Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	**B010101T/PY113**	**Title of the Course**	**Mathematical Physics and Newtonian Mechanics**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	**First**	**5**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics and Mathematics	**Co-requisite**	Basic knowledge of Mathematics and Physics				
Course Objectives	This course aims to make student aware about the Indian Contributors in the field of science and Technology. Also, this course gives students the competence about the methods and techniques of Mathematical Physics and Newtonian Mechanics. At the end of the course, the students are expected to have hands on experience in modeling, implementation and calculation of physical quantities of relevance.						

Course Outcomes	
CO1	Recognize the contribution of Indian Mathematician and Scientists, understand the difference between types of scalars, vectors, pseudo-scalars and the different operations possible with vector quantities.
CO2	To understand the physical interpretation of gradient, divergence and curl and their mutual conversion through different theorems.
CO3	Comprehend the difference and connection between different coordinate systems and study the origin of pseudo forces in rotating frame and study the response of the classical systems to external forces and their elastic deformation.
CO4	To understand the meaning of 4-vectors, Kronecker delta and Epsilon (Levi Civita) tensors
CO5	To understand the various concepts related to dynamics of classical particles, rotating reference frames and Coriolis force.
CO6	To understand the basic concepts of dynamics of rigid bodies and the concepts behind elastic behaviour.
CO7	To get an idea of the concepts behind the planetary motion and various types of satellites.
CO8	Comprehend the different features of Simple Harmonic Motion (SHM) and wave propagation.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Indian Knowledge System + Vector Algebra**	Ancient Indian Physics, Ancient and Medieval Indian Contributors in the development of Physics, Modern Indian Physicist in Science and Technology Coordinate rotation, reflection and inversion as the basis for defining scalars, vectors, pseudo-scalars and pseudo-vectors (include physical examples). Component form in 2D and 3D. Geometrical and physical interpretation of addition, subtraction, dot product, wedge product, cross product and triple product of vectors. Position, separation and displacement vectors.	7	CO1
2	**Vector Calculus**	Geometrical and physical interpretation of vector differentiation, Gradient, Divergence and Curl and their significance. Vector integration, Line, Surface (flux) and Volume integrals of vector fields. Gradient theorem, Gauss-divergence theorem, Stoke-curl theorem, Greens theorem and Helmholtz theorem (statement only). Introduction to Dirac delta function.	8	CO2
3	**Coordinate Systems**	2D and 3D Cartesian, Spherical and Cylindrical coordinate systems, basis vectors, transformation equations. Expressions for displacement vector, arc length, area element, volume element, gradient, divergence and curl in different coordinate systems. Components of velocity and acceleration in different coordinate systems. Examples of non-inertial coordinate system and pseudo-acceleration.	8	CO3
4	**Introduction to Tensors**	Principle of invariance of physical laws w. r. t. different coordinate systems as the basis for defining tensors. Coordinate transformations for general spaces of nD, contravariant, covariant and mixed tensors and their ranks, 4-vectors. Index notation and summation convention. Symmetric and skew-symmetric tensors. Invariant tensors, Kronecker delta and Epsilon (Levi Civita) tensors. Examples of tensors in physics.	7	CO4
5	**Dynamics of a System of Particles**	Review of historical development of mechanics up to Newton. Background, statement and critical analysis of Newton's axioms of motion. Dynamics of a system of particles, centre of mass motion, and conservation laws and their deductions. Rotating frames of reference, general derivation of origin of pseudo forces (Euler, Coriolis and centrifugal) in rotating frame, and effects of Coriolis force.	8	CO5
6	**Dynamics of a Rigid Body**	Angular momentum, Torque, Rotational energy and the inertia tensor. Rotational inertia for simple bodies (ring, disk, rod, solid and hollow sphere, solid and hollow cylinder, rectangular lamina). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Elasticity, relations between elastic constants, bending of beam and torsion of cylinder.	8	CO6
7	**Motion of Planets and Satellites**	Two particle central force problem, reduced mass, relative and centre of mass motion. Newton's law of gravitation, gravitational field and gravitational potential. Kepler's laws of planetary motion and their deductions. Motions of geo-synchronous and geo-stationary satellites and basic idea of Global Positioning System (GPS).	7	CO7
8	**Wave Motion**	Differential equation of simple harmonic motion and its solution, use of complex notation, damped and forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures. Differential equation of wave motion. Plane progressive waves in fluid media, reflection of waves and phase change, pressure and energy distribution. Principle of superposition of waves, stationary waves, phase and group velocity.	7	CO8

Reference Books:

1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017, 2e
2. A.W. Joshi, "Matrices and Tensors in Physics", New Age International Private Limited, 1995, 3e
3. Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017, 2e.
4. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 1", Pearson Education Limited, 2012
5. Hugh D. Young and Roger A. Freedman, "Sears and Zemansky's University Physics with Modern Physics", Pearson Education Limited, 2017, 14e
6. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981, 3e

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	2	----	----	----	----	----	1	2	----	1	----
CO2	3	----	----	----	----	----	2	3	----	1	----
CO3	2	----	----	----	----	----	1	1	----	2	----
CO4	3	----	----	----	----	----	2	2	----	3	----
CO5	2	----	----	----	----	----	3	1	----	1	----
CO6	1	----	----	----	----	----	2	3	----	1	----
CO7	3	----	----	----	----	----	2	3	----	1	----
CO8	1	----	----	----	----	----	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: 2024-25							
Course Code	B010102P/PY114	**Title of the Course**	**Mechanical Properties of Matter**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	First	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge/measurements in mechanics through different experiments related to its theoretical course.						

Course Outcomes	
CO1	Understand the Moment of Inertia and find the MI of an irregular body.
CO2	Determine elastic properties of rigid materials.
CO3	Understand the surface tension and viscosity of fluid.
CO4	Analyse waves and oscillations and understand the dynamics and gravitation
CO5	Demonstrate uses of Sextant by measuring dimensions of a given object.

Experiment No.	**Title of the Experiment**	**Content of Unit (*Offline)**	**Contact Hrs.**	**Mapped CO**
1	Flywheel	Moment of inertia of a flywheel	4	CO1
2	Inertia Table	Moment of inertia of an irregular body by inertia table	4	CO1
3	Statitcal Method	Modulus of rigidity by statical method (Barton's apparatus)	4	CO2
4	Maxwell's Needle	Modulus of rigidity by dynamical method (sphere / disc / Maxwell's needle)	4	CO2
5	Flexure Method	Young's modulus by bending of beam	4	CO2
6	Searle's Method	Young's modulus and Poisson's ratio by Searle's method	4	CO2
7	Poisson's Ratio	Poisson's ratio of rubber-by-rubber tubing	4	CO2
8	Capillary Rise Method	Surface tension of water by capillary rise method	4	CO3
9	Jaeger's Method	Surface tension of water by Jaeger's method	4	CO3
10	Poiseuille's Method	Coefficient of viscosity of water by Poiseuille's method	4	CO3
11	Compound Pendulum	Acceleration due to gravity by bar pendulum	4	CO4
12	Sonometer	Frequency of AC mains by Sonometer	4	CO4
13	Sextant	Height of a building by Sextant	4	CO5
14	C.R.O.	Study the waveform of an electrically maintained tuning fork / alternating current source with the help of cathode ray oscilloscope.	4	CO4
Unit No.	**Title of the Unit**	**Content of Unit (*Online Virtual Lab)**	**Contact Hrs.**	**Mapped CO**
1	Flywheel	Torque and angular acceleration of a flywheel	—	---
2	Torsion	Torsional oscillations in different liquids.	—	---
3	Flywheel	Moment of inertia of flywheel.	—	---
4	Newton's Second Law	Newton's second law of motion.	—	---
5	Ballistic Pendulum	Ballistic pendulum.	—	---
6	Collision Balls	Collision balls.	—	---
7	Projectile Motion	Projectile motion.	—	---
8	Collision	Elastic and inelastic collision.	—	---

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. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.

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

	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	B010201T/PY115	**Title of the Course**	**Thermal Physics and Semiconductor Devices**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	**Second**	**5**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The objective of this undergraduate course is to impart the knowledge of basic and advance concepts of thermodynamics, circuit fundamentals and basic electronics.						

Course Outcomes	
CO1	To understand the 0^{th} and 1st law of thermodynamics and their applications.
CO2	To understand the 2^{nd} and 3^{rd} law of thermodynamics and their applications.
CO3	Comprehend the kinetic model of gases w.r.t. various gas laws.
CO4	Study the implementations and limitations of fundamental radiation laws.
CO5	To understand the various electrical circuits, Network theorems and different types of AC bridges and their applications.
CO6	To get a deep insight in the semiconductor physics and the basic solid-state devices.
CO7	To understand the working of transistors and its various biasing techniques
CO8	To get familiar with multimeter and CRO and learn how to use them for the various types of electrical measurements.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	0^{th} & 1^{st} Law of Thermodynamics	State functions and terminology of thermodynamics. Zeroth law and temperature. First law, internal energy, heat and work done. Work done in various thermodynamical processes. Enthalpy, relation between CP and CV. Carnot's engine, efficiency and Carnot's theorem. Efficiency of internal combustion engines (Otto and diesel).	8	CO1
2	2^{nd} & 3^{rd} Law of Thermodynamics	Different statements of second law, Clausius inequality, entropy and its physical significance. Entropy changes in various thermodynamical processes. Third law of thermodynamics and unattainability of absolute zero. Thermodynamical potentials, Maxwell's relations, conditions for feasibility of a process and equilibrium of a system. Clausius- Clapeyron equation, Joule-Thompson effect.	8	CO2
3	Kinetic Theory of Gases	Kinetic model and deduction of gas laws. Derivation of Maxwell's law of distribution of velocities and its experimental verification. Degrees of freedom, law of equipartition of energy (no derivation) and its application to specific heat of gases (mono, di and poly atomic).	7	CO3
4	Theory of Radiation	Blackbody radiation, spectral distribution, concept of energy density and pressure of radiation. Derivation of Planck's law, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan- Boltzmann law and Wien's displacement law from Planck's law.	7	CO4
5	DC & AC Circuits	Growth and decay of currents in RL circuit. Charging and discharging of capacitor in RC, LC and RCL circuits. Network Analysis - Superposition, Reciprocity, Thevenin's and Norton's theorems. AC Bridges - measurement of inductance (Maxwell's, Owen's and Anderson's bridges) and measurement of capacitance (Schering's, Wein's and de Sauty's bridges).	7	CO5
6	Semiconductors & Diodes	P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode. Diode fabrication. PN junction diode and its characteristics, static and dynamic resistance. Principle, structure, characteristics and applications of Zener, Tunnel, Light Emitting, Point Contact and Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency and voltage regulation. Basic idea about filter circuits and voltage regulated power supply.	8	CO6
7	Transistors	Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. active, cutoff & saturation regions; characteristics; current, voltage & power gains; transistor currents & relations between them. Idea of base width modulation, base spreading resistance & transition time. DC Load Line analysis and Q-point stabilisation. Voltage Divider Bias circuit for CE amplifier. Qualitative discussion of RC coupled amplifier (frequency response not included).	7	CO7
8	Electronic Instrumentation	Multimeter: Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, electron gun, electrostatic focusing and acceleration (no mathematical treatment). Front panel controls, special features of dual trace CRO, specifications of a CRO and their significance. Applications of CRO to study the waveform and measurement of voltage, current, frequency & phase difference.	8	CO8

Reference Books:

1. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997, 7e
2. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998
3. Enrico Fermi, "Thermodynamics", Dover Publications, 1956
4. S. Garg, R. Bansal, C. Ghosh, "Thermal Physics", McGraw Hill, 2012, 2e
5. Meghnad Saha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973, 5e
6. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
7. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
8. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
9. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
10. A. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e
11. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

e-Learning Source:

1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
4. edX, https://www.edx.org/course/subject/physics
5. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/

	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	1	----	2	----	----	2	3	3	----	1	----
CO2	2	----	----	----	----	----	3	3	----	1	----
CO3	3	----	2	----	----	2	3	3	----	1	----
CO4	1	----	1	----	----	----	3	3	----	2	----
CO5	2	----	2	----	----	----	3	3	----	2	----
CO6	2	----	----	----	----	----	3	3	----	1	----
CO7	3	----	2	----	----	2	3	3	----	1	----
CO8	1	----	1	----	----	----	3	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: 2024-25							
Course Code	B010202P/PY116	**Title of the Course**	**Thermal Properties of Matter & Electronic Circuits – 1**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	**Second**	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge of Thermal Physics through different experiments related to its theoretical course.						

Course Outcomes	
CO1	Students will learn to find out the Mechanical Equivalent of Heat using Callender and Barne's method and Joule's calorimeter
CO2	Students will learn to find out the Thermal Conductivity of Copper and Rubber.
CO3	Students will learn to find out the Thermal Conductivity of Bad Conductor and Temperature Coefficient of Resistance.
CO4	Student will learn to find the value of Stefan's Constant and verify the Stefan's Law.
CO5	Student will learn to find the value of thermos-emf using a thermocouple.

Experiment No.	**Title of the Unit**	**Content of Unit (*Offline)**	**Contact Hrs.**	**Mapped CO**
1	Callender and Barne's Method	Mechanical Equivalent of Heat by Callender and Barne's method	4	CO1
2	Joule's Calorimeter	Mechanical Equivalent of Heat using Joule's calorimeter	4	CO1
3	Searle's Apparatus	Coefficient of thermal conductivity of copper by Searle's apparatus	4	CO2
4	Thermal Conductivity	Coefficient of thermal conductivity of rubber	4	CO2
5	Lee and Charlton's disc method	Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method	4	CO3
6	Platinum Resistance Thermometer	Temperature coefficient of resistance by Platinum resistance thermometer	4	CO3
7	Stefan's Constant	Value of Stefan's constant	4	CO4
8	Stefan's Law	Verification of Stefan's law	4	CO4
9	Thermocouple	Variation of thermo-emf across two junctions of a thermocouple with temperature	4	CO5
Unit No.	**Title of the Unit**	**Content of Unit (*Online Virtual Lab)**	**Contact Hrs.**	**Mapped CO**
1	Heat transfer	Heat transfer by radiation	----	----
2	Heat transfer	Heat transfer by conduction	----	----
3	Heat transfer	Heat transfer by natural convection	----	----
4	Phase Change	The study of phase change	----	----
5	Stefan's Constant	Black body radiation: Determination of Stefan's constant	----	----
6	Law of Cooling	Newton's law of cooling	----	----
7	Lee's disc apparatus	Lee's disc apparatus	----	----
8	Thermocouple	Thermo-couple: Seebeck effects	----	----

Reference Books:

1. B. L. Worsnop, H. T. Flint, "Advanced Practical Physics for Students", Methuen & Co. Ltd., London, 1962, 9th Edition
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1st Edition
3. R. K. Agarwal, Garima Jain, Rekha Sharma, B.Sc. Physics Practical – II, Krishna Prakashan Media (PP Ltd., 2019, 5th Edition
4. C.L. Arora, B.Sc. Practical Physics, S. Chand & Company Ltd. 2001, 19th Edition

e-Learning Source:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=194
2. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/be/#
3. Digital Platforms/Web Links of other virtual labs may be suggested/added to this list by individual Universities.

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

	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**	----	----	**2**
CO4	**2**	----	----	----	----	----	**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	**I010101V/PY117**	**Title of the Course**	**Electrician**	**L**	**T**	**P**	**C**
Year	First	**Semester**	First	**2**	**1**	**0**	**3**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this vocational course is to impart basic and key knowledge of electrical trade so that after completing this course the learner can work in this field.						

Course Outcomes	
CO1	Familiarized with the occupational safety and basic physics necessary for the electrician trade.
CO2	Know the different devices, measuring instruments and electrical wiring.
CO3	Understand the power generation, transmission and control.
CO4	Learn the practical techniques of the electrical trade.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Electrician Basics**	Occupational Safety and Health, Conductor, semiconductors, Insulator and electric cables, Tools for an Electrician, Soldering and D.C theory, Basic Electricity, Electrical accessories, Electro-chemical effect and chemical cell, Magnetism and electromagnetism, Alternating current theory, Earthing and Basic electronics.	8	CO1
2	**Electrician Theory-I**	Transistor, Amplifiers, Oscillators, Specific solid-state devices, Digital electronics, Electrical wiring, Direct current generator, Direct current motor, Transformer and Electrical measuring instruments.	8	CO2
3	**Electrician Theory-II**	Machine control panel, Electrical instrument, Electrical power generation, Electrical power transmission, Underground cables, Power distribution, Speed control and maintenance of electric machines, Electronic theory and communication.	8	CO3
4	**Electrical Practical**	Trade safety and first aid, Tools, wire, and joints, Allied trades, Resistor, and capacitor, Alternating current (A.C.) circuit, Cell and battery, Magnetic field, Earthing and Semi-conductor diode.	8	CO4

Reference Books:

1. National Electrical Code 2020 Handbook (NFPA)
2. Practical Electrical Wiring: Residential, Farm, Commercial and Industrial, 2014 Edition (F.P. Hartwell, Herbert P. Richter)
3. Electrical Motor Controls for Integrated Systems, 5th Edition (Gary Rockis, Glen A. Mazur).
4. Ultimate Guide: Wiring, 8th Edition
5. Electrical Trainee Guide, Level 1 by NCCER.

e-Learning Source:

1. https://www.youtube.com/channel/UCB3jUEyCLRbCw7QED0vnXYg
2. https://www.youtube.com/channel/UCpbI0bpvjxlVI_-V8OIspzw
3. https://www.youtube.com/c/CraigMichaudElectricalInstructor/featured
4. https://www.youtube.com/channel/UCwf9niZNaW8mkECB6GT6raQ

	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**	----	----	----	----	----	**1**	**2**	----	----	**1**
CO2	**3**	----	----	----	----	----	**2**	**2**	----	----	**2**
CO3	**3**	----	----	----	----	----	**3**	**3**	----	----	**3**
CO4	**3**	----	----	----	----	----	**3**	**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: 2024-25							
Course Code	B010205/ PY118	**Title of the Course**	**Artificial Intelligence and Physics**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	**Second**	**4**	**0**	**0**	**0**
Pre-Requisite	10+2 with Physics and Mathematics	**Co-requisite**					
Course Objectives	To make student aware about the basics of artificial intelligence and how it is useful in the different areas of physics.						

Course Outcomes	
CO1	To learn the basics of Artificial Intelligence and problem solving through it
CO2	To learn the basics of Machine Learning and Natural Language Processing
CO3	To learn the basic Physics behind the Quantum Computing
CO4	To know the different applications of Artificial Intelligence in the field of Physics.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Artificial Intelligence (AI) and Problem Solving through Artificial Intelligence (AI)**	History and evolution of AI, comparison of human and computer skill, Component of AI, Scope and significance in different domains, Ethical considerations in AI development and deployment, Intelligent Agent, logical agent. Defining problem as a state space search, analyzing the problem, solving problem by searching, informed search and Uninformed Search.	8	CO1
2	**Machine Learning Basics and natural Language Processing**	Neural networks and deep learning, Supervised and unsupervised learning, Feature selection and engineering, learning from observation, knowledge in learning. Brief history of NLP, Text processing, Sentiment analysis, language translation, Early NLP system, ELIZA system, LUNAR system, General NLP system	8	CO2
3	**Physics of Quantum Computing for Artificial Intelligence (AI)**	What is Quantum Computing, Postulates of Quantum Mechanics, Qubit – the smallest unit, Qubit – Bloch sphere representation, Multiple Qubit states and Quantum Gates, Quantum Circuits, No Cloning Theorem and Quantum Teleportation, Super Dense Coding	8	CO3
4	**Applications of Artificial Intelligence (AI) in Physics**	AI's role in Data Analysis and Simulations, AI and Particle Physics, AI and Astrophysics, AI and Atmospheric Physics, AI in Computational Physics and Material Science, AI and Relativity, AI and Thermodynamics.	8	CO4

Reference Books:

1. Artificial Intelligence by Patrick Henry Winston, 3rd Edition, Addison – Wesley Publishing Company
2. Explorations in Artificial Intelligence and Machine Learning by Roberto V. Zicari, CRC Press
3. A Textbook of Artificial Intelligence by Hema Dhingra, Rashi Bansal, Sayan Banerjee and Dr. Shalini Verma, Goyal Brothers Publications
4. Artificial Intelligence by R.B. Mishra, PHI Learning Private Limited
5. Machine Learning and Artificial Intelligence by Ameet V Joshi, Springer Nature Switzerland

e-Learning Source:

1. Quantum Information and Computing, NPTEL :: Physics - NOC: Quantum Information and Computing
2. What Artificial Intelligence can do for Physics? https://www.oecd-ilibrary.org/docserver/724b14a6-en.pdf?expires=1705508062&id=id&accname=guest&checksum=FE6968ED4CB05F58A07011FE37211CB9
3. Applications of Artificial Intelligence in Physics, 1345437330.pdf (inspirajournals.com)
4. How Artificial Intelligence is disrupting Physics, How Artificial Intelligence is Disrupting Physics (bbntimes.com)
5. Four Uses of AI in Physics, Four Uses for AI in Physics.
6. The Handbook of Artificial Intelligence, handbookofartific01barr.pdf (archive.org)

	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	1	1	----	----	----	3	1	----	1	----
CO2	3	1	1	----	----	----	3	----	2	----	----
CO3	3	2	2	----	----	----	3	1	----	1	----
CO4	3	2	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: 2024-25							
Course Code	B010103T / PY119	**Title of the Course**	**Renewable Energy and Energy Harvesting**	**L**	**T**	**P**	**C**
Year	First	**Semester**	First	**5**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**	-				
Course Objectives	The aim of this course is to impart theoretical knowledge to the students the different types of conventional and non-conventional energy and their harvesting.						

Course Outcomes	
CO1	Students will learn about the different sources of energy.
CO2	Students will learn about the different aspects of solar energy.
CO3	Students will learn about the different aspects of wind energy.
CO4	Students will learn about the different aspects of ocean energy.
CO5	Students will learn about the different aspects of geothermal energy.
CO6	Students will learn about the different aspects of hydrothermal energy.
CO7	Students will learn about the different aspects of piezoelectric energy.
CO8	Students will learn about the different aspects of electromagnetic energy.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Fossil fuels and Alternate Sources of energy	Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.	8	CO1
2	Solar energy	Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.	8	CO2
3	Wind Energy harvesting	Fundamentals of Wind energy, Nature and Origin of winds, Power in a wind stream, principles and basic components of wind mill, Efficiency of wind turbine, different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.	7	CO3
4	Ocean Energy	Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.	7	CO4
5	Geothermal Energy	Geothermal Resources, Geothermal Technologies, Energy Inside the Earth, Direct Use of Geothermal Energy, Geothermal Power Plants, Geothermal Heat Pumps, Geothermal Energy and The Environment.	7	CO5
6	Hydro Energy	Hydropower Resources, Types of Hydropower, Sizes of Hydropower Plants, Turbine Technologies, Hydropower Technologies, Environmental Impact of Hydro Power Sources.	7	CO6
7	Piezoelectric Energy harvesting	Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.	8	CO7
8	Electromagnetic Energy Harvesting	Linear generators, physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability.	8	CO8

Reference Books:

1. Non-conventional energy sources, B.H. Khan, McGraw Hill
2. Solar energy, Suhas P Sukhative, Tata McGraw - Hill Publishing Company Ltd
3. Renewable Energy, Power for a sustainable future, Godfrey Boyle, 3rd Edn., 2012, Oxford University Press.
4. Solar Energy: Resource Assessment Handbook, P Jayakumar, 2009
5. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

e-Learning Source:

1. NPTEL :: Physics - NOC: Physics of Renewable Energy Systems
2. NPTEL :: Chemical Engineering - NOC: Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems
3. NPTEL :: Chemical Engineering - NOC: Technologies For Clean And Renewable Energy Production

	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	----	----	----	----	3	3	1	2	----	----
CO2	3	----	----	----	----	3	3	1	2	----	----
CO3	3	----	----	----	----	3	3	1	2	----	----
CO4	3	----	----	----	----	3	3	1	2	----	----
CO5	3	----	----	----	----	3	3	1	2	----	----
CO6	3	----	----	----	----	3	3	1	2	----	----
CO7	3	----	----	----	----	3	3	1	2	----	----
CO8	3	----	----	----	----	3	3	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: 2024-25							
Course Code	B010104P / PY120	**Title of the Course**	**Solar Energy Lab**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	First	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Physics and Mathematics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge about the different parameters of a solar panel through different experiments.						

Course Outcomes	
CO1	Students will learn the various measurements of load and I-V characteristics of solar Panel
CO2	Students will learn to estimate the efficiency of solar panels.
CO3	Students will learn the effect of series and parallel combinations of solar panels
CO4	Student will learn about the different parameters which affects the functioning of a solar panel.

Experiment No.	**Title of the Unit**	**Content of Unit (*Offline)**	**Contact Hrs.**	**Mapped CO**
1	Voltage, current and power of a load	Measurement of voltage, current and power of a load.	4	CO1
2	I-V characteristic of given solar panel	Measure open circuit voltage and short circuit current and draw I-V characteristic of given solar panel.	4	CO1
3	Efficiency of solar photovoltaic panels	Estimation of efficiency of solar photovoltaic panels.	4	CO2
4	Parallel combination of PV cells	Study the effect of parallel combination of PV cells.	4	CO3
5	Series combination of PV cells	Study the effect of series combination of PV cells.	4	CO3
6	Shading effects of solar panels.	Study of shading effects of solar panels.	4	CO4
7	Loading effects in solar panels	Study of loading effects in solar panels.	4	CO4
8	Effect of tilt angle	Study the effect of tilt angle on solar photo voltaic panel.	4	CO4

Reference Books:

1. B. L. Worsnop, H. T. Flint, "Advanced Practical Physics for Students", Methuen & Co. Ltd., London, 1962, 9th Edition
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1st Edition
3. R. K. Agarwal, Garima Jain, Rekha Sharma, B.Sc. Physics Practical – II, Krishna Prakashan Media (PP Ltd., 2019, 5th Edition
4. C.L. Arora, B.Sc. Practical Physics, S. Chand & Company Ltd. 2001, 19th Edition

e-Learning Source:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=194
2. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/be/#
3. Digital Platforms/Web Links of other virtual labs may be suggested/added to this list 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**	----	----	**2**
CO4	**2**	----	----	----	----	----	**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	B010203P /PY121	**Title of the Course**	**Thermal Properties of Matter & Electronic Circuits – 2**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	**Second**	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge/measurements in Electrical and Electronics through different experiments related to its theoretical course.						

Course Outcomes	
CO1	Student will learn the charging and discharging behaviour of RC and RCL circuits and study the phenomenon of electrical resonance.
CO2	Student will learn to find the value of capacitance by de-Sauty's bridge and inductance by Anderson's bridge.
CO3	Students will learn about the characteristics of PN junction diode and Zener Diode.
CO4	Students will learn about the characteristics of Transistors and do various measurements using CRO
CO5	Student will be able to study the output of Half wave and Full wave rectifiers and differentiate between the output of unregulated and regulated power supplies

Experiment No.	**Title of the Unit**	**Content of Unit (*Offline)**	**Contact Hrs.**	**Mapped CO**
1	Charging and Discharging	Charging and discharging in RC and RCL circuits	4	CO1
2	Series and Parallel Resonance	To Study Resonance in series and parallel RCL circuit	4	CO1
3	De-Sauty's Bridge	To measure the capacitance 'C' by de-Sauty's bridge	4	CO2
4	Anderson Bridge	To measure the inductance 'L' by Anderson's bridge	4	CO2
5	Semiconductor Diodes	To study the characteristics of PN Junction diode	4	CO3
6	Semiconductor Diodes	To study the characteristics of Zener Diode	4	CO3
7	Transistors	To study the characteristics of a transistor (PNP and NPN) in CE, CB and CC configurations	4	CO4
8	CRO	To perform various measurements with Cathode Ray Oscilloscope (CRO)	4	CO4
9	Half wave and Full Wave Rectifier	Half wave & full wave rectifiers and Filter circuits	4	CO5
10	Power Supply	To Study the Unregulated and Regulated power supply	4	CO5
Unit No.	**Title of the Unit**	**Content of Unit (*Online Virtual Lab)**	**Contact Hrs.**	**Mapped CO**
1	Familiarisation with resistor	Familiarisation with resistor	----	----
2	Familiarisation with capacitor	Familiarisation with capacitor	----	----
3	Familiarisation with inductor	Familiarisation with inductor	----	----
4	Ohm's Law	Ohm's Law	----	----
5	RC Differentiator and integrator	RC Differentiator and integrator	----	----
6	Semiconductor Diodes	VI characteristics of a diode	----	----
7	Half wave and Full Wave Rectifier	Half & Full wave rectification	----	----
8	Capacitive rectification	Capacitive rectification	----	----
9	Zener Diode	Zener Diode voltage regulator	----	----
10	Common Emitter Characteristics	BJT common emitter characteristics	----	----
11	Common Base Characteristics	BJT common base characteristics	----	----
12	Common Emitter Amplifier	Studies on BJT CE amplifier	----	----

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. Agarwal, Garima Jain, Rekha Sharma, B.Sc. Physics Practical – II, Krishna Prakashan Media (PP Ltd., 2019, 5th Edition
4. C.L. Arora, B.Sc. Practical Physics, S. Chand & Company Ltd. 2001, 19th Edition
5. R. L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
6. A. Sudhakar, S. S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e

e-Learning Source:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=194
2. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/be/#
3. Digital Platforms/Web Links of other virtual labs may be suggested/added to this list by individual Universities.

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

	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**	----	----	**2**
CO4	**2**	----	----	----	----	----	**3**	**2**	----	----	**2**
CO5	**2**	----	----	----	----	----	**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: 2024-25							
Course Code	B010204T / PY122	**Title of the Course**	**Basics of Astrophysics and Cosmology**	**L**	**T**	**P**	**C**
Year	First	**Semester**	Second	**5**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**	-				
Course Objectives	The aim of this course is to impart theoretical knowledge to the students about the various components of Astrophysics and Cosmology.						

Course Outcomes	
CO1	Students will learn about the historical development of Astrophysics.
CO2	Students will learn about the different concepts and laws of Astrophysics.
CO3	Students will learn about the formation of solar system and the other bodies in the solar system.
CO4	Students will learn about the formation of stellar evolution and its different remnants
CO5	Students will learn about the different types of chemical and nuclear reactions taking place inside the stars.
CO6	Students will learn about the different types of stars and their different schemes of classifications.
CO7	Students will learn about the different theories of galaxy formation and different types of galaxies.
CO8	Students will learn about the formation of universe and its different theories.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Historical Background	Perception of different ancient civilizations, Contribution of different individuals in the development of space science in pre and post telescopic era. Limitation of Eye in space observation and their Remedies, Problems created by Atmosphere and its solution, Different types of astronomies.	10	CO1
2	Fundamentals of Astrophysics	Newton's law of gravitation, Kepler's law of planetary motion, Titius – Bode's law of planetary position, Acceleration due to gravity, Gravitational Potential and Gravitational Potential Energy, Escape Velocity and Orbital Velocity of a Satellite, different types of satellites. Brightness and Distance Measurement Techniques.	10	CO2
3	Solar System	Formation of our Solar System - Nebular theory and theory of Accretion, Origin and Fate of our Sun, Source of solar energy, CNO cycle, Solar Wind and its effect on different planets, Few other important bodies in solar system: Satellites, Asteroids Meteors and Comets.	7	CO3
4	Star Formation and Evolution	Star Formation and Evolution: Protostar, Main Sequence Star, Red-giant and Red Super-giant, Stellar Remnants: White Dwarfs, Neutron Star and Black Holes.	7	CO4
5	Stellar Nucleosynthesis	Nucleo–Synthesis and Formation of Elements, Triple alpha Process, P-P chain, Electron and Neutron Capture Process, Cosmic Ray Spallation.	6	CO5
6	Stellar Classification	Classification of Stars: Classification based on Mass of Star, Classification based on Brightness, Harvard Classification and Hertzsprung-Russel Diagram.	6	CO6
7	Galaxies	Different theories of Galaxy formation: Hierarchal Model, Hubble's classification of galaxies, Active and Passive Galaxies: Seyfert, Quasar and Blazers	7	CO7
8	Universe	Cosmic Microwave Background Radiation, Gravitational Redshift, Hubble Law and Expansion of Universe, Matter density in Universe, Steady State and Big Bang Theories of Universe, Dark Matter and Dark Energy.	7	CO8

Reference Books:

1. K. S. Krishnaswami, "Astrophysics: A modern Perspective", New Age International
2. K. S. Krishnaswami, "Understanding cosmic Panorama", New Age International.
3. Baidyanath Basu, T. Chattopadhyay, S. N. Biswas, "An Introduction to Astrophysics", Prentice Hall India.
4. D. Raine, E. Thomas, "An Introduction to the Science of Cosmology", Institute of Physics.
5. C. de Pree, A. Axelrod, "Idiots Guide to Astronomy", Pearson Education.
6. S. Weinberg, "The First Three Minutes - a modern view of the origin of the universe", Basic Books Publishers

e-Learning Source:

1. NPTEL :: General - Astronomy in Ancient, Medieval and Early Telescopic Era of India
2. NPTEL :: Physics - Astrophysics & Cosmology

	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	1	2	----	----
CO2	3	2	----	----	----	----	3	1	2	----	----
CO3	3	2	----	----	----	----	3	1	2	----	----
CO4	3	2	----	----	----	----	3	1	2	----	----
CO5	3	2	----	----	----	----	3	1	2	----	----
CO6	3	2	----	----	----	----	3	1	2	----	----
CO7	3	2	----	----	----	----	3	1	2	----	----
CO8	3	2	----	----	----	----	3	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: 2024-25							
Course Code	**B010101T/PY113**	**Title of the Course**	**Mathematical Physics and Newtonian Mechanics**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	**First**	**5**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics and Mathematics	**Co-requisite**	Basic knowledge of Mathematics and Physics				
Course Objectives	This course aims to make student aware about the Indian Contributors in the field of science and Technology. Also, this course gives students the competence about the methods and techniques of Mathematical Physics and Newtonian Mechanics. At the end of the course, the students are expected to have hands on experience in modeling, implementation and calculation of physical quantities of relevance.						

Course Outcomes	
CO1	Recognize the contribution of Indian Mathematician and Scientists, understand the difference between types of scalars, vectors, pseudo-scalars and the different operations possible with vector quantities.
CO2	To understand the physical interpretation of gradient, divergence and curl and their mutual conversion through different theorems.
CO3	Comprehend the difference and connection between different coordinate systems and study the origin of pseudo forces in rotating frame and study the response of the classical systems to external forces and their elastic deformation.
CO4	To understand the meaning of 4-vectors, Kronecker delta and Epsilon (Levi Civita) tensors
CO5	To understand the various concepts related to dynamics of classical particles, rotating reference frames and Coriolis force.
CO6	To understand the basic concepts of dynamics of rigid bodies and the concepts behind elastic behaviour.
CO7	To get an idea of the concepts behind the planetary motion and various types of satellites.
CO8	Comprehend the different features of Simple Harmonic Motion (SHM) and wave propagation.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Indian Knowledge System + Vector Algebra**	Ancient Indian Physics, Ancient and Medieval Indian Contributors in the development of Physics, Modern Indian Physicist in Science and Technology Coordinate rotation, reflection and inversion as the basis for defining scalars, vectors, pseudo-scalars and pseudo-vectors (include physical examples). Component form in 2D and 3D. Geometrical and physical interpretation of addition, subtraction, dot product, wedge product, cross product and triple product of vectors. Position, separation and displacement vectors.	7	CO1
2	**Vector Calculus**	Geometrical and physical interpretation of vector differentiation, Gradient, Divergence and Curl and their significance. Vector integration, Line, Surface (flux) and Volume integrals of vector fields. Gradient theorem, Gauss-divergence theorem, Stoke-curl theorem, Greens theorem and Helmholtz theorem (statement only). Introduction to Dirac delta function.	8	CO2
3	**Coordinate Systems**	2D and 3D Cartesian, Spherical and Cylindrical coordinate systems, basis vectors, transformation equations. Expressions for displacement vector, arc length, area element, volume element, gradient, divergence and curl in different coordinate systems. Components of velocity and acceleration in different coordinate systems. Examples of non-inertial coordinate system and pseudo-acceleration.	8	CO3
4	**Introduction to Tensors**	Principle of invariance of physical laws w. r. t. different coordinate systems as the basis for defining tensors. Coordinate transformations for general spaces of nD, contravariant, covariant and mixed tensors and their ranks, 4-vectors. Index notation and summation convention. Symmetric and skew-symmetric tensors. Invariant tensors, Kronecker delta and Epsilon (Levi Civita) tensors. Examples of tensors in physics.	7	CO4
5	**Dynamics of a System of Particles**	Review of historical development of mechanics up to Newton. Background, statement and critical analysis of Newton's axioms of motion. Dynamics of a system of particles, centre of mass motion, and conservation laws and their deductions. Rotating frames of reference, general derivation of origin of pseudo forces (Euler, Coriolis and centrifugal) in rotating frame, and effects of Coriolis force.	8	CO5
6	**Dynamics of a Rigid Body**	Angular momentum, Torque, Rotational energy and the inertia tensor. Rotational inertia for simple bodies (ring, disk, rod, solid and hollow sphere, solid and hollow cylinder, rectangular lamina). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Elasticity, relations between elastic constants, bending of beam and torsion of cylinder.	8	CO6
7	**Motion of Planets and Satellites**	Two particle central force problem, reduced mass, relative and centre of mass motion. Newton's law of gravitation, gravitational field and gravitational potential. Kepler's laws of planetary motion and their deductions. Motions of geo-synchronous and geo-stationary satellites and basic idea of Global Positioning System (GPS).	7	CO7
8	**Wave Motion**	Differential equation of simple harmonic motion and its solution, use of complex notation, damped and forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures. Differential equation of wave motion. Plane progressive waves in fluid media, reflection of waves and phase change, pressure and energy distribution. Principle of superposition of waves, stationary waves, phase and group velocity.	7	CO8

Reference Books:

1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017, 2e
2. A.W. Joshi, "Matrices and Tensors in Physics", New Age International Private Limited, 1995, 3e
3. Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017, 2e.
4. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 1", Pearson Education Limited, 2012
5. Hugh D. Young and Roger A. Freedman, "Sears and Zemansky's University Physics with Modern Physics", Pearson Education Limited, 2017, 14e
6. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981, 3e

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	2	----	----	----	----	----	1	2	----	1	----
CO2	3	----	----	----	----	----	2	3	----	1	----
CO3	2	----	----	----	----	----	1	1	----	2	----
CO4	3	----	----	----	----	----	2	2	----	3	----
CO5	2	----	----	----	----	----	3	1	----	1	----
CO6	1	----	----	----	----	----	2	3	----	1	----
CO7	3	----	----	----	----	----	2	3	----	1	----
CO8	1	----	----	----	----	----	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: 2024-25							
Course Code	B010102P/PY114	**Title of the Course**	**Mechanical Properties of Matter**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	First	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge/measurements in mechanics through different experiments related to its theoretical course.						

Course Outcomes	
CO1	Understand the Moment of Inertia and find the MI of an irregular body.
CO2	Determine elastic properties of rigid materials.
CO3	Understand the surface tension and viscosity of fluid.
CO4	Analyse waves and oscillations and understand the dynamics and gravitation
CO5	Demonstrate uses of Sextant by measuring dimensions of a given object.

Experiment No.	**Title of the Experiment**	**Content of Unit (*Offline)**	**Contact Hrs.**	**Mapped CO**
1	Flywheel	Moment of inertia of a flywheel	4	CO1
2	Inertia Table	Moment of inertia of an irregular body by inertia table	4	CO1
3	Statical Method	Modulus of rigidity by statical method (Barton's apparatus)	4	CO2
4	Maxwell's Needle	Modulus of rigidity by dynamical method (sphere / disc / Maxwell's needle)	4	CO2
5	Flexure Method	Young's modulus by bending of beam	4	CO2
6	Searle's Method	Young's modulus and Poisson's ratio by Searle's method	4	CO2
7	Poisson's Ratio	Poisson's ratio of rubber-by-rubber tubing	4	CO2
8	Capillary Rise Method	Surface tension of water by capillary rise method	4	CO3
9	Jaeger's Method	Surface tension of water by Jaeger's method	4	CO3
10	Poiseuille's Method	Coefficient of viscosity of water by Poiseuille's method	4	CO3
11	Compound Pendulum	Acceleration due to gravity by bar pendulum	4	CO4
12	Sonometer	Frequency of AC mains by Sonometer	4	CO4
13	Sextant	Height of a building by Sextant	4	CO5
14	C.R.O.	Study the waveform of an electrically maintained tuning fork / alternating current source with the help of cathode ray oscilloscope.	4	CO4
Unit No.	**Title of the Unit**	**Content of Unit (*Online Virtual Lab)**	**Contact Hrs.**	**Mapped CO**
1	Flywheel	Torque and angular acceleration of a flywheel	---	---
2	Torsion	Torsional oscillations in different liquids.	---	---
3	Flywheel	Moment of inertia of flywheel.	---	---
4	Newton's Second Law	Newton's second law of motion.	---	---
5	Ballistic Pendulum	Ballistic pendulum.	---	---
6	Collision Balls	Collision balls.	---	---
7	Projectile Motion	Projectile motion.	---	---
8	Collision	Elastic and inelastic collision.	---	---

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. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.

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

	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	B010201T/PY115	**Title of the Course**	**Thermal Physics and Semiconductor Devices**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	**Second**	**5**	**1**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The objective of this undergraduate course is to impart the knowledge of basic and advance concepts of thermodynamics, circuit fundamentals and basic electronics.						

Course Outcomes	
CO1	To understand the 0^{th} and 1st law of thermodynamics and their applications.
CO2	To understand the 2^{nd} and 3^{rd} law of thermodynamics and their applications.
CO3	Comprehend the kinetic model of gases w.r.t. various gas laws.
CO4	Study the implementations and limitations of fundamental radiation laws.
CO5	To understand the various electrical circuits, Network theorems and different types of AC bridges and their applications.
CO6	To get a deep insight in the semiconductor physics and the basic solid-state devices.
CO7	To understand the working of transistors and its various biasing techniques
CO8	To get familiar with multimeter and CRO and learn how to use them for the various types of electrical measurements.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	0^{th} & 1^{st} Law of Thermodynamics	State functions and terminology of thermodynamics. Zeroth law and temperature. First law, internal energy, heat and work done. Work done in various thermodynamical processes. Enthalpy, relation between CP and CV. Carnot's engine, efficiency and Carnot's theorem. Efficiency of internal combustion engines (Otto and diesel).	8	CO1
2	2^{nd} & 3^{rd} Law of Thermodynamics	Different statements of second law, Clausius inequality, entropy and its physical significance. Entropy changes in various thermodynamical processes. Third law of thermodynamics and unattainability of absolute zero. Thermodynamical potentials, Maxwell's relations, conditions for feasibility of a process and equilibrium of a system. Clausius- Clapeyron equation, Joule-Thompson effect.	8	CO2
3	Kinetic Theory of Gases	Kinetic model and deduction of gas laws. Derivation of Maxwell's law of distribution of velocities and its experimental verification. Degrees of freedom, law of equipartition of energy (no derivation) and its application to specific heat of gases (mono, di and poly atomic).	7	CO3
4	Theory of Radiation	Blackbody radiation, spectral distribution, concept of energy density and pressure of radiation. Derivation of Planck's law, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan- Boltzmann law and Wien's displacement law from Planck's law.	7	CO4
5	DC & AC Circuits	Growth and decay of currents in RL circuit. Charging and discharging of capacitor in RC, LC and RCL circuits. Network Analysis - Superposition, Reciprocity, Thevenin's and Norton's theorems. AC Bridges - measurement of inductance (Maxwell's, Owen's and Anderson's bridges) and measurement of capacitance (Schering's, Wein's and de Sauty's bridges).	7	CO5
6	Semiconductors & Diodes	P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode. Diode fabrication. PN junction diode and its characteristics, static and dynamic resistance. Principle, structure, characteristics and applications of Zener, Tunnel, Light Emitting, Point Contact and Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency and voltage regulation. Basic idea about filter circuits and voltage regulated power supply.	8	CO6
7	Transistors	Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. active, cutoff & saturation regions; characteristics; current, voltage & power gains; transistor currents & relations between them. Idea of base width modulation, base spreading resistance & transition time. DC Load Line analysis and Q-point stabilisation. Voltage Divider Bias circuit for CE amplifier. Qualitative discussion of RC coupled amplifier (frequency response not included).	7	CO7
8	Electronic Instrumentation	Multimeter: Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, electron gun, electrostatic focusing and acceleration (no mathematical treatment). Front panel controls, special features of dual trace CRO, specifications of a CRO and their significance. Applications of CRO to study the waveform and measurement of voltage, current, frequency & phase difference.	8	CO8

Reference Books:

1. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997, 7e
2. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998
3. Enrico Fermi, "Thermodynamics", Dover Publications, 1956
4. S. Garg, R. Bansal, C. Ghosh, "Thermal Physics", McGraw Hill, 2012, 2e
5. Meghnad Saha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973, 5e
6. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
7. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
8. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
9. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
10. A. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e
11. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

e-Learning Source:

1. Swayam - Government of India, https://swayam.gov.in/explorer?category=Physics
2. National Programme on Technology Enhanced Learning (NPTEL), https://nptel.ac.in/course.html
3. Coursera, https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
4. edX, https://www.edx.org/course/subject/physics
5. MIT Open Course Ware - Massachusetts Institute of Technology, https://ocw.mit.edu/courses/physics/

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	1	----	2	----	----	2	3	3	----	1	----
CO2	2	----	----	----	----	----	3	3	----	1	----
CO3	3	----	2	----	----	2	3	3	----	1	----
CO4	1	----	1	----	----	----	3	3	----	2	----
CO5	2	----	2	----	----	----	3	3	----	2	----
CO6	2	----	----	----	----	----	3	3	----	1	----
CO7	3	----	2	----	----	2	3	3	----	1	----
CO8	1	----	1	----	----	----	3	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: 2024-25							
Course Code	B010202P/PY116	**Title of the Course**	**Thermal Properties of Matter & Electronic Circuits**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	Second	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge/measurements in mechanics through different experiments related to its theoretical course.						

Course Outcomes	
CO1	Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the thermal properties.
CO2	Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the electronic properties.
CO3	Measurement precision and perfection is achieved through Lab Experiments.
CO4	Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Experiment No.	**Title of the Unit**	**Content of Unit (*Offline)**	**Contact Hrs.**	**Mapped CO**
1	Callender and Barne's Method	Mechanical Equivalent of Heat by Callender and Barne's method	4	CO1/3
2	Searle's Apparatus	Coefficient of thermal conductivity of copper by Searle's apparatus	4	CO1/3
3	Thermal Conductivity	Coefficient of thermal conductivity of rubber	4	CO1/3
4	Lee and Charlton's disc method	Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method	4	CO1/3
5	Stefan's Constant	Value of Stefan's constant	4	CO1/3
6	Stefan's Law	Verification of Stefan's law	4	CO1/3
7	Thermocouple	Variation of thermo-emf across two junctions of a thermocouple with temperature	4	CO2/3
8	Platinum Resistance Thermometer	Temperature coefficient of resistance by Platinum resistance thermometer	4	CO2/3
9	Charging and Discharging	Charging and discharging in RC and RCL circuits	4	CO2/3
10	A. C. Bridges	A.C. Bridges: Various experiments based on measurement of L and C	4	CO2/3
11	Series and Parallel Resonance	Resonance in series and parallel RCL circuit	4	CO2/3
12	Semiconductor Diodes	Characteristics of PN Junction, Zener, Tunnel, Light Emitting and Photo diode	4	CO2/3
13	Transistors	Characteristics of a transistor (PNP and NPN) in CE, CB and CC configurations	4	CO2/3
14	Half wave and Full Wave Rectifies	Half wave & full wave rectifiers and Filter circuits	4	CO2/3
15	Power Supply	Unregulated and Regulated power supply	4	CO2/3
16	CRO	Various measurements with Cathode Ray Oscilloscope (CRO)	4	CO2/3
Unit No.	**Title of the Unit**	**Content of Unit (*Online Virtual Lab)**	**Contact Hrs.**	**Mapped CO**
1	Heat transfer	Heat transfer by radiation	—	---
2	Heat transfer	Heat transfer by conduction	—	---
3	Heat transfer	Heat transfer by natural convection	—	---
4	Phase Change	The study of phase change	—	---
5	Stefan's Constant	Black body radiation: Determination of Stefan's constant	—	---
6	Law of Cooling	Newton's law of cooling	—	---
7	Lee's disc apparatus	Lee's disc apparatus	—	---
8	Thermocouple	Thermo-couple: Seebeck effects	—	---
9	Familiarisation with resistor	Familiarisation with resistor	—	---
10	Familiarisation with capacitor	Familiarisation with capacitor	—	---
11	Familiarisation with inductor	Familiarisation with inductor	—	---
12	Ohm's Law	Ohm's Law	—	---
13	RC Differentiator and integrator	RC Differentiator and integrator	—	---
14	Semiconductor Diodes	VI characteristics of a diode	—	---
15	Half wave and Full Wave Rectifies	Half & Full wave rectification	—	---
16	Capacitative rectification	Capacitative rectification	—	---
17	Zener Diode	Zener Diode voltage regulator	—	---
18	Common Emitter Characteristics	BJT common emitter characteristics	—	---
19	Common Base Characteristics	BJT common base characteristics	—	---
20	Common Emitter Amplifier	Studies on BJT CE amplifier	—	---

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. L. Boylestad, L. Nashelsky, “Electronic Devices and Circuit Theory”, Prentice-Hall of India Pvt. Ltd., 2015, 11e
4. A. Sudhakar, S. S. Palli, “Circuits and Networks: Analysis and Synthesis”, McGraw Hill, 2015, 5e
e-Learning Source:
1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=194
2. Virtual Labs an initiative of MHRD Govt. of India, http://vlabs.iitkgp.ac.in/be/#
3. Digital Platforms/Web Links of other virtual labs may be suggested/added to this list by individual Universities.

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

	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	---	---	2
CO4	2	---	---	---	---	---	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: 2022-23							
Course Code	**I010101V/PY117**	**Title of the Course**	**Electrician**	**L**	**T**	**P**	**C**
Year	First	**Semester**	First	**2**	**1**	**0**	**3**
Pre-Requisite	10+2 with Physics	**Co-requisite**					
Course Objectives	The purpose of this vocational course is to impart basic and key knowledge of electrical trade so that after completing this course the learner can work in this field.						

Course Outcomes	
CO1	Familiarized with the occupational safety and basic physics necessary for the electrician trade.
CO2	Know the different devices, measuring instruments and electrical wiring.
CO3	Understand the power generation, transmission and control.
CO4	Learn the practical techniques of the electrical trade.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Electrician Basics**	Occupational Safety and Health, Conductor, semiconductors, Insulator and electric cables, Tools for an Electrician, Soldering and D.C theory, Basic Electricity, Electrical accessories, Electro-chemical effect and chemical cell, Magnetism and electromagnetism, Alternating current theory, Earthing and Basic electronics.	8	CO1
2	**Electrician Theory-I**	Transistor, Amplifiers, Oscillators, Specific solid-state devices, Digital electronics, Electrical wiring, Direct current generator, Direct current motor, Transformer and Electrical measuring instruments.	8	CO2
3	**Electrician Theory-II**	Machine control panel, Electrical instrument, Electrical power generation, Electrical power transmission, Underground cables, Power distribution, Speed control and maintenance of electric machines, Electronic theory and communication.	8	CO3
4	**Electrical Practical**	Trade safety and first aid, Tools, wire, and joints, Allied trades, Resistor, and capacitor, Alternating current (A.C.) circuit, Cell and battery, Magnetic field, Earthing and Semi-conductor diode.	8	CO4

Reference Books:

1. National Electrical Code 2020 Handbook (NFPA)
2. Practical Electrical Wiring: Residential, Farm, Commercial and Industrial, 2014 Edition (F.P. Hartwell, Herbert P. Richter)
3. Electrical Motor Controls for Integrated Systems, 5th Edition (Gary Rockis, Glen A. Mazur).
4. Ultimate Guide: Wiring, 8th Edition
5. Electrical Trainee Guide, Level 1 by NCCER.

e-Learning Source:

1. https://www.youtube.com/channel/UCB3jUEyCLRbCw7QED0vnXYg
2. https://www.youtube.com/channel/UCpbI0bpvjxlVI_-V8OIspzw
3. https://www.youtube.com/c/CraigMichaudElectricalInstructor/featured
4. https://www.youtube.com/channel/UCwf9niZNaW8mkECB6GT6raQ

	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**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**	**-**	**1**
CO2	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**2**
CO3	**3**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**3**
CO4	**3**	**-**	**-**	**-**	**-**	**-**	**3**	**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: 2024-25							
Course Code	B010205/ PY118	**Title of the Course**	**Artificial Intelligence and Physics**	**L**	**T**	**P**	**C**
Year	**First**	**Semester**	**Second**	**4**	**0**	**0**	**0**
Pre-Requisite	10+2 with Physics and Mathematics	**Co-requisite**					
Course Objectives	To make student aware about the basics of artificial intelligence and how it is useful in the different areas of physics.						

Course Outcomes	
CO1	To learn the basics of Artificial Intelligence and problem solving through it
CO2	To learn the basics of Machine Learning and Natural Language Processing
CO3	To learn the basic Physics behind the Quantum Computing
CO4	To know the different applications of Artificial Intelligence in the field of Physics.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Artificial Intelligence (AI) and Problem Solving through Artificial Intelligence (AI)**	History and evolution of AI, comparison of human and computer skill, Component of AI, Scope and significance in different domains, Ethical considerations in AI development and deployment, Intelligent Agent, logical agent. Defining problem as a state space search, analyzing the problem, solving problem by searching, informed search and Uninformed Search.	8	CO1
2	**Machine Learning Basics and natural Language Processing**	Neural networks and deep learning, Supervised and unsupervised learning, Feature selection and engineering, learning from observation, knowledge in learning. Brief history of NLP, Text processing, Sentiment analysis, language translation, Early NLP system, ELIZA system, LUNAR system, General NLP system	8	CO2
3	**Physics of Quantum Computing for Artificial Intelligence (AI)**	What is Quantum Computing, Postulates of Quantum Mechanics, Qubit – the smallest unit, Qubit – Bloch sphere representation, Multiple Qubit states and Quantum Gates, Quantum Circuits, No Cloning Theorem and Quantum Teleportation, Super Dense Coding	8	CO3
4	**Applications of Artificial Intelligence (AI) in Physics**	AI's role in Data Analysis and Simulations, AI and Particle Physics, AI and Astrophysics, AI and Atmospheric Physics, AI in Computational Physics and Material Science, AI and Relativity, AI and Thermodynamics.	8	CO4

Reference Books:

1. Artificial Intelligence by Patrick Henry Winston, 3rd Edition, Addison – Wesley Publishing Company
2. Explorations in Artificial Intelligence and Machine Learning by Roberto V. Zicari, CRC Press
3. A Textbook of Artificial Intelligence by Hema Dhingra, Rashi Bansal, Sayan Banerjee and Dr. Shalini Verma, Goyal Brothers Publications
4. Artificial Intelligence by R.B. Mishra, PHI Learning Private Limited
5. Machine Learning and Artificial Intelligence by Ameet V Joshi, Springer Nature Switzerland

e-Learning Source:

1. Quantum Information and Computing, NPTEL :: Physics - NOC: Quantum Information and Computing
2. What Artificial Intelligence can do for Physics? https://www.oecd-ilibrary.org/docserver/724b14a6-en.pdf?expires=1705508062&id=id&accname=guest&checksum=FE6968ED4CB05F58A07011FE37211CB9
3. Applications of Artificial Intelligence in Physics, 1345437330.pdf (inspirajournals.com)
4. How Artificial Intelligence is disrupting Physics, How Artificial Intelligence is Disrupting Physics (bbntimes.com)
5. Four Uses of AI in Physics, Four Uses for AI in Physics.
6. The Handbook of Artificial Intelligence, handbookofartific01barr.pdf (archive.org)

	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	1	1				3	1		1	
CO2	3	1	1				3		2		
CO3	3	2	2				3	1		1	
CO4	3	2	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: 2023-24							
Course Code	B010301T/PY207	**Title of the Course**	**Electromagnetic Theory and Modern Optics**	**L**	**T**	**P**	**C**
Year	**Second**	**Semester**	Third	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**	Passed B.Sc. 1st Year				
Course Objectives	This course aims to give students the competence in the Electromagnetic Theory and Modern Optics. At the end of the course the students are expected to have hands on experience in modeling, implementation and calculation of physical quantities of relevance and also their applications in various fields.						

Course Outcomes	
CO1	To get a better understanding of electrical and magnetic phenomenon in daily life.
CO2	To troubleshoot simple problems related to electrical devices.
CO3	Comprehend the powerful applications of ballistic galvanometer.
CO4	Study the fundamental physics behind reflection and refraction of light (electromagnetic waves).
CO5	Study the working and applications of Michelson and Fabry-Perot interferometers.
CO6	Recognize the difference between Fresnel's and Fraunhofer's class of diffraction.
CO7	Comprehend the use of polarimeters.
CO8	Study the characteristics and uses of lasers.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Electrostatics**	Electric charge & charge densities, electric force between two charges. General expression for Electric field in terms of volume charge density (divergence & curl of Electric field), general expression for Electric potential in terms of volume charge density and Gauss law (applications included). Study of electric dipole. Electric fields in matter, polarization, auxiliary field **D** (Electric displacement), electric susceptibility and permittivity.	8	CO1, 2
2	**Magnetostatics**	Electric current & current densities, magnetic force between two current elements. General expression for Magnetic field in terms of volume current density (divergence and curl of Magnetic field), General expression for Magnetic potential in terms of volume current density and Ampere's circuital law (applications included). Study of magnetic dipole (Gilbert & Ampere model). Magnetic fields in matter, magnetisation, auxiliary field **H**, magnetic susceptibility and permeability.	8	CO1, 2
3	**Time Varying Electric Fields**	Faraday's laws of electromagnetic induction and Lenz's law. Displacement current, equation of continuity and Maxwell-Ampere's circuital law. Self and mutual induction (applications included). Derivation and physical significance of Maxwell's equations. Theory and working of moving coil ballistic galvanometer (applications included).	7	CO3, 4
4	**Electromagnetic Waves**	Electromagnetic energy density and Poynting vector. Plane electromagnetic waves in linear infinite dielectrics, homogeneous & inhomogeneous plane waves and dispersive & non-dispersive media. Reflection and refraction of homogeneous plane electromagnetic waves, law of reflection, Snell's law, Fresnel's formulae (only for normal incidence & optical frequencies) and Stoke's law.	7	CO3, 4
5	**Interference**	Conditions for interference and spatial & temporal coherence. Division of Wavefront - Fresnel's Biprism and Lloyd's Mirror. Division of Amplitude - Parallel thin film, wedge shaped film and Newton's Ring experiment. Interferometer - Michelson and Fabry-Perot.	8	CO5
6	**Diffraction**	Distinction between interference and diffraction. Fresnel's and Fraunhofer's class of diffraction. Fresnel's Half Period Zones and Zone plate. Fraunhofer diffraction at a single slit, n slits and Diffracting Grating. Resolving Power of Optical Instruments - Rayleigh's criterion and resolving power of telescope, microscope & grating.	8	CO6
7	**Polarization**	Polarisation by dichronic crystals, birefringence, Nicol prism, retardation plates and Babinet's compensator. Analysis of polarized light. Optical Rotation - Fresnel's explanation of optical rotation and Half Shade & Biquartz polarimeters.	7	CO7
8	**Lasers**	Characteristics and uses of Lasers. Quantitative analysis of Spatial and Temporal coherence. Conditions for Laser action and Einstein's coefficients. Three and four level laser systems. (Qualitative discussion).	7	CO8

Reference Books:

1. D.J. Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India Private Limited, 2002, 3e
2. E.M. Purcell, "Electricity and Magnetism (In SI Units): Berkeley Physics Course Vol 2", McGraw Hill, 2017,2e
3. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 2",Pearson Education Limited, 2012
4. D.C. Tayal, "Electricity and Magnetism", Himalaya Publishing House Pvt. Ltd., 2019, 4e
5. Francis A. Jenkins, Harvey E. White, "Fundamentals of Optics", McGraw Hill, 2017, 4e
6. Samuel Tolansky, "An Introduction to Interferometry", John Wiley & Sons Inc., 1973, 2e
7. A. Ghatak, "Optics", McGraw Hill, 2017, 6e

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: 2023-24							
Course Code	B010302P/PY208	**Title of the Course**	Demonstrative Aspects of Electricity & Magnetism	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Third	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Physics	**Co-requisite**	Passed B.Sc. 1st Year				
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge/measurements in the field of electricity and magnetism mechanics through different experiments related to its theoretical course.						

Course Outcomes	
CO1	Students will understand the effect of distance on the intensity of magnetic field
CO2	Student will learn to find the various parameters of a ballistic galvanometer
CO3	Students will learn the methods to find the values of high and low resistances and also how to find the self inductance of a coil
CO4	Students will learn the method to compare the capacitance and also about how to find specific resistance
CO5	Students will learn the methods to find the magnetic moment and earth's magnetic field components

Experiment No.	**Title of the Experiment**	**Aim of the Experiment (*Offline)**	**Contact Hrs.**	**Mapped CO**
1	Single Coil	Variation of magnetic field along the axis of single coil	6	CO1
2	Helmholtz Coil	Variation of magnetic field along the axis of Helmholtz coil	6	CO1
3	B.G. Parameter	Ballistic Galvanometer: Ballistic constant, current sensitivity and voltage sensitivity	6	CO2
4	Leakage Method	Ballistic Galvanometer: High resistance by Leakage method	6	CO3
5	Kelvin's Double Bridge Method	Ballistic Galvanometer: Low resistance by Kelvin's double bridge method	6	CO3
6	Rayleigh's Method	Ballistic Galvanometer: Self inductance of a coil by Rayleigh's method	6	CO3
7	Capacitance Comparison	Ballistic Galvanometer: Comparison of capacitances	6	CO4
8	Carey Foster Bridge	Carey Foster Bridge: Resistance per unit length and low resistance	6	CO4
9	Magnetometer	Deflection and Vibration Magnetometer: Magnetic moment of a magnet and horizontal component of earth's magnetic field	6	CO5
10	Earth Inductor	Earth Inductor: Horizontal component of earth's magnetic field	6	CO5
Experiment No.	**Title of the Experiment**	**Aim of the Experiment (*Online Virtual Lab)**	**Contact Hrs.**	**Mapped CO**
1	Tangent galvanometer	To determine the reduction factor of the given tangent galvanometer (K). To find out the horizontal component of earth's magnetic field (Bh).	--	--
2	Magnetic field along the axis of a circular coil carrying current	To study the variation of magnetic field with distance along the axis of a circular coil carrying current.	--	--
3	Deflection magnetometer	To find the horizontal intensity of earth's magnetic field at a place and moment of the bar magnet.	--	--
4	Van de Graff generator	To Know about Van de Graff generator	--	--
5	Barkhausen effect	To experience the sound produced according to the magnetization of the rod while the magnet is getting nearer to the rod.	--	--
6	Temperature coefficient of resistance	To identify the change in resistivity of the resistor according to the change in temperature	--	--
7	Anderson's bridge	To find the inductance of a coil using Anderson's Bridge	--	--
8	Quincke's method	To determine the volume magnetic susceptibilities of paramagnetic liquids.	--	--

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. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.

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

	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**	**2**	--	--	--	--	**3**	**3**	--	--	**3**
CO2	**2**	**2**	--	--	--	--	**3**	**3**	--	--	**3**
CO3	**3**	**2**	--	--	--	--	**2**	**3**	--	--	**3**
CO4	**2**	**2**	--	--	--	--	**3**	**3**	--	--	**3**
CO5	**3**	**2**	--	--	--	--	**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: 2023-24							
Course Code	B010401T/PY209	**Title of the Course**	Perspectives of Modern Physics & Basic Electronics	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Fourth	**4**	**0**	**0**	**4**
Pre-Requisite	10+2 with Physics	**Co-requisite**	Passed B.Sc. 1st Year				
Course Objectives	This course aims to give students the competence in the Electromagnetic Theory and Modern Optics. At the end of the course the students are expected to have hands on experience in modeling, implementation and calculation of physical quantities of relevance and also their applications in various fields.						

Course Outcomes	
CO1	Recognize the difference between the structure of space & time in Newtonian & Relativistic mechanics.
CO2	Understand the physical significance of consequences of Lorentz transformation equations.
CO3	Comprehend the wave-particle duality.
CO4	Develop an understanding of the foundational aspects of Quantum Mechanics.
CO5	Study the comparison between various biasing techniques.
CO6	Study the classification of amplifiers.
CO7	Comprehend the use of feedback and oscillators.
CO8	Comprehend the theory and working of optical fibers along with its applications.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Relativity-Experimental Background**	Structure of space & time in Newtonian mechanics and inertial & non-inertial frames. Galilean transformations. Newtonian relativity. Galilean transformation and Electromagnetism. Attempts to locate the Absolute Frame: Michelson-Morley experiment and significance of the null result. Einstein's postulates of special theory of relativity.	7	CO1, 2
2	**Relativity-Relativistic Kinematics**	Structure of space & time in Relativistic mechanics and derivation of Lorentz transformation equations (4-vector formulation included). Consequences of Lorentz Transformation Equations (derivations & examples included): Transformation of Simultaneity (Relativity of simultaneity); Transformation of Length (Length contraction); Transformation of Time (Time dilation); Transformation of Velocity (Relativistic velocity addition); Transformation of Acceleration; Transformation of Mass (Variation of mass with velocity). Relation between Energy & Mass (Einstein's mass & energy relation) and Energy & Momentum.	8	CO1, 2
3	**Inadequacies of Classical Mechanics**	Particle Properties of Waves: Spectrum of Black Body radiation, Photoelectric effect, Compton effect and their explanations based on Max Planck's Quantum hypothesis. Wave Properties of Particles: Louis de Broglie's hypothesis of matter waves and their experimental verification by Davisson-Germer's experiment and Thomson's experiment.	8	CO3, 4
4	**Introduction to Quantum Mechanics**	Matter Waves: Mathematical representation, Wavelength, Concept of Wave group, Group (particle) velocity, Phase (wave) velocity and relation between Group & Phase velocities. Wave Function: Functional form, Normalisation of wave function, Orthogonal & Orthonormal wave functions and Probabilistic interpretation of wave function based on Born Rule.	7	CO3, 4
5	**Transistor Biasing**	Faithful amplification & need for biasing. Stability Factors and its calculation for transistor biasing circuits for CE configuration: Fixed Bias (Base Resistor Method), Emitter Bias (Fixed Bias with Emitter Resistor), Collector to Base Bias (Base Bias with Collector Feedback) &, Voltage Divider Bias. Discussion of Emitter-Follower configuration.	7	CO5
6	**Amplifiers**	Classification of amplifiers based on Mode of operation (Class A, B, AB, C & D), Stages (single & multi stage, cascade & cascode connections), Coupling methods (RC, Transformer, Direct & LC couplings), Nature of amplification (Voltage & Power amplification) and Frequency capabilities (AF, IF, RF & VF). Theory & working of RC coupled voltage amplifier (Uses of various resistors & capacitors, and Frequency response) and Transformer coupled power amplifier (calculation of Power, Effect of temperature, Use of heat sink & Power dissipation). Calculation of Amplifier Efficiency (power efficiency) for Class A Series-Fed, Class A Transformer Coupled, Class B Series-Fed and Class B Transformer Coupled amplifiers.	7	CO6
7	**Feedback and Oscillators**	**Feedback Circuits:** Effects of positive and negative feedback. Voltage Series, Voltage Shunt, Current Series and Current Shunt feedback connection types and their uses for specific amplifiers. Estimation of Input Impedance, Output Impedance, Gain, Stability, Distortion, Noise and Band Width for Voltage Series negative feedback and their comparison between different negative feedback connection types. **Oscillator Circuits:** Use of positive feedback for oscillator operation. Barkhausen criterion for self- sustained oscillations. Feedback factor and frequency of oscillation for RC Phase Shift oscillator and Wein Bridge oscillator. Qualitative discussion of Reactive Network feedback oscillators (Tuned oscillator circuits): Hartley & Colpitt oscillators.	8	CO7
8	**Introduction to Fiber Optics**	Basics of Fiber Optics, step index fiber, graded index fiber, light propagation through an optical fiber, acceptance angle & numerical aperture, qualitative discussion of fiber losses and applications of optical fibers.	8	CO8

Reference Books:

1. A. Beiser, Shobhit Mahajan, "Concepts of Modern Physics: Special Indian Edition", McGraw Hill, 2009, 6e
2. John R. Taylor, Chris D. Zafiratos, Michael A.Dubson, "Modern Physics for Scientists and Engineers",Prentice-Hall of India Private Limited, 2003, 2e
3. R.A. Serway, C.J. Moses, and C.A. Moyer, "Modern Physics", Cengage Learning India Pvt. Ltd, 2004, 3e
4. R. Resnick, "Introduction to Special Relativity", Wiley India Private Limited, 2007
5. R. Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
6. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
7. J. Millman, C.C. Halkias, Satyabrata Jit, "Electronic Devices and Circuits", McGraw Hill, 2015, 4e
8. B.G. Streetman, S.K. Banerjee, "Solid State Electronic Devices", Pearson Education India, 2015, 7e
9. J.D. Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
10. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
11. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e
12. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

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	2	1	2
CO2	3	2	-	-	-	-	3	3	2	1	2
CO3	3	2	-	-	-	-	3	3	2	2	2
CO4	3	2	-	-	-	-	3	3	2	3	2
CO5	3	2	-	-	-	-	3	3	2	3	2
CO6	3	2	-	-	-	-	3	2	2	1	2
CO7	3	2	-	-	-	-	3	3	2	1	2
CO8	3	2	-	-	-	-	3	3	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: 2023-24							
Course Code	B010402P/PY210	**Title of the Course**	Basic Electronics Instrumentation	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Fourth	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 with Physics	**Co-requisite**	Passed B.Sc. 1st Year				
Course Objectives	The purpose of this undergraduate course is to impart practical knowledge/measurements in the field of electricity and magnetism mechanics through different experiments related to its theoretical course.						

Course Outcomes	
CO1	Students will learn about different transistor biasing and will also be able to do a Comparative Study of CE, CB and CC amplifier
CO2	Student will learn about Clipper, Clamper and Emitter Follower circuits
CO3	Students will learn about the Single Stage RC coupled and Transformer Coupled amplifier
CO4	Students will learn about the Schmitt Trigger circuit
CO5	Students will learn about the Hartley and Wein Bridge oscillator

Experiment No.	**Title of the Experiment**	**Aim of the Experiment (*Offline)**	**Contact Hrs.**	**Mapped CO**
1	Biasing Stability	To study the Transistor Bias Stability	6	CO1
2	CE, CB and CC amplifier	To do a Comparative Study of CE, CB and CC amplifier	6	CO1
3	Clipper Clamper	To study the Clippers and Clampers circuits	6	CO2
4	Emitter follower	To Study the Emitter Follower circuit	6	CO3
5	RC Coupled Amplifier	To study the Frequency response of single stage RC coupled amplifier	6	CO3
6	Transformer Coupled Amplifier	To study the Frequency response of single stage Transformer coupled amplifier	6	CO3
7	Negative Feedback RC Coupled Amplifier	To study the Effect of negative feedback on frequency response of RC coupled amplifier	6	CO3
8	Schmitt Trigger	To study the Schmitt Trigger Circuit	6	CO4
9	Hartley Oscillator	To study the Hartley oscillator	6	CO5
10	Wein Bridge Oscillator	To study the Wein Bridge oscillator	6	CO5
Experiment No.	**Title of the Experiment**	**Aim of the Experiment (*Online Virtual Lab)**	**Contact Hrs.**	**Mapped CO**
1	Diode as Clippers	Diode as Clippers	--	--
2	Diode as Clampers	Diode as Clampers	--	--
3	BJT as switch and Load Lines	BJT as switch and Load Lines	--	--
4	RC frequency response	RC frequency response	--	--
5	Hartley oscillator	Hartley oscillator	--	--
6	Colpitt oscillator	Colpitt oscillator	--	--
7	Fiber Optic Analog and Digital Link	Fiber Optic Analog and Digital Link	--	--
8	Fiber Optic Bi-directional Communication	Fiber Optic Bi-directional Communication	--	--
9	Wavelength Division Multiplexing	Wavelength Division Multiplexing	--	--
10	Measurement of Bending Losses in Optical Fiber	Measurement of Bending Losses in Optical Fiber	--	--
11	Measurement of Numerical Aperture	Measurement of Numerical Aperture	--	--
12	Study of LED and Detector Characteristics	Study of LED and Detector Characteristics	--	--

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. John M. Senior, "Optical Fiber Communications: Principles and Practice", Pearson Education Limited, 2010, 3e
6. John Wilson, John Hawkes, "Optoelectronics: Principles and Practice", Pearson Education Limited, 2018, 3e
7. S.L. Gupta, V. Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e

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=201
3. Virtual Labs an initiative of MHRD Govt. of India http://vlabs.iitkgp.ac.in/psac/#
4. Virtual Labs an initiative of MHRD Govt. of Indiahttp://vlabs.iitkgp.ac.in/be/#
5. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities.

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

	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**	**2**	--	--	--	--	**3**	**3**	--	--	**3**
CO2	**2**	**2**	--	--	--	--	**3**	**3**	--	--	**3**
CO3	**3**	**2**	--	--	--	--	**2**	**3**	--	--	**3**
CO4	**2**	**2**	--	--	--	--	**3**	**3**	--	--	**3**
CO5	**3**	**2**	--	--	--	--	**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	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. 2nd 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
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. 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**