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**