Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B010501T/PY311	**Title of the Course**	Classical & Statistical Mechanics	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**	Passed B.Sc. 2nd Year				
Course Objectives	This course aims to give students the competence in the basic Classical Mechanics and Statistical Mechanics. At the end of the course the students are expected to the thorough knowledge of basic concepts of Classical Mechanics and Statistical Mechanics.						

Course Outcomes	
CO1	Understand the concepts of generalized coordinates and D'Alembert's principle.
CO2	Understand the Lagrangian dynamics and the importance of cyclic coordinates.
CO3	Comprehend the difference between Lagrangian and Hamiltonian dynamics.
CO4	Study the important features of central force and its application in Kepler's problem.
CO5	Recognize the difference between macrostate and microstate.
CO6	Comprehend the concept of ensembles.
CO7	Understand the classical and quantum statistical distribution laws.
CO8	Study the applications of statistical distribution laws

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Constrained Motion**	Constraints - Definition, Classification and Examples. Degrees of Freedom and Configuration space. Constrained system, Forces of constraint and Constrained motion. Generalised coordinates, Transformation equations and Generalised notations & relations. Principle of Virtual work and D'Alembert's principle	6	CO1
2	**Lagrangian Formalism**	Lagrangian for conservative & non-conservative systems, Lagrange's equation of motion (no derivation), Comparison of Newtonian & Lagrangian formulations, Cyclic coordinates, and Conservation laws (with proofs and properties of kinetic energy function included). Simple examples based on Lagrangian formulation.	9	CO2
3	**Hamiltonian Formalism**	Phase space, Hamiltonian for conservative & non-conservative systems, Physical significance of Hamiltonian, Hamilton's equation of motion (no derivation), Comparison of Lagrangian & Hamiltonian formulations, Cyclic coordinates, and Construction of Hamiltonian from Lagrangian. Simple examples based on Hamiltonian formulation.	8	CO3
4	**Central Force**	Definition and properties (with prove) of central force. Equation of motion and differential equation of orbit. Bound & unbound orbits, stable & non-stable orbits, closed & open orbits and Bertrand's theorem. Motion under inverse square law of force and derivation of Kepler's laws. Laplace-Runge-Lenz vector (Runge-Lenz vector) and its applications.	7	CO4
5	**Macrostate and Microstate**	Macrostate, Microstate, Number of accessible microstates and Postulate of equal a priori. Phase space, Phase trajectory, Volume element in phase space, Quantisation of phase space and number of accessible microstates for free particle in 1D, free particle in 3D & harmonic oscillator in 1D.	6	CO5
6	**Concept of Ensemble**	Problem with time average, concept of ensemble, postulate of ensemble average and Liouville's theorem (proof included). Micro Canonical, Canonical & Grand Canonical ensembles. Thermodynamic Probability, Postulate of Equilibrium and Boltzmann Entropy relation.	6	CO6
7	**Distribution Laws**	Statistical Distribution Laws: Expressions for number of accessible microstates, probability & number of particles in ith state at equilibrium for Maxwell-Boltzmann, Bose-Einstein & Fermi- Dirac statistics. Comparison of statistical distribution laws and their physical significance. Canonical Distribution Law: Boltzmann's Canonical Distribution Law, Boltzmann's Partition Function, Proof of Equipartition Theorem (Law of Equipartition of energy) and relation between Partition function and Thermodynamic potentials.	10	CO7
8	**Applications of Statistical Distribution Laws**	Application of Bose-Einstein Distribution Law: Photons in a black body cavity and derivation of Planck's Distribution Law. Application of Fermi-Dirac Distribution Law: Free electrons in a metal, Definition of Fermi energy, Determination of Fermi energy at absolute zero, Kinetic energy of Fermi gas at absolute zero and concept of Density of States (Density of Orbitals).	8	CO8

Reference Books:

1. Herbert Goldstein, Charles P. Poole, John L. Safko, "Classical Mechanics", Pearson Education, India, 2011, 3e
2. N.C. Rana, P.S. Joag, "Classical Mechanics", McGraw Hill, 2017
3. R.G. Takwale, P.S. Puranik, "Introduction to Classical Mechanics", McGraw Hill, 2017
4. F. Reif, "Statistical Physics (In SI Units): Berkeley Physics Course Vol 5", McGraw Hill, 2017, 1e
5. B.B. Laud, "Fundamentals of Statistical Mechanics", New Age International Private Limited, 2020, 2e
6. B.K. Agarwal, M. Eisner, "Statistical Mechanics", New Age International Private Limited, 2007, 2e

e-Learning Source:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	-	-	-	-	3	2	-	1	2
CO2	3	2	-	-	-	-	3	3	-	1	2
CO3	3	2	-	-	-	-	3	3	-	2	2
CO4	3	2	-	-	-	1	3	3	-	3	2
CO5	3	2	-	-	-	-	3	3	-	3	2
CO6	3	2	-	-	-	-	3	2	-	1	2
CO7	3	2	-	-	-	-	3	3	-	1	2
CO8	3	2	-	-	-	-	3	3	-	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: 2024-25							
Course Code	B010502T/PY312	**Title of the Course**	**Quantum Mechanics and Spectroscopy**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**	Passed B.Sc. 2nd Year				
Course Objectives	This course aims to give students the competence in the basic Quantum Mechanics and Spectroscopy. At the end of the course the students are expected to gain the thorough knowledge of basic Quantum Mechanics and Spectroscopy.						

Course Outcomes	
CO1	Understand the significance of operator formalism in Quantum mechanics.
CO2	Study the eigen and expectation value methods.
CO3	Understand the basis and interpretation of Uncertainty principle.
CO4	Develop the technique of solving Schrodinger equation for 1D and 3D problems.
CO5	Comprehend the success of Vector atomic model in the theory of Atomic spectra.
CO6	Study the different aspects of spectra of Group I and II elements.
CO7	Study the production and applications of X-rays.
CO8	Develop an understanding of the fundamental aspects of Molecular spectra.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Operator Formalism**	**Operators:** Review of matrix algebra, definition of an operator, special operators, operator algebra and operators corresponding to various physical-dynamical variables. **Commutators:** Definition, commutator algebra and commutation relations among position, linear momentum and angular momentum and energy and time. Simple problems based on commutation relations.	5	CO1
2	**Eigen and Expectation Values**	**Eigen and Expectation Values:** Eigen equation for an operator, eigen state (value) and eigen functions. Linear superposition of eigen functions and Non-degenerate and Degenerate eigen states. Expectation value pertaining to an operator and its physical interpretation. **Hermitian Operators:** Definition, properties and applications. Prove of the Hermitian nature of various physical-dynamical operators.	6	CO2
3	**Uncertainty Principle and Schrodinger Equation**	**Uncertainty Principle:** Commutativity and simultaneity (theorems with proofs). Non commutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various conjugate pairs of physical- dynamical parameters and its applications. **Schrodinger Equation:** Derivation of time independent and time dependent forms, Schrodinger equation as an eigen equation, Deviation and interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation.	7	CO3
4	**Applications of Schrodinger Equation**	**Application to 1D Problems:** Infinite Square well potential (Particle in 1D box), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator. **Application to 3D Problems:** Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom (radial distribution function and radial probability included). (Direct solutions of Hermite, Associated Legendre and Associated Laguerre differential equations to be substituted).	12	CO4
5	**Vector Atomic Model**	Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification due to finite mass of nucleus and Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical and geometrical interpretations of various quantum numbers for single and many valence electron systems. LS and JJ couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H-alpha line on the basis of vector atomic model.	10	CO5
6	**Spectra of Alkali and Alkaline Elements**	**Spectra of Alkali Elements:** Screening constants for s, p, d and f orbitals; sharp, principle, diffuse and fundamental series; doublet structure of spectra and fine structure of Sodium D line. **Spectra of Alkaline Elements:** Singlet and triplet structure of spectra.	6	CO6
7	**X – Rays and X – Ray Spectra**	Nature and production, Continuous X-ray spectrum and Duane-Hunt's law, Characteristic X-ray spectrum and Mosley's law, Fine structure of Characteristic X-ray spectrum, and X-ray absorption spectrum.	7	CO7
8	**Molecular Spectra**	Discrete set of energies of a molecule, electronic, vibrational and rotational energies. Quantisation of vibrational energies, transition rules and pure vibrational spectra. Quantisation of rotational energies, transition rules, pure rotational spectra and determination of inter nuclear distance. Rotational-Vibrational spectra; transition rules; fundamental band and hot band; O, P, Q, R, S branches.	7	CO8

Reference Books:

1. D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson Education, India, 2004, 2e
2. E. Wichmann, "Quantum Physics (In SI Units): Berkeley Physics Course Vol 4", McGraw Hill, 2017
3. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 3", Pearson Education Limited, 2012
4. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
5. H.E. White, "Introduction to Atomic Spectra", McGraw Hill, 1934
6. C.N. Banwell, E.M. McCash, "Fundamentals of Molecular Spectroscopy", McGraw Hill, 2017, 4e
7. S.L. Gupta, V. Kumar, R.C. Sharma, "Elements of Spectroscopy", Pragati Prakashan, Meerut, 2015, 27e

e-Learning Source:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	-	-	-	-	3	2	-	1	2
CO2	3	2	-	-	-	-	3	3	-	1	2
CO3	3	2	-	-	-	-	3	3	-	2	2
CO4	3	2	-	-	-	-	3	3	-	3	2
CO5	3	2	-	-	-	-	3	3	-	3	2
CO6	3	2	-	-	-	-	3	2	-	1	2
CO7	3	2	-	-	-	-	3	3	-	1	2
CO8	3	2	-	-	-	-	3	3	-	2	2

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

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

Integral University, Lucknow

Effective from Session: 2024-25								
Course Code	B010503P/PY313	**Title of the Course**	**Demonstrative Aspects of Optics & Lasers**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Fifth	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Physics	**Co-requisite**	Passed B.Sc. 2nd Year				
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge/measurements in Optics through different experiments related to its theoretical course.						

Course Outcomes	
CO1	To understand the application of Fresnel's Biprism in determination of Wavelength of Light and thickness of a thin sheet.
CO2	To understand the application of Newton's Ring in determination of Wavelength of Light and Refractive Index of a Transparent Liquid.
CO3	To find the Resolving Power of a grating and to understand its application in determination of wavelength of different colours of light.
CO4	To find the dispersive power of a prism and refractive index of its material using spectrometer.
CO5	To find the specific resistance of sugar solution using polarimeter and wavelength of Laser light using single slit diffraction.

*** A student has to perform at least 7 experiments from the Offline Experiment List and 3 from the Online Virtual Lab Experiment List / Link.**

Experiment No.	Title of the Experiment	Content of Unit (*Offline)	Contact Hrs.	Mapped CO
1	Wavelength by Fresnel's Biprism	Fresnel Biprism: Wavelength of sodium light	4	CO1
2	Thickness by Fresnel's Biprism	Fresnel Biprism: Thickness of mica sheet	4	CO1
3	Wavelength by Newton's Ring	Newton's Rings: Wavelength of sodium light	4	CO2
4	Refractive Index by Newton's Ring	Newton's Rings: Refractive index of liquid	4	CO2
5	Resolving power of Grating	Plane Diffraction Grating: Resolving power	4	CO3
6	Wavelength by Diffraction Grating	Plane Diffraction Grating: Spectrum of mercury light	4	CO3
7	Refractive index of Prism	Spectrometer: Refractive index of the material of a prism using sodium light	4	CO4
8	Dispersive Power of Prism	Spectrometer: Dispersive power of the material of a prism using mercury light	4	CO4
9	Specific Rotation by Polarimeter	Polarimeter: Specific rotation of sugar solution	4	CO5
10	Wavelength of Laser Light	Wavelength of Laser light using diffraction by single slit	4	CO5
Experiment No.	**Title of the Experiment**	**Content of Unit (*Online Virtual Lab)**	**Contact Hrs.**	**Mapped CO**
1	Michelson's Interferometer - Working	Michelson's Interferometer	4	CO1
2	Wavelength by Michelson's Interferometer	Michelson's Interferometer: Wavelength of laser beam	4	CO4
3	Wavelength by Newton's Ring	Newton's Rings: Wavelength of light	4	CO1
4	Refractive Index by Newton's Ring	Newton's Rings: Refractive index of liquid	4	CO4
5	Brewster's Law	Brewster's angle determination	4	CO4
6	Laser Beam Divergence	Laser beam divergence and spot size	4	CO2
7	Refractive index of Prism	Spectrometer: Refractive index of the material of a prism	4	CO4
8	Dispersive Power of Prism	Spectrometer: Dispersive power of a prism	4	CO2
9	Cauchy's Constant	Spectrometer: Determination of Cauchy's constants	4	
10	Wavelength by Diffraction Grating	Diffraction Grating	4	

Reference Books:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. R.K. Agrawal, G. Jain, R. Sharma, "Practical Physics", Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014, 2e

e-Learning Source:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74
2. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/index.php?sub=1&brch=281
3. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	2	---	---	---	---	---	3	3	---	---	3
CO2	2	---	---	---	---	---	3	3	---	---	3
CO3	3	---	---	---	---	---	2	3	---	---	3
CO4	2	---	---	---	---	---	3	3	---	---	3
CO5	3	---	---	---	---	---	2	3	---	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: 2024-25							
Course Code	B010601T/PY314	**Title of the Course**	**Solid State and Nuclear Physics**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**	Passed B.Sc. 2nd Year				
Course Objectives	This course aims to give students the competence in the basic Solid State and Nuclear Physics. At the end of the course the students are expected to gain the thorough knowledge of Solid State and Nuclear Physics.						

Course Outcomes	
CO1	Understand the crystal geometry w.r.t. symmetry operations.
CO2	Comprehend the power of X-ray diffraction and the concept of reciprocal lattice.
CO3	Study various properties based on crystal bindings.
CO4	Recognize the importance of Free Electron and Band theories in understanding the crystal properties.
CO5	Study the salient features of nuclear forces and radioactive decays.
CO6	Understand the importance of nuclear models and nuclear reactions.
CO7	Comprehend the working and applications of nuclear accelerators and detectors.
CO8	Understand the classification and properties of basic building blocks of nature.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Crystal Structure**	Lattice, Basis and Crystal structure. Lattice translation vectors, Primitive and non-primitive cells. Symmetry operations, Point group and Space group. 2D and 3D Bravais lattice. Parameters of cubic lattices. Lattice planes and Miller indices. Simple crystal structures - HCP and FCC, Diamond, Cubic. Zinc Sulphide, Sodium Chloride, Cesium Chloride and Glasses.	7	CO1
2	**Crystal Diffraction**	X-ray diffraction and Bragg's law. Experimental diffraction methods - Laue, Rotating crystal and Powder methods. Derivation of scattered wave amplitude. Reciprocal lattice, Reciprocal lattice vectors and relation between Direct and Reciprocal lattice. Diffraction conditions, Ewald's method and Brillouin zones. Reciprocal lattice to SC, BCC and FCC lattices. Atomic Form factor and Crystal Structure factor.	7	CO2
3	**Crystal Binding**	Classification of Crystals on the Basis of Bonding - Ionic, Covalent, Metallic, van der Waals (Molecular) and Hydrogen bonded. Crystals of inert gases, Attractive interaction (van der Waals- London) and Repulsive interaction, Equilibrium lattice constant, Cohesive energy and Compressibility and Bulk modulus. Ionic crystals, Cohesive energy, Madelung energy and evaluation of Madelung constant.	7	CO3
4	**Lattice Vibrations**	**Lattice Vibrations:** Lattice vibrations for linear mono and di atomic chains, Dispersion relations and Acoustical and Optical branches (qualitative treatment). Qualitative description of Phonons in solids. Lattice heat capacity, Dulong-Petit's law and Einstein's theory of lattice heat capacity. **Free Electron Theory:** Fermi energy, Density of states, Heat capacity of conduction electrons, Paramagnetic susceptibility of conduction electrons and Hall effect in metals. **Band Theory:** Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Effective mass of an electron and Concept of Holes and Classification of solids on the basis of band theory.	9	CO4
5	**Nuclear Forces and Radioactive Decays**	**General Properties of Nucleus:** Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and electric quadrupole moment tensor. **Nuclear Forces:** General characteristic of nuclear force and Deuteron ground state properties. **Radioactive Decays:** Nuclear stability, basic ideas about beta minus decay, beta plus decay, alpha decay, gamma decay and electron capture, fundamental laws of radioactive disintegration and radioactive series.	9	CO5
6	**Nuclear Models and Nuclear Reactions**	**Nuclear Models:** Liquid drop model and Bethe-Weizsacker mass formula. Single particle shell model (the level scheme in the context of reproduction of magic numbers included). **Nuclear Reactions:** Bethe's notation, types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative), Nuclear reactors and Nuclear fusion.	9	CO6
7	**Accelerators and Detectors**	**Accelerators:** Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron. **Detectors:** Theory, working and applications of GM counter, Semiconductor detector, Scintillation counter and Wilson cloud chamber.	6	CO7
8	**Elementary Particles**	Fundamental interactions and their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsic-spin, mass, interaction and lifetime. Families of Leptons, Mesons, Baryons and Baryon Resonances. Conservation laws for mass-energy, linear momentum, angular momentum, electric charge, baryonic charge, leptonic charge, isospin and strangeness. Concept of Quark model.	6	CO8

Reference Books:

1. Charles Kittel, "Introduction to Solid State Physics", Wiley India Private Limited, 2012, 8e
2. A.J. Dekker, "Solid State Physics", Macmillan India Limited, 1993
3. R.K. Puri, V.K. Babbar, "Solid State Physics", S. Chand Publishing, 2015
4. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
5. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
6. S.N. Ghoshal, "Nuclear Physics", S. Chand Publishing, 2019

e-Learning Source:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	-	-	3	2	-	1	2
CO2	3	2	-	-	-	-	3	3	-	1	2
CO3	3	2	-	-	-	-	3	3	-	2	2
CO4	3	2	-	-	-	-	3	3	-	3	2
CO5	3	2	-	-	-	-	3	3	-	3	2
CO6	3	2	-	-	-	-	3	2	-	1	2
CO7	3	2	-	-	-	-	3	3	-	1	2
CO8	3	2	-	-	-	-	3	3	-	2	2

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B010602T/PY315	**Title of the Course**	**Analog & Digital Principles & Applications**	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Sixth	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**	Passed B.Sc. 2^{nd} Year				
Course Objectives	This course aims to give students the competence in Analog and Digital Electronics. At the end of the course the students are expected to gain the thorough knowledge of Analog and Digital Electronics and their applications in daily life.						

Course Outcomes	
CO1	Study the drift and diffusion of charge carriers in a semiconductor.
CO2	Understand the Two-Port model of a transistor.
CO3	Study the working, properties and uses of FETs.
CO4	Comprehend the design and operations of SCRs and UJTs.
CO5	Understand various number systems and binary codes.
CO6	Familiarize with binary arithmetic.
CO7	Study the working and properties of various logic gates.
CO8	Comprehend the design of combinational and sequential circuits.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Semiconductor Junction**	Expressions for Fermi energy, Electron density in conduction band, Hole density in valence band, Drift of charge carriers (mobility & conductivity), Diffusion of charge carries and Life time of charge carries in a semiconductor. Work function in metals and semiconductors. Expressions for Barrier potential, Barrier width and Junction capacitance (diffusion & transition) for depletion layer in a PN junction. Expressions for Current (diode equation) and Dynamic resistance for PN junction.	9	CO1
2	**Transistor Modelling**	Transistor as Two-Port Network. Notation for dc & ac components of voltage & current. Quantitative discussion of Z, Y & h parameters and their equivalent two-generator model circuits. h-parameters for CB, CE & CC configurations. Analysis of transistor amplifier using the hybrid equivalent model and estimation of Input Impedance, Output Impedance and Gain (current, voltage & power).	8	CO2
3	**Field Effect Transistors**	**JFET:** Construction (N channel & P channel); Configuration (CS, CD & CG); Operation in different regions (Ohmic or Linear, Saturated or Active or Pinch off & Break down); Important Terms (Shorted Gate Drain Current, Pinch Off Voltage & Gate Source Cut-Off Voltage); Expression for Drain Current (Shockley equation); Characteristics (Drain & Transfer); Parameters (Drain Resistance, Mutual Conductance or Transconductance & Amplification Factor); Biasing w.r.t. CS configuration (Self Bias & Voltage Divider Bias); Amplifiers (CS & CD or Source Follower); Comparison (N & P channels and BJTs & JFETs). **MOSFET:** Construction and Working of DE-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of DE-MOSFET and E-MOSFET; Comparison of JFFET and MOSFET.	8	CO3
4	**Other Devices**	**SCR:** Construction; Equivalent Circuits (Two Diodes, Two Transistors & One Diode-One Transistor); Working (Off state & On state); Characteristics; Applications (Static switch, Phase control system & Battery charger). **UJT:** Construction; Equivalent Circuit; Working (Cutoff, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); Applications (Trigger circuits, Relaxation oscillators & Sawtooth generators).	5	CO4
5	**Number System**	Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion. Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation.	6	CO5
6	**Binary Arithmetic**	Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division.	5	CO6
7	**Logic Gates**	Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistor). De Morgan's theorems. NOR & NAND gates as Universal Gates. Application of EX-OR & EX-NOR gates as pairty checker. Boolean Algebra. Karnaugh Map.	9	CO7
8	**Combinational and Sequential Circuits**	**Combinational Circuits:** Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor. Data **Processing Circuits:** Multiplexer, Demultiplexer, Decoders & Encoders. **Sequential Circuits:** SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters.	10	CO8

Reference Books:

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e
6. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
7. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
8. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

e-Learning Source:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)									
PO-PSO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	-	-	-	-	3	2	-	1	2
CO2	3	2	-	-	-	-	3	3	-	1	2
CO3	3	2	-	-	-	-	3	3	-	2	2
CO4	3	2	-	-	-	-	3	3	-	3	2
CO5	3	2	-	-	-	-	3	3	-	3	2
CO6	3	2	-	-	-	-	3	2	-	1	2
CO7	3	2	-	-	-	-	3	3	-	1	2
CO8	3	2	-	-	-	-	3	3	-	2	2

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B010603P/PY317	**Title of the Course**	**Analog & Digital Circuits**	**L**	**T**	**P**	**C**
Year	**Third**	**Semester**	Sixth	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Physics	**Co-requisite**	Passed B.Sc. 2nd Year				
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge/measurements in Analog and Digital Electronics through different experiments related to its theoretical course.						

Course Outcomes	
CO1	To learn about the different methods of finding the energy band gap of a semiconductor.
CO2	To calculate the hybrid parameter of a transistor from normal parameters.
CO3	To study the behaviour of FET and MOSFET from their characteristic curves.
CO4	To study the behaviour of SCR and UJT from their characteristic curves.
CO5	To study the functioning the working of different logic gates.

*** A student has to perform at least 7 experiments from the Offline Experiment List and 3 from the Online Virtual Lab Experiment List / Link.**

Experiment No.	**Title of the Experiment**	**Aim of the Experiment (*Offline)**	**Contact Hrs.**	**Mapped CO**
1	Energy Band Gap	To find the energy band gap of semiconductor by reverse saturation current method.	4	CO1
2	Four Probe Method	To find the energy band gap of semiconductor by four probe method.	4	CO1
3	Hybrid parameters of transistor	To find the hybrid parameters (h – parameters) of a transistor in Common Emitter Mode	4	CO2
4	Field Effect Transistor (FET)	To study the characteristics of FET.	4	CO3
5	Metal Oxide Field Effect Transistor (MOSFET)	To study the characteristics of MOSFET.	4	CO3
6	Silicon Controlled Rectifier	To study the characteristics of SCR.	4	CO4
7	Unijunction Transistor	To study the characteristics of UJT.	4	CO4
8	Logic Gates	To study and verify the logics of: (i) AND gate using TTL IC 7408 (ii) OR gate using TTL IC 7432 (iii) NOT gate using TTL IC 7404 (iv) Ex-OR gate using TTL IC 7486 (v) NAND gate and use as Universal gate using TTL IC 7400 (vi) NOR gate and use as Universal gate using TTL IC 7402	4	CO5
Experiment No.	**Title of the Experiment**	**Aim of the Experiment (*Online Virtual Lab)**	**Contact Hrs.**	**Mapped CO**
1	Field Effect Transistor (FET)	I_D-V_D characteristics of Junction Field Effect Transistor (JFET)	--	--
2	Silicon Controlled Rectifier	Silicon Controlled Rectifier (SCR) characteristics	--	--
3	Unijunction Transistor	Unijunction Transistor (UJT) and relaxation oscillator	--	--
4	Logic Gates	Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex- NOR gates	--	--
5	Half Adder and Full Adder	Construction of half and full adder using XOR and NAND gates and verification of its operation	--	--
6	Half Subtractor and Full Subtractor	To study and verify half and full subtractor	--	--
7	Universal Gates	Realization of logic functions with the help of Universal Gates (NAND, NOR)	--	--
8	NOR Gate Latch	Construction of a NOR gate latch and verification of its operation	--	--
9	Flip Flops	Verify the truth table of RS, JK, T and D Flip Flops using NAND and NOR gates	--	--
10	Shift Registers	Design and verify the 4-Bit Serial In - Parallel Out Shift Registers	--	--
11	Decoder and Encoders	Implementation and verification of decoder or demultiplexer and encoder using logic gates	--	--
12	Multiplexer and Demultiplexer	Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates	--	--
13	Synchronous and Asynchronous Counter	Design and verify the 4-Bit Synchronous or Asynchronous Counter using JK Flip Flop	--	--
14	Binary to Gray and Gray to Binary conversion	Verify Binary to Gray and Gray to Binary conversion using NAND gates only	--	--
15	1-Bit and 2-Bit comparator	Verify the truth table of 1-Bit and 2-Bit comparator using logic gates	--	--

Reference Books:

1. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
2. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
3. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
4. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e
6. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
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8. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

e-Learning Source:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74
2. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/index.php?sub=1&brch=281
3. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	2	---	---	---	---	---	3	3	---	---	3
CO2	2	---	---	---	---	---	3	3	---	---	3
CO3	3	---	---	---	---	---	2	3	---	---	3
CO4	2	---	---	---	---	---	3	3	---	---	3
CO5	3	---	---	---	---	---	2	3	---	2	3

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

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