TECHNO INDIA UNIVERSITY, WEST BENGAL

CURRICULUM

For

MASTERS

IN

PHYSICS

<u>**DEPARTMENT OF PHYSICS**</u>

Department of Physics

Techno India University, West Bengal, Kolkata – 700091 (India)

Effective from academic year 2024-2025 onwards

TECHNO INDIA UNIVERSITY
WEST BENGAL

STRUCTURE OF MSc PHYSICS

SEMESTER I	Code	Name of the subject	L	T	P	C
	Theory					
	TIU-PPH-T115	Electronics	3	1	0	4
	TIU-PPH-T113	Classical Mechanics	3	1	0	4
	TIU-PPH-T111	Mathematical Methods of Physics	3	1	0	4
	TIU-PPH-T107	Quantum Mechanics-I	2	1	0	3
	Practical					
	TIU-PPH-L115	Electronics Lab	0	0	6	3
	TIU-PPH-L111	Computer Programming Lab (through C/C++)	0	0	4	2
	Total					20

SEMESTER II	Code	Name of the subject	L	T	P	C
	Theory					
	TIU-PPH-T102	Numerical Method & Computational Technique	3	0	0	3
	TIU-PPH-T104	Electrodynamics	3	1	0	4
	TIU-PPH-T108	Quantum Mechanics-II	2	1	0	3
	TIU-PPH-T112	Solid State Physics	3	1	0	4
	TIU-PPH-T116	Atomic and Molecular Physics	3	1	0	4
	Practical					
	TIU-PPH-L102	Numerical Methods and Programming Lab	0	0	4	2
	TIU-PPH-L112	General Physics Lab-I	0	0	6	3
	Total					23

	Code	Name of the subject	L	T	P	C
SEMESTER III	**Code**	**Name of the subject**	**L**	**T**	**P**	**C**
	Theory					
	TIU-PPH-T215	Nuclear Physics	3	1	0	4
	TIU-PPH-T217	Statistical Mechanics	3	1	0	4
	TIU-PPH-T219	Material Physics I* (Special Paper – I*)	3	1	0	4
	TIU-PPH-T221	Nuclear Reaction I* (Special Paper – I*)	3	1	0	4
	TIU-PPH-E203A	Introduction to Cryogenics and Vacuum Technology (Elective Paper I**)	3	1	0	4
	TIU-PPH-E203B	Physics of Nanomaterials and thin films (Elective Paper I**)	3	1	0	4
	Practical					
	TIU-PPH-L201	General Physics Lab-II	0	0	6	3
	Sessional					
	TIU-PES-S291	Entrepreneurship Skill Development I	0	0	2	1
	TIU-PPH-P297	Project I	0	0	4	2
	TIU-PPH-L205	Introduction to Python Programming	0	0	4	2
	TIU-PPH-L203	Use of AI and Different Software for scientific Research	0	0	4	2
	Total					26

***Special Paper – I (Any one) [Semester III]**	****Elective Paper I (Any one) [Semester III]**
1. Material Physics I	1. Introduction to Cryogenics
2. Nuclear Reaction I	2. Physics of Nanomaterials and thin films

SEMESTER IV	Code	Name of the subject	L	T	P	C
		Theory				
	TIU-PPH-T220	Material Physics II* (Special Paper – II*)	3	1	0	4
	TIU-PPH-T222	Nuclear Reaction II* (Special Paper – II*)	3	1	0	4
	TIU-PPH-E204A	Superconducting Materials and Devices (Elective Paper – II**)	3	1	0	4
	TIU-PPH-E204B	Renewable Energy and Energy Harvesting (Elective Paper – II**)	3	1	0	4
	TIU-PPH-E206A	Advanced Condensed Matter Physics (Elective Paper III***)	3	1	0	4
	TIU-PPH-E206B	Introduction to Plasma Physics (Elective Paper III***)	3	1	0	4
	TIU-PPH-E206C	Laser Physics (Elective Paper III***)	3	1	0	4
		Practical				
	TIU-PPH-L202	Advanced Physics Lab	0	0	6	3
		Sessional				
	TIU-PES-S292	Entrepreneurship Skill Development II	0	0	2	1
	TIU-PPH-P298	Project II	0	0	12	6
	TIU-PPH-G298	Comprehensive Viva	0	0	4	2
	TIU-PPH-L208	Advanced Project on Experimental Design	0	0	4	2
		Total				26

***Special Paper – II (Any one) [Semester IV]**	****Elective Paper - II(Any one) [Semester IV]**
1. Material Physics II 2. Nuclear Physics II	1. Superconducting Materials and Devices 2. Renewable Energy and Energy Harvesting
*****Elective Paper - III(Any one) [Semester IV]**	
1. Advanced Condensed Matter Physics 2. Introduction to Plasma Physics 3. Laser Physics	

**NOTE: Total teaching hours for a 4 credit course = 39 – 45 hours (3 lecture hours, 1 tutorial)
Total teaching hours for a 3 credit course = 39 – 45 hours
Total teaching hours for a 2 credit course = 30 hours
Total teaching hours for a 1 credit course = 15 hours

SEMESTER I

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Electronics	**Subject Code:** TIU-PPH-T115
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Expand fundamental electronics knowledge by exploring advanced topics such as circuit analysis.
2. Understand the utilization of semiconductor devices in both analog and digital circuits.
3. Develop the ability to analyze and design complex electronic circuits for various applications.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand the mathematical representation of electrical networks using different matrices and response functions.	K2
CO-2:	Analyze the characteristics and high-frequency behavior of semiconductor devices.	K4
CO-3:	Apply feedback and phase shift techniques in active filter design.	K3
CO-4:	Apply operational amplifier principles in practical circuit design.	K3
CO-5:	Apply digital logic design techniques and microprocessor basics.	K3
CO-6:	Analyze and design modulation and detection systems for communication applications.	K4

COURSE CONTENT :

MODULE 1:	**CIRCUIT ANALYSIS**	**10 Hours**
Admittance, impedance, scattering and hybrid matrices for two and three port networks and their cascade and parallel combinations. Review of Laplace Transforms. Response functions, location of poles and zeros of response functions of active and passive systems (Nodal and Modified Nodal Analysis).		

MODULE 2:	SEMICONDUCTOR DEVICE PHYSICS	10 Hours
Reviews on p-n junction, BJT, JFET, equivalent circuits and high frequency effects, UJT; 4 layer pn pn device (SCR), MOS diode, accumulation, depletion and inversion, MOSFET: I-V, C-V characteristics. Enhancement and depletion mode MOSFET. Metal-semiconductor junctions; Ohmic and rectifying contacts, Schottky diode, I-V, C-V relations.		
MODULE 3:	**ANALOG CIRCUITS**	**5 Hours**
Active filters and equalizers with feedback, Phase shift and delay.		
MODULE 4:	**OPERATIONAL AMPLIFIER**	**4 Hours**
Op Amps and its applications.		
MODULE 5:	**DIGITAL CIRCUITS**	**8 Hours**
Introduction to digital IC parameters (switching time, propagation delay, fan out, fan in etc.). TTL, MOS and CMOS gates, Emitter-coupled logic, MOSFET as transmission gate. A/D and D/A converters. Basics of micro-processor and micro-controller.		
MODULE 6:	**COMMUNICATION SYSTEMS**	**8 Hours**
Amplitude, Angle and Pulse-analog modulation: Generation and detection. Model of communication system, classification of signals, representation of signals.		
TOTAL LECTURES		**45 Hours****

Books:

1. Network Analysis and Syntesis, F. F. Kuo (2nd ED., Wiley, 2010)
2. Electronic Devices and Circuits, J. Millman and C. C. Halkias and S. Jit (4th Ed., 18 McGraw-Hill, 2015)
3. Integrated Electronics, J. Millman, C. C. Halkias and C. D. Parikh (2nd Ed., McGrawHill, 2011)
4. Communication Systems, Simon Haykins (5th Ed., Wiley, 2009)
5. Digital Signal Processing, J. G. Proakis and D. G. Manolakis (4th Ed., Pearson, 2007)
6. Introduction to Semiconductor Materials and Devices, M. S. Tyagi (1st Ed., Wiley, 2012)
7. Digital principles and Applications, A.P. Malvino and D.P.Leach (8th Ed., McGrawHill, 2014)
8. Network Analysis with Applications, W.D. Stanley (4th Ed., Pearson, 2003)
9. Solid State Electronic Devices, B.G. Streetman (7th Ed., Pearson, 2015)
10. Digital Design, M. Mano (5th Ed., Pearson, 2013)

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	2	2	-	-	-	1	3	3	2
CO-2	3	3	3	2	-	-	-	1	3	3	2
CO-3	3	3	3	3	-	-	-	1	3	3	2
CO-4	3	3	2	2	-	-	-	1	3	3	2
CO-5	3	3	3	3	-	-	-	1	3	3	2
CO-6	3	3	3	3	-	-	-	1	3	3	2
Average	3	3	2.67	2.50	0	0	0	1	3	3	2

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Classical Mechanics	**Subject Code:** TIU-PPH-T113
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. To provide a deep understanding of classical mechanics through Lagrangian and Hamiltonian formulations.
2. To analyze central force problems, small oscillations, and rigid body motion using advanced mathematical techniques.
3. To introduce classical field theory and fundamental concepts of relativity, including gravitational waves and spacetime curvature.
4. Integrate Lagrangian and Hamiltonian principles into relativistic mechanics, bridging the gap between classical and modern physics.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand the fundamental principles of Lagrangian mechanics, including generalized coordinates, D'Alembert's principle, and the equations of motion.	K2
CO-2:	Apply Hamiltonian mechanics to physical systems by utilizing Legendre transformations, Poisson brackets, and canonical transformations.	K3
CO-3:	Analyze small oscillations in mechanical systems using eigenvalue problems, normal modes, and dissipation effects.	K4
CO-4:	Explain the Lagrangian and Hamiltonian formulation of continuous systems and their role in classical field theory.	K2
CO-5:	Solve problems related to the special theory of relativity, including Lorentz transformations, relativistic kinematics, and mass-energy relationships.	K3
CO-6:	Identify and describe the transformation of fields and potentials in relativistic electrodynamics and the basics of chaotic dynamical systems.	K1

COURSE CONTENT :

MODULE 1:	LAGRANGIAN MECHANICS	10 Hours
Generalized coordinates, Principle of virtual work, D'Alembert's principle, Lagrange equation and Hamilton's principle, Lagrange equation from Hamilton's principle, Central force including Two body problem in central force, Equations of motion, Effective potential energy, Virial theorem, Kepler's problem		
MODULE 2:	**HAMILTONIAN FORMULATION**	**10 Hours**
Legendre transformations, Hamilton's equations, Symmetries and conservation laws in Hamiltonian picture, Hamilton's principle, Canonical transformations, Poisson brackets, Hamilton-Jacobi theory, Action-angle variables.		
MODULE 3:	**SMALL OSCILLATIONS**	**8 Hours**
Eigen value problem, frequencies of free vibrations and normal modes, forced vibrations, dissipation.		
MODULE 4:	**CLASSICAL FIELD THEORY**	**8 Hours**
Lagrangian and Hamiltonian formulation of continuous system, Symmetry and Conservation Laws		
MODULE 5:	**SPECIAL THEORY OF RELATIVITY**	**9 Hours**
Inadequacy of classical mechanics, Lorentz Transform, Relativistic Kinematics and Mass-Energy Relationship, Transformation of fields and potentials, Classical Electrodynamics, Chaotic Dynamical Systems.		
TOTAL LECTURES		**45 Hours****

Books:

1. H. Goldstein, C. P. Poole and J. Safko, *Classical Mechanics,* 3rd Edition, Pearson (2012).
2. N. C. Rana and P. S. Joag, *Classical Mechanics*, Tata Mcgraw Hill (2001).
3. L. Landau and E. Lifshitz, *Mechanics,* Oxford (1981).
4. S. N. Biswas, *Classical Mechanics*, Books and Allied (P) Ltd., Kolkata (2004).
5. F. Scheck, *Mechanics,* Springer (1994).

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	2	-	-	-	-	-	-	3	-	-
CO-2	3	3	2	2	-	-	-	-	3	-	1
CO-3	3	2	-	-	-	-	-	-	3	-	-
CO-4	3	3	-	-	-	-	-	-	3	-	-
CO-5	1	3	-	-	-	-	-	-	3	-	-
CO-6	3	3	2	-	-	-	-	-	3	-	-
Average	2.67	2.67	2	2	0	0	0	0	3	0	0

TECHNO INDIA UNIVERSITY
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Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Mathematical Methods for Physics	**Subject Code:** TIU-PPH-T111
Contact Hours/Week: 3-1-0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Distinguish between real and complex analysis by exploring complex functions, differentiability, and analyticity.
2. Develop a strong foundation in vector spaces, linear transformations, and basis functions.
3. Analyze the theory of groups, homomorphisms, isomorphisms, and permutation groups.
4. Develop an understanding of Legendre polynomials, Bessel functions, and their applications in solving differential equations.
5. Understand the fundamentals of contravariant, covariant, and mixed tensors.
6. Master Laplace transforms, inverse Laplace transforms, Fourier integrals, and their applications.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Distinguish between complex variables and complex variable algebra from its real counterpart and apply complex variable properties and algebra to solve a problem in mathematical methods of physics	K4
CO-2:	Construct and modify the concept of vector spaces and the concept of operators and use operators are used in different branches of physics to simplify calculations.	K4
CO-3:	Investigate and devise the theory of groups, homomorphism, isomorphism and permutation groups so as to be able to apply these concepts to classify mathematical objects	K4
CO-4:	Construct the concepts of Legendre, Bessel's Functions and Green's Function.	K3
CO-5:	Interpret and Utilize the fundamentals of contravariant, covariant and mixed tensors and algebra related to tensors to apply the abstract concepts of representation of a physical quantity in higher dimension.	K3
CO-6:	Optimize and solve Laplace's Transform, Inverse Laplace's Transform, Fourier Integrals and time series analysis	K3

COURSE CONTENT :

MODULE 1:	**COMPLEX VARIABLE**	**4 Hours**
Cauchy-Riemann equation, Cauchy's integral formula.		
MODULE 2:	**LINEAR SPACE AND OPERATORS**	**6 Hours**
Vector space, inner product space, Linear operators, matrix representation of operators, conjugate operators, unitary operators, orthogonality		
MODULE 3:	**GROUPS**	**8 Hours**
Definition of groups, isomorphism, homomorphism, Permutation groups, SU(2), O(3); Applications of Group theory in physics		
MODULE 4:	**DIFFERENTIAL EQUATIONS**	**10 Hours**
The hypergeometric equation and functions; Confluent hypergeometric equation and functions; Representation of Legendre, Bessel and Hermite functions in terms of hypergeometric functions. Properties of Legendre, Bessel, Hermite and Green's Functions. Applications of Legendre, Bessel, Hermite and Green's Functions		
MODULE 5:	**TENSORS**	**8 Hours**
General definition, contravariant, covariant and mixed tensors and their ranks, Outer product of tensors, contraction of tensors, inner product of tensors, Symmetric and antisymmetric tensors, Kronecker delta, Metric tensor, raising and lowering of indices**.** Application of tensor theory		
MODULE 6:	**TRANSFORM THEORY**	**9 Hours**
Laplace transformation and inverse Laplace transformation, Applications of Laplace transformation, Use of Fourier transformation in solving differential equations, Time series analysis and applications		
TOTAL LECTURES		**45 Hours****

Books:

1. G. B. Arfken, H. J. Weber and F. E. Harris, *Mathematical Methods for Physicists*, Seventh Edition, Academic Press (2012).
2. S. Andrilli & D. Hecker, *Elementary Linear Algebra*, Academic Press (2006).
3. A.W. Joshi, *Elements of Group Theory*, New Age Int. (2008).
4. A.W. Joshi, *Matrices and Tensors in Physics*, 3rd Edition, New Age Int. (2005).
5. M. L. Boas, *Mathematical Methods in Physical Sciences*, John Wiley & Sons (2005).
6. S. Lang, *Introduction to Linear Algebra*, Second Edition, Springer (2012).
7. T. Lawson, *Linear Algebra*, John Wiley & Sons (1996).
8. P. Dennery & A. Krzywicki, *Mathematics for Physicists*, Dover Publications (1996).

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	1	3	-	-
CO2	3	3	-	-	-	-	-	1	3	-	-
CO3	3	3	-	-	-	-	-	1	3	-	-
CO4	3	2	-	-	-	-	-	1	3	-	-
CO5	3	2	-	-	-	-	-	1	3	-	-
CO6	3	2	-	-	-	-	-	1	3	-	-
Average	3	2.33	0	0	0	0	0	1	3	0	0

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Quantum Mechanics-I	**Subject Code:** TIU-PPH-T107
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to

1. To introduce the fundamental concepts of linear vector spaces and their applications in quantum mechanics.
2. To provide a detailed understanding of angular momentum, its algebra, eigenvalues, and eigenstates in quantum systems.
3. To explore three-dimensional quantum problems, including the hydrogen atom, and apply perturbation theory to understand real-world physical phenomena.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall and define fundamental concepts of quantum mechanics such as postulates of quantum mechanics, Schrödinger equation in 1D, inner product spaces, operators, eigenvalues, eigenvectors, and Dirac notation.	K1
CO-2:	Explain the principles of angular momentum, including spin angular momentum, Pauli matrices, and the addition of angular momentum.	K2
CO-3:	Apply the principles of quantum mechanics to solve three dimension problems involving spherical harmonics, central potentials, and the hydrogen atom.	K3
CO-4:	Analyze the effects of perturbations in quantum systems, including the Zeeman and Stark effects, using time-independent perturbation theory.	K4
CO-5:	Apply time-independent perturbation theory to calculate energy shifts in systems with relativistic corrections, spin-orbit coupling, and hyperfine interactions.	K3
CO-6:	Analyze the behavior and structure of multi-electron systems like the helium atom, considering Pauli's Exclusion Principle and exchange interactions.	K4

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**2 Hours**

Review based on postulates of Quantum Mechanics and Schrödinger equation.		
MODULE 2:	**OVERVIEW OF LINEAR VECTOR SPACES:**	**6 Hours**
Inner product space, operators, expectation values of physical variables, bases, Dirac notation, eigen values and eigen vectors, commutation relations, Hilbert space.		
MODULE 3:	**ANGULAR MOMENTUM:**	**10 Hours**
Commutation relations, spin angular momentum, Pauli matrices, raising and lowering operators, Solution of harmonic oscillator using raising and lowering operators, L-S coupling, Total angular momentum, addition of angular momentum, Clebsch-Gordon coefficients.		
MODULE 4:	**THREE DIMENSIONAL PROBLEMS:**	**12 Hours**
Spherical harmonics, free particle in a spherical cavity, central potential, Three dimensional harmonic oscillator, degeneracy, Hydrogen atom.		
MODULE 5:	**TIME INDEPENDENT PERTURBATION THEORY:**	**15 Hours**
Non-degenerate and Degenerate cases, Zeeman and Stark effects, induced electric dipole moment of Hydrogen; Real Hydrogen Atom: relativistic correction, spin-orbit coupling, hyperfine interaction, limitation of perturbation theory for Helium atom, Pauli's exclusion principle, exchange interaction.		
TOTAL LECTURES		**45 Hours****

Books:

1. R. Shankar, Principles of Quantum Mechanics, Springer (India) (2008).
2. J. J. Sakurai, Modern Quantum Mechanics, Pearson Education (2002).
3. K. Gottfried and T-M Yan, Quantum Mechanics: Fundamentals,2nd Ed., Springer (2003).
4. D. J. Griffiths, Introduction to Quantum Mechanics, Pearson Education (2005).
5. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill(1995).
6. F. Schwabl, Quantum Mechanics, Narosa (1998).
7. L. Schiff, Quantum Mechanics, Mcgraw-Hill (1968).
8. E. Merzbacher, Quantum Mechanics, John Wiley (Asia) (1999).
9. B. H. Bransden and C. J. Joachain, Quantum Mechanics, Pearson Education 2nd Ed. (2004).

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	2	2	-	-	-	1	3	2	-
CO-2	3	3	2	2	-	-	-	1	3	2	-
CO-3	3	3	3	2	-	-	-	1	3	3	-
CO-4	3	3	3	3	-	-	-	1	3	3	-
CO-5	3	3	3	3	-	-	-	1	3	3	-
CO-6	3	3	3	3	-	-	-	1	3	3	-
Average	3	3	2.67	2.50	0	0	0	1	3	2.67	0

TECHNO INDIA UNIVERSITY
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Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Electronics Laboratory	**Subject Code:** TIU-PPH-L115
Contact Hours/Week: 0–0–6 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE:

Enable the student to:

1. Acquire knowledge of various types of electronic components, their functions, and how they operate within electronic systems.
2. Perform hands-on experiments to analyze and design digital electronic circuits, enhancing practical understanding and technical proficiency.
3. Gain experience in creating and implementing programs using microprocessors to control and automate electronic systems.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Demonstrate the working principles of rectifiers, voltage regulators, and power supplies using semiconductor devices and ICs	K3
CO-2:	Analyze the characteristics and performance of BJTs and FETs in various configurations and amplifier circuits.	K4
CO-3:	Design and implement operational amplifier circuits, including adder, subtractor, differentiator, integrator, and active filters.	K5
CO-4:	Construct and test oscillator circuits, multivibrators, and timing circuits using NE555 and OP-AMPs	K5
CO-5:	Demonstrate and verify digital logic principles, including logic gates, De Morgan's theorem, adders, multiplexers, comparators, counters, and flip-flops.	K3
CO-6:	Develop and execute assembly language programs using the Intel 8085 microprocessor kit, including interfacing experiments.	K3

COURSE CONTENT:

MODULE 1:	**Wave Rectifiers**	**6 Hours**

Construct half-wave and full-wave rectifiers Circuits , conversion AC to DC, efficiency ,output waveforms, ripple factor, voltage smoothing.		
MODULE 2:	**Zener Diode**	**6 Hours**
Voltage regulation using Zener diodes, to maintain its stable output voltage despite variations in input voltage or load conditions.		
MODULE 3:	**Regulated Dual Voltage Power Supply**	**6 Hours**
Construct dual voltage power supply, functionality of dual voltage regulators,applications.		
MODULE 4:	**Bipolar Junction Transistor**	**6 Hours**
analyze the input and output characteristics of a Bipolar Junction Transistor (BJT) in both Common Base (CB) and Common Emitter (CE) configurations,behavior of BJTs in different operating regions and their applications in amplifier circuits.		
MODULE 5:	**FET**	**6 Hours**
Construction of single-stage amplifier using a Field Effect Transistor (FET), voltage gain and frequency response		
MODULE 6:	**OP-AMP Circuit**	**6 Hours**
Design and build various operational amplifier circuits, such as adders, subtractors, differentiators, and integrators, as well as active filters.		
MODULE 7:	**Oscillators**	**6 Hours**
Construction Colpitts and Wien bridge oscillators to generate sine wave signals. frequency determination , stability, generating RF and audio frequencies.		
MODULE 8:	**Multivibrator using NE555**	**6 Hours**
Monostable (one-shot pulse) and astable (oscillating) multivibrators using the NE555 timer IC, timing pulses, frequency oscillations etc		
MODULE 9:	**NOR/NAND Gates**	**6 Hours**
Demonstrates the universality of NOR and NAND, implement circuits using only NOR or NAND gates to realize all basic logic operations.		
MODULE 10:	**De Morgan’s Theorem**	**6 Hours**
Verification of De Morgan's Theorem , applications in digital circuit design.		
MODULE 11:	**Adder**	**6 Hours**

Designing and testing half adders and full adders, perform binary addition, arithmetic units in digital computers and other systems.		
MODULE 12:	**Multiplexers and Demultiplexer**	**6 Hours**
Multiplexers (MUX) and demultiplexers (DEMUX) function ,communication ,data routing systems.		
MODULE 13:	**Comparator and Mod-Counters**	**6 Hours**
Compare voltages,count through a series of states. decision-making circuits and digital counters for sequential operations.		
MODULE 14:	**JK Flip-Flop**	**6 Hours**
Analyze the behavior of the JK flip-flop, a fundamental sequential logic circuit,toggling between states based on its inputs and is used in memory ,timing applications.		
MODULE 15:	**Microprocessor**	**6 Hours**
Assembly language programming using the INTEL 8085 microprocessor, along with interfacing experiments using 8155/8255 ICs.		
TOTAL		**90 Hours****

Books:

1. "Electronics: Principles and Applications" by Charles A. Schuler
2. "Digital Electronics: A Practical Approach with VHDL" by William Kleitz
3. "Digital Electronics" by Rakshit and Chattopadhyay
4. "The 8085 Microprocessor: Architecture, Programming, and Applications" by R.S. Gaonkar

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	2	2	1	-	1	-	1	1	-	3
CO-2	3	2	2	1	-	1	-	1	1	-	3
CO-3	3	3	3	2	-	1	-	1	1	-	3
CO-4	3	3	3	2	-	3	-	1	1	-	3
CO-5	3	3	3	2	-	1	-	1	1	-	3
CO-6	3	3	3	2	-	1	-	1	1	-	3
Average	3	2.67	2.67	1.67	0	1.33	0	1	1	0	3

TECHNO INDIA UNIVERSITY
W E S T B E N G A L

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: : Computer Programming Lab (Through C/C++)	**Subject Code:** TIU-PPH-L111
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. Acquire a solid foundation in basic computer programming concepts and techniques.
2. Learn to design and write computer programs to solve a wide range of problems accurately and efficiently.
3. Develop skills to write precise and optimized code that addresses computational challenges effectively.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Learn about the C programming language and its applications in basic transformations, numerical operations, and so forth.	K4
CO-2:	Use programming language to carry out fundamental mathematical operations in the area of number system.	K3
CO-3:	Learn how to use C programming to execute algebraic operations	K3
CO-4:	Apply their knowledge to execute programmes on Mensuration.	K3
CO-5:	Solve a variety of equations in motion using C programming.	K3
CO-6:	Learn to perform various matrices operations .	K5

COURSE CONTENT :

MODULE 1:	**Introduction to C Programming**	**6 Hours**
Introduction to C programming C programming, temperature conversion, Celsius to Fahrenheit, basic I/O, arithmetic operations, Gauss Elimination, forward elimination, back substitution, augmented matrix, system of linear equations		
MODULE 2:	**Sum and Average of Real Numbers**	**6 Hours**
Sum, average, real numbers, floating-point variables, arithmetic operations		

MODULE 3:	**Sum of Numbers**	**6 Hours**
Even numbers, odd numbers, loops, conditional statements, summation.		
MODULE 4:	**Largest of Three Numbers Using Functions**	**6 Hours**
Functions, arguments, return values, conditional statements		
MODULE 5:	**Bubble Sort Technique for Ascending Order**	**6 Hours**
Sorting, Bubble Sort, ascending order, arrays, loops		
MODULE 6:	**Matrix Addition**	**6 Hours**
Matrices, addition, 2D arrays, nested loops		
MODULE 7:	**Matrix Multiplication**	**6 Hours**
Matrices, multiplication, compatibility check, 2D arrays, checking the compatibility for multiplication.		
MODULE 8:	**Roots of a Quadratic Equation Using Switch Statement**	**6 Hours**
Quadratic equation, roots, switch statement, decision-making		
MODULE 9:	**Programming application on Distance Travelled by a Vehicle**	**6 Hours**
Find the distance(S) final velocity(v) travelled by a vehicle, given it's initial velocity 'u', acceleration 'a' and time 't' [use $S = ut + (\frac{1}{2})at^2$, $v = u + at$, $v^2 = u^2 + 2aS$]		
MODULE 10:	**Programming application on Volume Calculations of Geometric Shapes**	**6 Hours**
Programming for computing the volume of sphere, cone and cylinder assume that dimensions are integer's use type casting wherever necessary.		
TOTAL		**60 Hours****

Books:

1. Problem Solving and Program Design in C, 4th edition, by jeri R. Hanly and Elli B.Koffman. P. V.P.Siddhartha Institute of Technology(Autonomous), I B.Tech. syllabus under PVP14 regulations
2. Programming in C by Pradip Dey, Manas Ghosh 2nd edition Oxford University Press.
3. E.Balaguruswamy, Programming in ANSI C 5th Edition McGraw-Hill
4. A first book of ANSI C by Gray J.Brosin 3rd edition Cengagedelmer Learning India P.Ltd
5 .AL Kelly, Iraphol, Programming in C,4th edition Addison-Wesley – Professional
6. Brain W.Kernighan & Dennis Ritchie, C Programming Language, 2nd edition, PH

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	3	2	-	2	-	1	-	-	3
CO-2	3	3	3	2	-	2	-	1	-	-	3
CO-3	3	3	3	2	-	2	-	1	-	-	3
CO-4	3	3	3	2	-	2	2	1	-	-	3
CO-5	3	3	3	2	-	2	2	1	-	-	3
CO-6	3	3	3	2	-	2	2	1	-	-	3
Average	3	3	3	2	0	2	2	1	0	0	3

SEMESTER II

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Numerical Method & Computational Technique	**Subject Code:** TIU-PPH-T102
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Introduce fundamental numerical methods for solving algebraic and transcendental equations, interpolation, differentiation, and integration.
2. Develop computational skills for implementing numerical algorithms and solving boundary value problems in scientific computing.
3. Apply numerical techniques in real-world physics and engineering problems, enhancing students' problem-solving and analytical abilities

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Define and explain the sources of errors, their propagation, and methods for error analysis, and understand the various root-finding methods.	K2
CO-2:	Apply linear equation-solving techniques and the least squares fitting method and analyze their efficiency in solving real-world problems. Additionally, they will apply power methods for eigenvalue problems.	K4
CO-3:	Apply interpolation methods to approximate functions and construct numerical differentiation formulas to solve problems involving function approximations.	K3
CO-4:	Apply various numerical integration methods for solving integrals, and evaluate their accuracy and efficiency in practical applications.	K3
CO-5:	Apply methods for solving initial value problems of ordinary differential equations (ODEs) and analyze their convergence and stability for different problem types.	K4
CO-6:	Find solutions for boundary value problems and evaluate their effectiveness in real-world applications. Additionally, students will use software tools like MATHEMATICA or PYTHON to implement numerical methods.	K3

COURSE CONTENT :

MODULE 1:	**ERRORS AND ROOTS OF FUNCTIONS**	**7 Hours**

Errors: its sources, propagation and analysis; Roots of functions: bisection, Newton-Raphson, secant method, fixed-point iteration, applications		
MODULE 2:	**LINEAR EQUATIONS AND EIGENVALUE PROBLEMS**	**10 Hours**
Linear equations: Gauss and Gauss-Jordan elimination, Gauss-Seidel, LU decomposition; Eigenvalue Problem: power methods and its applications; Least square fitting of functions and its applications		
MODULE 3:	**INTERPOLATION**	**8 Hours**
Newton's and Chebyshev polynomials; Numerical differentiation: forward, backward and centred difference formulae		
MODULE 4:	**NUMERICAL INTEGRATION**	**7 Hours**
Trapezoidal and Simpson's rule, Gauss-Legendre integration, applications, Error Analysis in numerical integration		
MODULE 5:	**SOLUTIONS OF ODE**	**7 Hours**
Initial value problems, Euler's method, second and fourth order Runge-Kutta methods, Application in solving ordinary differential equations		
MODULE 6:	**BOUNDARY VALUE PROBLEM**	**6 Hours**
Finite difference method, applications. Application using MATHEMATICA or PYTHON		
TOTAL LECTURES		**45 Hours****

Books:

1. K. E. Atkinson, Numerical Analysis, John Wiley (Asia) (2004).
2. S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, Tata McGraw Hill (2002).
3. J. D. Hoffman, Numerical Methods for Engineers and Scientists, 2nd ed. CRC Press, Special Indian reprint (2010).
4. J. H. Mathews, Numerical Methods for Mathematics, Science, and Engineering, PrenticeHall of India (1998).
5. S. S. M. Wong, Computational Methods in Physics, World Scientific (1992).
6. W. H. Press, S. A. Teukolsky, W. T. Verlling and B. P. Flannery, Numerical Recipes in C,Cambridge (1998).

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	2	2	-	-	-	1	2	2	-
CO-2	3	3	2	2	-	-	-	1	2	2	-
CO-3	3	3	2	2	-	-	-	1	2	2	-
CO-4	3	3	2	2	-	-	-	1	2	2	-
CO-5	3	3	2	2	-	-	-	1	2	2	-
CO-6	3	3	2	3	-	-	-	1	2	2	2
Average	3	3	2	2.17	0	0	0	1	2	2	2

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Electrodynamics	**Subject Code:** TIU-PPH-T104
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Illustrate the evaluation of fields and forces in electrodynamics and magnetodynamics using fundamental scientific methods.
2. Develop a deep understanding of relativistic electrodynamics and its theoretical foundations.
3. Explore the applications of electrodynamics in various branches of physical sciences.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Demonstrate a strong understanding of electrostatics, magnetostatics and Maxwell's equations for time-varying fields.	K3
CO-2:	Analyze wave propagation in different media and apply reflection/refraction principles using Fresnel equations and Group Velocity Dispersion (GVD).	K4
CO-3:	Examine surface waves, waveguides, resonant cavities, and antennas, and evaluate their applications in communication and scattering phenomena.	K4
CO-4:	Understand and apply the concepts of different electromagnetic potentials and accelerated charges and physical phenomena observed in plasma.	K3
CO-5:	Comprehend the fundamentals of special relativity and apply the relativistic electrodynamics.	K3
CO-6:	Understand the principles of quantum electrodynamics, including photon states, Feynman diagrams, and radiative corrections in scattering processes.	K3

COURSE CONTENT:

MODULE 1:	**MAXWELL'S EQUATIONS, AND WAVE PROPAGATION**	**10 Hours**
Review of electrostatics and magnetostatics boundary value problems using Laplace's equation. Maxwell's equations for time varying fields, polarization and conductivity, plane waves in dielectrics and conductors, reflection/refraction, critical reflection, Fresnel Equation, Group Velocity Dispersion (GVD)		
MODULE 2:	**WAVEGUIDES, TRANSMISSION LINES, AND ANTENNAS**	**8 Hours**

Surface waves and medium frequency communication, Fieldsat the surface of and within a Conductor; Cylindrical Cavities and Wave Guides, Resonant Cavities, Power losses in a Cavity and Q of a Cavity, transmission lines, dipole antenna, antenna array, Rayleigh scattering.		
MODULE 3:	**RADIATION THEORY**	**8 Hours**
Scalar and vector potentials, Coulomb gauge and Lorentz gauge, Gauge transformations, Lienard-Wiechert potentials, Radiation from accelerated charges, Applications to communication and radar, Total power Radiated by an Accelerating charge, Larmor's formula.		
MODULE 4:	**PLASMA**	**5 Hours**
Interaction of electromagnetic wave with plasma, Concept about plasma equilibrium, Wave propagation in plasmas.		
MODULE 5:	**SPECIAL RELATIVITY AND RELATIVISTIC ELECTRODYNAMICS**	**8 Hours**
Postulates of special relativity, Lorentz transformations, Minkowski Space and Four vectors, Concepts of Four velocity, Four-momentum , Four Acceleration, mass-energy equivalence, relativistic covariance of Maxwell's equations. Relativistic formation of electrodynamics.		
MODULE 6:	**QUANTUM ELECTRODYNAMICS**	**6 Hours**
Quantization of the electromagnetic field, Photon states and Fock space, Feynman Diagrams: Basic rules and applications, Scattering processes and cross-sections, Radiative Corrections: Vacuum polarization, Lamb shift and anomalous magnetic moment.		
TOTAL LECTURES		**45 Hours****

Books:

1. J. D. Jackson, Classical Electrodynamics, John Wiley (Asia) (2011).
2. Griffiths, D.J., (2012), Introduction to Electrodynamics, PHI Learning
3. H. J. W. Muller Kirsten, Electrodynamics, World Scientific (2011).
4. E. C. Jordan and K. G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice Hall (1995).
5. J. Schwinger et al., Classical Electrodynamics, Persesus Books (1998).
6. G. S. Smith, Classical Electromagnetic Radiation, Cambridge (1997).

CO-PO Mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**
CO-1	3	3	-	-	-	-	-	-	3	2	-
CO-2	2	3	-	-	-	-	-	-	3	3	-
CO-3	3	2	2	-	-	-	-	-	2	3	-
CO-4	3	3	-	2	-	-	-	-	2	3	-
CO-5	3	2	-	-	-	-	-	-	2	3	-
CO-6	3	3	-	-	-	-	-	-	3	3	-
Average	2.83	2.67	2	2	0	0	0	0	2.50	2.83	0

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Quantum Mechanics-II	**Subject Code:** TIU-PPH-T108
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. To develop an understanding of the Schrödinger equation in the presence of a slowly varying potential and its implications in quantum mechanics.
2. To explore and apply the variational method and perturbation theory to solve complex quantum mechanical problems.
3. To introduce fundamental concepts of scattering theory and radiation theory, emphasizing their applications in modern physics.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall the formalism of Schrödinger's equation for a slowly varying potential and the WKB approximation, including the turning points and connection formulae.	K1
CO-2:	Understand the variational method, including trial wave functions, and explain its applications to solving simple potential problems in quantum mechanics.	K2
CO-3:	Explain time-dependent perturbation theory, sinusoidal perturbations, and apply Fermi's Golden Rule to various potential fields.	K2
CO-4:	Apply the semi-classical treatment of radiation theory, including Einstein's coefficients, to explain spontaneous and stimulated emission and absorption, and their applications in lasers.	K3
CO-5:	Apply scattering theory, including the Born approximation and Green's functions, to calculate scattering cross-sections and analyze scattering in different potential fields.	K3
CO-6:	Analyze the Lorentz invariance and derive the Klein-Gordon and Dirac equations for free particles, understanding their significance in relativistic quantum mechanics.	K4

COURSE CONTENT :

MODULE 1:	**SCHRODINGER EQUATION FOR A SLOWLY VARYING POTENTIAL:**	**9 Hours**
WKB approximation, turning points, connection formulae, derivation of Bohr-Sommerfeld quantization condition, applications of WKB.		

MODULE 2:	**VARIATIONAL METHOD:**	**8 Hours**
trial wave function, applications to simple potential problems.		
MODULE 3:	**TIME DEPENDENT PERTURBATION THEORY:**	**10 Hours**
Sinusoidal perturbation, Fermi's Golden Rule; Special topics in radiation theory: semi-classical treatment of interaction of radiation with matter, Einstein's coefficients, spontaneous and stimulated emission and absorption, application to lasers.		
MODULE 4:	**SCATTERING THEORY:**	**10 Hours**
Born approximation, scattering cross section, Greens functions, scattering for different kinds of potentials, applications.		
MODULE 5:	**RELATIVISTIC QUANTUM MECHANICS:**	**8 Hours**
Lorentz invariance, free particle Klein-Gordon and Dirac equations.		
TOTAL LECTURES		**45 Hours****

Books:

1. B. H. Bransden and C. J. Joachain, Quantum Mechanics, Pearson Education 2nd Ed. (2004).
2. R. L. Liboff, Introductory Quantum Mechanics, Pearson Education, 4th Ed. (2003).
3. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill (1995).
4. F. Schwabl, Quantum Mechanics, Narosa (1998).
5. L. I. Schiff, Quantum Mechanics, McGraw Hill (1968).
6. J. J. Sakurai, Modern Quantum Mechanics, Pearson Education (2002).
7. R. Shankar, Principles of Quantum Mechanics, Springer; 2nd edition (1994).

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	-	-	-	3	2	-
CO2	3	3	3	2	-	-	-	-	3	2	-
CO3	3	3	2	2	-	-	-	-	3	2	-
CO4	3	3	3	3	-	-	-	-	2	3	-
CO5	3	3	3	3	-	-	-	-	3	3	-
CO6	3	3	3	3	-	-	-	-	2	3	-
Average	3	3	2.67	2.50	0	0	0	0	2.67	2.50	0

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Solid State Physics	**Subject Code:** TIU-PPH-T112
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Develop a thorough understanding of fundamental solid-state physics concepts.
2. Learn crucial theoretical principles that govern solid-state systems.
3. Gain exposure to essential experimental techniques for a well-rounded understanding of the subject.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand crystal structures, symmetry operations, diffraction principles, and reciprocal lattices.	K2
CO-2:	Analyze lattice dynamics, vibrational models, and phonon-related phenomena in solids.	K4
CO-3:	Apply free-electron theory to explain the electrical, thermal, and transport properties of metals.	K3
CO-4:	Explain the formation of energy bands, Bloch's theorem, and solid-state electronic properties.	K2
CO-5:	Analyze semiconductor properties, charge carrier mechanisms, and electronic transport.	K4
CO-6:	Explain the fundamental principles of magnetic resonance and superconductivity.	K2

COURSE CONTENT :

MODULE 1:	**CRYSTAL STRUCTURE**	**8 Hours**
Diffraction of waves by crystals: Bragg's law of X-ray diffraction, Symmetry operations and classification of Bravais lattices, common crystal structures, reciprocal lattice, Brillouin zone, Von Laue's formulation, diffraction from non-crystalline systems. Geometrical factors of SC, FCC, BCC and diamond lattices.		
MODULE 2:	**LATTICE DYNAMICS**	**8 Hours**
Failure of the static lattice model, vibrations of linear monoatomic and diatomic lattice, quantization of lattice vibrations, Einstein and Debye theories of specific heat, phonon density of states, neutron scattering.		

MODULE 3:	FREE ELECTRON THEORY OF METALS	6 Hours
Drude theory, DC conductivity, magneto-resistance, thermal conductivity, thermoelectric effects, Fermi-Dirac distribution, thermal properties of an electron gas, WiedemannFranz law, critique of free-electron model.		
MODULE 4:	**BAND THEORY OF SOLIDS**	**8 Hours**
Wave functions in a periodic lattice and the Bloch theorem, The Kronig-Penny model , Approximate solution near a zone boundary and band gap, the tight binding approximation, cyclotron resonance, the De-Haas Van Alphben effect. Fermi surface and Brillouin zones.		
MODULE 5:	**SEMICONDUCTORS**	**4 Hours**
General properties and band structure, carrier statistics, impurities, intrinsic and extrinsic semiconductors, drift and diffusion currents, mobility, Hall effect.		
MODULE 6:	**MAGNETIC RESONANCES**	**6 Hours**
Nuclear magnetic resonances, Paramagnetic resonance, Bloch equation, Longitudinal and transverse relaxation time; Spin echo; Motional narrowing in line width; Absorption and dispersion; Hyperfine field; Electron-spin resonance.		
MODULE 7:	**SUPERCONDUCTORS**	**5 Hours**
Phenomenology, review of basic properties, thermodynamics of superconductors, London's equation and Meissner effect, Type-I and Type-II superconductors, BCS theory of superconductors.		
TOTAL LECTURES		**45 Hours**

Books:

1. Introduction to Solid State Physics, C. Kittel, 8th ed; John Wiley & Sons (2005).
2. Solid State Physics, J. D. Patterson and B.C. Bailey; Springer (2007).
3. Solid State Physics, A. J. Dekker; Prentice Hall
4. Solid State Physics, N. W. Ashcroft and N. D. Mermin; Harcourt Asia Pte. Ltd. (2001).
5. Solid State Physics, M. S. Rogalski and S. B. Palmer; Gordon and Breach Science Publishers (2001).
6. Solid State Physics, R.L. Singhal and P.A. Alvi; Kedar Nath Ram Nath

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	3	2	1
CO2	3	3	2	1	-	-	-	-	3	2	1
CO3	3	2	2	1	-	-	-	1	3	3	2
CO4	3	2	1	1	-	-	-	-	3	2	1
CO5	3	3	2	2	-	-	-	1	3	3	2
CO6	3	2	1	1	-	-	-	-	3	3	1
Average	3	2.33	1.50	1.17	0	0	0	1	3	2.50	1.33

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Atomic and Molecular Physics	**Subject Code:** TIU-PPH-T116
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. To develop a detailed understanding of the structure, properties, and interactions of one-electron, two-electron, and many-electron atoms.
2. To explore the fundamentals of molecular structure, bonding, and the interaction of molecules with electromagnetic fields.
3. To understand various spectroscopic techniques with the aim of correlating it with advanced experimental analysis.
4. To introduce students to various spectroscopic techniques and modern advancements such as Bose-Einstein condensates, laser cooling and magneto-optical traps.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Apply the spectrum of hydrogen, helium and alkali atoms to problems in structural elucidation in matter	K3
CO-2:	Recognize the central field approximations and also the coupling of angular momentum	K2
CO-3:	Investigate and devise the interaction of the spectral line under the presence of the electromagnetic fields	K4
CO-4:	Construct and apply various spectroscopic techniques	K3
CO-5:	Interpret and Utilize the processes behind laser cooling and trapping of atoms and understand simple optical trapping systems and magneto optical traps	K3
CO-6:	Illustrate the fundamental processes in operation of LASERS	K3

COURSE CONTENT :

MODULE 1:	**REVIEW OF ONE-ELECTRON AND TWO-ELECTRON ATOMS**	**3 Hours**
Excited state of hydrogen, wave function and energy levels of helium and alkali atoms.		
MODULE 2:	**MANY ELECTRON ATOMS**	**6 Hours**

Central field approximation, Thomas-Fermi model, Slater determinant, Hartee-Fock and self-consistent field methods, Hund's rule, L-S and j-j coupling, Equivalent and nonequivalent electrons, Spectroscopic terms, Lande interval rule		
MODULE 3:	**INTERACTION WITH ELECTROMAGNETIC FIELDS**	**5 Hours**
Zeeman, Paschen Back and Stark effects, Hyperfine structure and isotope shift, selection rules, Lamb shift		
MODULE 4:	**MOLECULAR SPECTRA**	**6 Hours**
Rotational, vibrational, electronic, Raman and Infra-red spectra of diatomic molecules, electronic and nuclear spin, Hund's rule, Frank–Condon principle and selection rules.		
MODULE 5:	**MOLECULAR STRUCTURE**	**10 Hours**
Molecular potential, Born-Oppenheimer approximation, diatomic molecules, electronic angular momenta, Approximation methods, linear combination of atomic orbitals (LCAO) approach, states for hydrogen molecular ion, shapes and term symbols for simple molecules		
MODULE 6:	**SPECTROSCOPIC TECHNIQUES**	**5 Hours**
Basic principles of microwave, infrared, Raman, NMR, ESR and Mossbauer spectroscopies		
MODULE 7:	**LASER SPECTROSCOPY**	**6 Hours**
Spontaneous and Stimulated emission, Einstein's A-B coefficients, Optical Pumping, Population Inversion, Rate equation, modes of resonator and coherence length, Semiconductor Laser, He-Ne Laser.		
MODULE 8	**MODERN DEVELOPMENTS**	**4 Hours**
Qualitative idea of Optical cooling and trapping of atoms, molecular spectroscopy in a magneto-optical trap, time resolved spectroscopy in the femto second regime		
TOTAL LECTURES		**45 Hours****

Books:

1. B. H. Bransden and C. J. Joachain, Physics of Atoms and Molecules,2nd Ed. Pearson (2008).
2. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed.,Tata McGraw (2004).
3. G. K. Woodgate, Elementary Atomic Structure, Clarendon Press (1989).
4. I. N. Levine, Quantum Chemistry, PHI (2009).
5. F. L. Pilar, Elementary Quantum Chemistry, McGraw Hill (1990).
6. H. E. White, Introduction to Atomic Spectra, Tata McGraw Hill (1934).
7. W. Demtroder, Atoms, Molecules and Photons, 2nd Ed., Springer (2010).
8. C. J. Foot, Atomic Physics, Oxford (2005).

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	1	-	-	-	-	3	2	-
CO2	3	3	3	2	-	-	-	-	3	3	-
CO3	3	2	-	2	-	-	-	-	3	2	3
CO4	3	3	3	3	-	-	-	2	3	3	3
CO5	3	3	3	3	-	-	-	2	3	3	3
CO6	3	2	-	2	-	-	-	-	3	3	3
Average	3	2.67	3	2.17	0	0	0	2	3	2.67	3

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: : Numerical Methods and Programming Lab	**Subject Code:** TIU-PPH-L102
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE:

Enable the student to:

1. Develop a comprehensive understanding of advanced mathematical calculations and their applications.
2. Acquire practical skills in using C programming tools to perform complex mathematical operations and problem-solving.
3. Implement algorithms in C to achieve accurate and efficient mathematical solutions.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Learn multiple programming methodologies for identifying function roots and numerically solving various sets of linear equations.	K1
CO-2:	Discover the least squares fitting strategy for any function and learn how to address eigen value problems.	K3
CO-3:	Able to solve various interpolation difficulties	K2
CO-4:	Use computation programming to tackle a range of numerical differentiation and integration problems.	K3
CO-5:	Learn how to solve various boundary value issues, as well as how to solve differential equations	K3
CO-6:	Able to apply their knowledge of differential equations and mathematical techniques to solve various initial value problems using different methods, including analytical, numerical, and approximation techniques, to effectively model and solve real-world scenarios.	K5

COURSE CONTENT:

MODULE 1:	**Experiment:1**	**8 Hours**
To find the Roots of Functions by Bisection method ; To find the Roots of Functions by Newton-Raphson method; To find the Roots of Functions by Secant method To find the Roots of Functions by fixed-point iteration		
MODULE 2:	**Experiment:2**	**8 Hours**

To find the solution of different set of linear equations by Gauss and Gauss-Jordan elimination method To find the solution of different set of linear equations by Gauss-Seidel method To find the solution of different set of linear equations by LU decomposition method		
MODULE 3:	**Experiment:3**	**8 Hours**
To solve various eigen value problems by power methods To solve various eigen value problems by Least square fitting method		
MODULE 4:	**Experiment:4**	**8 Hours**
To solve Newton's and Chebyshev polynomials To solve numerical differentiation by forward, Backward and centered difference formulae;		
MODULE 5:	**Experiment:5**	**8 Hours**
To solve numerical integration by Trapezoidal To solve numerical integration by Simpson's rule To solve numerical integration by Gauss-Legendre integration.		
MODULE 6:	**Experiment:6**	**8 Hours**
To find Solutions of ODE of Initial value problems by Euler's method To find Solutions of ODE of Initial value problems by Second and fourth order Runge-Kutta methods To find Boundary Value Problems by Finite difference methods		
MODULE 7:	**Experiment:7**	**8 Hours**
Application using Mathematica		
TOTAL HOURS		**56 Hours****

Books:

1.K. E. Atkinson, Numerical Analysis, Jhon Wiley (Asia) (2004).
2.S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, Tata McGraw Hill (2002).
3. J. D. Hoffman, Numerical methods for Engineering and Scientists, 2nd ed. CRC Press, Special Indian reprint (2010)
4.J. H. Mathews, Numerical Methods for Mathematics, Science and engineering, PrenticeHall of India (1998).
5. S. S. M. Wong, Computational Methods in Physics, World Scientific (1992).
6. W. H. Press, S. A. Teukolsky, W. T. Verlling and B. P. Flannery, Numerical Recipes in C, Cambridge (1998).

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	3	-	-	1	-	1	-	1	3
CO-2	3	3	3	-	-	1	-	1	-	1	3
CO-3	3	3	3	-	-	1	-	1	-	1	3
CO-4	3	3	3	-	-	1	-	1	-	1	3
CO-5	3	3	3	-	-	1	-	1	-	1	3
CO-6	3	3	3	-	-	1	-	1	-	1	3
Average	3	3	3	0	0	1	0	1	0	1	3

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: General Physics Laboratory I	**Subject Code:** TIU-PPH-L112
Contact Hours/Week: 0–0–6 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Gain hands-on experience with advanced experimental techniques in condensed matter physics and semiconductor physics.
2. Acquire theoretical and practical knowledge of magnetic, electrical, and optical properties of materials through precise experimentation.
3. Develop the ability to critically analyze data, compare with theoretical predictions, and draw meaningful conclusions.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Demonstrate the ability to measure and analyze the magnetic susceptibility of solids and study magnetic hysteresis characteristics.	K3
CO-2:	Analyze the interference patterns and determine physical parameters using the Michelson interferometer	K4
CO-3:	Investigate semiconductor properties by measuring electrical resistivity and examining temperature-dependent characteristics of p-n junctions.	K4
CO-4:	Study advanced quantum phenomena and fundamental constants through experiments like the Frank-Hertz experiment and measurement of e/m by magnetron valve	K5
CO-5:	Examine the temperature variation of refractive index in liquids using laser sources and study the dispersion relation in monoatomic and diatomic lattices	K4
CO-6:	Determine magnetoresistance and Curie temperature to understand magnetic and electronic material properties.	K4

COURSE CONTENT :

MODULE 1:	**Magnetic Susceptibility of a Solid**	**9 Hours**
Magnetic susceptibility, paramagnetic, diamagnetic, ferromagnetic materials, Gouy's method, magnetic field, mass susceptibility, volume susceptibility.		
MODULE 2:	**Michelson Interferometer**	**9 Hours**

Michelson interferometer, interference pattern, wavelength, refractive index, path difference, coherence, fringe shift.		
MODULE 3:	**Frank-Hertz Experiment**	**9 Hours**
Frank-Hertz experiment, electron excitation, energy levels, inelastic collisions, quantum theory, mercury vapor, excitation spectrum.		
MODULE 4:	**Electrical Resistivity of Semiconductors**	**9 Hours**
Electrical resistivity, semiconductors, temperature dependence, conductivity, intrinsic and extrinsic semiconductors, band gap, activation energy.		
MODULE 5:	**Magnetic Hysteresis**	**9 Hours**
Magnetic hysteresis, magnetization curve, ferromagnetic materials, coercivity, remanence, magnetic domains, hysteresis loop.		
MODULE 6:	**Temperature Dependent Characteristics of P-N Junction**	**9 Hours**
P-N junction, temperature dependence, forward bias, reverse bias, diode characteristics, band gap, thermionic emission.		
MODULE 7:	**Dispersion Relation for Monoatomic and Diatomic Lattice**	**9 Hours**
Dispersion relation, monoatomic lattice, diatomic lattice, phonon, acoustic branch, optical branch, lattice vibrations, Brillouin zone.		
MODULE 8:	**Temperature Variation of Refractive Index of a Liquid**	**9 Hours**
Refractive index, temperature dependence, hollow prism, laser light, total internal reflection, Brewster's angle, refractive index measurement.		
MODULE 9:	**Magnetoresistance of the Given Material**	**6 Hours**
Magnetoresistance, resistivity, magnetic field, Hall effect, conduction electrons, resistance variation, external magnetic field.		
MODULE 10:	**Determination of Curie Temperature**	**6 Hours**
Curie temperature, ferromagnetic transition, magnetic susceptibility, temperature dependence, paramagnetic-to-ferromagnetic transition.		
MODULE 11:	**Measurement of e/m by Magnetron Valve**	**6 Hours**
e/m ratio, magnetron valve, charge-to-mass ratio, electron trajectory, magnetic field, velocity selector, circular motion of electrons.		
TOTAL	**(Any 8 experiments)**	**90 Hours****

Books:

1. R. A. Dunlop, Experimental Physics, Oxford University Press (1998)
2. A. Lipson, S. G. Lipson, H. Lipson, Optical Physics, Cambridge University Press; 4th (2010)
3. E. Hecht, Optics, Addition-Wesley; 4th Edition (2001)
4. Laboratory Manual with details about the experiments

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	2	-	-	1	-	1	3	2	3
CO-2	3	3	2	-	-	1	-	1	3	2	3
CO-3	3	2	2	-	-	1	-	1	3	3	3
CO-4	3	3	2	-	-	1	-	1	2	2	3
CO-5	3	2	3	-	-	1	-	1	3	2	3
CO-6	3	3	2	-	-	1	-	1	3	3	3
Average	3	2.67	2.17	0	0	1	0	1	2.83	2.33	3

SEMESTER III

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Nuclear Physics	**Subject Code:** TIU-PPH-T215
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Provide a comprehensive understanding of nuclear properties and nuclear reactions, covering fundamental concepts such as nuclear size, binding energy, and angular momentum.
2. Explore nuclear models and examine the practical aspects of nuclear reactions, including reaction mechanisms, Q-values, and experimental observables.
3. Apply theoretical knowledge to analyze and solve problems related to nuclear properties, decay processes, and reactions, with a focus on their real-world applications in nuclear physics.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Define basic nuclear properties such as nuclear size, charge distribution, mass, binding energy, angular momentum, spin, parity, symmetry, and the magnetic dipole and electric quadrupole moments.	K1
CO-2:	Understand the nature of nuclear forces, including charge independence, charge symmetry, and isospin invariance.	K2
CO-3:	Solve the Schrödinger equation for the ground state of the deuteron, including determining the RMS radius and interpret the properties of the deuteron. Understand the role of tensor forces.	K3
CO-4:	Analyze various types of radioactive decay (alpha, beta, gamma) compare different decay processes and their implications in nuclear physics.	K4
CO-5:	Understand different nuclear models, such as the Liquid Drop Model, Bethe-Weizsäcker mass formula, Shell Model, and Collective Model.	K2
CO-6:	Apply concepts of nuclear reactions to calculate Q-values, explain energy and time scales for direct and compound reactions, and interpret experimental observables such as cross-sections, angular distributions, and excitation functions.	K4

COURSE CONTENT :

MODULE 1:	NUCLEAR PROPERTIES	10 Hours
Basic nuclear properties: nuclear size, nuclear radius and charge distribution, nuclear form factor, mass and binding energy, Angular momentum, spin, parity and symmetry, Magnetic dipole moment and electric quadrupole moment, Nature of nuclear forces: charge independence, charge symmetry and isospin invariance of nuclear forces.		
MODULE 2:	**TWO-BODY BOUND STATE**	**6 Hours**
Properties of deuteron, Schrodinger equation and its solution for ground state of deuteron, rms radius, spin dependence of nuclear forces, electromagnetic moment and magnetic dipole moment of deuteron and the necessity of tensor forces.		
MODULE 3:	**RADIOACTIVITY AND NUCLEAR DECAY**	**8 Hours**
Radioactivity, successive nuclear disintegration, alpha decay, beta decay, gamma decay.		
MODULE 4:	**NUCLEAR MODELS**	**9 Hours**
Liquid drop model, Bethe-Weizsacker mass formula, Shell model and Collective model.		
MODULE 5:	**NUCLEAR REACTIONS**	**12 Hours**
Types of reactions and Q-values, Reaction mechanisms: Energy and time scales for direct and compound reactions, center of mass frame and laboratory frame, Experimental observables: Cross sections - definitions and units; Angular distributions, Excitation functions, Partial wave analysis and phase shifts.		
TOTAL LECTURES		**45 Hours****

Books:

1. K. S. Krane, Introductory Nuclear Physics, John Wiley (1988).
2. R. R. Roy and B. P. Nigam, Nuclear Physics: Theory and Experiment, New Age (1967).
3. A. Das and T. Ferbel, Introduction to nuclear and particle physics, John Wiley (1994).
4. M. A. Preston and R. K. Bhaduri, Structure of the nucleus, Addison-Wesley (1975).
5. I. S. Hughes, Elementary Particles, Cambridge (1991).
6. F. Halzen and A. D. Martin, Quarks and Leptons, John Wiley (1984).
7. D. Perkins, Introduction to High Energy Pysics, Cambridge University Press; 4th edition (2000).

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	2	2	-	-	-	1	3	2	1
CO-2	3	3	2	2	-	-	-	1	3	2	1
CO-3	3	3	2	2	-	-	-	1	3	2	1
CO-4	3	3	2	2	-	-	-	1	3	2	1
CO-5	3	3	2	2	-	-	-	1	3	2	1
CO-6	3	3	2	2	-	-	-	1	3	2	1
Average	3	3	2	2	0	0	0	1	3	2	1

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Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 2^{nd} Yr.,3^{rd} Sem.
Course Title: Statistical Mechanics	**Subject Code:** TIU-PPH-T217
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Develop the ability to analyze and explain thermodynamic systems from a statistical mechanics perspective.
2. Understand the connection between the microscopic behavior of a system and its macroscopic properties..
3. Explore the necessity of statistical mechanics and study classical and quantum theories for describing thermodynamic systems effectively

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand the fundamental concepts of statistical mechanics, including macroscopic and microscopic states.	K2
CO-2:	Apply ensemble theory to describe thermodynamic systems and their fluctuations.	K3
CO-3:	Analyze the properties of quantum statistical systems and quantum gases.	K4
CO-4:	Explain the behavior of Bose-Einstein condensation, blackbody radiation, and phonons.	K2
CO-5:	Apply statistical models to interacting systems and solve the Ising model using transfer matrix methods.	K3
CO-6:	Describe the thermodynamic properties of systems using different statistical ensembles.	K2

COURSE CONTENT :

MODULE 1:	**FUNDAMENTAL OF STATISTICAL MECHANICS**	**12 Hours**
Statistical description: macroscopic and microscopic states for classical and quantum systems, connection between statistics and thermodynamics, entropy, classical ideal gas, entropy of mixing and Gibb's paradox.		
MODULE 2:	**ENSEMBLE THEORY AND APPLICATIONS**	**14 Hours**

Microcanonical Ensemble: Phase space, Liouville's theorem, applications of ensemble theory to classical and quantum systems; Canonical Ensemble: partition function, thermodynamics in canonical ensemble, classical systems, ideal gas, energy fluctuation, equipartition and Virial theorem, system of harmonic oscillators, statistics of paramagnetism, negative temperature; Grand Canonical Ensemble: equilibrium between a system and a particle-energy reservoir, partition function, density and energy fluctuation.		
MODULE 3:	**QUANTUM STATISTICAL MECHANICS**	**12 Hours**
Formulation of Quantum Statistics: Quantum mechanical ensemble theory, density matrix, statistics of various ensembles, examples; Theory of quantum ideal gases: Ideal gas in different quantum mechanical ensembles, identical particles, many particle wave function, occupation numbers, classical limit of quantum statistics, molecules with internal motion; Ideal Bose Gas: Bose-Einstein condensation, blackbody radiation, phonons, Helium II;		
MODULE 4:	**INTERACTING SYSTEMS AND MODELS**	**7 Hours**
Interacting Systems: Models of interacting systems, Ising, Heisenberg and XY models, Solution of Ising model in one dimension by transfer matrix method.		
TOTAL LECTURES		**45 Hours**

Books:

1. R. K. Pathria and P. D. Beale, Statistical Mechanics, 3rd ed. Butterworth-Heinemann (2011).
2. S. R. A. Salinas, Introduction to Statistical Physics, Springer (2004).
3. W. Greiner, L Neise, and H. Stocker, Thermodynamics and Statistical Mechanics, Springer (1994).
4. K. Huang, Statistical Mechanics, John Wiley Asia (2000).
5. L. D. Landau and E. M. Lifshitz, Statistical Physics, Pergamon (1980).

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	2	2	-	-	-	1	3	3	1
CO-2	3	3	3	2	-	-	-	1	3	3	1
CO-3	3	3	3	3	-	-	-	1	3	3	1
CO-4	3	3	2	2	-	-	-	1	3	3	1
CO-5	3	3	3	3	-	-	-	1	3	3	1
CO-6	3	3	3	3	-	-	-	1	3	3	1
Average	3	3	2.67	2.50	0	0	0	1	3	3	1

TECHNO INDIA UNIVERSITY
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Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Material Physics I	**Subject Code:** TIU-PPH-T219
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Provide a comprehensive understanding of material science, including classification, preparation, and characterization of materials.
2. Explore the fundamental properties of semiconductors, nanomaterials, and carbon nanotechnology, and their applications in technology.
3. Develop the ability to analyze and apply material properties, structures, and phases in various technological contexts using modern characterization techniques.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Understand the basic concepts of material science, including the classification and applications of materials in technology.	K2
CO-2:	Demonstrate the ability to prepare and characterize materials using various techniques	K4
CO-3:	Analyze the atomic structure, interatomic bonding, and the thermodynamics of solutions and phase diagrams in materials.	K4
CO-4:	Understand and apply the principles of semiconductor materials, carrier transport, and the effects of temperature, doping, and recombination processes.	K3
CO-5:	Explore the properties and applications of nanomaterials in electronics, medicine, and energy, and understand the quantum effects in low-dimensional systems.	K3
CO-6:	Examine the geometry, properties, and applications of nanoscale carbon materials such as fullerenes, carbon nanotubes, and graphene	K3

COURSE CONTENT:

MODULE 1:	**INTRODUCTION TO MATERIAL PHYSICS**	**5 Hours**
Overview of material science and engineering, Classification of materials (metals, ceramics, polymers, composites), Importance and applications of materials in technology.		

MODULE 2:	MATERIAL PREPARATION AND CHARACTERIZATION	12 Hours
Preparation of materials by different techniques: Bulk crystal growth, Epitaxial growth, Thermal and electron evaporation technique, Sputtering, CVD, Melt and quenching, PVD, Sol-Gel. Characterization of material by XRD, thermal methods (DSC, DTA), Optical method (IR, FTIR, Raman), Microscopic (SEM, TEM, STEM, AFM etc.).Mechanical and electrical methods. Non-destructive testing, introductory ideas of liquid crystal.		
MODULE 3:	**STRUCTURE OF MATERIALS AND PHASES**	**6 Hours**
Atomic structure and interatomic bonding, Structure of crystalline solids, structure of non-crystalline solids (SRO and MRO); Radial distribution function, Solid solutions. Thermodynamics of solutions, Phase rule, Binary phase diagrams, Binary isomorphous systems, Binary eutectic systems, ternary phase diagrams, kinetics of solid state reactions.		
MODULE 4:	**PHYSICS OF SEMICONDUCTORS**	**10 Hours**
Semiconductor materials - elemental & compound semiconductors & their properties Intrinsic & extrinsic semiconductors. Degenerate & compound semiconductors. Direct & indirect band gap semiconductors. Variation of energy bands for gr III– V ternary, quaternary alloys with alloy composition Concepts of Fermi level, Drift & Diffusion of carrier conductivity & mobility. Effect of Temperature and Doping. Hall Effect in semiconductors. Excess carriers in semiconductors - low & high level injection, Generation & recombination process, Direct & indirect recombination, Concept of 'quasi' Fermi level. Basic equation for semiconductor device operations. Continuity equation, Current flow equation, Carrier transport equation, etc. Excess Carrier distribution in steady state, Minority Carrier life time & Diffusion length.		
MODULE 5:	**Nanomaterials and Nanotechnology**	**8 Hours**
Introduction to nanomaterials, Applications in electronics, medicine, and energy, electronic properties of low dimensional systems, Quantum effects in low-dimensional systems, Environmental and health impacts of nanomaterials.		
MODULE 6:	**Carbon Nanotechnology**	**4 Hours**
Geometry of nanoscale carbon, fullerenes, carbon nanotubes, graphene, and their applications.		
TOTAL LECTURES		**45 Hours****

Books:

1. Materials Science and Engineering An Introduction, William D. Callister, Jr., John Wiley & Sons, Inc.
2. The Physics of Semiconductors, Marius Grundmann, Springer
3. Semiconductor Materials, An Introduction to Basic Principles, B. G. Yacobi, KLUWER ACADEMIC PUBLISHERS
4. Phase Transformations in Metals and Alloys, DAVID A. PORTER, KENNETH E. EASTERLING, and MOHAMED Y. SHERIF, CRC Press, Third Edition

5. Fundamental s o f Semiconductor s, Peter Y. Yu, Manuel Cardona, Springer

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	-	-	-	-	-	-	-	3	3	-
CO-2	3	3	-	3	-	-	-	-	-	3	1
CO-3	3	3	3	-	-	-	-	-	3	3	-
CO-4	3	3	2	-	-	-	-	-	3	3	-
CO-5	3	3	3	-	-	-	2	-	3	3	-
CO-6	3	3	3	2	-	-	2	-	3	3	-
Average	3	3	2.75	2.50	0	0	2	0	3	3	1

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Nuclear Reaction I	**Subject Code:** TIU-PPH-T221
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Provide students with a comprehensive understanding of the fundamental principles of nuclear reactions and their applications in astrophysical contexts.
2. Explore the theoretical aspects of nuclear reactions, focusing on the mechanisms, cross-sections, and reaction rates of different nuclear processes.
3. Provide a deep understanding of thermonuclear reactions, stellar structure, and nucleosynthesis across a wide range of astrophysical environments.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Define and describe various nuclear reactions and explain reaction mechanisms, the concept of Q-values and cross-sections with an understanding of the time and energy scales involved.	K1
CO-2:	Apply the optical model to describe direct reactions. They will also apply the concept of angular distributions in understanding scattering processes and explain the process of transfer reactions through spectroscopic factors and the Asymptotic Normalization Constant (ANC).	K3
CO-3:	Understand the principles behind compound nuclear reactions using statistical models, nuclear fission through Bohr-Wheeler theory and evaluate the applicability of R-matrix methods, dispersion theory, and the one-level formula for analyzing nuclear reactions.	K2
CO-4:	Apply their knowledge of nuclear astrophysics to analyze thermonuclear reaction rates, including the effects of low-energy behavior. They will also be able to understand the concept of astrophysical S-factors and the Gamow peak.	K3
CO-5:	Understand the processes involved in Big Bang nucleosynthesis, such as He production, the Be bottleneck, and the abundance of light elements.	K2

CO-6:	Apply the principles of nuclear burning in stars to analyze H burning, He burning, and advanced nuclear burning processes. They will also evaluate stellar nucleosynthesis processes and assess how these processes contribute to the production of elements in stellar environments.	K4

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**8 Hours**
Survey of reactions of nuclei: Strong, electromagnetic and weak processes, Types of reactions and Q-values, Reaction mechanisms: Energy and time scales for direct and compound reactions, Experimental observables: Cross sections - definitions and units; Angular distributions, Excitation functions		
MODULE 2:	**MODELS FOR NUCLEAR REACTIONS**	**16 Hours**
Direct reactions: Optical Model: From Hamiltonian to cross sections for elastic scattering; Partial waves, Phase shifts, Scattering amplitudes, S-matrix and its symmetry and reciprocity; Angular distributions, Optical potential. Transfer reactions: Spectroscopic factors, Asymptotic normalization constant (ANC). Compound nuclear reactions: Statistical model. R-matrix methods: Dispersion theory, One level formula. Nuclear Fission: Spontaneous fission, Mass energy distribution of fission fragments, Bohr-Wheeler theory, Fission isobars, Super-heavy nuclei.		
MODULE 3:	**NUCLEAR ASTROPHYSICS**	**8 Hours**
Thermonuclear reactions: Reaction rates. Low energy behaviour and astrophysical S-factors, Forward and reverse reactions, Nonresonant and resonant reactions, Maxwell-Boltzmann distribution of velocities, Gamow peak.		
MODULE 4:	**BIG BANG NUCLEOSYNTHESIS**	**6 Hours**
He production, Be bottleneck, Abundance of light elements. Stellar structure: Classical stars, Degenerate stars.		
MODULE 5:	**STELLAR NUCLEOSYNTHESIS**	**7 Hours**
Nuclear burning in stars: H burning, He burning, Advanced nuclear burning, Core collapse. Stellar nucleosynthesis: Abundance of elements, Production of nuclei, r-, s- and p-processes.		
TOTAL LECTURES		**45 Hours****

Books:

1. K. S. Krane, Introductory Nuclear Physics, John Wiley (1988).
2. Ian J. Thompson and Filomena M. Nunes, Nuclear Reactions for Astrophysics Principles, Calculation and Applications of Low-Energy Reactions, Cambridge University Press (2009)
3. M. A. Preston and R. K. Bhaduri, Structure of the nucleus, Addison-Wesley (1975).

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	3	3	-	-	-	1	3	2	1
CO-2	3	3	3	3	-	-	-	1	3	2	1
CO-3	3	3	3	3	-	-	-	1	3	2	1
CO-4	3	3	3	3	-	-	-	1	2	3	1
CO-5	3	3	3	3	-	-	-	1	2	3	1
CO-6	3	3	3	3	-	-	-	1	2	3	1
Average	3	3	3	3	0	0	0	1	2.50	2.50	1

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Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Introduction to Cryogenics and Vacuum Technology	**Subject Code:** TIU-PPH-TE203A
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Provide a comprehensive understanding of cryogenic principles, techniques, and applications, including the production and measurement of low temperatures.
2. Analyze the behavior of materials under cryogenic conditions and explore their applications in research and industry.
3. Develop expertise in designing, operating, and maintaining vacuum systems, along with understanding safety protocols for handling cryogenic and vacuum equipment.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall the basic terminologies and concepts related to cryogenics, vacuum physics, and cryogenic safety practices, including the fundamental principles of cryogenic temperature production and vacuum systems.	K1
CO-2:	Understand various liquefaction systems, for N_2 & He, as well as, Cryo-refrigerators. Also understand the methods of ultralow temperature production in milli and micro-kelvin range.	K2
CO-3:	Understand various sensors for cryo-temperature measurements, cryogen level sensors, and their controllers. They will also understand various possible cryogenic hazards and safety aspects.	K2
CO-4:	Interpret various important features and scopes of vacuum technology and their application to various modern vacuum pumps for production of high and ultrahigh vacuum.	K3
CO-5:	Understand the principles, operation and calibration procedures of various types of vacuum gauges for measurement of vacuum between 760 torr and 10^{-12} Torr and various methods of leak detection techniques, helium mass spectrometer leak detectors.	K2
CO-6:	Analyze the designing of high and ultra-high vacuum systems and various commercial applications of vacuum technology.	K4

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**4 Hours**
What is cryogenics, its importance and applications.		

MODULE 2:	CRYOGENIC TEMPERATURE PRODUCTION	15 Hours
Production of low temperatures: Basics of Nitrogen & Helium liquefiers, Cryo refrigerators. Production of temperatures in mK range (Adiabatic demagnetization and Dilution refrigeration)		
MODULE 3:	**PROPERTIES OF MATERIALS AT CRYOGENIC TEMPERATURES**	**9 Hours**
Electrical, Thermal and Mechanical Properties of solids at cryogenic Temperatures; Cryogenic Temperature sensors and calibration, Temperature controls at cryogenic temperatures; Cryogenic level sensing & controls. Cryogenic safety practices.		
MODULE 4:	**VACUUM TECHNOLOGY AND ITS APPLICATIONS**	**7 Hours**
Basic terminologies in vacuum physics, Flow regimes and applications; Conductance calculations; Production of vacuum from rough to ultra-high vacuum (~10-12 torr): Rotary pumps, Oil diffusion pumps, Turbo-molecular pumps and Cryo pumps		
MODULE 5:	**VACUUM MEASUREMENT, LEAK DETECTION, AND SYSTEM DESIGN**	**10 Hours**
Measurement of vacuum: Pirani and thermocouple gauges, Ionization gauges; Leak detection in vacuum systems; Basics of designing high and ultrahigh vacuum systems; Applications of vacuum technology.		
TOTAL LECTURES		**45 Hours****

Books:

1. Cryogenic Systems (Oxford University Press) ………………….. R. F. Barron.
2. Vacuum Technology (Third Edition) ………………….. …………A. Roth.
3. Experimental Techniques in Low Temperature Physics… ……. G. K. White
4. Cryogenic Engineering (CRC Press) …………………. …………T. M. Flynn.
5. Fundamentals of Vacuum Technology ….. ……… Dr. Walter Umrath (Leybold Vacuum)

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	2	2	-	-	-	1	3	2	2
CO-2	3	3	3	3	-	-	-	1	2	3	3
CO-3	3	3	2	2	-	-	-	1	3	2	2
CO-4	3	3	3	3	-	-	-	1	2	3	3
CO-5	3	3	3	3	-	-	-	1	2	3	3
CO-6	3	3	3	3	-	-	-	1	2	3	3
Average	3	3	3	2.67	0	0	0	1	2.83	2.67	2.67

TECHNO INDIA UNIVERSITY
W E S T B E N G A L

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr.,3rd Sem.
Course Title: Physics of Nanomaterials and thin films	**Subject Code:** TIU-PPH-E203B
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Understand the fundamentals of nanoscience, the significance of nanotechnology, and the impact of scaling laws on physical properties.
2. Learn various surface analysis techniques, thin film deposition methods, and nanofabrication processes, including lithography and etching techniques.
3. Explore nanoparticle and nanowire fabrication methods, including 2D and 3D assemblies, VLS growth, and carbon nanotube synthesis mechanisms.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand the basic concepts of nanoscience, scaling laws, and classification of nanomaterials.	K2
CO-2:	Explain the fundamentals of vacuum science, surface crystallography, thin film deposition, and surface analysis techniques.	K2
CO-3:	Analyze different nanofabrication methods, including lithography and etching techniques.	K3
CO-4:	Evaluate different nanoparticle assembly techniques and nanowire growth mechanisms.	K4
CO-5:	Explain the synthesis and growth mechanisms of carbon nanotubes and their applications.	K2
CO-6:	Apply nanotechnology concepts to analyze thin films, nanoparticle synthesis, and nanofabrication processes.	K3

COURSE CONTENT :

MODULE 1:	INTRODUCTION TO NANOTECHNOLOGIES	10 Hours
Discussion on nanoscience and its importance, modification of physical properties, laws of scaling in physics, methodologies: bottom up/ top down, study of nanomaterials.		
MODULE 2:	**SURFACE ANALYSIS AND THIN FILMS**	**12 Hours**
Fundamentals of vacuum science and technology, physical surface: perfect surfaces and real surfaces, surface crystallography, deposition and growth techniques of thin film, techniques for surface and nanostructure analysis.		
MODULE 3:	**NANOFABRICATION TECHNIQUES**	**11 Hours**
Lithographic techniques: optical and e-beam lithography, etching techniques: wet chemical etching, dry etching.		
MODULE 4:	**NANOPARTICLE AND NANOWIRE FABRICATION**	**12 Hours**
2D and 3D nanoparticle assemblies, VLS and other method of nanowire growth. Carbon nanotubes synthesis and growth mechanism.		
TOTAL LECTURES		**45 Hours**

Books:

1. Nanotechnologies: The physics of nanomaterials, volume 1, David S. Schmool, Apple academic press (1st Ed. 2021)
2. An introduction to nanoscience and nanotechnology, A. Nouailhat, (Wiley, 2008)
3. Nanomaterials, M. Benelmekki, (Morgan & Claypool Publishers, 2019)
4. The physics of thin films, R. W. Hoffman, (Academic Press, 1971)
5. Nanomaterial: An introduction to synthesis, Properties and Applications, 2nd Edition, D. Vollath (Wiley, 2013)

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	3	2	-	-	-	1	3	3	1
CO-2	3	3	3	2	-	-	-	1	3	3	2
CO-3	3	3	3	3	-	-	-	1	3	3	2
CO-4	3	3	2	2	-	-	-	1	3	3	2
CO-5	3	3	3	3	-	-	-	1	3	3	2
CO-6	3	3	3	3	-	-	-	1	3	3	3
Average	3	3	2.83	2.50	0	0	0	1	3	3	2

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 1st Yr., 3rd Sem.
Course Title: General Physics Laboratory II	**Subject Code:** TIU-PPH-L201
Contact Hours/Week: 0–0–6 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. To provide students with hands-on experience in conducting fundamental physics experiments.
2. To develop proficiency in using advanced laboratory instruments and analyzing experimental data.
3. To enhance problem-solving skills and apply experimental techniques to real-world applications.

COURSE OUTCOME : On completion of the course, the student will be able to:

CO-1:	Demonstrate the ability to detect and analyze radiation using a GM counter and study the Hall effect in semiconductors.	K3
CO-2:	Accurately determine Planck's constant and measure the dielectric constant of materials to understand their electrical properties.	K4
CO-3:	Investigate the principles of Electron Spin Resonance (ESR) spectroscopy and analyze the wavelength of a He-Ne laser using a ruler.	K4
CO-4:	Apply Fourier Transform techniques to analyze waveforms and experimental data.	K3
CO-5:	Evaluate the efficiency of a solar cell by studying its variation with frequency, angle of inclination, and area.	K5
CO-6:	Develop data analysis, error estimation, and experimental reporting skills for physics research and practical applications.	K6

COURSE CONTENT :

MODULE 1:	**Radiation Detection Using GM Counter**	**12 Hours**
GM Counter, radiation detection, ionizing radiation, count rate, background radiation, beta particles, gamma radiation.		
MODULE 2:	**Planck's Constant Measurement**	**9 Hours**
Planck's constant, photoelectric effect, work function, threshold frequency, photon energy, light source, stopping potential		
MODULE 3:	**Dielectric Constants Measurement**	**12 Hours**

Dielectric constant, permittivity, electric field, capacitance, material polarization, electric displacement, dielectric material.		
MODULE 4:	**Hall Effect in Semiconductors**	**12 Hours**
Hall effect, semiconductor, magnetic field, charge carrier concentration, Hall voltage, current, magnetic force.		
MODULE 5:	**Electron Spin Resonance (ESR) Spectroscopy**	**12 Hours**
Electron Spin Resonance (ESR), magnetic field, electron spin, resonance frequency, spectrometer, g-factor, paramagnetic materials.		
MODULE 6:	**Wavelength Measurement of He-Ne Laser**	**9 Hours**
He-Ne laser, wavelength, diffraction, ruler method, interference pattern, fringe spacing, laser beam, diffraction angle.		
MODULE 7:	**Fourier Transform Analysis**	**12 Hours**
Fourier transform, frequency analysis, signal processing, time-domain, frequency-domain, Fourier series, spectrum.		
MODULE 8:	**Solar Cell Efficiency Measurement**	**12 Hours**
Solar cell efficiency, frequency dependence, angle of inclination, area, light intensity, photovoltaic effect, solar energy conversion.		
TOTAL		**90 Hours****

Books:

1. R. A. Dunlop, Experimental Physics, Oxford University Press (1988)
2. A. C. Melissinos, Experiments in Modern Physics, Academic Press (1996)
3. E. Hecht, Optics, Addition-Wesley; 4th Edition (2001)
4. J. Verma, Nuclear Physics Experiments, New Age Publishers (2001)
5. Laboratory Manual with details about the experiments

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	2	2	2	-	-	-	-	1	2	3
CO-2	3	2	2	-	-	-	-	-	1	3	3
CO-3	3	2	3	2	-	-	-	-	1	2	3
CO-4	3	3	3	2	-	-	-	-	1	2	3
CO-5	3	2	3	2	-	-	-	-	1	2	3
CO-6	3	3	3	3	2	-	-	-	1	3	3
Average	3	2.33	2.67	2.20	2	0	0	0	1	2.33	3

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 2^{nd} Yr., 3^{rd}Sem
Course Title: Entrepreneurship Skill Development I	**Subject Code:** TIU-PES-S291
Contact Hours/Week: 0–0–2 (L–T–P)	**Credit:** 1

COURSE OBJECTIVE :

Enable the student to:

1. Implement and test the proposed solution.
2. Work in teams to develop a structured project.
3. Learn basic business strategies for taking a scientific idea forward.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Develop a prototype or working model of the solution.	K1
CO-2:	Collaborate effectively to execute a structured project.	K2
CO-3:	Understand fundamental business strategies for project sustainability.	K3
CO-4:	Apply cost analysis techniques to optimize prototype development.	K4
CO-5:	Demonstrate teamwork and problem-solving in project execution.	K5
CO-6:	Formulate strategies for improving and scaling up the solution.	K6

COURSE CONTENT :

MODULE 1:	**EXECUTION AND PROTOTYPE DEVELOPMENT**	**10 Hours**
Designing and building a functional model of the solution. Testing and refining based on performance. Documenting findings and improvements.		
MODULE 2:	**BUSINESS STRATEGY AND TEAM COLLABORATION**	**20 Hours**
Basics of structuring a scientific startup idea. Team roles, responsibilities, and project management. Overcoming challenges in execution and decision-making.		
TOTAL LECTURES		**30 Hours****

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	2	-	3	2	-	-	-	2	-	2	3
CO-2	-	2	-	-	2	3	-	2	-	-	3
CO-3	-	2	-	-	-	-	3	-	-	2	-
CO-4	2	-	-	3	-	-	-	2	-	2	-
CO-5	-	2	-	-	2	3	-	2	-	-	3
CO-6	-	-	2	-	-	2	2	3	-	2	2
Average	2	2	2.50	2.50	2	2.67	2.50	2.50	0	2	2.75

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Project I	**Subject Code:** TIU-PPH-P297
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE:

Enable the student to:

1. Identify and analyze research problems through a structured literature review.
2. Assess theoretical and experimental gaps to formulate research objectives.
3. Synthesize findings into a well-structured technical report and presentation.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Identify a relevant research problem through idea conceptualization.	K2
CO-2:	Analyze existing literature to refine objectives and research gaps.	K4
CO-3:	Analyze existing literature to identify theoretical or experimental gaps and define research objectives.	K4
CO-4:	Develop a mathematical model or experimental framework for the problem.	K6
CO-5:	Assess the scientific and societal impact of the research findings.	K5
CO-6:	Communicate research outcomes through a technical report and presentation.	K6

COURSE CONTENT:

MODULE 1:	**RESEARCH PROBLEM IDENTIFICATION**	**7 Hours**
Introduction to research methodology and scientific inquiry, Identifying research gaps and formulating a problem statement, Understanding ethical considerations in research		
MODULE 2:	**LITERATURE REVIEW & BACKGROUND STUDY**	**15 Hours**
Planning and conducting a literature survey, Tools for literature search: Journals, databases (Scopus, IEEE, Web of Science), Reviewing relevant theories, experiments, and models		
MODULE 3:	**IDENTIFYING RESEARCH GAPS & DEFINING OBJECTIVES**	**10 Hours**

Literature Analysis: Evaluating key findings, limitations, and contradictions. Gap Identification: Recognizing theoretical or experimental gaps in existing research. Research Objectives: Defining precise research questions and justifying their relevance.		
MODULE 4:	**MATHEMATICAL MODELING / EXPERIMENTAL DESIGN**	**10 Hours**
Formulating hypotheses and research objectives. Developing a mathematical model or experimental setup. Selecting appropriate methods for data collection and analysis		
MODULE 5:	**RELEVANCE & SOCIETAL IMPACT**	**8 Hours**
Assessing the significance of the study in physics and interdisciplinary fields. Evaluating technological, industrial, and societal applications. Ethical implications and sustainability considerations.		
MODULE 6:	**TECHNICAL REPORT & PRESENTATION**	**10 Hours**
Structuring a scientific report (Abstract, Introduction, Methods, Results, Discussion, Conclusion). Preparing figures, tables, and references (LaTeX/MS Word). Presenting research findings through oral/poster presentations		
TOTAL HOURS		**60 Hours****

Books:

Journals

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	2	3	3	-	-	-	-	-	-	2	3
CO-2	-	3	2	-	-	-	-	-	-	3	2
CO-3	-	3	2	-	-	-	-	-	-	3	2
CO-4	3	2	3	3	-	-	-	2	-	3	3
CO-5	-	2	2	-	-	-	2	-	-	3	-
CO-6	-	2	-	-	2	2	-	-	-	-	3
Average	2.50	2.33	2.40	3	2	2	2	2	0	2.33	2.60

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Introduction to Python Programming	**Subject Code:** TIU-PPH-L205
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. Understand and apply fundamental Python programming concepts, gaining proficiency in syntax and basic structures.
2. Write clean, efficient, and effective Python code for practical applications in data analysis, machine learning, and scientific computing.
3. Leverage advanced Python features and libraries to tackle complex problems in postgraduate-level studies and research.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall and recognize Python syntax, control structures (conditional statements and loops), and basic data types.	K1
CO-2:	Understand the concepts of defining functions, working with modules, and using Python data structures like lists, tuples, dictionaries, and sets.	K2
CO-3:	Apply Python skills to read and write files, handle exceptions, and debug code using various techniques.	K3
CO-4:	Analyze and implement object-oriented programming concepts like inheritance, polymorphism, and encapsulation, while performing data manipulation using Pandas.	K4
CO-5:	Apply the use of Pandas for data analysis and assess the effectiveness of visualizations created using Matplotlib and Seaborn.	K3
CO-6:	Apply Python programming to manipulate data, clean datasets, and create complex visualizations for data analysis	K3

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO PYTHON AND CONTROL STRUCTURES**	**12 Hours**
Overview of Python, Setting up the environment, Python syntax and semantics, Variables and data types, Conditional statements (if, else, elif), Loops (for, while), List comprehensions.		

MODULE 2:	FUNCTIONS AND MODULES AND DATA STRUCTURES	12 Hours
Defining functions, Function arguments and return values, Importing and using modules, Lists, tuples, and dictionaries, Sets and frozensets, Iterators and generators		
MODULE 3:	**FILE HANDLING, ERROR HANDLING AND DEBUGGING**	**12 Hours**
Reading and writing files, Working with CSV and JSON files, Exception handling, Debugging techniques, Logging.		
MODULE 4:	**OBJECT-ORIENTED PROGRAMMING (OOP) AND DATA ANALYSIS WITH PANDAS**	**12 Hours**
Classes and objects, Inheritance and polymorphism, Encapsulation and abstraction, Introduction to Pandas, DataFrames and Series, Data cleaning and manipulation		
MODULE 5:	**DATA VISUALIZATION WITH MATPLOTLIB AND SEABORN**	**12 Hours**
Introduction to Matplotlib, Plotting with Seaborn, Creating complex visualizations		
TOTAL LECTURES		**60 Hours****

Books:

1. "Python Crash Course" by Eric Matthes
2. "Fluent Python" by Luciano Ramalho
3. "Introduction to Machine Learning with Python" by Andreas C. Müller & Sarah Guido

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	1	2	2
CO2	3	2	1	1	-	-	-	-	1	2	2
CO3	3	3	1	2	-	-	-	-	1	2	2
CO4	3	3	1	2	-	-	-	-	1	3	2
CO5	3	2	1	2	-	-	-	-	1	3	2
CO6	3	3	1	2	-	-	-	-	1	3	2
Average	3	2.50	1	1.67	0	0	0	0	1	2.50	2

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Use of AI and Different Software for scientific Research	**Subject Code:** TIU-PPH-L203
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. Effectively use AI tools and LaTeX for creating professional presentations and scientific reports and apply fundamental Python programming concepts, gaining proficiency in syntax and basic structures.
2. Gain proficiency in using various software tools for data analysis, enabling them to interpret and analyze complex data sets. Clean, efficient, and effective Python code for practical applications in data analysis, machine learning, and scientific computing.
3. Learn how to generate high-quality figures and visualizations for scientific presentations, enhancing data communication and understanding advanced Python features and libraries to tackle complex problems in postgraduate-level studies and research.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall and identify the basic concepts of Artificial Intelligence (AI) and its advantages in different areas, including its use in presentations and report writing.	K1
CO-2:	Understand how to use AI-based software to create scientific presentations, write resumes, and generate research document summaries.	K2
CO-3:	Apply LaTeX commands and syntax to prepare and format scientific reports, including equations, figures, and tables.	K3
CO-4:	Apply LaTeX to manage references, citations using BibTeX, and customize document layouts and styles for scientific writing.	K3
CO-5:	Analyze and process data using software tools like OCTAVE, Origin, and other specialized software for data analysis, including generating statistical measures and performing Fast Fourier Transform (FFT) on signals.	K4
CO-6:	Apply the knowledge for generating accurate scientific plots and visualizations (bar-plots, contour-plots, surface plots, 3D & 4D plots) using software tools like Octave, Origin, Gnuplot, and Python.	K3

COURSE CONTENT :

MODULE 1:	PREPARING PRESENTATION AND WRITING SCIENTIFIC REPORT USING AI	12 Hours
Overview of Artificial Intelligence (AI) and its advantages in different area, preparing scientific presentation using AI based software, writing resume using AI, writing synopsis of a research document using AI.		
MODULE 2:	**WRITING SCIENTIFIC REPORT USING LATEX**	**16 Hours**
Overview of LaTex and its advantages for scientific writing, basic LaTex commands and syntax, formatting equation, figures and tables in Latex. Managing references and citations using BibTex, Customizing documents layouts and styles in LaTex.		
MODULE 3:	**DATA ANALYSIS USING SOFTWARES:**	**16 Hours**
Reading and writing files, Working with CSV and JSON files, Exception handling, Debugging techniques, Logging.		
MODULE 4:	**GENERATING SCIENTIFIC PLOTS USING SOFTWARES:**	**16 Hours**
Classes and objects, Inheritance and polymorphism, Encapsulation and abstraction, Introduction to Pandas, DataFrames and Series, Data cleaning and manipulation		
TOTAL LECTURES		**60 Hours****

Books:

1. GNU Octave: Beginner's Guide by J. S. Hansen
2. AI for Beginners : A Concise Guide to ChatGPT, Bard, Bing AI and DALL-E by M. Jasim
3. The Power of Ai Presentation Maker: Unleashing Your Creative Potential by N.Tripathi
4. Gnuplot in Action- Understanding Data with Graphs by Philipp K. Janert.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	-	-	1	3	2
CO2	3	2	2	2	-	-	-	-	1	3	2
CO3	3	3	2	2	-	-	-	-	1	2	2
CO4	3	3	2	2	-	-	-	-	1	3	2
CO5	3	2	2	2	-	-	-	-	1	3	2
CO6	3	3	2	2	-	-	-	-	1	3	2
Average	3	2.50	2	2	0	0	0	0	1	2.83	2

SEMESTER IV

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Material Physics II	**Subject Code:** TIU-PPH-T220
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Explore dielectric, optical, and magnetic properties of materials and their applications.
2. Examine advanced topics in material physics, including ferroelectrics, polymers, smart materials, and the latest research trends in material science.
3. Understand the interaction of electromagnetic waves with materials and their applications in cutting-edge technologies like quantum materials and energy storage systems.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Explain the polarization mechanisms and dielectric properties of materials.	K2
CO-2:	Analyze optical phonon modes and their applications in photonics, optoelectronics, and telecommunications.	K4
CO-3:	Apply knowledge of optical properties and their role in advanced material devices such as plasmonics and metamaterials.	K3
CO-4:	Understand the theory and applications of ferroelectric materials, piezoelectric effects, and related phenomena.	K2
CO-5:	Investigate magnetic properties in reduced dimensions, including their applications in nanomaterials, thin films, and magnetoresistance.	K4
CO-6:	Explore recent advancements in polymer physics and material physics, including energy storage materials, quantum computing, and biomaterials for modern technological applications.	K2

COURSE CONTENT:

MODULE 1:	**DIELECTRIC AND OPTICAL PROPERTIES OF MATERIALS**	**9 Hours**

Theory of Electronic polarization and optical absorption, Ionic polarization, orientational polarization. Polarisation mechanism, Claussius-Mosotti equation for an isotropic linear dielectric, Temperature dependence of Dielectric Constants and Permanent Molecular dipole moment.Response of dielectrics to alternating fields.		
MODULE 2:	**OPTICAL PHONON MODE IN AN IONIC CRYSTAL**	**7 Hours**
Interaction of electromagnetic waves with optical modes, Polariton, Dispersion curves of Transverse Optical (TO) phonon and optical photon in a diatomic ionic crystal, LST relation. Dielectric function of the electron gas: Plasmon. Exciton, Metal-Insulator transition.		
MODULE 3:	**OPTICAL PROPERTIES OF MATERIALS**	**5 Hours**
Interaction of light with matter. Optical constants (refractive index, absorption coefficient) Photonic materials and devices. Applications in optoelectronics and telecommunications, Plasmonics and metamaterials.		
MODULE 4:	**FERROELECTRIC CRYSTAL**	**5 Hours**
Theory of Ferroelectric transition- first order and second order phase transitions. Antiferroelectricity, Piezo electricity, Electrostriction.Luminescence, Fluorescence, Phosphorescence, Raman scattering, Spectroscopic techniques.		
MODULE 5:	**MAGNETISM IN REDUCED DIMENSION**	**8 Hours**
Techniques XMLD, XMCD, MFM, Spin-Glass systems, Magnetism of nanoparticles, nano-wires, thin films, Magnetoresistance, GMR, TMR, CMR etc., Magnetic domain walls, domain wall dynamics.		
MODULE 6:	**POLYMER PHYSICS**	**5 Hours**
Introduction to Polymer Physics, Different types of polymers, conjugate polymers and its different properties.		
MODULE 7:	**ADVANCED TOPICS AND CURRENT RESEARCH**	**6 Hours**
Smart materials and intelligent systems (shape memory alloys, piezoelectrics), Materials for energy storage and conversion (batteries, fuel cells, solar cells), Biomaterials and applications in biotechnology, Recent advancements and future trends in material physics, Materials for quantum computing and quantum materials.		
TOTAL LECTURES		**45 Hours****

Books:

1. Solid State Physics – Ashcroft amd Mermin
2. Solid State Physics – Kittel
3. Solid State Physics – A J Dekker
4. Materials Science and Engineering An Introduction, William D. Callister, Jr., John Wiley & Sons, Inc.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	3	2	-
CO2	3	3	1	1	-	-	-	-	3	3	-
CO3	3	3	2	1	-	-	-	-	3	3	2
CO4	3	2	1	1	-	-	-	-	3	2	-
CO5	3	3	1	1	-	-	-	-	3	3	2
CO6	3	2	2	2	-	-	1	-	3	2	1
Average	3	2.50	1.17	1	0	0	1	0	3	2.50	0.83

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Nuclear Reaction II	**Subject Code:** TIU-PPH-T222
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Provide students with a fundamental understanding of the interaction of radiation with matter, various types of radiation detectors, and the working principles of particle accelerators.
2. Gain knowledge of Radioactive Ion Beam (RIB) production methods and existing facilities, as well as acquire a comprehensive understanding of vacuum techniques, including their applications in scientific experiments.
3. Equip with the skills required to comprehend and apply the principles of electronics and data acquisition systems in radiation detection, facilitating practical problem-solving in nuclear physics and related fields.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Analyze how alpha, beta, and gamma radiation interact with different types of matter, and distinguish the differences in their interaction mechanisms. Use this knowledge to predict radiation behavior in various materials.	K4
CO-2:	Classify various types of radiation detectors, including gas-filled, scintillation, and semiconductor detectors. Critically assess their advantages, limitations, and applications in detecting different types of radiation.	K4
CO-3:	Analyze the working principles of various types of particle accelerators, such as electrostatic accelerators, cyclotrons, synchrotrons, and linear accelerators. Apply this understanding to evaluate their uses in nuclear and particle physics.	K4
CO-4:	Understand the production of radioactive ion beams (RIB), exploring the different methods and existing facilities used for RIB generation.	K2

CO-5:	Describe the basic definitions and classifications of vacuum techniques, the types of vacuum pumps, and the devices used for measuring and controlling vacuum.	K2
CO-6:	Illustrate the process of analog pulse formation in radiation detectors, including the basic and specialized circuits used in data acquisition systems.	K3

COURSE CONTENT :

MODULE 1:	**INTERACTION OF RADIATION WITH MATTER**	**9 Hours**
Interaction of alpha, beta and gamma radiation with matter		
MODULE 2:	**RADIATION DETECTORS**	**10 Hours**
Gas-filled detectors, Scintillation detectors, Semiconductor detectors		
MODULE 3:	**PARTICLE ACCELERATORS**	**10 Hours**
Electrostatic accelerators, Cyclotrons, Synchrotrons, Linear accelerators, Details of RIB, Different methods to produce Radioactive Ion BeaM, Existing facilities		
MODULE 4:	**VACUUM TECHNIQUES**	**8 Hours**
Basic definitions and classifications, vacuum pumps, vacuum measuring/controlling devices.		
MODULE 5:	**ELECTRONICS AND DATA ACQUISITION SYSTEM**	**8 Hours**
Analog pulse formation from radiation detectors, Analog to digital conversion, Basic electronic circuits, specialized electronic circuits.		
TOTAL LECTURES		**45 Hours****

Books:

1. An Introduction to Experimental Nuclear Reactions, Chinmay Basu, CRC Press (2022)
2. K. S. Krane, Introductory Nuclear Physics, John Wiley (1988).
3. 1. Radiation Detection and Measurement, Glenn F Knoll

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	3	2	-
CO2	3	2	-	-	-	-	-	-	3	2	-
CO3	3	2	2	-	-	-	-	-	3	3	-
CO4	3	2	-	-	-	-	-	-	3	2	-
CO5	3	2	2	-	-	-	-	-	3	3	-
CO6	3	3	2	-	-	-	-	-	3	3	-
Average	3	2.17	2	0	0	0	0	0	3	2.50	0

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Superconducting Materials and Devices	**Subject Code:** TIU-PPH-E204A
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Develop a comprehensive understanding of the fundamental properties, theories, and types of superconductors, including the Meissner effect and London's theory.
2. Explore the critical properties of superconductors and their design, fabrication, and applications in superconducting systems such as wires, magnets, and storage devices.
3. Analyze the working principles and applications of SQUIDs in various fields, including biomagnetism and infrared detection.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Students will be able to define and list the basic properties of superconductors, such as zero resistance, perfect diamagnetism, the Meissner effect, and London's theory. They will also recognize the differences between Type 1 and Type 2 superconductors.	K1
CO-2:	Students will explain the fundamental principles of the Meissner effect, coherence length, penetration depth, and energy gap, and describe the behavior of superconductors in different states (e.g., intermediate and mixed states). They will also illustrate the differences between the critical fields and currents for Type 1 and Type 2 superconductors.	K2
CO-3:	Students will be able to apply London's theory to analyze superconducting materials and calculate the penetration depth, critical currents, and fields in various superconducting systems. They will also demonstrate the working principles of superconducting magnets and systems such as SMES (Superconducting Magnetic Energy Storage) through practical examples.	K3

CO-4:	Students will analyze the role of flux flow and flux pinning in Type 2 superconductors, compare the behavior of these superconductors under different magnetic fields, and evaluate the effects of magneto-thermal instabilities. They will also analyze the different stabilization criteria (Cryostatic, Dynamic, and Enthalpic) used in superconducting systems.	K4
CO-5:	Students will evaluate the effectiveness of superconducting energy storage (SMES) systems and interpret the operation of superconducting quantum interference devices (SQUIDs) in terms of their theoretical models. They will also compare the applications of DC and RF SQUIDs in various real-world situations.	K4
CO-6:	Students will be able to design basic superconducting magnets and fabricate simple superconducting systems, such as multifilamentary wires. They will also develop a conceptual framework for designing superconducting devices, including persistent switches and infrared detectors, based on the principles of superconductivity.	K4

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO SUPERCONDUCTIVITY AND BASIC PROPERTIES**	**8 Hours**
Discovery, Zero resistance, Perfect Diamagnetism, Meissner effect, London's theory, Penetration depth, concept of coherence length and surface energy. Type 1 andType 2 superconductors, Intermediate and mixed states, Critical currents and critical fields		
MODULE 2:	**THEORETICAL FOUNDATIONS AND ENERGY GAP IN SUPERCONDUCTORS**	**4 Hours**
Outlines of B-C-S theory, Concept of energy gap		
MODULE 3:	**FLUX DYNAMICS AND STABILITY OF SUPERCONDUCTORS**	**15 Hours**
Flux Flow, Flux Pinning, pinning force, Magneto-thermal instabilities in Type 2 superconductors, Flux jumps. Stabilization Criterion: Cryostatic, Dynanic& Enthalpic Stabilization.		
MODULE 4:	**FABRICATION AND ENGINEERING OF SUPERCONDUCTING MATERIALS**	**9 Hours**
Manufacture of long length superconducting multifilamentary wires, Design, fabrication of superconducting magnets. Persistent switches, Superconducting magnets energization. Basic concepts of Superconducting Energy Storage (SMES)		
MODULE 5:	**APPLICATIONS OF SUPERCONDUCTIVITY IN TECHNOLOGY**	**9 Hours**
Superconducting Quantum InterferenceDevices (SQUIDs): Theories of DC & RF SQUIDs, SQUIDs fabrications, Various applications of SQUIDs. Superconductive Switches, Infrared detectors and biomagnetism.		
TOTAL LECTURES		**45 Hours****

Books:

1. Introduction to Superconductivity ……………. Roseins&Rhodrih
2. Applied Superconductivity, Vol. I & II ………… Newhouse
3. Superconducting Materials …………………….. Foner & Swartz.
4. Fundamentals of Superconductivity ………. ….. Vladimir Z. Kresin & Stuart A. Wolf.
5. Applied Superconductivity ……………………… Williams
6. Superconducting Magnet Design ………………… Wilson

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	2	2	-	-	-	-	3	2	-
CO-2	3	3	2	2	-	-	-	-	3	2	-
CO-3	3	3	3	3	-	-	-	-	2	3	-
CO-4	3	3	3	3	-	-	-	-	2	3	-
CO-5	3	3	3	3	-	-	-	-	2	3	-
CO-6	3	3	3	3	-	-	-	-	2	3	-
Average	3	3	2.67	2.67	0	0	0	0	2.33	3	0

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Renewable Energy and Energy Harvesting	**Subject Code:** TIU-PPH-E204B
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Introduce students to the limitations of fossil fuels and the significance of renewable energy sources in sustainable development.
2. Provide an in-depth understanding of various renewable energy technologies and energy harvesting methods.
3. Analyze the working principles, efficiency, and environmental impact of different energy conversion and harvesting techniques.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Explain the importance of renewable energy and assess the limitations of fossil fuels.	K2
CO-2:	Analyze the working principles and applications of solar and wind energy systems.	K4
CO-3:	Compare various ocean, geothermal, and hydro energy technologies in terms of efficiency and feasibility.	K4
CO-4:	Analyze different energy harvesting methods, including piezoelectric and electromagnetic systems.	K4
CO-5:	Understand the role of fuel cells in energy conversion and storage.	K2
CO-6:	Examine the environmental impact and sustainability of renewable energy sources.	K4

COURSE CONTENT:

MODULE 1:	**INTRODUCTION TO RENEWABLE ENERGY**	**5 Hours**
Fossil fuels and nuclear energy: Limitations and environmental concerns, Need for renewable energy and overview of non-conventional energy sources, Developments in solar, wind, ocean, biomass, geothermal, and hydro energy		

MODULE 2:	**SOLAR ENERGY**	**7 Hours**
Importance and storage of solar energy, solar pond, Applications: solar water heater, flat plate collector, solar distillation, solar cooker, greenhouses, Photovoltaic (PV) systems: characteristics, PV models, equivalent circuits, Maximum power point tracking (MPPT), sun-tracking systems		
MODULE 3:	**WIND ENERGY HARVESTING**	**6 Hours**
Fundamentals of wind energy, wind turbines, types of wind generators, Electrical machines used in wind turbines, power electronic interfaces, Grid interconnection: synchronization, current injection, islanding		
MODULE 4:	**OCEAN ENERGY**	**5 Hours**
Ocean energy vs. wind and solar energy, Wave characteristics, wave energy devices, Tidal characteristics, tidal energy technologies, Ocean Thermal Energy Conversion (OTEC), osmotic power, ocean biomass energy		
MODULE 5:	**GEOTHERMAL AND HYDRO ENERGY**	**5 Hours**
Geothermal resources and energy extraction technologies, Hydropower resources and technologies, Environmental impact of hydro energy		
MODULE 6:	**PIEZOELECTRIC ENERGY HARVESTING**	**5 Hours**
Basics of piezoelectricity: physics and material characteristics, Mathematical modeling of piezoelectric generators, Piezoelectric energy harvesting applications		
MODULE 7:	**ELECTROMAGNETIC ENERGY HARVESTING & SUSTAINABILITY**	**5 Hours**
Linear generators, physics and mathematical models, Recent advancements in electromagnetic energy harvesting, Carbon capture technologies, energy storage in cells and batteries, Environmental impact and sustainability		
MODULE 8:	**FUEL CELLS & THEIR APPLICATIONS**	**7 Hours**
Design principles and operation of fuel cells, Types of fuel cells and their conversion efficiency, Applications of fuel cells in energy storage and transport		
TOTAL LECTURES		**45 Hours****

Books:

1. *Renewable Energy: Power for a Sustainable Future* – Godfrey Boyle
2. Solar Energy: Principles of Thermal Collection and Storage – S.P. Sukhatme & J.K. Nayak
3. *Wind Energy Explained: Theory, Design, and Application* – J.F. Manwell, J.G. McGowan, A.L. Rogers
4. *Introduction to Ocean Energy Technologies* – Vikas Khare & Savita Nema
5. *Geothermal Energy: Renewable Energy and the Environment* – William E. Glassley
6. *Hydropower Development: Renewable Energy and the Environment* – Paul Breeze
7. Energy Harvesting for Autonomous Systems – Stephen Beeby & Neil White
8. *Handbook of Fuel Cells: Fundamentals, Technology, and Applications* – Wolf Vielstich, Arnold Lamm, Hubert A. Gasteiger

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	2	-	2	2	-
CO2	3	2	2	-	-	-	-	-	2	3	-
CO3	3	2	2	-	-	-	-	-	2	3	-
CO4	3	2	2	-	-	-	-	-	2	3	-
CO5	3	1	-	-	-	-	-	-	2	2	-
CO6	3	2	-	-	-	-	3	-	2	3	-
Average	3	1.83	2	0	0	0	2.50	0	2	2.67	0

TECHNO INDIA UNIVERSITY
W E S T B E N G A L

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Advanced Condensed Matter Physics	**Subject Code:** TIU-PPH-E206A
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Apply the Concept of the Semiclassical Model of Electron Dynamics
2. Recognize the Fundamentals of the Semiclassical Theory of Conduction in Metals
3. Investigate and Devise the Phenomena of Band Structure of Selected Metals
4. Construct and Apply Concepts of Beyond the Relaxation Time Approximation Model
5. Interpret and Utilize the Fundamentals of Beyond the Independent Electron Approximation
6. Analyze Surface Effects and Understand the Concept of Defects in Crystal

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Apply the concept of Semiclassical Model of Electron Dynamics	K3
CO-2:	Recognize the fundamentals of Semiclassical Theory of Conduction in Metals	K2
CO-3:	Investigate and devise the phenomena of Band Structure of Selected Metals	K4
CO-4:	Construct and apply concepts of Beyond the Relaxation time Approximation Model	K3
CO-5:	Interpret and Utilize the fundamentals of Beyond the Independent Electron Approximation and use it in physics problems.	K3
CO-6:	Analyze Surface Effects and understand the concept of defects in crystals.	K4

COURSE CONTENT :

MODULE 1:	**SEMICLASSICAL MODEL OF ELECTRON DYNAMICS**	**5 Hours**
Wave Packets of Bloch Electrons, Semiclassical Mechanics, General Features of the Semiclassical Model, Static Electric Fields, The General Theory of Holes, Uniform Static Magnetic Fields, Hall Effect and Magnetoresistance		
MODULE 2:	**SEMICLASSICAL THEORY OF CONDUCTION IN METALS**	**7 Hours**

The Relaxation-Time Approximation, General form of Nonequilibrium Distribution Function, DC Electrical Conductivity, AC Electrical Conductivity, Thermal Conductivity, Thermoelectric Effects, Conductivity in a Magnetic Field		
MODULE 3:	**BAND STRUCTURE OF SELECTED METALS**	**7 Hours**
Alkali Metals, Noble Metals, Divalent Simple Metals, Trivalent Simple Metals, Tetravalent Simple Metals, Semimetals, Transition Metals, Rare Earth Metals, Alloys.		
MODULE 4:	**BEYOND THE RELAXATION TIME APPROXIMATION**	**7 Hours**
Source of Electronic Scattering, Scattering Probability and Relaxation Time, Genrral Description of Collisions, The Boltzmann Transport Equation, Impurity Scattering, Wiedemann – Franz Law, Matthiessen's Rule, Scattering in isotropic Materials.		
MODULE 5:	**BEYOND THE INDEPENDENT ELECTRON APPROXIMATION**	**7 Hours**
The Hartree Equations, The Hartree – Fock Equation for solids, Correlation, Screening – The Dielectric Function		
MODULE 6:	**SURFACE EFFECTS**	**7 Hours**
The work Function, Contact Potentials, Low energy Electron Diffraction, Field Ion Microscopy, Electronic Surface levels		
MODULE 7:	**DEFECTS IN CRYSTALS**	**5 Hours**
Thermodynamics of Point Defects, Schottky and Frenkel Defects, Annealing, Electrical Conductivity of Ionic Crystals, Color Centers, Polarons and Excitons, Dislocations, Strength of Crystals, Crystal Growth, Stacking Faults and Grain Boundaries		
TOTAL LECTURES		**45 Hours****

Books:

1. Solid State Physics – Ashcroft and Mermin
2. Solid State Physics – Kittel

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	1	-	-	-	-	-	-	3	-
CO-2	3	3	1	-	-	-	-	-	-	3	-
CO-3	3	3	1	-	-	-	-	-	-	3	-
CO-4	3	3	1	-	-	-	-	-	-	3	-
CO-5	1	3	1	-	-	-	-	-	-	3	-
CO-6	3	3	3	-	-	-	-	-	-	3	-
Average	2.67	3	1.33	0	0	0	0	0	0	3	0

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Introduction to Plasma Physics	**Subject Code:** TIU-PPH-E206B
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. To understand the fundamental properties and applications of plasma in various scientific and technological domains.
2. To analyze theoretical models of plasma, including single-particle motion, fluid dynamics, and kinetic theory, for explaining plasma behavior.
3. To explore plasma drifts, waves, instabilities and different nonlinear effects in both collisional and collisionless plasmas.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	recall and list key plasma characteristics such as quasineutrality, Debye shielding, temperature, and density, as well as explain the concept of plasma oscillation.	K1
CO-2:	understand and explain the motion of particles in various uniform and nonuniform fields and describe the resulting plasma drifts.	K2
CO-3:	apply the fluid model of plasma to address problems involving continuity, magnetic pressure, and magnetic field dynamics within plasma systems.	K3
CO-4:	understand the different types of plasma waves and explain their characteristics in both fluid and kinetic theory contexts.	K2
CO-5:	apply the principles of kinetic theory to solve problems involving the Boltzmann equation, Vlasov equation, and analyze Landau damping in plasma systems.	K3
CO-6:	analyze the stability of plasma, classify plasma instabilities, and apply the principles of non-linear effects to understand plasma dynamics.	K4

COURSE CONTENT :

MODULE 1:	**INTRODUCTION:**	**5 Hours**
Development, Temperature, Density, Quasineutrality, Debye Shielding, Plasma parameters, application of plasma physics in different areas of science.		

MODULE 2:	ORBIT THEORY:	5 Hours
Particle motion in uniform Electric, Magnetic and Gravitational field. Plasma Drifts- ExB drift, Grad-B drift, Curvature drift, Polarization drift, Finite Larmor radius effect		
MODULE 3:	**FLUID MODEL:**	**5 Hours**
The fluid equation of motion, Fluid drift perpendicular to **B**, Fluid drift parallel to **B,** Magnetic Pressure, Frozen in Magnetic field.		
MODULE 4:	**PLASMA WAVES:**	**6 Hours**
Plasma oscillations, Electron Plasma waves, Ion acoustic waves, Electrostatic electron oscillations perpendicular to B, Electrostatic ion waves perpendicular to B, Lower-Hybrid Frequency, MHD waves.		
MODULE 5:	**KINETIC THEORY OF PLASMA:**	**10 Hours**
Statistical description of plasmas, B.B.G.K.Y hierarchy, Boltzmann equation, Vlasov equation, Electron Landau damping, Ion-Landau damping.		
MODULE 6:	**EQUILIBRIUM AND STABILITY:**	**7 Hours**
Hydromagnetic Equilibrium, The concept of β, Classification of Instabilities, Two stream Instability, Nyquist method-Penrose criterion of stability, Bump on tail instability, BGK waves.		
MODULE 7:	**NON-LINEAR EFFECTS:**	**7 Hours**
Ponderomotive force, Kd-V equation, Plasma echo, Nonlinear Schrodinger Equation.		
TOTAL LECTURES		**45 Hours****

Books:

1. Introduction to Plasma Physics and Controlled Fusion by F F Chen
2. Fundamental of Plasma Physics by J. A. Bittencourt
3. Basic Plasma Physics by Basudev Ghosh
4. Principle of Plasma Physics by N. A. Krall and A. W. Trivelpiece

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	2	2	-	-	-	2	3	2	2
CO-2	3	3	2	2	-	-	-	2	3	2	2
CO-3	3	3	3	3	-	-	-	2	3	3	2
CO-4	3	3	3	3	-	-	-	2	3	3	2
CO-5	3	3	3	3	-	-	-	2	3	3	3
CO-6	3	3	3	3	-	-	-	2	3	3	3
Average	3	3	2.67	2.67	0	0	0	2	3	2.67	2.33

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Laser Physics	**Subject Code:** TIU-PPH-E206C
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. To develop a fundamental understanding of laser physics, including coherent electromagnetic waves, transition rates, population inversion, and laser resonators.
2. To explore laser construction, pumping systems, beam propagation, resonator stability, Q-switching, and ultrafast laser techniques.
3. To study different types of lasers, including gas, solid-state, chemical, and semiconductor lasers, and their applications in various fields.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Apply the basic concepts of principle of operation of a LASER	K3
CO-2:	Recognize the fundamentals of Q-switching and construction of a LASER	K2
CO-3:	Investigate and devise the phenomena of Gaussian beam propagation	K4
CO-4:	Construct and apply concepts of various types of resonators	K3
CO-5:	Interpret and Utilizethe advanced concepts of various kinds of Q-switching	K3
CO-6:	Analyze the different kinds of LASERS and their principle of operation.	K4

COURSE CONTENT :

MODULE 1:	**BASIC LASER PRINCIPLE**	**5 Hours**
Coherent electromagnetic wave, Summary of black body radiation, Quantum theory for evaluation of the transition rates and Einstein coefficients-Allowed and forbidden levels-Metastable state, Basic theory of laser resonator and principle behind laser oscillator, Population inversion, Rate equations for three level and four level lasers, Two band laser and Quasi-band laser, Threshold of power calculation, Various broadening mechanism, Homogeneous and inhomogeneous broadening.		
MODULE 2:	**BASIC LASER SYSTEM**	**7 Hours**
Basic concept of construction of laser system, Various pumping system, Pumping cavities for solid state laser system, Q switching, Characteristics of host materials and doped ions.		
MODULE 3:	**OPTICAL BEAM PROPAGATION**	**7 Hours**

Paraxial ray analysis, Wave analysis of beams and resonators, Propagation and properties of Gaussian beam, Gaussian beam in lens like medium, ABCD law-Gaussian beam focusing.		
MODULE 4:	**RESONATORS**	**7 Hours**
Stability of resonators-'g' parameter, Various types of resonators, Evaluation of beam waist of such combination, Design aspect of resonator for various types of lasers, Unstable resonator and their application.		
MODULE 5:	**Q-SWITCHING**	**7 Hours**
Giant pulse theory, Different Q-switching techniques: mechanical Q-switching, electro-optic Q-switching, acousto-optic Q-switching, dye Q-switching, Raman-Nath effect.		
MODULE 6:	**ULTRAFAST PHENOMENA**	**7 Hours**
Basics of femtosecond pulses, Principle of generation of ultrafast pulses (mode locking), Active and passive mode locking, Basic concepts for measurement of fast processes, Streak technique, Stroboscopy, sampling technique, Nonlinear optical methods for measuring ultrashort pulses.		
MODULE 7:	**DIFFERENT LASER SYSTEMS**	**5 Hours**
Gas Lasers: (i) Molecular gas lasers- CO_2 laser & N_2, (ii) Ionic gas laser – Ar^+ laser, (iii) Gas dynamic laser (iv) High pressure pulsed gas laser, Solid State Laser: (i) Nd:YAG laser, (ii) Nd:Glass laser, comparison of performances, (iii) Tunable solid state laser: Ti:sapphire laser; Alexandrite laser Chemical Laser: HF laser, HCl laser, COIL Excimer laser; Color centre laser; Free electron laser; semiconductor diode laser		
TOTAL LECTURES		**45 Hours****

Books:

1. Lasers:Principles, Types and Applications by K. R. Nambiar, New Age International, 2006
ISBN: 8122414923, 9788122414929
2. Lasers by A. E. Siegman, University Science Books, 1986
ISBN: 0935702113, 9780935702118

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	3	2	-	-	-	-	-	-	3	1
CO-2	3	3	2	-	-	-	-	-	-	3	1
CO-3	3	3	1	-	-	-	-	-	-	3	1
CO-4	3	3	1	-	-	-	-	-	-	3	1
CO-5	3	3	1	-	-	-	-	-	-	3	1
CO-6	3	3	-	-	-	-	-	-	-	3	1
Average	3	3	1.4	0	0	0	0	0	0	3	1

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Advanced Physics Lab	**Subject Code:** TIU-PPH-L202
Contact Hours/Week: 0–0–6 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Develop an understanding of advanced experimental techniques for investigating electrical, optical, and thermal properties of various materials, including nano-materials and thin films.
2. Enhance practical skills in using modern scientific instruments such as UV/VIS spectrophotometers, fiber optics setups, and charge particle detectors for precise measurements.
3. Analyze and interpret experimental data related to quantum efficiency, thermoelectric properties, piezoelectric coefficients, and electrical transport in materials for real-world applications.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Demonstrate the ability to measure and analyze the electrical transport properties of nano-materials, thin films, and semiconductor devices.	K3
CO-2:	Investigate the Faraday effect, piezoelectric behavior, and optical properties of various materials using He-Ne LASER, UV/VIS spectrophotometer, and fiber optics systems.	K4
CO-3:	Assess the thermal properties of solids, thin films, and materials by measuring thermal conductivity, thermoelectric power, and thermal expansion.	K5
CO-4:	Conduct experiments to determine the energy calibration of charged particles and barrier potential of transistors, and interpret doping profiles in semiconductor junctions.	K3
CO-5:	Design and implement experimental techniques for accurate thickness determination of thin foils and materials using advanced measurement tools	K6
CO-6:	Examine and interpret the quantum efficiency of LEDs, ionic conductivity of materials, and absorption/transmission spectra for understanding advanced material properties	K5

COURSE CONTENT :

MODULE 1:	I-V Characteristics of Nano-Materials	6 Hours
I-V characteristics, current-voltage curve, nano-materials, resistivity, nano-scale, conductance, nanostructures, electrical properties.		
MODULE 2:	**Faraday Effect using He-Ne Laser**	**6 Hours**
Faraday effect, optical rotation, magneto-optical effect, magnetic field, polarization, He-Ne laser, Faraday rotation, optical material.		
MODULE 3:	**Thermal Conductivity of Solids**	**6 Hours**
Thermal conductivity, heat transfer, Fourier's law, steady-state conduction, temperature gradient, heat flow, solid materials.		
MODULE 4:	**Fibre Optics Parameters Measurement**	**6 Hours**
Fibre optics, refractive index, numerical aperture, critical angle, attenuation, light propagation, optical fibers, modal dispersion.		
MODULE 5:	**Electrical Transport in Nano-Fibres**	**6 Hours**
Nano-fibres, electrical transport properties, conductance, resistance, current, quantum effects, charge carriers, nano-scale materials.		
MODULE 6:	**P-E Loop and Piezoelectric Coefficients Measurement**	**6 Hours**
P-E loop, piezoelectric effect, polarization, electric field, piezoelectric coefficients, hysteresis, material response, mechanical stress.		
MODULE 7:	**Thermoelectric Power of Thin Films**	**9 Hours**
Thermoelectric power, Seebeck effect, thin films, temperature gradient, voltage generation, material conductivity, thermocouple.		
MODULE 8:	**Energy Calibration of Charged Particles**	**6 Hours**
Charged particles, energy calibration, particle detector, ionization, energy spectrum, particle acceleration, detection techniques.		
MODULE 9:	**Thickness Measurement of Thin Foil**	**9 Hours**
Thin foil, thickness measurement, optical interference, light absorption, reflectivity, interference fringes, surface analysis.		
MODULE 10:	**Barrier Potential and Doping Profile of Transistor Junctions**	**6 Hours**
Barrier potential, doping profile, transistor junctions, semiconductor, p-n junction, current-voltage characteristics, built-in voltage.		
MODULE 11:	**Ionic Conductivity Measurement**	**6 Hours**

Ionic conductivity, ion transport, conductivity, electrolytes, solution conductivity, conductivity cell, electrolyte.		
MODULE 12:	**Absorption/Transmission Spectra of Thin Films**	**6 Hours**
Absorption spectrum, transmission spectrum, thin films, UV-VIS spectrophotometer, optical properties, band gap, light absorption.		
MODULE 13:	**Linearization of LED Characteristics and Quantum Efficiency**	**6 Hours**
LED characteristics, quantum efficiency, light emission, forward voltage, current-voltage curve, linearization, emission spectrum.		
MODULE 14:	**Thermal Expansion of a Material**	**6 Hours**
Thermal expansion, coefficient of linear expansion, temperature change, material properties, length change, thermal stress, heat conduction.		
TOTAL	**Any 8 experiments**	**90 Hours****

Books:

1. R. A. Dunlop, Experimental Physics, Oxford University Press (1988)
2. A. C. Melissinos, Experiments in Modern Physics, Academic Press (1996)
3. E. Hecht, Optics, Addition-Wesley; 4th Edition (2001)
4. J. Verma, Nuclear Physics Experiments, New Age Publishers (2001)
5. Laboratory Manual with details about the experiments
6. R. A. Dunlop, Experimental Physics, Oxford University Press (1998)
7. A. Lipson, S. G. Lipson, H. Lipson, Optical Physics, Cambridge University Press; 4th (2010)
8. E. Hecht, Optics, Addition-Wesley; 4th Edition (2001)
9. Laboratory Manual with details about the experiments
10. Manuals and journals

CO-PO Mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**
CO-1	3	2	2	3	-	1	-	1	1	2	3
CO-2	3	3	2	2	-	1	-	1	1	3	3
CO-3	3	3	2	2	-	1	-	1	1	2	3
CO-4	3	3	2	1	-	1	-	1	1	2	3
CO-5	3	3	3	2	-	1	-	1	1	2	3
CO-6	3	3	2	3	-	1	-	1	1	3	3
Average	3	2.83	2.17	2.17	0	1	0	1	1	2.33	3

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 2ndYr.,4thSem
Course Title: Entrepreneurship Skill Development II	**Subject Code:** TIU-PES-S292
Contact Hours/Week: 0–0–2 (L–T–P)	**Credit:** 1

COURSE OBJECTIVE :

Enable the student to:

1. Present the developed solution as a prototype.
2. Demonstrate the real-world applicability of the idea.
3. Communicate the project effectively in a structured format.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Finalize and refine the prototype model.	K1
CO-2:	Prepare and deliver an effective presentation on the project.	K2
CO-3:	Communicate the scientific and business potential of the solution.	K3
CO-4:	Apply data-driven decision-making to validate the final prototype.	K4
CO-5:	Demonstrate networking and pitching skills for scientific solutions.	K5
CO-6:	Formulate future strategies for commercialization and further research.	K6

COURSE CONTENT :

MODULE 1:	**PROTOTYPE FINALIZATION AND TESTING**	**10 Hours**
Refining the prototype based on feedback. Testing for efficiency, sustainability, and reliability. Troubleshooting and improving design.		
MODULE 2:	**FINAL PRESENTATION AND PROJECT REPORT**	**20 Hours**
Structuring the final project report. Presenting findings to faculty and peers. Discussing future prospects and scalability of the idea.		
TOTAL LECTURES		**30 Hours****

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	2	2	-	-	-	-	1	2	2	2
CO2	-	1	-	-	3	2	-	-	-	1	-
CO3	1	2	2	-	2	2	-	-	1	2	1
CO4	2	2	3	2	-	-	-	-	2	3	2
CO5	-	2	2	-	3	3	-	-	1	2	-
CO6	2	2	2	-	-	-	-	1	2	2	2
Average	1.75	1.83	2.20	2	2.67	2.33	0	1	1.60	2	1.75

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Project II	**Subject Code:** TIU-PPH-P298
Contact Hours/Week: 0–0–12 (L–T–P)	**Credit:** 6

COURSE OBJECTIVE:

Enable the student to:

1. Implement mathematical models or synthesis techniques to investigate the research problem.
2. Utilize appropriate analytical methods to interpret results and ensure their accuracy.
3. Present research findings through a structured technical report and oral presentation.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Enhance and optimize the research problem based on prior findings.	K6
CO-2:	Apply the developed mathematical model or synthesis procedure.	K3
CO-3:	Employ appropriate analytical methods to interpret research data.	K4
CO-4:	Analyze extracted results and validate them against existing theories or experiments.	K6
CO-5:	Compile findings into a structured technical report.	K6
CO-6:	Communicate research outcomes effectively through oral or visual presentations.	K6

COURSE CONTENT:

MODULE 1:	**REFINEMENT OF RESEARCH IDEA**	**20 Hours**
Reviewing Phase 1 findings and feedback. Optimizing research objectives based on previous analysis. Finalizing research scope and approach		
MODULE 2:	**IMPLEMENTATION OF METHODOLOGY**	**40 Hours**
Applying mathematical models or synthesis procedures. Executing theoretical calculations, simulations, or material synthesis. Addressing challenges in implementation		

MODULE 3:	ANALYTICAL TECHNIQUES & DATA INTERPRETATION	40 Hours
Selecting and applying appropriate analytical methods. Processing and interpreting research findings. Comparing results with existing theoretical or experimental data		
MODULE 4:	**RESULT VALIDATION & CRITICAL ANALYSIS**	**30 Hours**
Assessing accuracy and reliability of obtained results. Evaluating consistency with established scientific principles. Identifying limitations and proposing improvements		
MODULE 5:	**TECHNICAL REPORT WRITING**	**25 Hours**
Structuring the research report (Abstract, Introduction, Methodology, Results, Discussion, Conclusion). Formatting and referencing using scientific writing tools (LaTeX/MS Word). Preparing research figures, tables, and citations		
MODULE 6:	**RESEARCH PRESENTATION**	**20 Hours**
Designing an effective oral or poster presentation. Communicating key findings with clarity and precision. Addressing questions and feedback from evaluators		
TOTAL LECTURES		**175 Hours****

Books:

Journals

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	3	2	2	-	-	-	1	2	2	2
CO2	2	2	2	2	-	-	-	-	2	3	2
CO3	3	3	2	3	-	-	-	-	3	3	2
CO4	3	3	2	3	-	-	-	-	3	3	2
CO5	2	2	-	-	2	-	-	-	2	2	2
CO6	2	2	-	-	3	2	-	-	2	2	2
Average	2.33	2.50	2	2.50	2.50	2	0	1	2.33	2.50	2

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M.Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Comprehensive Viva	**Subject Code:** TIU-PPH-G298
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE:

Enable the student to:

1. Consolidate and integrate theoretical knowledge acquired throughout the MSc Physics program to ensure a comprehensive understanding of core concepts.
2. Develop critical thinking and problem-solving abilities by discussing and analyzing fundamental and advanced physics topics.
3. Foster effective scientific communication skills by articulating answers confidently in a viva voce setting.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Demonstrate a comprehensive understanding of fundamental and advanced concepts in classical mechanics, quantum mechanics, statistical mechanics, and thermodynamics.	K2
CO-2:	Analyze and interpret complex physical phenomena related to condensed matter physics, nuclear physics, particle physics, and electromagnetic theory.	K4
CO-3:	Apply mathematical methods and computational techniques to solve complex physics problems and model physical systems accurately.	K3
CO-4:	Evaluate experimental techniques, data analysis methods, and instrumentation related to advanced experimental physics.	K5
CO-5:	Integrate interdisciplinary concepts to understand and explain real-world physical applications and advanced research problems.	K5
CO-6:	Demonstrate effective scientific communication skills by clearly presenting theoretical concepts, problem-solving approaches, and experimental findings during the viva voce.	K3

COURSE CONTENT:

MODULE :		
The Grand Viva for MSc Physics will cover fundamental and advanced topics from the entire curriculum, including Classical Mechanics, Quantum Mechanics, Statistical Mechanics, Thermodynamics, Condensed Matter Physics, Nuclear and Particle Physics, Electromagnetic Theory, Optics, Mathematical Physics, and Advanced Experimental Techniques. Students will be examined on their conceptual understanding, analytical problem-solving skills, experimental knowledge, and ability to integrate interdisciplinary concepts. The viva will also assess students' ability to effectively communicate scientific ideas and present coherent explanations of both theoretical concepts and experimental findings.		

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	3	2	-
CO2	3	3	-	-	-	-	-	-	3	3	-
CO3	3	3	2	-	-	-	-	-	3	2	2
CO4	3	3	2	2	-	-	-	-	3	3	2
CO5	3	3	2	-	-	-	-	-	2	3	2
CO6	-	2	-	-	3	2	-	-	-	2	2
Average	3	2.67	2	2	3	2	0	0	2.33	2.50	2

TECHNO INDIA UNIVERSITY
WEST BENGAL

Department of Physics

Program: M. Sc. in Physics	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Advanced Project on Experimental Design	**Subject Code:** TIU-PPH-L208
Contact Hours/Week: 0–0– 4 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE:

Enable the student to:

1. Apply formulated designs to develop and evaluate functional prototypes.
2. Analyze experimental outcomes to enhance and iterate on selected designs.
3. Incorporate developed experiments into graduate and undergraduate courses.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Arrange formulated designs to create and test prototypes.	K1
CO-2:	Analyze prototype performance through structured testing.	K4
CO-3:	Evaluate prototypes based on experimental results.	K6
CO-4:	Devise developed experiments for educational purposes.	K5
CO-5:	Prepare technical reports and present research outcomes.	K6
CO-6:	Evaluate the significance of developed prototypes in research and education.	K6

COURSE CONTENT:

MODULE 1:	**CONCEPTUALIZATION AND IMPLEMENTATION OF RESEARCH IDEA**	**48 Hours**
Introduction to design thinking in science & engineering. Identification of research/educational gaps. The design formulated will be employed to produce and test prototypes, refine and iterate on the selected design. Tools for prototyping: hardware, software, fabrication basics. Safety standards and considerations		
MODULE 2:	**SCIENTIFIC COMMUNICATION AND RESEARCH IMPACT**	**12 Hours**
Technical Report Writing. Poster and oral presentations. Ethics in research and publication The experiments that are developed are incorporated within the graduate and undergraduate curriculum.		
TOTAL HOURS		**60 Hours****

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO-1	3	2	3	2	-	3	-	-	-	2	3
CO-2	3	3	2	3	-	-	-	-	-	2	3
CO-3	3	3	2	3	-	-	-	-	-	2	3
CO-4	3	2	3	2	2	-	-	-	-	2	3
CO-5	3	2	2	2	3	3	-	-	-	2	3
CO-6	3	2	2	3	2	-	-	-	-	2	3
Average	3	2.33	2.33	2.50	2.33	3	0	0	0	2	3