Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY401	**Title of the Course**	Mathematical Physics	**L**	**T**	**P**	**C**
Year	1st	**Semester**	1st	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart advanced knowledge of mathematical methods used in different disciplines of physics.						

Course Outcomes	
CO1	Given square, symmetric or Hermitian matrices, the students will be able to determine their rank, inverse, adjoint, eigenvalue, eigenvectors and perform other related operations.
CO2	For given mathematical functions satisfying per-requisite conditions, students will be able to perform their Laplace transform, Inverse Laplace transform, Fourier transform, Inverse Fourier transform and expand them in Fourier series.
CO3	For given complex functions, students will be able to identify their analytic behavior, classify different singularities, evaluate integrals using analytic continuation, Cauchy integral theorem, residue theorem and using gamma function.
CO4	Determine the series solution of Linear ordinary differential equations and second-order differential equations by power method and Frobenius method.
CO5	Explain the types, properties and symmetries of the groups and obtain their representations and multiplication table.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Matrices	Linear vector spaces, matrix spaces, linear operators, eigenvectors and eigenvalues, matrix diagonalization, special matrices	08	1
2	Integral Transforms and Fourier Series	Laplace Transform: properties of LT., shifting theorems on LT, LT of derivatives, Derivatives of LT., LT. of integrals, integration of LT, initial and final value theorems, inverse LT. by partial fractions, Fourier Series, Dirichlet's conditions, determination of Fourier coefficients, FS for arbitrary period, half-wave expansions, Fourier integral theorem, Fourier sine and cosine transforms, Fourier Transforms of Dirac Delta function, simple problems.	08	2
3	Complex Analysis	Analytic functions, Cauchy-Riemann conditions, classification of singularities, Cauchy's theorem, Taylor and Laurent expansions, analytic continuation, residue theorem, evaluation of definite integrals, summation of series, gamma function.	08	3
4	Differential Equations and special Functions	Linear ordinary differential equations and their singularities, series solution of second- order equations, Legendre's polynomial, Hermite polynomial, Laguerre and Bessel functions, classical polynomials, Sturm-Liouville problem, expansion in orthogonal functions, wave and heat equations in 2D and 3D.	08	4
5	Group Theory	Symmetries and groups, multiplication table and representations, Isomorphism and Homomorphism, permutation group, translation and axial rotation groups, SO (2), SO (3), SU(2), lie algebra and representation of a lie group, translation group and reciprocal lattice.	08	5

Reference Books:

1. G.B. Arfken, *Mathematical Methods for Physicists*
2. P. Dennery and A. Krzywicki, *Mathematics for Physicists*
3. P.K. Chattopadhyay, *Matrices and Tensors in Physics*
4. A.W. Joshi, *Complex Variables and Applications*
5. R.V. Churchill and J.W. Brown, *Complex Variables and Applications*
6. P.M. Morse and H. Feshbach, *Methods of Theoretical Physics (Volume I and II)*

e-Learning Source:

1. **https://www.freebookcentre.net/Physics/Mathematical-Physics-Books.html**
2. **https://nptel.ac.in/courses/115106086/**
3. **www.youtube.com**

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**	**1**	**2**		**2**		**2**						**2**	**1**	**2**	**3**	**1**	**3**
CO2	**3**	**2**	**1**		**1**		**2**						**1**	**1**	**-**	**2**	**3**	**1**
CO3	**2**	**1**	**2**		**2**		**1**						**1**	**-**	**2**	**1**	**1**	**3**
CO4	**3**	**1**	**2**		**1**		**1**						**2**	**1**	**3**	**1**	**3**	**2**
CO5	**3**	**2**	**3**	**1**	**3**	**1**	**3**						**3**	**1**	**2**	**1**	**3**	**3**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY402	**Title of the Course**	**Classical Mechanics**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	1st	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart basic and key knowledge of classical physics, the Newtonian physics. Despite many modern theories the Newtonian mechanics remain essential part of every single in daily life. After successful completion of course, the student will able to utilize the classical mechanics to the level of its validity.						

Course Outcomes	
CO1	Students will gain an understanding of the Newtonian mechanics and the limitation of it which introduce the concept of classical mechanics.
CO2	Students will be able to represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.
CO3	students will gain an understanding of two-particle central force problem in relative and centre of mass coordinates, derive Kepler's planetary laws of motion and scattering in central force problem which develop a deep understanding of planetary motion.
CO4	Students will create the own understanding of small oscillations which helps them to find frequency of small oscillations.
CO5	Students will be able to understand, what is the need of quantum mechanics? And the mathematics formulated as applied to physics.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Preliminaries	Newtonian mechanics of one and many particle systems, Simple Pendulum with rigid support, Two connected masses with string passing over a pully, Virtual work, Rolling mass inside or outside a circular ring, Constraints; their classification, D'Alembert's principle, generalized coordinates.	08	1
2	Lagrangian and Hamiltonian Formulations of Mechanics	Calculus of variations, Hamilton's principle of least action, Lagrange's equations of motion, conservation laws, systems with a single degree of freedom, rigid body dynamics, symmetrical top, Hamilton's equations of motion, phase plots, fixed points and their stabilities.	08	2
3	Two-Body Central Force Problem	Equation of motion and first integrals, classification of orbits, Kepler problem, scattering in central force field.	08	3
4	Small Oscillations	Concept of small oscillations, Expression of kinetic energy and potential energy for the problem of small oscillations, Frequencies of free vibration, and Normal coordinates. Linearization of equations of motion. Vibrations of coupled systems, vibrations of tri- atomic molecule.	08	4
5	Hamiltonian Mechanics and Chaos	Canonical transformations, Poisson brackets, Hamilton-Jacobi theory, action-angle variables, perturbation theory, integrable systems, introduction to chaotic dynamics.	08	5

Reference Books:

1. H. Goldstein, *Classical Mechanics.*
2. L.D. Landau and E.M. Lifshitz, *Mechanics*
3. I.C. Percival and D. Richards, *Introduction to Dynamics*
4. J.V. Jose and E.J. Saletan, *Classical Dynamics: A Contemporary Approach*
5. E.T. Whittaker, *A Treatise on the Analytical Dynamics of Particles and Rigid Bodies*
6. N.C. Rana and P.S. Joag, *Classical Mechanics*

e-Learning Source:

1. https://nptel.ac.in/courses/115/105/115105098/
2. https://nptel.ac.in/courses/115/106/115106068/
3. https://nptel.ac.in/courses/122/106/122106027/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	2	2	1	3	2	1	1						1	2	1	2	1	
CO2	3	1	2	1	3	1							1	3	1	3	1	
CO3	2	3	2	2	3	2	1						2	2	2	2	1	
CO4	3	1	2	1	2	1							3	1	1	1	2	
CO5	3	2	1	1	2	2	2						3	1	3	1	3	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY403	**Title of the Course**	**Quantum Mechanics-I**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	1st	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	This Course offers a systematic introduction to fundamental non-relativistic quantum mechanics. After successful completion of course, the student will able to work on the postulates of quantum mechanics for physical systems.						

Course Outcomes	
CO1	Would be able to analyze the inadequacies of classical mechanics in atomic domain and provide the understanding of probabilistic outcomes in quantum mechanics. Would be able to represent a problem in state vector notion.
CO2	To analyse the central concepts and principles in quantum mechanics, such as the Schrödinger equation.
CO3	To solve the Schrodinger's equation for time independent problems like free particle, particle in an infinite potential well, square potential well, the step potential and potential barrier and the simple harmonic oscillator. Applying ladder operators to solve the quantum mechanical problems.
CO4	To analyze the structure of the hydrogen atom and show an understanding of quantisation of angular momentum.
CO5	Would be able to apply the symmetry operations and basis transformations.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Linear vector Space, Empirical basis, wave-particle duality, electron diffraction, notion of state vector and its probability interpretation	08	1
2	Structure of Quantum Mechanics	Operators and observables, significance of eigen functions and eigenvalues, commutation relations, uncertainty principle, measurement in quantum theory.	08	2
3	Quantum Dynamics	Time-dependent Schrödinger equation, stationary states and their significance, time- independent Schrödinger equation. Free-particle solution, wave packets, particle in a square well potential, transmission through a potential barrier, simple harmonic oscillator by wave equation and operator methods, charged particle in a uniform magnetic field, coherent states.	08	3
4	Spherically Symmetric Potentials	Separation of variables in spherical polar coordinates, orbital angular momentum, parity, spherical harmonics, free particle in spherical polar coordinates, square well potential, hydrogen atom.	08	4
5	Symmetry in Quantum Mechanics	Symmetry operations and unitary transformations, conservation principles, space and time translations, rotation, space inversion and time reversal, symmetry and degeneracy.	08	5

Reference Books:

1. C. Cohen-Tannoudji, B. Diu and F. Laloe, *Quantum Mechanics (Volume I).*
2. L.I. Schiff, *Quantum Mechanics.*
3. E. Merzbacher, *Quantum Mechanics*
4. R.P. Feynman, *Feynman Lectures on Physics (Volume3)*
5. A. Messiah, *Quantum Mechanics (Volume I)*
6. R. Shankar, *Principles of Quantum Mechanics*

e-Learning Source:

1. https://nptel.ac.in/courses/115/102/115102023/
2. https://nptel.ac.in/courses/115/104/115104096/
3. https://nptel.ac.in/courses/115/103/115103104/
4. https://nptel.ac.in/courses/115/101/115101107/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	2	2		1	1		1						3	1	1	1	1	1
CO2	3	1	1		1		2						3	2	1	1	1	1
CO3	2	1	2	2	3		3						3	1	3	3	1	1
CO4	3	2	3		1		2						3	1	3	3	1	1
CO5	3	1		2	2		2						3	1	1	1	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY404	**Title of the Course**	**Statistical Mechanics-I**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	1st	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart basic and key knowledge of Statistical Mechanics. By using the principles of physics and mathematics students will be able to obtain quantitative relations which are very important for higher studies. After successful completion of course, the student will be able to explore the subject into their respective dimensions.						

Course Outcomes	
CO1	Students will gain an understanding of basic tools of statistics, their significance and practical applications in different domains of real life.
CO2	Students will be able to apply the basic and advance mathematical concepts to solve the problems of thermodynamics.
CO3	Students will gain understanding of fundamental concepts of classical statistical mechanics and apply them to solve thermodynamical problems from statistical point of view.
CO4	Students will develop their own understanding of quantum statistical mechanics and solve the problems associated with the systems obeying Bose-Einstein statistics.
CO5	Students will be able to apply their knowledge to deal with the problems of the systems obeying Fermi-Dirac statistics.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Elementary Probability Theory	Random variables, mean, variance and standard deviations, Binomial, Poisson and Gaussian distributions, central limit theorem. problems	08	1
2	Review of Thermodynamics	Basic postulates of thermodynamics, Extensive and intensive variables The Euler Equation, The Gibbs-Duhem relation, Legendre transformations and thermodynamic potentials, Maxwell relations, applications of thermodynamics to (a) ideal gas, (b) magnetic material, and (c) Electromagnetic radiation.	08	2
3	Formalism of Equilibrium Statistical Mechanics	Concept of phase space, Liouville's theorem, basic postulates of statistical mechanics, ensembles; microcanonical, canonical, grand canonical, and NPT ensembles and their connection to thermodynamic variables, fluctuations in energy density and no. of particles in various ensembles, applications of various ensembles, statistical mechanics of a system of harmonic oscillators, equation of state for a non-ideal gas, Vander Waals' equation of state, Meyer cluster expansion, Virial coefficients	08	3
4	Quantum Statistics-1	The density matrix, application of quantum statistics to (i) an electron in a magnetic field (ii) A free particle in a box (iii) and a linear harmonic oscillator. Bose-Einstein statistics, applications of the formalism to; Ideal Bose gas, Debye theory of specific heat of solids, thermodynamics of black-body radiation, Bose-Einstein condensation, experimental studies on atomic BEC.	08	4
5	Quantum Statistics-2	Fermi-Dirac statistics, Thermodynamic behavior of Ideal Fermi gas, thermionic emission, photoelectric emission, Pauli paramagnetism, electronic specific heat, white dwarf stars, mass radius relationship, Chandrashekhar limit.	08	5

Reference Books:

1. K. Huang, *Statistical Mechanics*, John Wiley and Sons, 2nd Edition, 1987.
2. R.K. Pathria, *Statistical Mechanics*, Academic Press, 3rd Edition, 2011.
3. E.M. Lifshitz and L.P. Pitaevskii, *Physical Kinetics*, Pergamon Press, 2012.
4. D.A. McQuarrie, *Statistical Mechanics*, Harper and Row Publication, 2000.
5. L.P. Kadanoff, *Statistical Physics: Statistics, Dynamics and Renormalization*, World Scientific Press, 2000.

e-Learning Source:

1. https://nptel.ac.in/courses/115/103/115103113/
2. https://nptel.ac.in/courses/115/106/115106111/
3. https://youtu.be/D1RzvXDXyqA

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**	**2**	**1**	**2**	**2**	**3**	**1**						**2**	**2**	**1**	**1**	**2**	
CO2	**3**	**3**	**2**		**3**	**1**	**3**						**3**	**1**	**3**	**2**	**1**	
CO3	**2**	**1**	**1**		**2**	**3**	**2**						**2**	**2**	**2**	**3**	**3**	
CO4	**3**	**2**	**3**		**1**	**1**	**3**						**2**	**1**	**3**	**2**	**1**	
CO5	**2**	**3**	**2**		**2**	**1**	**2**						**2**	**2**	**2**	**1**	**2**	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY405	**Title of the Course**	**Solid State Electronics**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	1st	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	To understand the fundamental principle of Solid State Physics. To learn about the relationship between electron transport properties and operation of semiconductor devices. To learn the working and use of different types of diodes. To learn the analysis of different BJT configurations and Biasing methods.						

Course Outcomes	
CO1	Students shall be able to Apply the fundamental principle of Quantum Mechanics and SolidState Physics to understand the parameters of semiconductor materials also able to describe the relationship between electron transport properties and operation of semiconductor devices.
CO2	Students will be familiar with the working and use of different types of diodes, able to discuss the concepts of various biasing methods for BJT also able to Analyze the BJT configurations.
CO3	Students shall be able to Investigate the different configuration and obtain the device small signal model of BJTs, Analysis of a Transistor amplifier circuit using h parameters.
CO4	Students will be familiar with the construction and characteristics of JFET, transfer characteristic and Analyze the FET Biasing concepts, FET and MOSFET amplifier, small signal analysis.
CO5	Students shall be able to analyze and compare the features of different power electronic devices like SCR, UJT etc.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Conduction Mechanism in Metals & Semiconductors	Mobility and conductivity, Density of states, Equilibrium concentration of electrons and holes- the Fermi level and energy distribution of carriers inside the bands- temperature dependence of carrier concentration inside the bands - Carrier transport in semiconductors - drift of carriers in electric fields, carrier flow by diffusion - constancy of Fermi level across junction, recombination, Einstein relation, continuity equation.	08	1
2	Junction Devices	Theory of PN junction diode, Zener diode, Photodiode, Tunnel diode, PIN diode and Varactor diode, GUNN diode, Transistor biasing, CB, CE, CC configurations, Input output characteristics, Early Effect, Graphical analysis of the CE configuration, Thermal stabilization, The operating point, Bias stability.	08	2
3	Transistor Models	Transistor hybrid model, h parameters, Analysis of a Transistor amplifier circuit using h parameters, Measurement and graphical determination of h parameters, Hybrid π model, The re transistor model, Ebers-Moll models.	08	3
4	Field Effect Transistors	Construction and characteristics of JFET, transfer characteristic, The FET small signal model, Measurement of gm and rd, JFET fixed bias, Self bias and voltage divider configurations, Use of FET as voltage controlled resistor, JFET source follower (commonDrain) configuration, JFET Common – Gate configuration, Depletion and enhancement type MOSFETs	08	4
5	Power Electronics	SCR: Its operation, characteristics, SCR as Series Static switch, variable resistance phase controller, battery charging regulator, as a temperature controller, as emergency lighting system, as voltage sensor, as sawtooth generator, silicon controlled switch, light activated SCR, Shockley diode, Diac, Triac, UJT Characteristics	08	5

Reference Books:

1. Solid State Electronic Devices by B.G. Streetman
2. Electronic Devices and Circuit Theory by R.L. Boylested and L. Nashelsky
3. Integrated Electronics by J. Millman and C.C. Halkias
4. Introduction to Semiconductor Devices by M. S. Tyagi

e-Learning Source:

1. https://nptel.ac.in/courses/117/103/117103063/
2. https://nptel.ac.in/courses/108/102/108102095/
3. https://nptel.ac.in/courses/108/102/108102145/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	2		2	1							1	1	2	2	2	1
CO2	3	3	3		1	2	1						1	2	2	2	2	2
CO3	2	1	1	3	2	1	2						2	2	3	1	3	2
CO4	3	2	3	1	1								2	3	1	2	3	3
CO5	2	3	2	2	2		1						2	2	2	1	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY406	**Title of the Course**	**General and Optics Lab**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	1st	**0**	**0**	**8**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart practical knowledge/measurements in optics and electronics.						

Course Outcomes	
CO1	Student will be able to apply the theoretical understanding of Interference, Diffraction and LASER into practical applications.
CO2	Student will learn to verify the principle of polarization and also how to produce circularly and elliptically polarized light.
CO3	Student will learn the behavior of solid state devices like UJT and FET.
CO4	Student will learn how to design a regulated power supply and CE amplifier.
CO5	Student will learn how to find the energy band gap of a semiconductor and also how to design digital logic elements using transistors.

Experiment No.	Title of the Experiment	Content of Unit	Contact Hrs.	Mapped CO
1	**Reflection Grating**	To determine the wavelength of prominent lines of mercury with the help of reflection grating.	08	1
2	**Laser**	(a) To plot the power distribution of a laser beam. (b) To determine the divergence of a given laser source.	08	1
3	**Babinet Compensator**	The study of elliptically and circularly polarized light with help of Babinet's compensator.	08	2
4	**Etalon**	To determine the thickness of air film between glass plates, the integral part of the order of fringes at the center and the fractional part, if any, in an Etalon.	08	1
5	**Fresnel's Formula**	To verify Fresnel's formula of reflection for plane polarized light and to determine Brewster's angle for glass.	08	2
6	**Characteristics of UJT and FET**	To study the transfer characteristics of UJT and FET.	08	3
7	**Common Emitter Amplifier**	To study the design of CE Amplifier.	08	4
8	**Regulated Power Supply**	To study the design of Regulated Power Supply.	08	4
9	**Four Probe Method**	Determination of band gap of semiconductor from temperature dependence of resistivity using Four Probe Method.	08	5
10	**Logic Gates**	Design of simple logic gates using transistors.	08	5

Reference Books:

1. Hand book of electronics by V. Kumar
2. Modern Digital Electronics by R.P.Jain
3. Practical physics by Kumar P.R.S., PHI learning private limited

e-Learning Source:

1. https://circuitdigest.com/electronic-circuits/designing-and-gate-using-transistors
2. https://www.circuitstoday.com/characteristics-of-jfets
3. https://www.youtube.com/watch?v=HG22Y0KrvI0
4. http://www.rossnazirullah.com/BSc/BSc.htm

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**	**2**	**2**	**1**	**2**	**1**	**1**						**2**	**1**	**2**	**3**	**1**	**2**
CO2	**3**	**3**	**2**		**1**	**1**	**2**						**3**	**1**	**2**	**2**	**1**	**2**
CO3	**2**	**2**	**3**	**1**	**2**		**3**						**1**	**2**	**2**	**1**	**3**	**1**
CO4	**3**	**2**	**1**		**1**		**1**						**2**	**1**	**2**	**3**	**1**	**2**
CO5	**2**	**2**	**2**	**1**	**2**	**1**	**1**						**3**	**2**	**1**	**2**	**2**	**2**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY407	**Title of the Course**	**Quantum Mechanics-II**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	2nd	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	This course is aimed at providing a comprehensive review of the core concepts of quantum mechanics through problem solving and introducing some advanced topics with illustrative examples.						

Course Outcomes	
CO1	Ability to solve problems related to angular momentum and determine the coefficients corresponding to addition of angular momentum.
CO2	Students can account for the phenomena involved in the Zeeman effect and spin-orbit coupling, what is meant by identical particles and quantum statistics, and they will be able to perform calculations on systems of identical particles.
CO3	Students will be able to develop the solution of actual or perturbed problems based on exact problems or Hamiltonians.
CO4	Analysis of scattering and differential cross section of wave packets.
CO5	Students will be able to solve Dirac's equation. They will be able to analyze the spin orbit interaction comprehensively.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Angular Momentum	Rotation operators, angular momentum algebra, eigen values of J^2 and J_Z, Matrix representation of S_X, S_Y, S_Z, J_X, J_Y, J_Z, J^2, spinors and Pauli matrices, addition of angular momenta, Clebsch-Gordon coefficients.	08	1
2	Identical Particles and Time-independent Approximation Methods	Indistinguishability, symmetric and anti-symmetric wave functions, incorporation of spin, Slater determinants, Pauli exclusion principle. Non-degenerate perturbation theory, degenerate case, Stark effect, Zeeman effect and other examples, variational methods, WKB method, tunneling.	08	2
3	Time-dependent Problems	Schrödinger and Heisenberg picture, time-dependent perturbation theory, transition probability calculations, golden rule, adiabatic approximation, sudden approximation, beta decay as an example.	08	3
4	Scattering Theory	Differential cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering.	08	4
5	Relativistic Quantum Mechanics	Klein-Gordon equation, Dirac equation and its plane wave solution, Significance of negative energy solutions, Spin angular momentum of the Dirac particle, Electron in EM fields, Spin- orbit interaction, Dirac equation for a particle in a central force field.	08	5

Reference Books:

1. C. Cohen-Tannoudji, B. Diu and F. Laloe, *Quantum Mechanics (Volume II).*
2. A. Messiah, *Quantum Mechanics (Volume I)*
3. Flügge, *Practical Quantum Mechanics*
4. J.J. Sakurai, *Modern Quantum Mechanics*
5. K. Gottfried, *Quantum Mechanics*

e-Learning Source:

1. https://nptel.ac.in/courses/115/103/115103104/
2. https://nptel.ac.in/courses/115/102/115102023/
3. https://nptel.ac.in/courses/115/108/115108074/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1		1		1						3	2	1	3	1	
CO2	3	1	1		1		1						3	2		1	1	
CO3	3	1	1		1		1						3	2		3	1	
CO4	3	1	1		1		1						3	2	2		1	
CO5	3	1	1		1		1						3	2	3	3	1	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY408	**Title of the Course**	**Electromagnetic Theory**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	2nd	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart basic and key knowledge and basic skills required to understand electromagnetic theory and emphasis on the inter-relationship between Electricity and Magnetism. By using the principal of physics and mathematics to obtain quantitative relations which are very important for higher studies. After successful completion of course, the student will be able explore subject into their respective dimensions						

Course Outcomes	
CO1	Students will impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications and understand the basic mathematical concepts related to electromagnetic vector fields.
CO2	Students will be able understand the methods for solving boundary value problems for magnetic field and to evaluate the Biot-Savat law, Ampere's law.
CO3	Students will gain an understanding of Maxwell's equations and be able to apply them to solving practical electromagnetic fields problems.
CO4	Students will gain an understanding of laws governing electrodynamics, plane wave propagation in different media, power flow, polarization, transmission and reflection at an interface, transmission lines, waveguides.
CO5	Students will understand the fundamental equations acquire a sense of unity in physics at a fundamental level by embracing the concepts of special relativity as emerged through the laws of electrodynamics and equipped with the necessary mathematical concepts to be able to solve relative problems.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Electrostatics	Differential equation for electric field, Poisson and Laplace equations, formal solution for potential with Green's functions, boundary value problems, examples of image method and Green's function method, solutions of Laplace equation in cylindrical and spherical coordinates by orthogonal functions, dielectrics, polarization of a medium, electrostatic energy.	08	1
2	Magnetostatics	Biot-Savart law, differential equation for static magnetic field, magnetic field from localized current distributions, examples of magnetostatic problems, Faraday's law of induction, magnetic energy of steady current distributions.	08	2
3	Maxwell's Equations	Displacement current, Maxwell's equations, vector and scalar potentials, gauge symmetry, Coulomb and Lorentz gauges, electromagnetic energy and momentum, conservation laws, inhomogeneous wave equation and Green's function solution.	08	3
4	Electromagnetic Waves	Plane waves in a dielectric medium, reflection and refraction at dielectric interfaces, frequency dispersion in dielectrics and metals, dielectric constant and anomalous dispersion, wave propagation in one dimension, group velocity, metallic wave guides, boundary conditions at metallic surfaces, propagation modes in wave guides, resonant modes in cavities.	08	4
5	Radiation and Covariant Formulation of Electrodynamics	Field of a localized oscillating source, fields and radiation in dipole and quadrupole approximations, antenna, radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lorentz formula. Four-vectors relevant to electrodynamics, electromagnetic field tensor and Maxwell's equations, transformation of fields, fields of uniformly moving particles.	08	5

Reference Books:

1. J.D. Jackson, *Classical Electrodynamics*
2. D.J. Griffiths, *Introduction to Electrodynamics*
3. J.R. Reitz, F.J. Milford and R.W. Christy, *Foundations of Electromagnetic Theory*
4. W.K.H. Panofsky and M. Phillips, *Classical Electricity and Magnetism*
5. F.F. Chen, *Introduction to Plasma Physics and Controlled Fusion*

e-Learning Source:

https://nptel.ac.in/courses/115/101/115101004/

https://nptel.ac.in/courses/115/104/115104088/

https://nptel.ac.in/courses/115/106/115106122/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	1		2	1	2						3	2	1	1	2	1
CO2	3	1	2	1	3		3						2	3	3	1	3	2
CO3	2	3	2		3	2	2						3	1	2	2	2	1
CO4	3		1	1	2		1						2	2	3	1	3	3
CO5	1	2	1	2	2	1							3	2	2	1	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY409	**Title of the Course**	**Condensed Matter Physics**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	2nd	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	This course aims to establish fundamental concepts in condensed matter physics and applies the physics you have learned previously (in particular quantum mechanics, classical mechanics, electromagnetism and statistical mechanics) to these real-world materials.						

Course Outcomes	
CO1	Examine the electric and thermal transport phenomena in solids based on the free electron theory.
CO2	Conceptualize the different types of bonds that exists in nature, the problem of X-ray diffraction and appreciate the beauty of Bragg's treatment along with the contribution of Von Laue and Miller in solving it.
CO3	Students will understand the role of electronic energy band structures of solids in governing various electrical and optical properties of materials.
CO4	Students will create the own understanding of molecular vibrations in determining thermal properties of materials.
CO5	Explain the origin of superconducting and magnetic properties of materials and compare on the basis of quantum theory.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Free Electron Theory and Transport Phenomena in solids	Drude theory, Review of Sommerfeld model of Free electron gas, critique of free-electron model, Boltzmann Transport Equations, Electrical and Thermal Conductivity of metals, Wiedemann-Franz law, Hall effect and magneto-resistance, Thermo-electric effects.	08	1
2	Bonding in Solids and Crystal Lattices	Bond classifications: Nature of bonding, ionic crystals, cohesive energy and Madelung Constant, covalent, molecular and hydrogen bonding. Bravais lattices and their classification. Symmetry operations, reciprocal lattice, X-ray diffraction, Bragg's law, Von Laue's formulation, Miller indices, relation between Miller Indices of a family of planes and inter planar spacing.	08	2
3	Band Theory of Solids	Energy spectra in atoms, molecules and solids, formation of energy bands, comparative picture of bands structure of metals, semiconductors and insulators. Electron wave equation in a periodic potential (Bloch theorem), Kronig Penney model. Motion of electron in a one dimensional periodic potential, crystal momentum and effective mass. Brillouin zones and Fermi surface. Cyclotron Resonance and De Hass Van Alphen Effect.	08	3
4	Lattice Dynamics	Wave motion of one dimensional atomic lattice, group velocity and phase velocity, vibrations of a one dimensional lattice with two atoms per primitive cell, normal modes of vibrations, density of states, quantization of vibrations (Phonons), inelastic scattering of photons by long wavelength phonons. Thermal properties of solids: Specific heat, Dulong Pettit's law, Einstein and Debye model of specific heat.	08	4
5	Magnetism and Superconductivity	Origin of magnetism, classical theory of diamagnetism and paramagnetism, ferromagnetism, hysteresis, energy loss, Curie law, Weiss theory of ferromagnets and Curie-Weiss law. Superconductivity: Thermodynamics of superconductors, London's equation and Meissner effect, Type-I and Type-II superconductors	08	5

Reference Books:

1. C. Kittel, *Introduction to Solid State Physics*
2. N.W. Ashcroft and N.D. Mermin, *Solid State Physics.*
3. J.M. Ziman, *Principles of the Theory of Solids.*
4. A.J. Dekker, *Solid State Physics*
5. G. Burns, *Solid State Physics*
6. M.P. Marder, *Condensed Matter Physics.*

e-Learning Source:

1. https://nptel.ac.in/courses/115/103/115103102/
2. https://nptel.ac.in/courses/115/106/115106061/
3. https://nptel.ac.in/courses/115/105/115105099/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	1		2	2	3						3	1	1	1	1	1
CO2	2	3	2	1	2	2	2						2	1	3	1	1	2
CO3	3	1	2		3	1							1	2	2	2	2	1
CO4	2	1	1		2	1	2						3	2	2	2	2	2
CO5	3	3	2		2	2	3						2	3	3	2	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY410	**Title of the Course**	Nuclear and Particle Physics	**L**	**T**	**P**	**C**
Year	1st	**Semester**	2nd	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart basic and key knowledge of Nuclear Physics. By using the basic principles of Nuclear Physics and its fundamentals reactions to obtain quantitative relations which are very important for higher studies and its applications. After successfully completion of course, the student will be able explore the subject into their respective dimensions.						

Course Outcomes	
CO1	Students will gain an understanding of the basic Nuclear properties and Nuclear forces involved in the formation of a nucleus.
CO2	Students will be able to develop a deep understanding of various phenomenon of Nuclear Reactions, Type of reactions and counters and detectors.
CO3	Students will gain an understanding of the different nuclear models and decay theories.
CO4	Students will be able to understand the classification and properties of elementary particles various types of interactions and conservation rules in fundamental interactions.
CO5	Students will gain an understanding of approaches to the Particle Physics, Strange particles and its conservation.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Basic Nuclear properties and Nuclear forces	Mass, Charge, and Constituents of the nucleus, Nuclear size and distribution of nucleons, Angular momentum, Parity and symmetry, Magnetic dipole moment and electric quadrupole moment, Characteristics of nuclear forces-Range and strength, Ground and exited states of deuteron, Magnetic dipole moment and electric quadrupole moment of deuteron -The tensor forces. Scattering length, Yukawa hypothesis	08	1
2	Nuclear reactions and Detectors	Nuclear Reactions and Cross sections, Type of reactions and Conversation laws. Q- value and its significance. Resonance: Breit-Wigner Dispersion Formula, The compound Nucleus, Statistical theory of Nuclear Reactions, Geiger-Muller Counter, Semiconductor detectors.	08	2
3	Nuclear disintegration and models	Review of the Semi-empirical mass formula, Liquid drop model, Single particle Shell model. Tunneling theory of alpha decay, Fermi theory of Beta decay, inverse beta process, Double- beta decay, Different types of neutrinos: the two neutrino experiment, The neutrino helicity, Gamma decay, Fermi and Gammow- Teller selection rules.	08	3
4	Particle Physics I	Classification and properties of elementary particles, Leptons, Baryons, mesons, particles and antiparticles, excited states and resonances, Various types of interactions, gravitational, electromagnetic, weak and strong interactions and their mediating quanta, Conservation rules in fundamental interactions.	08	4
5	Particle Physics II	Charge symmetry and charge independence, Parity and charge conjugation, Conservation of parity and its violation in different types of interactions. Gell-Mann Nishijima formula, Strange particles, associated production, strangeness and decay modes of charged Kaons, Isospin and its conservation. Idea of eight fold way and quarks	08	5

Reference Books:

1. G.D. Coughlan and J.E. Dodd, *The Ideas of Particle Physics*
2. D. Griffiths, *Introduction to Elementary Particles*
3. D.H. Perkins, *Introduction to High Energy Physics*
4. I. Kaplan, *Nuclear Physics*
5. R.R. Roy and B.P. Nigam, *Nuclear Physics*
6. M.A. Preston and R.K. Bhaduri, *Structure of the Nucleus*
7. M.G. Bowler, *Nuclear Physics*

e-Learning Source:

1. https://archive.nptel.ac.in/courses/115/103/115103101/
2. https://archive.nptel.ac.in/courses/115/104/115104043/
3. https://archive.nptel.ac.in/courses/115/102/115102017/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	1		1	3	2						3	3	2	2	3	3
CO2	2	2	3		3	2	3						2	1	1	1	3	3
CO3	3	1	2		1	3	2						2	1	1	1	3	3
CO4	2	2	3		2	1	3						3	3	2	2	3	3
CO5	2	1	1		1	2	2						3	3	2	2	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY411	**Title of the Course**	**Digital Electronics**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	2nd	**3**	**1**	**0**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	1. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits. 2. To prepare students to perform the analysis and design of various digital electronic circuits.						

Course Outcomes	
CO1	Student shall be able to understand the basics of operational amplifier (Op-Amp) along with examine, analyze and evaluate its various version including voltage source rectifiers and filters.
CO2	For the given logic families of integrated circuits, student shall be able to understand its specifications. Students would examine, analyze the DTL, TTL, MOSFET, CMOS and evaluate universal gates.
CO3	Given a number, students shall be able to represent various conversions in mathematical form. Student shall be able to analyze and evaluate various theorems and K- Map method and able to design various logic circuits.
CO4	For a given Combinational circuit and sequential circuits, student shall be able to understand its various building blocks and examine, analyze and evaluate adders, Subtractor, multiplexer, encoders, multivibrator, A/D and D/A converter and last able to design various logic circuits.
CO5	For a given 8085 microprocessor, student would be able to understand and analyze its architecture, Interfacing devices, Instruction set and programming.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Operational Amplifier Basic and Application	Review of Feedback, Linear Circuit, Op-Amp Basic, Inverting and Non-inverting amplifiers, Unity follower, Summing amplifiers, Integrator, Differentiator, Op- Amp Specifications- DC Off- set parameter, Frequency parameters, Imperfection in Op- Amplifier application- multiple stage gain, Voltage summing and subtraction, Current controlled voltage source, Voltage controlled current source, Rectifiers and Limiters, Comparators and Schmitt Triggers, Active filters.	08	1
2	Digital Logic Gates	Symbols and truth tables, Classes of digital integrated circuits (Diode logic, DTL, TTL, ECL, MOSFET, CMOS), Transistor- Transistor Logic (TTL), Single Input TTL Inverter (transfer characteristic), Multi-collector transistors, Propagation delays, Diode Logic, DTL NAND Gate (transfer characteristic, noise immunity, fan out), Emitter Coupled Logic (transfer characteristic of OR/NOR gate, practical implementation, MOSFET Logic- Review of MOSFET, MOSFET Inverter with active load, MOSFET NOR and NAND gates, Complementary MOS (CMOS)-CMOS inverter, CMOS NOR and NAND, Power dissipation in CMOS, Advantages/Disadvantages of CMOS	08	2
3	Digital Electronics and Logic Gate	Binary, Octal, Hexadecimal number system, Base conversion system, Bipolar junction and Field Effect transistor as switches, Basic digital logic gates (OR, AND and NOT, NOR, NAND and Exclusive OR), XOR gate, Boolean laws and theorem, Sum of Product (SOP) and Product of Sum (POS) method, Karnaugh map, pair, quad and octave, POS simplification, min term, max- term.	08	3
4	Application of Digital Logic Gate	Half adder and Full adder circuit, multiplexers, demultiplexer, Flip- Flop and Registers- RS Flip Flop, D- Flip Flop, T- Flip Flop, JK- Flip Flop, JK Master- Slave Flip Flop, Astable, Monostable and Bi-stable multivibrator, types of registers, serial-in-serial out, serial-in-parallel out, parallel-in- serial out, parallel-in parallel out, Counters and Convertors- asynchronous and synchronous counter, Mod-3 and Mod-5 counters, shift counters, Digital-to Analog Converters-D/A converter, ladder network, A/D converters.	08	4
5	Microprocessor	Intel 8085 microprocessor architecture, interfacing devices, BUS timing, instruction set, simple illustrative program	08	5

Reference Books:

1. Electronic Device and Circuit: R. Boylested and L. Nashelsky
2. Analysis and Design of Digital Integrated Circuit: Hodges, Jackson and Saleh
3. Digital Principles and Implementation: A.P. Malvino and D.P. Leach
4. Op- Amp and Linear Integrated Circuit: Ramakant A. Gayakwad

e-Learning Source:

1. https://archive.nptel.ac.in/courses/108/106/108106177/
2. https://archive.nptel.ac.in/courses/108/105/108105113/
3. https://archive.nptel.ac.in/courses/117/106/117106114/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	1		1	1							1	2	3	3	2	1
CO2	3	2	2	1	2	1	1						2	1	2	2	3	2
CO3	2	1	3		3	2	1						2	3	2	1	2	2
CO4	3	3	2	1	2	1	3						3	2	1	2	1	3
CO5	1	1	3		1								1	1	3	2	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	PY412	**Title of the Course**	**Programming and Condensed Matter Physics Lab**	**L**	**T**	**P**	**C**
Year	1st	**Semester**	2nd	**0**	**0**	**8**	**4**
Pre-Requisite	B.Sc. with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this postgraduate course is to impart practical measurements using numerical techniques in condensed matter physics						

Course Outcomes	
CO1	To determine solution of transcendental/polynomial equations and perform matrix operations using MATLAB.
CO2	To determine numerical solution of differential equations and perform integration of given functions.
CO3	To study the characteristics of a Geiger–Müller (GM) counter and demonstrate its utilization and also experimentally visualize Hall effect.
CO4	To learn the technique of formation of nanoparticles .
CO5	To analyze and evaluate magnetic, dielectric and transport properties of materials/semiconductors.

Experiment No.	**Title of the Experiment**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Newton – Raphson Method**	Solution of transcendental or polynomial equations by the Newton Raphson method.	08	1
2	**Curve Fitting and Correlation Coefficeint**	Linear curve fitting and calculation of linear correlation coefficient using MATLAB.	08	1
3	**Simpson's Method**	Numerical integration using the Simpson's method.	08	2
4	**Numerical Differentiation**	Numerical first order differentiation of a given function.	08	2
5	**Solution of Equation**	Matrix inversion and solution of simultaneous equation.	08	2
6	**Geiger-Muller (GM) Counter**	To determine resolving/dead time of a GM counter by double source method.	08	3
7	**Hall Effect**	Study of Hall Voltage as a function of probe current and magnetic field and determination of Hall Coefficient and carrier concentration in given sample.	08	3
8	**Ball Mill**	Preparation of nano-crystalline powder specimen by ball milling: analysis of their x-ray spectra and particle size estimation by Scherrer formula.	08	4
9	**Hysteresis Loop Tracer**	Magnetic parameters of a magnetic material by hysteresis loop tracer.	08	5
10	**Dielectric Constant**	Dielectric constant of insulating and ferroelectric materials at room and elevated temperatures.	08	5

Reference Books:

1. Solid State Electronic Devices by B.G. Streetman
2. Electronic Devices and Circuit Theory by R.L. Boylested and L. Nashelsky
3. Integrated Electronics by J. Millman and C.C. Halkias
4. Introduction to Semiconductor Devices by M. S. Tyagi

e-Learning Source:

1. https://nptel.ac.in/courses/117/103/117103063/
2. https://nptel.ac.in/courses/108/102/108102095/
3. https://nptel.ac.in/courses/108/102/108102145/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	3		1	1	2						1	2	3	1	3	1
CO2	3	3	1		2	3	3						2	2	1	2	1	1
CO3	2	2	2		1	1	2						2	1	1	3	2	1
CO4	3	2	1		2	2	3						1	3	2	2	1	2
CO5	2	2	3		1	1	2						2	1	2	1	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**