:
Generation of X-rays, Moseley's law, Absorption of X-rays, Absorption edge, structure factor, Powder method, Rotation method, Filter, detectors and counters. X-ray characterization of single crystal, polycrystalline, thin films, super-lattices and nanomaterials. Determination of crystal structure, lattice parameter and strain (Tensile and compressive), XRF Basics electron diffraction. Working principles and construction of Scanning electron microscope, electron gun, field emission, resolution, types of scans: line scan and area scan. Basics of EDS, Sample preparation, Factors influencing image. Working principles and construction of transmission electron microscope, analysis of image. Principles and working of DTA, DSC, TGA and Dilatometry. Basics UV- Visible Spectroscopy, Photoluminiscence, FTIR and Raman Spectroscopy. Resistivity/Sheet Resistance of Semiconductors, Basics of linear four probe and Van der Pauw methods, I- V characteristics of metal – semiconductor, Thermoelectric measurements.

List of Text Books:

1.	Elements of X- ray diffraction, B.D. Cullity

2.	Transmission electron microscopy: A text book of Materials Science, David Williams and C.B.Carter
3.	Scanning Electron Microscopy: Physics of Image Formation and Microanalysis: Ludwig Reimer
List of Reference Books:	
1.	Introduction to Thermal Analysis Techniques and Applications, Brown and M Ewert
2.	Electrical characterization of semiconductor materials and devices, M. Deen and F. Pascal
3.	Electrical Properties of Materials, D. Walsh and L. Solymar
4.	Introduction to Thermal Analysis Techniques and Applications, Brown and M Ewert
URLs:	
1.	https://www.youtube.com/watch?v=-JEJmGLNL68&list=PLuLbAPvMsV-TrNGW8Yq6kKgc6-yviwwAf
2.	https://nptel.ac.in/courses/105106200
3.	https://nptel.ac.in/courses/105108078
4.	https://nptel.ac.in/courses/113104004
5.	https://nptel.ac.in/courses/113105101
6.	https://nptel.ac.in/courses/115103030
7.	https://nptel.ac.in/courses/113106034
8.	https://nptel.ac.in/courses/118104008

Name of Program	**M.Sc. Physics**	**Semester-III**	**Year: 2025**

Name of Course	**General Theory of Relativity**	
Course Code	**PY MS 2153**	
Core / Elective / Other	**Elective**	**Credit: 3**

Course Objective: This course provides an introduction to general relativity, exploring curved spacetime, geodesics, black holes, and the expanding universe. It also covers modern cosmology, including the ΛCDM model, cosmic microwave background radiation, dark matter, dark energy, and the inflationary universe.

Course Outcomes:

- CO1: Understand the concept of Spacetime Curvature, Geodesic deviation in free fall
- CO2: Develop the skill to analyze, solve and interpret Einstein's field equation
- CO3: Analyze the space time structure near Balck hole
- CO4: Describe and understand Gravitational wave propagation and polarization in vacuum.
- CO5: Understand and comprehend Accelerating expansion of the Universe

Syllabus: Covariance of Physical Laws, Special Relativity, The Equivalence Principle, Space and Space-time Curvature, Tensors in Curved Space-time, The Geodesic equation, geodesic Deviation Equation, Curvature and Einstein Field equations, Geometry Outside of a Spherical Star, Tests of General Relativity, Gravitational Radiation, Black Holes, Cosmology.

List of Text Books:

1.	Gravity- An introduction to Einstein's general relativity – James B. Hartle
2.	Gravitation and Cosmology - S. Weinberg
3.	Space-time and Geometry: An Introduction to General Relativity - Sean Carroll, Pearson.
4.	Introduction to General Relativity - J. V. Narlikar, Cambridge.
5.	Classical Theory of Fields - L. D. Landau and E. M. Lifshitz, Butterworth-Heinemann

List of Reference Books:

1.	The Early Universe by Kolb and Turner
2.	An Introduction to Modern Cosmology by A. Liddle
3.	A First Course in General Relativity by Schutz

URLs:

1.	https://ocw.mit.edu/courses/8-962-general-relativity-spring-2020/
2.	https://www.youtube.com/watch?v=EotEgl8MMaw
3.	https://www.youtube.com/watch?v=5yMueWR0ExQ
4.	https://www.youtube.com/watch?v=Tz24fHX_cUY

Name of Program	**M.Sc. Physics**	**Semester-III**	**Year: 2025**

Name of Course	**Plasma Physics**	
Course Code	**PY MS 2154**	
Core / Elective / Other	**Elective**	**Credit: 3**

Course Objective:
To provide students with a deep understanding of the fundamental and applied aspects of plasma physics, covering theoretical, computational, and experimental approaches.

Course Outcomes:

- Develop a strong foundation in plasma dynamics, including Debye shielding, plasma frequency, and quasi-neutrality.
- Understand various plasma waves (electrostatic and electromagnetic) and their instabilities, such as Rayleigh-Taylor and drift instabilities.
- Explore kinetic theory and fluid models to describe plasma behavior.
- Apply plasma physics concepts to industrial and technological applications

Syllabus:

Plasma state, Plasma parameters, applications of Plasmas, Drift of charge particle under different combinations of electric and magnetic field, crossed electric and magnetic fields, homogenous electric and magnetic fields, spatially and time varying electric and magnetic fields, Simplified magnetohydrodynamic equations - Electron plasma oscillations, Debye shielding phenomenon and criteria for plasma, Electric field drift, curvature drift, fundamental equations of magneto-hydrodynamics(MHD), two-fluid hydrodynamic plasma models, and wave propagation in a magnetic field, plasma confinement schemes, magnetic confinement.

List of Text Books:

1.	Introduction to Plasma Physics by Chen, F.F
2.	Fundamentals of Plasma Physics by J. A. Bittencourt
3.	Principles of Plasma Physics by N. A. Krall, A. W. Trivelpiece

List of Reference Books:

1.	Introduction to Plasma theory by Nicholson, D. R
2.	Fundamentals of Plasma Physics by Paul M. Bellan
3.	Plasma Physics: Theoretical Principles and Applications by P.K. Shukla and A.A. Mamun

URLs:

1.	https://archive.nptel.ac.in/courses/115/102/115102020/

Name of Program	**M.Sc. Physics**	**Semester-III**	**Year: 2025**

Name of Course	**Quantum Many-Body Theory**	
Course Code	**PY MS 2155**	
Core / Elective / Other	**Elective**	**Credit: 3**

Course Objective:
This advance course aims to provide deep understanding with the basic theoretical tools to address different aspects of quantum many-body problems in condensed matter physics in and out of the equilibrium.

Course Outcomes:
Upon completion of the course, students will be able to:

- CO1: Understand the fundamentals of quantum many-body systems, application of quantum field theory in condensed matter physics and second quantization (occupation number) formalism.
- CO2: Understand many-body Green's function theory, including causal, retarded, and advanced Green's functions, and interpret their physical significance in equilibrium and non-equilibrium systems.
- CO3: Apply analytical equation of motion and perturbation theory to solve basic many-body problems.
- CO4: Apply non-equilibrium transport theory, including Keldysh formalism
- CO5: Study the Meir-Wingreen/Landauer/Kubo formulas to study electronic transport in mesoscopic systems.

Syllabus:
Introduction to many-body systems and quantum field theory in condensed matter physics; Second quantization formalism; Boson and Fermion creation and annihilation operators; general form for second quantization operators and basis change; Examples: operators for kinetic energy, spin, density, Coulomb interaction and hybridization. Schrodinger, Heisenberg and Dirac (interaction) pictures; Equilibrium Green function theory: Single-particle double-time Green's functions (casual, retarded, and advanced) and their analytic structures; Lehmann spectral representation and physical interpretation of Green's functions; imaginary time formulation; analytic continuation; measuring the single-particle spectral function – tunneling and optical spectroscopy.
Green's functions equation of motion technique; Example: Anderson impurity model with correlation effects (Hartree-Fock mean-field approximation). Perturbation theory: S-matrix; Wick's theorem; Feynman rules and diagrammatic perturbation theory for equilibrium Green's function; Dyson series and self-energy; Example: impurity scattering. Non-equilibrium transport theory: Keldysh formalism; contour ordered and non-equilibrium Green's functions (lesser and greater); Dyson and Keldysh equations; Meir–Wingreen and Landauer/Kubo formula for current; linear response theory; Example: electrical conduction in hybrid normal-QD nanodevice.

List of Text Books:

1.	A. A. Abrikosov, et. al., Methods of Quantum Field Theory in Statistical Physics, Oxfard Univ. (1965)
2.	A. L. Fetter and J. D. Walecka, Quantum theory of many particle systems, McGraw-Hill (1971)
3.	R. D. Mattuck, A guide to Feynman diagrams in the many-body problem, Dover publication (1973)
4.	G. D. Mahan, Many Particle Physics, Plenum Press, New York (1993).
5.	H. Bruus and K. Flensberg, Many-body quantum theory in condensed matter physics, Oxford Univ. Press, (2007).
6.	H. Haug and A.-P Jauho, Quantum Kinetics in Transport and Optics of Semiconductors (Solid-State Sciences vol 123), Springer Berlin, Heidelberg, 2nd edn., (2008)
7.	A. Altland and B. Simons, Condensed Matter Field Theory, Cambridge Univ. Press (2010)
8.	P. Coleman, Introduction to Many-Body Physics, Cambridge Univ. Press (2015)

List of References:

1.	P. Coleman, Introduction to Many-Body Physics, Cambridge Univ. Press (2015)
2.	H. Haug and A.-P Jauho, Quantum Kinetics in Transport and Optics of Semiconductors (Solid-State Sciences vol 123), Springer Berlin, Heidelberg, 2nd edn., (2008)
3.	H. Bruus and K. Flensberg, Many-body quantum theory in condensed matter physics, Oxford Univ. Press, (2007).
4.	R. D. Mattuck, A guide to Feynman diagrams in the many-body problem, Dover publication (1973)
5.	L. V. Keldysh, Sov. Phys.-JETP 20, 1018-1026, (1965).
6.	P. W. Anderson, Localized Magnetic States in Metals, Phys. Rev. 124, 41 (1961)
7.	D. N. Zubarev, Double-time Green functions in statistical physics, Sov. Phys. Usp. **3**, 320 (1960)

URLs:

1.	https://www.youtube.com/playlist?list=PL6FyrZIBwD8LMWizZW1FUN2dS_l44yuiy
2.	https://onlinecourses.nptel.ac.in/noc22_ph09/preview