Progressive Education Society's

Modern College of Arts, Science and Commerce (*Autonomous*),
Shivajinagar, Pune 5

(An Autonomous College Affiliated to Savitribai Phule Pune University)

Framework and Syllabus

For

T. Y. B. Sc. (Physics)

Choice Based Credit System (CBCS) Syllabus under National Education Policy 2020 (NEP-2020)

To be implemented from Academic Year 2024-2025

Level: 5.5 (Third Year) Sem: V

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T (2+2+2+2 or 4 + 2+2 or 4 + 4) P (2+2 or 4)	24ScPhyU5101	Introduction to Mathematical Methods in Physics	2		2		20	30	50
	24ScPhyU5102	Introduction to Classical Mechanics	2		2		20	30	50
	24ScPhyU5103	Introduction to Quantum Mechanics	2		2		20	30	50
	24ScPhyU5104	Atomic and Molecular Physics	2		2		20	30	50
	24ScPhyU5105	Lab Course on General Physics V		2		4	20	30	50
	24ScPhyU5106	Lab Course on General Physics VI		2		4	20	30	50
Major Elective (T/P) (2+2 or 4)	24ScPhyU5201	Electronics and Instrumentation	2		2		20	30	50
	24ScPhyU5202	Lab Course on Elective Physics I		2		4	20	30	50
	24ScPhyU5203	Physics of Semiconductor Devices	2		2		20	30	50
	24ScPhyU5204	Lab Course on Elective Physics II		2		4	20	30	50
VSC P (2)	24ScPhyU5501	Lab Course on Quantum Computing I		2		4	20	30	50
FP (2)	24ScPhyU5001	Field Project II		2		4	20	30	50
Minor (T/P) (2)	24ScPhyU5302	Lab Course on Minor Physics III		2		4	20	30	50
Total			10	12	10	24			550

Level: 5.5 (Third Year) Sem: VI

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T (2+2+2+2 or 4+2+2 or 4+4) P (2+2 or 4)	24ScPhyU6101	Introduction to Electrodynamics	2		2		20	30	50
	24ScPhyU6102	Introduction to Solid State Physics	2		2		20	30	50
	24ScPhyU6103	Nuclear Physics	2		2		20	30	50
	24ScPhyU6104	Statistical Mechanics	2		2		20	30	50
	24ScPhyU6105	Lab Course on General Physics VII		2		4	20	30	50
	24ScPhyU6106	Lab Course on General Physics VIII		2		4	20	30	50
Major Elective (T/P) (2+2 or 4)	24ScPhyU6201	Physics of Nanomaterials	2		2		20	30	50
	24ScPhyU6202	Lab Course on Elective Physics III		2		4	20	30	50
	24ScPhyU6203	Medical and Biophysics	2		2		20	30	50
	24ScPhyU6204	Lab Course on Elective Physics IV		2		4	20	30	50
VSC P (2)	24ScPhyU6501	Lab Course on Quantum Computing II		2		4	20	30	50
OJT (2)	24ScPhyU6004	On Job Training		4		8	40	60	100
Total			10	12	10	24			550

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T.Y.B.Sc. Physics
(2024 Course under NEP 2020)

Course Code: 24ScPhyU5101

Course Name: Introduction to Mathematical Methods in Physics

Teaching Scheme: TH: 2 Hours/Week

Credit: 02

Examination Scheme: CIA : 20 Marks

End-Sem : 30 Marks

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus

Course objective

- To study Vector calculus and Vector algebra, complex numbers
- To understand the Fourier series expansion and its applications
- To develop problem-solving skills using different methods of obtaining solutions of differential equations

Course Outcomes:

Successful completion of this course students will able to:

CO No	Course Outcomes (COs)	Blooms Cognitive level
CO 1	Define and Understand the terms: vector operators, vector spaces, complex numbers, differentiation equations	1
CO 2	Understand the physical significance of Gradient of Scalar fields, Diversions and Curl of vector fields Express a periodic function in Fourier Series as a combination of sinusoidal waves of different phases and wavelengths	2
CO 3	Apply vector operators and Matrix representations	3
CO 4	Estimate/Calculate line and area integrations of given one- and two-dimensional simple function respectively	4
CO 5	Predict the Eigenvalues, solutions of the differential equations using various methods	5
CO 6	Apply Fourier series and Fourier transforms	6

Course Contents

Unit 1	Vector Analysis	8 Lectures
	• Revision- Vector operators (addition, subtraction, Cross product and dot product), Scalar triple product and vector triple product. • Divergent, gradient and Curl (representations in different coordinate systems). • Line, Surface and Volume integrals • Stokes theorem, Gauss's theorem.	
Unit 2	Complex numbers	8 Lectures
	• Definition of complex numbers, real and imaginary parts • Algebraic operators (addition, subtraction, multiplication, division) • Complex conjugate • Polar form • Eulers' Equation • Roots of Unity • Functions of Complex Numbers: Roots, Exponential, Logarithmic, Trigonometric.	
Unit 3	Differential Equations	5 Lectures
	• Ordinary differential equation (first order, second order, linear and nonlinear) • Partial Differential equation (Wave function and Laplace's equation) • Methods of Solutions (separation of variables, integrating factor, power series)	
Unit 4	Fourier Series	9 Lectures
	• Fourier series (periodic function, series representation and fourier constants) • Complex fourier Series • Fourier transform (continuous function and properties - linearity, time-shift invariance, frequency-shift invariance, convolution theorem, and Parseval's theorem)	

References:

1. Mathematical methods for physicists, Arfken and Weber, Acadmic Press Newyork.
2. Mathematical methods in the physical sciences – Marry L. Boas, John Willy and sons publication.
3. Mathematical Physics, H. K. Dass and Rama Verma, S Chand and Sons Publications.
4. Mathematical Physics, S.Prakash, S Chand and Sons Publications

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T.Y.B.Sc. Physics
(2024 Course under NEP 2020)

Course Code: 24ScPhyU5102

Course Name: Introduction to Classical mechanics

Teaching Scheme: TH: 2 Hours/Week

Credit: 02

Examination Scheme: CIA : 20 Marks

End-Sem : 30 Marks

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus
- Completed first year course 24ScPhyU1101

Course objective

- To introduce students to the fundamental principles of classical mechanics
- To develop problem-solving skills using Newtonian, Lagrangian, and Hamiltonian mechanics
- To understand the motion of particles under central forces and the mechanics of systems of particles
- To study the principles of scattering and apply them to physical systems

Course Outcomes:

Successful completion of this course students will able to:

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Recall Newton's laws of motion and their applications. Define key concepts like center of mass, conservation laws, and equations of motion.	1
CO 2	Explain the motion of a particle in a central force field. Interpret Kepler's laws of planetary motion. Describe the concepts of scattering and differential cross-section.	2
CO 3	Explain the motion of a particle in a central force field. Interpret Kepler's laws of planetary motion. Describe the concepts of scattering and differential cross-section	3
CO 4	Analyze scattering processes in laboratory and center-of-mass frames. Examine constraints, degrees of freedom, and D'Alembert's principle.	4
CO 5	Evaluate the limitations of Newtonian mechanics and compare it with Lagrangian and Hamiltonian formulations. Assess the impact of scattering parameters on physical systems.	5
CO 6	Formulate equations of motion using Lagrangian and Hamiltonian mechanics. Design models and computational simulations of mechanical systems.	6

Course Contents

Unit 1	Mechanics of system of particles	6 Lectures
	• Revision of Newton's laws of motion. • Applications of Newton's laws of motion to solve problems of projectile motion in resistive medium • Rocket motion, Motion of a charged particle in constant electric, Magnetic and electromagnetic field, Systems of particles • Center of mass, conservation of linear and angular momentum, energy of system of particles • Problems	
Unit 2	Motion in Central Force Field	8 Lectures
	• Central force, equivalent one body problem, Motion in central force field • General features of motion • Equation of orbit • Deduction of Kepler's laws of planetary motion and their applications, tidal force field.	
Unit 3	Scattering of particles	8 Lectures
	• Laboratory and centre of mass system. Scattering • Relation between scattering angles in laboratory and centre of mass system. • Differential cross-section, impact Parameter, total cross-section • Rutherford scattering	

	• Problems	
Unit 4	Lagrangian and Hamiltonian formulation:	8 Lectures
	• Limitations of Newtonian formulation • Types of constraints, degrees of freedom, generalized coordinates, configuration space • Principle of Virtual Work ◦ d'Alembert's principle • Lagrangian equation from d'Alembert's principle, Hamilton's equations.	

References:

1. Classical Mechanics, J.C. Upadhyaya, Himalaya publishing Houses, 2nd Edition of 2005.
2. Introduction to Classical Mechanics, R. G. Takawale, P. S. Puranik, Tata McGraw Hill publishing Company Ltd., New Delhi.
3. Classical Mechanics, NC Rana and PS Joag, Tata McGraw Hill Education Private Limited, New Delhi, 1991.
4. Classical Mechanics by P.V.Panat.
5. Classical Mechanics, Herbert Goldstein, Narosa Publishing House.

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Course Code: 24ScPhyU5103 **Course Name: Introduction to Quantum Mechanics**

Teaching Scheme: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA : 20 Marks **End-Sem : 30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus
- Familiarity with basic calculus

Course Objectives:

- To understand Schrodinger equation and its solution for simple systems
- To understand interpretation of the Wave function in quantum mechanics
- To study operators in quantum mechanics and be able to calculate expectation values of observables like position, momentum, energy etc.
- Extend wave mechanics to three dimensions using separation of variables to derive the radial and angular solutions for the Hydrogen atom and its associated quantum numbers

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Study the Schrodinger equation and its simple applications	1
CO 2	Understand the physical interpretation of wave function	2
CO 3	Apply quantum mechanics for simple 1D, 2D and 3D cases	3
CO 4	Analyse the difference between classical mechanics and similar quantum mechanical systems	4
CO 5	Evaluate expectation values for given wavefunction	5
CO 6	Solve simple problems in quantum mechanics	6

Course Contents

Unit 1	The Wave Function	05 Lectures
	• The Schrodinger Equation • Statistical Interpretation of Wave Function • Concept of Wave Packet • Ehrenfest's Theorem • Heisenberg's Uncertainty Principle	
Unit 2	Time-Independent Schrodinger Equation	09 Lectures
	• Introduction to Stationary States • Infinite Potential Well • Harmonic Oscillator • The Free Particle • Finite Potential Well	
Unit 3	Linear Algebraic Formalism	09 Lectures
	• Introduction to Hilbert Space • Observables in Quantum Mechanics • Eigenfunction of Hermitian Operator • Uncertainty Principle • Vector and Operators	
Unit 4	Quantum Mechanics in Three Dimensions	07 Lectures
	• Schrodinger Equation • Infinite Box • The Hydrogen Atom	

References:

1. Introduction to Quantum Mechanics; 3rd Edition David J. Griffiths and Darrell F. Schroeter
2. Principles of Quantum Mechanics; 2nd Edition; R. Shankar
3. Quantum Mechanics: Theory and Applications; Ajoy Ghatak and S. Lokanathan
4. Concept of Modern Physics, Arthur Beiser

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Course Code: 24ScPhyU5104 **Course Name: Atomic and Molecular Physics**

Teaching Scheme: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA : 20 Marks **End-Sem : 30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus

Course Objectives:

1. To understand different atomic models
2. Understand the one valence electron and two electron spectroscopy
3. To study the behaviour of spectral lines in electromagnetic fields
4. Understand the molecular spectroscopy

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Study different atomic models and the atomic structure	1
CO 2	Interpretation of different atomic and molecular spectra.	2
CO 3	Apply quantum mechanical principles to analyze atomic and molecular systems	3
CO 4	Analyzing the complexities of multi-electron atoms by considering concepts like Pauli's Exclusion principle	4
CO 5	Evaluate different energy states in one valence and two valence electron systems.	5
CO 6	Solve quantitative problems related to atomic and molecular systems	6

Course Contents

Unit 1	Atomic structure	07 Lectures
	• Thomson's and Rutherford's atomic models • Electron orbits • Bohr atomic model • Energy levels and spectra • Franck-Hertz Experiment • Vector atom model (Concepts of space and spin quantization)	

	● Atomic excitation and atomic spectra	
Unit 2	One valence and two valence electron Systems	13 Lectures
	● Pauli's Exclusion principle and electron configuration, quantum states ● Spectral notations of quantum states ● Spin-Orbit Interaction (Concept only) ● Energy levels of hydrogen atom, selection rules, Fine structures ● Energy levels of sodium atom, Spectrum of sodium atom, sodium Doublet ● Spectral terms of two electron atoms, terms for equivalent electrons ● LS and JJ coupling schemes ● Singlet-Triplet separation for interaction energy of LS coupling ● Lande's Interval rule ● Helium atom spectrum	
Unit 3	Spectral lines in electromagnetic field	05 Lectures
	● Early discoveries and developments ● Experimental arrangement of Zeeman Effect ● Normal and anomalous Zeeman Effect ● Stark effect (concept only)	
Unit 4	Molecular Spectroscopy	05 Lectures
	● Rotational energy levels ● Vibrational energy levels ● Rotational and Vibrational spectra ● Electronic spectra of molecules	

References:

1. Sear's and Zimansky's University Physics with Modern Physics, Young and Freedman
2. Fundamentals of Physics, Resnick and Halliday
3. Quantum Physics, Eisberg and Resnick
4. Concept of Modern Physics, Arthur Beiser
5. Molecular spectroscopy, C. N. Banwell

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Course Code: 24ScPhyU5105 **Course Name: Lab Course on General Physics V**
Teaching Scheme: 4 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Familiarity with physics courses in 10+2 level, first year B.Sc. and second year B.Sc.
- Familiarity with Basic concepts in Physics

Course Objectives:

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of optical systems for various measurements.
- Apply the analytical techniques and graphical analysis to the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

Course Outcomes:

On completion of the course, student should be able to–

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Find the various procedures and techniques for the experiments related to general physics.	1
CO 2	Generalize the mathematical concepts/equations to obtain quantitative results.	2
CO 3	Integrate the basic communication skills through working in groups in performing the laboratory experiments and by interpreting the result.	3
CO 4	Correlate the technical and evaluative skills using laboratory equipment, tools, and materials.	4
CO 5	Test practical knowledge by applying the experimental methods to correlate with the Physics theory.	5
CO 6	Adapt the knowledge of mechanical, electrical and optical systems for various measurements.	6

Content

	1. Modulus of rigidity of disc using torsional oscillation 2. Moment of inertia by Bifilar Suspension using Hollow cylinder 3. Moment of inertia by Bifilar Suspension using solid cylinder 4. Surface tension of mercury by Quinke's methods 5. Transistor characteristics 6. Op-Amp as an Integrator 7. Double Refracting Prism 8. Calibration of constant deviation spectrometer by using mercury source 9. Determination of Rydberg's constant by using hydrogen discharge tube 10. Thermal conductivity of Rubber tube 11. Virtual Lab based on Major Physics 12. Virtual Lab based on Major Physics 13. Virtual Lab based on Major Physics 14. Activity and Demonstrations 15. Study Tour	

References :

1. An Advanced course in Practical Physics, D. Chattopadhyay and P. C. Rakshit
2. B. Sc. Practical Physics, C.L.Arora
3. B. Sc. Practical Physics, Harnam Singh
4. University Physics with Modern Physics, Sears and Zemansky
5. Fundamental of Physics, Halliday and Resnick
6. Fundamental of Optics, Francis Jenkins, Harvey White
7. https://phet.colorado.edu
8. https://vlab.amrita.edu/

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Course Code: 24ScPhyU5106 **Course Name: Lab Course on General Physics VI**
Teaching Scheme: 4 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Familiarity with physics courses in 10+2 level, first year B.Sc. and second year B.Sc.
- Familiarity with Basic concepts in Physics

Course Objectives:

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of optical systems for various measurements.
- Apply the analytical techniques and graphical analysis to the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

Successful completion of this course students will able to:

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Find the various procedures and techniques for the experiments related to general physics.	1
CO 2	Generalize the mathematical concepts/equations to obtain quantitative results.	2
CO 3	Integrate the basic communication skills through working in groups in performing the laboratory experiments and by interpreting the result.	3
CO 4	Correlate the technical and evaluative skills using laboratory equipment, tools, and materials.	4
CO 5	Test practical knowledge by applying the experimental methods to correlate with the Physics theory.	5
CO 6	Adapt the knowledge of mechanical, electrical and optical systems for various measurements.	6

Course Contents

	1. I-V Characteristics of crystalline Si Solar Cell: Series Connection 2. I-V Characteristics of crystalline Si Solar Cell: Parallel Connection 3. Surface tension of liquid by Ferguson methods 4. Determination of resolving power of grating 5. Study of combinational circuits (encoder and decoder) 6. 'Y' by Koeing's method	

	7. Specific heat of Graphite 8. Study of Multiplexer and De-multiplexer 9. Active Band Pass Filter (High pass and low pass) 10. Computer: Inverse of Matrix 11. Virtual Lab based on Major Physics 12. Virtual Lab based on Major Physics 13. Virtual Lab based on Major Physics 14. Activity and Demonstrations 15. Study Tour	

References:

1. An Advanced course in Practical Physics, D. Chattopadhyay and P. C. Rakshit
2. B. Sc. Practical Physics, C.L.Arora
3. B. Sc. Practical Physics, Harnam Singh
4. University Physics with Modern Physics, Sears and Zemansky
5. Fundamental of Physics, Halliday and Resnick
6. Fundamental of Optics, Francis Jenkins, Harvey White
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Course Code:24ScPhyU5201 **Course Name: Electronics and Instrumentation**

Teaching Scheme: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus
- Completion of Course 24ScPhyU4102

Course Objectives:

- To introduce the fundamentals of Electronics Instruments
- To gain practical knowledge in the field of electronic circuits through experiments.

Course Outcomes:

CO No.	Course Outcomes (COs)	Bloom's Cognitive Level
CO1	Understanding the conversion process, such as how a strain gauge converts mechanical deformation into a change in electrical resistance.	1
CO2	Understand how light interacts with semiconductors (LEDs and Photodiodes) to create isolated signals via Optocouplers.	2
CO3	Learn BJTs and JFETs functioning as the amplifier Circuit	3
CO4	Understand the conceptual difference between changing a Amplitude, Frequency and Phase	4
CO5	Use Op-Amps to perform mathematical operations like integration and differentiation-essential for PID controllers	5
CO6	Apply the IC-555 Timer to create pulses, delays and oscillations (Astable and Monostable modes)	6

Course Contents

Unit 1	Semiconductor Devices	8 Lectures
	• LED and Photodiode, Optocoupler (Working Principles) • BJT: Transistor amplifier • Field Effect Transistor: JFET (Introduction, classification, principle, working and IV characteristics) • Problems	
Unit 2	Applications of Semiconductor Devices	8 Lectures
	• Modulation and Demodulation: Concept of Carrier Wave, Need of Modulation and Demodulation, Methods of Modulation like AM, FM, PM (Concepts Only) • Problems	
Unit 3	Integrated Circuits	7 Lectures
	• Integrated Circuits: Introduction, Scale of Integration • Advantages and drawbacks of IC • OP-AMP Applications as Adder, Substractor, Integrator, Differentiator, Comparator • Timer IC-555: Block diagram, Astable, monostable multivibrator (working and design) • Problems	
Unit 4	Sensors	7 Lectures

	• Introduction to Sensors, types of sensors: Active and Passive • Displacement sensors classification of displacement (linear and rotary): • Resistive type: Potentiometric linear and rotary (angular)), strain gauges- responding to dimensional changes and resistivity change namely electrical and semiconductor type. • Capacitive type: linear and angular type, responding to change in distance, • Inductive type: Responding to change in Mutual inductance (LVDT), Self inductance, Variable reluctance, Eddy current sensors, Magnetostriction gauge • Hall Effect sensors for displacement measurement. • Optical sensors: optical pyrometers (total radiation and selective radiation type) • Temperature measurement sensors: Temperature scales, Liquid filled thermometer, Resistance type: Platinum resistance temperature sensor, and (PT 100) thermistors. Thermocouples- Seebeck effect, Peltier effect & Thompson effect, types of thermocouples: T, E, J, K, R, S, B types. With their ranges, • Pressure sensors: Diaphragm, Bellows and Bourdon Tubes	

References:

- 1. Malvino, Electronic Principles (6th Ed.), Tata McGraw Hill, New Delhi
- 2. R. P. Jain, Modern Digital Electronics (3rd Ed.), Tata McGraw Hill, New Delhi
- 3. B. L. Theraja, Basic Electronics - Solid State, S. Chand and Company, New Delhi
- 4. K. R. Botkar, Integrated Circuits, Khanna Publishers, Delhi and Dorling Kindersley Publishing, Inc.(2006)
- Rangan, Mani, Sharma, Instrument of Device System
- B. C. Nakra, K. K. Chaudhari, Instrument measurement and analysis
- Electronic Instrumentation By H.S. Kalsi, 3rd Edition McGraw Hills Educa

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Course Code: 24ScPhyU5202 **Course Name: Lab Course on Elective Physics I**

Teaching Scheme: 4 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Familiarity with physics courses in 10+2 level, first year B.Sc. and second year B.Sc.
- Familiarity with Basic concepts in Physics

Course Objectives:

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of optical systems for various measurements.
- Apply the analytical techniques and graphical analysis to the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

Course Outcomes:

On completion of the course, student should be able to–

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Find the various procedures and techniques for the experiments related to general physics.	1
CO 2	Generalize the mathematical concepts/equations to obtain quantitative results.	2
CO 3	Integrate the basic communication skills through working in groups in performing the laboratory experiments and by interpreting the result.	3
CO 4	Correlate the technical and evaluative skills using laboratory equipment, tools, and materials.	4
CO 5	Test practical knowledge by applying the experimental methods to correlate with the Physics theory.	5
CO 6	Adapt the knowledge of mechanical, electrical and optical systems for various measurements.	6

Course Contents

	1. Scaling circuits (MOD 2, MOD 5, MOD 10) 2. Study of LVDT 3. Instrumentation amplifier using three Op-Amps. 4. Characteristics of JFET 5. Astable multivibrator using IC 555 6. Schmitt trigger: DC and AC operation 7. Temperature coefficients of Pt resistance thermometer	

	8. Inverting and non-inverting amplifier using op-Amp 9. Study of 4 bit DAC (R-2R ladder) 10. Study of Strain gauge 11. Virtual Lab based on Elective Physics I 12. Virtual Lab based on Elective Physics I 13. Virtual Lab based on Elective Physics I 14. Activity and Demonstrations 15. Study Tour	

References:

1. An Advanced course in Practical Physics, D. Chattopadhyay and P. C. Rakshit
2. B. Sc. Practical Physics, C.L.Arora
3. B. Sc. Practical Physics, Harnam Singh
4. University Physics with Modern Physics, Sears and Zemansky
5. Fundamental of Physics, Halliday and Resnick
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Course Code: 24ScPhyU5203 **Course Name: Physics of Semiconductor Devices**

Teaching Scheme: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus
- Completed first year course 23ScPhyU5101

Course Objectives:

- To understand the Physics of semiconductor devices
- To be able to plot and interpret the current voltage characteristics for basic semiconductor devices
- The student should be able to understand the behaviour, characteristics and applications of
  optoelectronic devices such as solar cell, LED, photodiode

Course Outcomes:

CO No.	Course Outcomes (COs)	Bloom's Cognitive Level
CO1	Define fundamentals of energy band theory in semiconducting materials.	1
CO2	Explain the basic of Intrinsic and Extrinsic Semiconductors	2
CO3	Identify the fundamental operation of a bipolar transistor	3
CO4	Examine the band diagram and depletion layer in PN junctions	4
CO5	Perform experiments for studying the behavior of semiconductor devices for circuit design applications	5
CO6	Elaborate the importance of doping to change carrier density	6

Course Contents

Unit 1	Properties of Semiconductor	8 Lectures
	• Band structure of semiconductors • carrier concentration at thermal equilibrium for intrinsic and doped semiconductors • carrier energy distribution • application of Fermi factor to semiconductors • Density of available states Excess carriers • Carrier transport phenomena. • Mobility Resistivity • Hall effect, • Recombination process • Basic equation for semiconductor device operation	
Unit 2	PN Junction	7 Lectures
	• Basic device technology, • Depletion region and depletion capacitance, • Current Voltage characteristics : Ideal case, Shockley Equation, Generation recombination process, • High injection condition, Diffusion capacitance, Narrow base diode, Junction breakdown.	
Unit 3	Junction Transistor & Field-Effect-Devices	7 Lectures

	• Formation of transistor, • Basic current Voltage relationship, • current gain in transistor Injection efficiency, • Base transport factor, Depletion layer and surface recombination. • Static characteristics common base and common emitter configurations. • Power transistor, General consideration, second breakdown switching transistor, uni-juction transistor. • Schottky diode, semiconductor controlled rectifier, • Junction field effect transistor. • Basic characteristics: static characteristics and Dynamic characteristics, current limiter.	
Unit 4	Metal & Metal Insulator Semiconductor Devices	8 Lectures
	• Schottky effect, • Energy Band relation at metal semiconductor contact, • Ideal condition and surface states depletion Layer, • General expression for barrier height Current Transport Theory in Schottky barrier, • Thermionic Emission Theory, Diffusion theory. • Measurement of Schottky barrier height current voltage measurement, • Forward characteristics. Reverse characteristics, metal semiconductor IMPATT Diode. Ideal MIS diode, surface states, surface charges and space charges, Effects of metal work function.	

References:

1. Physics of Semiconductor Devices - S.M. Sze
2. Physics Solid State Devices - Streetman B.B.
3. Semiconductor Physics - Smith
4. Fundamentals of Semiconductor Devices - J. Lindmayer and C.Y. Wrigley
5. Physics of Semiconductor Devices - Michael shur
6. Introduction to Semiconductor devices - K.J.M. Rao

1. 7. Jacob Millman and Christos Halkias: Electronic Devices and Circuits, Tata McGrawHill Edition

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Course Code: 24ScPhyU5204 **Course Name: Lab Course on Elective Physics II**

Teaching Scheme: 4 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Course Objectives:

- To understand the Physics of semiconductor devices
- To be able to plot and interpret the current voltage characteristics for basic semiconductor devices
- The student should be able to understand the behaviour, characteristics and applications of optoelectronic devices such as solar cell, LED, photodiode

Course Outcomes:

CO No.	Course Outcomes (COs)	Bloom's Cognitive Level
CO1	Define fundamentals of energy band theory in semiconducting materials.	1
CO2	Explain the basic of Intrinsic and Extrinsic Semiconductors	2
CO3	Identify the fundamental operation of a bipolar transistor	3
CO4	Examine the band diagram and depletion layer in PN junctions	4
CO5	Perform experiments for studying the behavior of semiconductor devices for circuit design applications	5
CO6	Elaborate the importance of doping to change carrier density	6

	2. Study of optoelectronic properties of semiconductor devices (Solar cell) 3. Studies on the characterization of JFET (Output & transfer characteristic) 4. Studies on the characterization of MOSFET 5. Determination of band gap of semiconductor from temperature dependence of resistivity using four probe method 6. Opamp as a differential and subtraction application 7. Temperature and frequency dependent dielectric properties of the material. 8. Studies on the diode characteristics such as zener breakdown p-n junction diode etc 9. To measure the resistivity of semiconductor crystal with temperature by four -probe method. 10. To find out the chemical bond present in deposited thin films using FTIR. 11. To Synthesize the Thin Films using Chemical Route Synthesis method. 12. Virtual Lab based on Elective Physics I 13. Virtual Lab based on Elective Physics I 14. Virtual Lab based on Elective Physics I	

	15. Activity and Demonstrations 16. Study Tour	

References:

1. An Advanced course in Practical Physics, D. Chattopadhyay and P. C. Rakshit
2. B. Sc. Practical Physics, C.L.Arora
3. B. Sc. Practical Physics, Harnam Singh
4. University Physics with Modern Physics, Sears and Zemansky
5. Fundamental of Physics, Halliday and Resnick
6. Fundamental of Optics, Francis Jenkins, Harvey White
7. https://phet.colorado.edu
8. https://vlab.amrita.edu/

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Course Code: 24ScPhyU5501 **Course Name: Lab Course on Quantum Computing I**
Teaching Scheme: 4 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Course Prerequisites:

- Basic understanding of concepts of quantum mechanics e.g. wave mechanics, spin etc.
- Familiarity with Python for using the Qiskit Software Development Kit (SDK).

Course Objectives:

- To construct and verify fundamental quantum protocols such as Teleportation, Superdense Coding, and Entanglement generation.
- To introduce the concept of quantum parallelism and interference through foundational algorithms like Deutsch-Jozsa and Bernstein-Vazirani.

Course Outcomes:

	Course Outcomes (COs)	**Bloom's Cognitive level**
CO 1	Define single-qubit states (0, 1, +) and represent them using statevectors and the Bloch Sphere visualization.	1
CO 2	Explain the principles of quantum interference and superposition by observing constructive and destructive interference sequences.	2
CO 3	Apply CNOT gates and single-qubit rotations to construct circuits for Quantum Teleportation and Superdense Coding.	3
CO 4	Analyze the statistical correlations of Bell states to verify the violation of the CHSH inequality ($S > 2$).	4
CO 5	Evaluate the efficiency of the Deutsch-Jozsa algorithm in distinguishing between constant and balanced functions compared to classical methods.	5
CO 6	Construct a True Random Number Generator using quantum superposition and validate its output for statistical randomness.	6

Course Content

Unit 1		15

	1. To represent single-qubit states using state vectors and the Bloch Sphere visualization. 2. To verify the action of Pauli-X, Y, Z, Hadamard, and Ry(θ) gates by visualizing their rotation trajectories on the Bloch sphere. 3. To demonstrate wave-like interference by creating a superposition with a Hadamard gate and observing how a second Hadamard creates constructive/destructive interference (the H-Z-H vs H-X-H sequences). 4. To construct 2-qubit quantum circuits using the CNOT gate and analyze the resulting statevectors and probability histograms for input states. 5. To generate the four maximally entangled Bell states i.e. $\|\phi^+\rangle$, $\|\phi^-\rangle$, $\|\psi^+\rangle$ & $\|\psi^-\rangle$ and verify their correlations via measurement statistics. 6. To simulate the CHSH game (Bell's inequality test) and calculate the expectation value S, verifying that quantum mechanics violates the classical limit ($S > 2$). 7. To implement the teleportation circuit to transfer an unknown quantum state. 8. To transmit two classical bits of information using a single qubit and an entangled pair, demonstrating the capacity advantage of quantum entanglement. 9. To implement Deutsch’s algorithm to determine if a hidden 1-bit function (oracle) is constant or balanced using only a single query, demonstrating quantum parallelism. 10. To extend the previous experiment to an N-bit oracle, distinguishing between constant and balanced functions exponentially faster than classical deterministic algorithms **(Deutsch-Jozsa Algorithm).** 11. To find a hidden binary string s inside a "black box" function in a single shot, illustrating how quantum interference can reveal global properties of a function (**Bernstein-Vazirani Algorithm)** 12. To estimate the phase θ of a unitary operator eigenvalue $e^{2pi*i*\theta}$ using a simple 1-qubit control circuit (the "Kickback" mechanism). 13. To implement the Swap Test circuit to measure the fidelity (overlap). 14. To build and characterize a True Random Number Generator using purely quantum superposition and measurement, checking the output for statistical randomness (e.g., frequency test) 15. Project.	

References:

- Quantum Computation and Quantum Information, Michael A. Nielson and Issac L. Chuang, 10th Anniversary Edition, Cambridge University Press.
- https://quantum.cloud.ibm.com/docs/en/guides
- Scientific Computation in Python (2nd Edition), Abhikit Kar Gupta, Techno World Publication

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Course Code: 24ScPhyU5001 **Course Name: Field Project II**

Teaching Scheme: 2 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus

Course Objectives:

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Course Code: 24ScPhyU5302 **Course Name: Lab Course on Minor Physics III**
Teaching Scheme: TH: 4 Hours/Week **Credit: 02**
Examination Scheme: CIA : 20 Marks **ESE : 30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus

Course Objectives:

- To introduce students to concepts of Thermal Physics.
- To study the laws of thermodynamics and thermodynamics processes.
- To study Thermal Properties of Matter.

On completion of the course, student should be able to–

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Find the various procedures and techniques for the experiments related to general physics.	1
CO 2	Generalize the mathematical concepts/equations to obtain quantitative results.	2
CO 3	Integrate the basic communication skills through working in groups in performing the laboratory experiments and by interpreting the result.	3
CO 4	Correlate the technical and evaluative skills using laboratory equipment, tools, and materials.	4
CO 5	Test practical knowledge by applying the experimental methods to correlate with the Physics theory.	5
CO 6	Adapt the knowledge of mechanical, electrical and optical systems for various measurements.	6

Course Contents

	1. Moment of inertia by Bifilar Suspension using Hollow cylinder 2. Moment of inertia by Bifilar Suspension using solid cylinder 3. Young's modulus by Koenig's Method 4. Surface tension of mercury by Quinke's methods 5. Study of various Flipflops 6. Study of Integrator (using Function Generator) 7. Double Refracting Prism 8. Calibration of constant deviation spectrometer by using mercury source 9. Determination of Rydberg's constant by using hydrogen discharge tube	

	10. Thermal conductivity of Rubber tube 11. Virtual Lab based on Major Physics 12. Virtual Lab based on Major Physics 13. Virtual Lab based on Major Physics 14. Activity and Demonstrations 15. Study Tour	

References:

1. An Advanced course in Practical Physics, D. Chattopadhyay and P. C. Rakshit
2. Practical Physics, R.K.Shukla and Anchal Shrivastava
3. B. Sc. Practical Physics, Harnam Singh
4. University Physics with Modern Physics, Sears and Zemansky
5. Fundamental of Physics, Halliday and Resnick
6. Fundamental of Optics, Francis Jenkins, Harvey White
7. B. Sc. Practical Physics, C.L.Arora
8. https://phet.colorado.edu
9. https://vlab.amrita.edu/

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Course Code: 24ScPhyU6101 **Course Name: Introduction to Electrodynamics**

Teaching Scheme: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:
- Familiarity with 10+2 level physics syllabus
- Completed first year course 24ScPhyU2101

Course Objectives:
- To understand the fundamental concepts of electrostatics, magnetostatics, and electrodynamics
- To solve boundary value problems using Poisson's and Laplace's equations
- To analyze the behavior of dielectric and magnetic materials in the presence of electric and magnetic fields
- To study Maxwell's equations and their applications to electromagnetic wave propagation
- To develop problem-solving skills in classical electrodynamics and its applications

Course Outcomes:

CO No.	Course Outcomes (COs)	Bloom's Cognitive Level
CO1	Define the fundamental laws of electrostatics, magnetostatics, and electrodynamics, including Coulomb's law, Gauss's law, and Faraday's law.	1
CO2	Explain the physical significance of Maxwell's equations and their role in describing electromagnetic phenomena.	2
CO3	Apply boundary conditions, Poisson's and Laplace's equations and the method of image charges to solve electrostatic problems.	3
CO4	Analyze the behavior of electromagnetic waves in different media, including reflection, refraction, and polarization effects.	4
CO5	Evaluate the concepts of electromagnetic energy, Poynting theorem, and wave propagation in free space and dielectric materials.	5

CO6	Develop mathematical models and computational approaches to solve real-world electrodynamics problems.	6

Course Contents

Unit 1	Electrostatics	10 Lectures
	• Revision - Coulomb's law, Gauss law, Electric field,Electrostatic Potential,Potential energy of the system of charges • Statement of Poisson's equation, Boundary Value problems electrostatics-solution of Laplace equation in Cartesian system • Method of image charges: Point charge near an infinite grounded conducting plane, Point charge near grounded conducting sphere • Electric Polarization and Displacement vector, Electric susceptibility and dielectric constant, bound volume and surface charge densities • Problems	
Unit 2	Magnetostatics	10 Lectures
	• Revision - Magnetic induction, magnetic flux and magnetic field, Application of Biot Savart's law and Ampere's circuital law, • Energy density in magnetic field, magnetization of matter, Relationship between **B**, **H** and **M** • Equation of continuity, Magnetic vector potential • Magnetic susceptibility and permeability, Hysteresis loss, B-H curve • Problems	
Unit 3	Electrodynamics	10 Lectures
	• Concept of electromagnetic induction, Faraday's law of induction, Lenz's law, displacement current, generalization of Amperes' law • Maxwell's equations (Differential and Integral form) and their physical significance • Poynting theorem & Poynting vector, Polarizations of plane waves. • Microscopic form of ohm's law ($\mathbf{J} = \sigma . \mathbf{E}$) • Introduction to Special theory of Relativity • Problems	

References:

1.Introduction to Electrodynamics; D. J. Griffith; Cambridge India; Fourth edition (2020)
2. Classical Electrodynamics; J. D. Jackson; Wiley; Third edition (2007)
3. Introduction to Electrodynamics; A. Z. Capri, Panat P. V.; Alpha science international ltd; Illustrated edition(2002)
4.Foundations of electromagnetic theory; Reitz, Milford and Christy; Pearson education

India; Fourth edition (2010)
5.Electrodynamics; Gupta, Kumar, Singh; Pragati Prakashan; Nineteenth edition (2011)
6.Electromagnetic field and waves; Paul-Lorrain, D. R. Corson; W.H. Freeman & co. Ltd; Second edition (1970)
7. Electricity and magnetism; Murugeshan; S. Chand; (2020)
8.Electromagnetic theory and electrodynamics; Satya Prakash; Kedar Nath Ram Nath; (2020)

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Third Year of B.Sc.

(2024 Course under NEP 2020)

Course Code: 24ScPhyU6102 **Course Name: Introduction to Solid State Physics**

Teaching Scheme: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem:30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus
- Completed courses 24ScPhyU5103 and 24ScPhyU5104

Course Objectives:

- To introduce students to the fundamental principles of crystalline structures and X-ray diffraction.
- To understand free electron theory and band theory of metals for explaining electrical conductivity.
- To study different types of magnetism and their theoretical foundations.
- To develop problem-solving skills in solid-state physics using theoretical models.

Course Outcomes:

CO No.	Course Outcomes (COs)	Bloom's Cognitive Level
CO1	Recall fundamental concepts of crystal structures, including lattices, unit cells, symmetry, and Miller indices.	1
CO2	Explain Bragg's law, reciprocal lattice properties, and X-ray diffraction principles..	2
CO3	Apply free electron theory and band theory to classify solids into conductors, semiconductors, and insulators.	3
CO4	Analyze the Hall Effect, density of states, and Fermi energy to interpret electronic properties of materials.	4
CO5	Evaluate different magnetic phenomena, including diamagnetism, paramagnetism, and ferromagnetism, using Langevin and domain theories.	5
CO6	Formulate models for superconductivity, magnetic properties, and their applications in modern technology.	6

Course Contents

Unit 1	The Crystalline Structures	8 Lectures
	• Lattice, Basis, Translational Vectors, Primitive Unit Cell, Symmetry Operations • Different types of lattices: 2D and 3D (Bravais lattices) • Miller indices, Interplanar Distances, SC, BCC and FCC structures • Packing Fraction • Crystal structures NaCl, diamond, CsCl, ZnS, HCP • Concept of Reciprocal Lattice and its properties • Problems	
Unit 2	X ray Diffraction	6 Lectures
	• Bragg's Diffraction, Bragg's Law • X-ray diffractometer • Experimental X-ray diffraction Methods: The Laue Method,The Powder Crystal Method, Analysis of cubic structure by Powder Method, • Ewald's Construction • Bragg's Diffraction condition in direct and reciprocal lattice, • Problems	
Unit 3	Free Electron and Band Theory of Metals	8 Lectures
	• Assumptions of Classical and Sommerfeld Free Electron model • Energy levels and Density of States (One and Three Dimensions) • Nearly free electron model • Fermi energy,Fermi level • Hall Effect, Mobility, Hall Angle • Band Theory of Solids: Origin of energy gap • Energy bands in Solids, Distinction between metal, semiconductor and insulator • Problems	
Unit 4	Magnetism	8 Lectures

	• Revision of B, H, M, magnetic susceptibility and permeability • Diamagnetism • Langevin theory of Diamagnetism • Superconductivity concept, Occurrence of Superconductivity • Critical magnetic field and Meissner effect • Paramagnetism • Langevin theory of Paramagnetism • Ferromagnetism • Ferromagnetic domain • Hysteresis • Curie temperature • Ferrites and its applications • Antiferromagnetism, Neel temperature • Problem	

References:

- Solid State Physics S.O.Pillai, 6th Edition, New Age International (P) Ltd, Publisher, (2010).
- Fundamentals of Solid State Physics – B.S.Saxena, R.C.Gupta and P.N.Saxena, Pragati Prakashan, Meerut , Uttar Pradesh
- Introduction to Solid State Physics- Charles Kittel, John Wiley and Sons, 7th Edition.
- Solid State Physics- A.J.Dekker, Macmillan India Ltd, (1998).
- Solid State Physics- R.K. Puri, V.K. Babbar, S. Chand Publication.
- Elementary Solid State Physics Principles and Applications, M Ali Omar, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.(2006)
- Problems and Solution in Solid State Physics-S.O. Pillai, New Age International (P) Ltd.

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Third Year of B. Sc.
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Course Code: 24ScPhyU6103 **Course Name: Nuclear Physics**

Teaching Scheme: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem:30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus

Course Objectives:

- To impart knowledge about basic nuclear physics properties and nuclear models for understanding of related reaction dynamics.
- To gain a comprehensive understanding of the structure, properties, and behaviour of atomic nuclei, including their constituent particles, the forces that bind them together, and the various nuclear reactions that can occur, including radioactive decay, fission, and fusion.
- To develop problem-solving skills in nuclear physics using theoretical models.

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Course Outcomes:

CO No.	Course Outcomes (COs)	Bloom's Cognitive Level
CO1	Define and describe basic properties of the nucleus.	1
CO2	Explain the concept of radioactivity. Classify different radiation detectors and nuclear models.	2
CO3	Solve problems related to nuclear and particle physics.	3
CO4	Analyze nuclear reaction dynamics, nuclear reactors and accelerators.	4
CO5	Interpret the nuclear changes or processes including fission, fusion and decay reactions.	5
CO6	Compile knowledge of elementary particles to understand nuclear phenomena.	6

Course Contents

Unit 1	Basic Properties of Nucleus	6 Lectures
	• Composition, charge, size, density of nucleus, Nuclear Angular momentum, Nuclear magnetic dipole moment, Electric quadrupole moment, parity and symmetry, • classification of nuclei, • Mass defect and Binding energy, packing fraction, • Stability of nuclei (N vs Z curve). • Problems	
Unit 2	Radioactivity	6 Lectures
	• Radioactivity disintegration (concept of natural and artificial radioactivity, Properties of α, β, γ-rays • Laws of radioactive decay, half-life, mean life, Specific activity and its units • Successive disintegration and equilibriums and radioisotopes • Radiocarbon dating • Application of radioactivity (Agricultural, Medical, Industrial, Archaeological) • Problems	
Unit 3	Particle Accelerator and Radiation Detectors	6 Lectures

	• Introduction and Classification • Linear Accelerator (electron/proton LINAC) • Cyclic Accelerator (Cyclotron) • Particle Accelerators In India (Discussion only) • Classification of Nuclear Detectors • Gas filled Detectors (G. M. counter) • Solid state detectors (scintillation counter) • Problems	
Unit 4	Nuclear forces and Nuclear Models	6 Lectures
	• Meson theory of nuclear forces, • Properties Of nuclear forces, properties of deuteron system, • Elementary particles, • Quarks model for elementary particles • Shell Model: Assumptions, Evidences, • Problems	
Unit **5**	**Nuclear Reactions**	**6 Lectures**

	• Nuclear Reaction and Conservation laws • The Q-value equation, Exothermic and Endothermic reaction • Compound nucleus • Threshold energy • Nuclear cross-section • Nuclear fission, nuclear fusion stellar energy, chain reaction and critical mass, • Nuclear reactor and its basic components, homogeneous and heterogeneous reactors, power reactor, fast breeders • Nuclear Reactors In India (Discussion only) • Problems.	

References:

- Dr. S. N. Ghoshal, Nuclear Physics, Revised Edition, S. Chand Publication, 2014
- D. C. Tayal, Nuclear Physics, Revised Enlarged Edition, Himalaya Publishing House
- K.S. Krane, Introductory Nuclear Physics, Wiley, India, 1988
- B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill
- I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989
- S. B. Patel, Nuclear Physics: An Introduction, New Age International, 1991

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Third Year of B.Sc.
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Course Code:24ScPhyU6104 **Course Name: Statistical Mechanics**

Teaching Scheme: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus
- Completed course 24ScPhyU4101

Course Objectives:

- To study thermodynamic functions and Maxwell relations and apply them to analyze thermodynamic processes including Joule-Thomson effect and TdS equations.
- To introduce the basic principles of probability and statistical methods including random walk, binomial and Gaussian distributions.
- To develop an understanding of statistical mechanics concepts such as ensembles, density of states, and thermal and mechanical interactions.
- To apply microcanonical and canonical ensemble theory to calculate thermodynamic quantities and mean values.

Course Outcomes:

CO No.	Course Outcomes (COs)	Bloom's Cognitive Level
CO1	Explain the postulates of kinetic theory of gases and evaluate transport phenomena such as viscosity, thermal conductivity, diffusion, and mean free path.	1
CO2	Apply thermodynamic functions and Maxwell relations to solve problems involving TdS equations, Joule-Thomson effect, specific heat, and latent heat equations.	2
CO3	Understand fundamental concepts of probability and statistical methods including random walk, binomial and Gaussian distributions, and calculation of mean values.	3
CO4	Describe statistical ensembles and apply basic postulates to analyze density of states, thermal and mechanical interactions of systems.	4
CO5	Apply microcanonical and canonical ensemble concepts to calculate thermodynamic quantities and mean values	5

CO6	Differentiate between Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics and apply quantum distribution functions to physical systems.	6

Course Contents

Unit 1	Kinetic Theory of Gases	5 Lectures
	• Revision- Assumptions of kinetic theory of gases • Mean free path • Transport phenomena- Viscosity, Thermal conductivity, Diffusion • Problems	
Unit 2	Maxwell Relations and Applications	5 Lectures
	• Thermodynamical functions: Internal energy, Enthalpy, Helmholtz function, Gibbs function • Maxwell Thermodynamical relations • First and Second TdS equations • Specific heat • Latent heat equations • Joule-Thomson effect (Throttling process)	
Unit 3	Elementary Concepts of Statistics	5 Lectures
	• Probability • Distribution functions • Random walk and binomial distribution • Simple random walk problem • Calculation of mean values • Probability distribution for large scale N • Gaussian probability distribution. • Problems	
Unit 4	Statistical Distribution of System of Particles	5 Lectures
	• Specification of state of system • Statistical ensembles • Basic postulates • Probability calculations • Behavior of density of states • Thermal Interactions • Mechanical Interactions	
Unit 5	Statistical Ensembles	5 Lectures
	• Micro-canonical ensemble (Isolated system) • Canonical ensembles • Simple application of canonical ensembles • Calculation of mean values in canonical ensemble	
Unit 6	Quantum Statistics	5 Lectures
	• Quantum Distribution Function • Maxwell-Boltzmann's statistics • Bose-Einstein Statistics	

	• Fermi-Dirac Statistics • Comparison of the distributions	

References:

1. Statistical and Thermal Physics – Lokanathan & R. S. Gambhir; Prentice Hall of India.
2. Fundamentals of Statistical and Thermal Physics – F. Reif; McGraw-Hill.
3. Perspectives of Modern Physics – A. Beiser; McGraw-Hill.
4. Fundamentals of Statistical Mechanics – B. B. Laud; New Age International.
5. A Primer of Statistical Mechanics – R. B. Singh; New Age International.
6. Statistical Mechanics – Gupta & Kumar; Pragati Prakashan.

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Third Year of B.Sc.
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Course Code: 24ScPhyU6105 Course Name: Lab Course on General Physics VII

Teaching Scheme: 4 Hours/Week **Credit: 02**

Examination Scheme: CIA : 20 Marks **End-Sem : 30 Marks**

Prerequisite Courses:

- Familiarity with physics courses in 10+2 level, first year B.Sc. and second year B.Sc.
- Familiarity with Basic concepts in Physics

Course Objectives:

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of optical systems for various measurements.
- Apply the analytical techniques and graphical analysis to the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

Course Outcomes:

On completion of the course, student should be able to–

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Find the various procedures and techniques for the experiments related to general physics.	1
CO 2	Generalize the mathematical concepts/equations to obtain quantitative results.	2
CO 3	Integrate the basic communication skills through working in groups in performing the laboratory experiments and by interpreting the result.	3
CO 4	Correlate the technical and evaluative skills using laboratory equipment, tools, and materials.	4
CO 5	Test practical knowledge by applying the experimental methods to correlate with the Physics theory.	5
CO 6	Adapt the knowledge of mechanical, electrical and optical systems for various measurements.	6

Course Contents

	1. Characteristics of GM Counter 2. Viscosity by rotating cylinder method	

	3. Determination of Hall carrier concentration by varying magnetic field. 4. Determination of carrier concentration by varying Probe current 5. Resistivity of a semiconductor using Four probe method 6. Study of Flip-flops 7. Directional characteristics of Dipole antenna 8. Magnetic susceptibility of $FeCl_3$ 9. e/m ratio by Thomson’s method 10. Energy gap of semiconductor (Ge diode) 11. Virtual Lab based on Major Physics 12. Virtual Lab based on Major Physics 13. Virtual Lab based on Major Physics 14. Activity and Demonstrations 15. Study Tour	

References:

1. Practical Physics, R.K.Shukla and Anchal Shrivastava
2. An Advanced course in Practical Physics, D. Chattopadhyay and P. C. Rakshit
3. B. Sc. Practical Physics, Harnam Singh
4. University Physics with Modern Physics, Sears and Zemansky
5. Fundamental of Physics, Halliday and Resnick
6. Fundamental of Optics, Francis Jenkins, Harvey White
7. B. Sc. Practical Physics, C.L.Arora
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(2024 Course under NEP 2020)

Course Code: 24ScPhyU6106 **Course Name: Lab Course on General Physics VIII**

Teaching Scheme: 4 Hours/Week **Credit: 02**

Examination Scheme: CIA : 20 Marks **End-Sem : 30 Marks**

Prerequisite Courses:

- Familiarity with physics courses in 10+2 level, first year B.Sc. and second year B.Sc.
- Familiarity with Basic concepts in Physics

Course Objectives:

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of optical systems for various measurements.
- Apply the analytical techniques and graphical analysis to the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

Course Outcomes:

On completion of the course, student should be able to–

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Find the various procedures and techniques for the experiments related to general physics.	1
CO 2	Generalize the mathematical concepts/equations to obtain quantitative results.	2
CO 3	Integrate the basic communication skills through working in groups in performing the laboratory experiments and by interpreting the result.	3
CO 4	Correlate the technical and evaluative skills using laboratory equipment, tools, and materials.	4
CO 5	Test practical knowledge by applying the experimental methods to correlate with the Physics theory.	5
CO 6	Adapt the knowledge of mechanical, electrical and optical systems for various measurements.	6

Course Contents

	1. G.M. Counter: Counting Statistics 2. Study of B-H Curve	

	3. Newton's ring: Determination of Radius of curvature 4. Diffraction from cylindrical obstacle 5. Anderson's Bridge 6. Maxwell's Bridge 7. Estimation of Band gap using four probe method 8. Directional characteristics of Yagi Antennas 9. Directional characteristics of Parabolic Antennas 10. Flash type ADC 11. Virtual Lab based on Major 12. Virtual Lab based on Major 13. Virtual Lab based on Major 14. Study tour, Activity 15. Demosntrations, Assignments	

References:

1. Practical Physics, R.K.Shukla and Anchal Shrivastava
2. An Advanced course in Practical Physics, D. Chattopadhyay and P. C. Rakshit
3. B. Sc. Practical Physics, Harnam Singh
4. University Physics with Modern Physics, Sears and Zemansky
5. Fundamental of Physics, Halliday and Resnick
6. Fundamental of Optics, Francis Jenkins, Harvey White
7. B. Sc. Practical Physics, C.L.Arora
8. https://phet.colorado.edu
9. https://vlab.amrita.edu/

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T.Y.B.Sc. Physics

(2024 Course under NEP 2020)

Course Code: 24ScPhyU6201 **Course Name: Physics of Nanomaterials**

Teaching Scheme: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **ESE: 30 Marks**

Prerequisite Courses:

- Familiarity with physics courses in 10+2 level, first year B.Sc. and second year B.Sc.
- Completed 24ScPhyU5103 and 24ScPhyU5104

Course Objectives:

- To study the basics of nanomaterials.
- To study methods for synthesis of nanomaterials.
- To study different applications of nanomaterials.

Course Outcomes:

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

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Define the different types of nanomaterials.	1
CO 2	Compare 0D, 1D, 2D and 3D nanomaterials.	2
CO 3	Determine the methods required to synthesize different types of nanomaterials.	3
CO 4	Explain the principles of various characterization techniques.	4
CO 5	Predict the properties of different sized nanomaterials.	5
CO 6	Write the applications of nanomaterials.	6

Course Contents

Unit 1	**Introduction to nanomaterials**	**08 Lectures**
	• Introduction to Nano-sized materials and Structures • Significance of Nano-size • Properties of Nanomaterials: Mechanical, Electrical, Thermal and Optical properties • Classification of nanostructured materials	
Unit 2	**Methods for Synthesis of Nanomaterials**	**08 Lectures**
	• Bottom-up and Top-down approaches • Classification of Synthesis Techniques: Vapour phase and Liquid phase approach. • Synthesis Methods: Thermal Evaporation, Sputter deposition, Colloidal method, Sol-gel Method, Chemical Vapour deposition and Electrochemical Deposition.	
Unit 3	**Characterization Techniques**	**08 Lectures**
	• Scanning electron microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) • Transmission electron microscopy (TEM) • UV- visible spectroscopy • Raman Spectroscopy • Fourier Transform Infrared Spectroscopy (FTIR)	
Unit 4	**Special nanomaterials**	**03 Lectures**
	• Carbon nanotubes, their types and properties • Quantum dots and their properties • Zinc Oxide	
Unit 5	**Applications of nanomaterials**	**03 Lectures**

	• Nanomaterials for application in Nano-electronics, Cosmetics, Medical, Biosensors Automobiles, Space, Sports, Cloth industry etc. • Nanomaterials for environmental pollution monitoring and reduction etc. • Nanomaterials for energy generation and storage		

References:

1. Nanotechnology: Principles and Practices by Sulbha Kulkarni, Capital Publishing Co. New Delhi.

2. Introduction to nanotechnology, by C. P. Poole Jr. and F. J. Ownes, Willey Publications.

3. Origin and development of nanotechnology by P. K. Sharma, Vista International publishing house.

4. Nanostructure and nanomaterials synthesis, Properties and applications, by G. Cao, Imperials College Press, London.

5. The chemistry of nanomaterials: Synthesis, properties and applications, C. N. R. Rao, A. Muller, A. K. Cheetham (Eds) Wiley VCH Verlag Gmbh& Co, Weinheim, 2004.

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(2024 Course under NEP 2020)

Course Code: 24ScPhyU6202 **Course Name: Lab Course on Elective Physics III**

Teaching Scheme: 4 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus and basic concepts of solid-state physics
- Preliminary Knowledge on Nano

Course objective

- To develop a foundational understanding of material properties and the defects in solids, alongside the mechanisms and principles of atomic diffusion.
- To enable students to analyze and interpret phase diagrams, applying fundamental principles such as the Gibbs phase rule and lever rule to real-world systems.
- To introduce the concepts, significance, and challenges of nanomaterials, emphasizing their properties and classifications.
- To acquaint students with diverse methods for synthesizing nanomaterials, including physical, chemical, hybrid, and biological approaches.
- To provide basic knowledge of advanced techniques for characterizing material properties, such as spectroscopy and various electron microscopy methods.

Successful completion of this course students will able to:

CO NO.	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Identify and recall the classification of materials, their properties (mechanical, electrical, and thermal), and common defects in solids (point, line, surface, and volume).	**1**
CO 2	Explain the significance of Gibb's phase rule, the phase diagrams of solutions like sugar-water and NaCl-water, and concepts such as solid solubility and imperfections in crystals.	**2**
CO 3	Demonstrate the application of Fick's laws of diffusion in practical scenarios and utilize lever rule for calculating the phase fractions in multi-phase systems.	**3**
CO 4	Distinguish between the methods of nanomaterial synthesis (e.g., physical, chemical, hybrid, and biological methods) and evaluate their advantages and limitations.	**4**
CO 5	Assess the challenges and significance of nanotechnology by critically analyzing properties of nanostructured materials and their applications.	**5**
CO 6	Develop a comprehensive approach for characterizing nanomaterials using techniques like UV-visible spectroscopy, X-ray diffraction, and electron microscopy, integrating insights.	**6**

Course Contents

	1. Determination of crystal structure using XRD data 2. Determination of crystallite size of nanoparticles using XRD data 3. Determination of a band gap using UV-Visible spectra 4. Synthesis of nanomaterials using Chemical bath deposition 5. Synthesis of nanomaterials using Chemical route method 6. Analysis of SEM images using imageJ software 7. Deposition of ZnO thin film using Spin coater. 8. Study of FTIR 9. Study of Raman spectroscopy 10. Study of cyclic voltammetry. 11. Synthesis of nanoparticles using hydrothermal method 12. Virtual lab based on Elective III 13. Virtual lab based on Elective III 14. Virtual lab based on Elective III 15. Study tour, Demonstrations, Activity, Assignments	

References :

1. An Advanced course in Practical Physics, D. Chattopadhyay and P. C. Rakshit
2. B. Sc. Practical Physics, C.L.Arora
3. B. Sc. Practical Physics, Harnam Singh
4. University Physics with Modern Physics, Sears and Zemansky
5. Fundamental of Physics, Halliday and Resnick
6. Fundamental of Optics, Francis Jenkins, Harvey White

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Third Year of B.Sc.

(2024 Course under NEP 2020)

Course Code: 24ScPhyU6203 **Course Name: Medical and Biophysics**

Teaching Scheme: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses

- Familiarity with 10+2 level Physics (Mechanics, Electricity, Optics, Thermodynamics).
- Basic knowledge of Biology (Cell structure, Photosynthesis, Human Physiology, Genetics).

Course Objectives:

- To introduce the fundamental concepts and historical development of Biophysics and its interdisciplinary nature.
- To explain the structural and functional organization of cells, biomolecules (proteins, amino acids), and genetic material using physical principles.
- To study bioenergetics, redox systems, Gibbs free energy, and electron transport mechanisms involved in biological processes like photosynthesis.
- To understand the origin and measurement of bioelectric signals including resting potential, action potential, and compound action potentials (ECG, EEG, ERG, EOG).
- To develop knowledge about biomedical instruments such as spectrophotometer, colorimeter, ECG machine, pH meter, centrifuge, SEM, and TEM.

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Recall and identify physical properties related to biological systems. .	1
CO 2	Discuss types of transducers used for processing bioelectric signals	2
CO 3	Solve qualitative and quantitative problems	3
CO 4	Explain the working of bioinstruments and other techniques used for analysing biological signals	4
CO 5	Evaluate bioelectric signals.	5
CO 6	Integrate physics concepts with biological systems for better understanding .	6

Course Contents

Unit 1	**Introduction of Biophysics**	10 Lectures
	• Definition and History of Biophysics [Physical properties applied to biology- Surface tension, Viscosity, adsorption, diffusion, osmosis, dialysis and colloids] Cell: Animal and plant cell, types of cell and composition, • Functional aspects of cell membrane, cytoplasm, nucleus, mitochondria, chloroplast (Bioenergetics of mitochondria and chloroplast), Protein structure (Primary, Secondary, Tertiary and Quaternary structure): Amino-acids structure (Specify types), Bond length, Bond angles, peptides, and Bond-Rigid planer peptides. Cis and trans configuration, torsion angle, Ramchandran plot. • Photosynthesis Process: - electron transport, Gibbs's free energy, Redox couple. [Redox potential, Oxidation and reduction, Examples of redox potential in biological system. • Genetic code- symmetry, DNA structure	
Unit 2	**Bio potentials**	10 Lectures

	• Bioelectric signals: structure of neuron, resting potential, action Potential, Nernst equation, Bio-potential amplifier: input impedance, frequency characteristics, gain, CMRR, Calibration, Noise, Temperature sensitive stability. • Compound action potentials of the human body ECG, EEG, ERG, EOG (in brief), • Transducers: Definition, types- resistive, capacitive and inductive transducers, LVDT, photo diode, • Bio electrodes- Half cell potential, polarizable and non-polarizable electrodes, metal and glass electrodes, types and electric characteristics	
Unit 3	**Medical instruments**	5 Lectures
	• Basic principle, Construction and working of colorimeters, spectrophotometer, ECG machine, PH meter, Centrifuge measurement. (10L), Electro microscope: SEM, TEM.	
Unit 4	**Emerging Fields in Biomedical**	5 Lectures
	• Biostatistics and Biometry ,Definition and concept in brief • Mathematical modeling and computational biology (Concept only)	

References:

1. Introduction to Biophysics - by P. Narayanan.New Age P.
2. Medical Instrumentation - by Khandpur, TMH
3. Laboratory Manuals of Biophysics Instruments - by P.B. Vidyasagar
4. Biophysics -by VatsalaPiramal, Dominant Publisher and Distributors, New Delhi-110002
5. Textbook of Biophysics - by R.N. Roy
6. Photosynthesis - by Hall and Rao.

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(2024 Course under NEP 2020)

Course Code: 24ScPhyU6204 **Course Name: Lab Course on Elective Physics IV**

Teaching Scheme: 4 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level Physics syllabus
- Basic knowledge of Biology (Human Physiology & Cell Biology)
- Familiarity with laboratory instruments and safety procedures

Course Objectives:

- To provide practical exposure to the application of physics principles in biological and medical systems.
- To develop skills in handling biomedical instruments such as ECG, spectrophotometer, pH meter, and centrifuge.
- To understand optical and electrical methods used in biological measurements and diagnostic techniques.
- To analyze experimental data using graphical and statistical methods relevant to biophysical studies.
- To enhance teamwork, scientific communication, and laboratory ethics in medical and biophysical experiments.

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Course Outcomes:
On completion of the course, student should be able to–

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Demonstrate the procedures and safety measures involved in medical and biophysics laboratory experiments.	1
CO 2	Apply physical laws (electrical, optical, and mechanical principles) to biological and medical measurements.	2
CO 3	Analyze and interpret experimental data such as ECG signals, absorption spectra, and pH measurements.	3
CO 4	Operate biomedical instruments like ECG apparatus, spectrophotometer, centrifuge, and pH meter effectively.	4

CO 5	Evaluate experimental results and correlate them with theoretical concepts of medical physics and biophysics.	5
CO 6	Design and adapt experimental techniques for solving basic problems in biological and medical systems.	6

Course Contents

	1. Recording and analysis of ECG signals 2. Verification of Beer's and Lambert's Law 3. Absorption spectrum of Blood/Chlorophyll. 4. pH value of Amino acids. 5. Bimolecular model building using standard kits. 6. Separation of components of Milk/Chlorophyll using centrifuge machine. 7. Study of Surface Tension of biological fluids using stalagmometer method. 8. Measurement of Viscosity of biological fluid using Ostwald viscometer. 9. Construction and study of simple resistive and capacitive transducers. 10. Study of Photo diode characteristics and its application in biomedical sensing. 11. Determination of Gibbs Free Energy change in biochemical reaction (model experiment). 12. Basic statistical analysis (Mean, Standard deviation, Error analysis) of biological data. 13.Virtual lab based on Elective III 14. Virtual lab based on Elective III 15. Virtual lab based on Elective III	

References:

- Medical Physics and Biomedical Engineering – E. Russell Bushberg et al., Academic Press.
- Biophysics – Rodney Cotterill, John Wiley & Sons.
- Principles of Biochemistry – David L. Nelson & Michael M. Cox, W.H. Freeman.
- Fundamentals of Biophysics – Narosa Publishing House.
- Biomedical Instrumentation and Measurements – Leslie Cromwell, Fred J. Weibell & Erich A. Pfeiffer, Prentice Hall.
- Optics – Ajoy Ghatak, McGraw Hill (For Beer–Lambert Law & absorption spectroscopy).
- Vogel's Textbook of Quantitative Chemical Analysis – Pearson (For pH measurement & analytical techniques).
- https://phet.colorado.edu
- https://vlab.amrita.edu/

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(2024 Course under NEP 2020)

Course Code: 24ScPhyU6501 **Course Name: Lab Course on Quantum Computing II**

Teaching Scheme: 4 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Course Prerequisites:

- Familiarity with contents of 24ScPhyU5103 and 24ScPhyU5501

Course Objectives:

- To simulate real physical systems, including Hamiltonian time evolution Ising Model) and molecular ground states (Hydrogen molecule)
- To characterize real-world quantum hardware constraints by measuring noise parameters like T_1 relaxation and T_2 dephasing
- To implement and analyze complex algorithms like the Quantum Fourier Transform (QFT) and Grover's Search
- To introduce Quantum Error Correction for a single qubit

Course Outcomes:

	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Recall the transformation process from the computational basis to the Fourier basis using the Quantum Fourier Transform (QFT) circuit	1
CO 2	Interpret the amplitude amplification process in Grover's Search algorithm and its scaling advantage ($\sim \sqrt{N}$) over classical search	2
CO 3	Apply the Variational Quantum Eigensolver (VQE) ansatz to calculate the ground state energy of the H_2 molecule at various bond lengths	3
CO 4	Analyze quantum hardware performance by distinguishing between energy relaxation (T_1) and coherence dephasing (T_2) errors	4
CO 5	Determine the effectiveness of Quantum Error Correction codes (Bit Flip and Phase Flip) in mitigating specific error types	5
CO 6	Design and optimize a quantum circuit for execution on an actual IBM Quantum processor, comparing real hardware results with ideal simulations.	6

Course Content

		15
	1. To measure the T_1 (energy relaxation) time of a real (or noisy simulated) qubit by varying delay times before measurement and fitting the decay curve. 2. To measure the T_2 (coherence) time using a Ramsey interference fringe experiment or Hahn Echo experiment, distinguishing between relaxation and dephasing. 3. To use Qiskit's AerSimulator to introduce custom noise models (depolarizing noise, thermal relaxation) and observe how they degrade the fidelity of a Bell state. 4. To implement a simple VQE ansatz (parameterized circuit) to find the minimum eigenvalue of a 2x2 matrix (representing a toy Hamiltonian). 5. To calculate the ground state energy of the Hydrogen molecule (H_2) at different bond lengths using VQE and map the interatomic potential energy curve. 6. To simulate the time evolution of a 3-spin 1D Ising chain under a transverse magnetic field using Trotterization (approximating e^{-iHt}). 7. To implement a 1D discrete quantum random walk on a line and compare the probability distribution (ballistic spreading) with a classical random walk (diffusive spreading). 8. To implement the 3-qubit Bit Flip repetition code, introducing a bit-flip error, and correcting it using syndrome measurements and classical feedback. 9. To implement the 3-qubit Phase Flip code, correcting for Z-errors (phase flips) by converting them to bit flips using Hadamard gates. 10. To implement Grover's search to find a "marked" state in an unstructured database of size N=4, observing the amplitude amplification process. 11. To scale Grover's algorithm to N=8 and plot the probability of the marked state vs. number of iterations to verify the ($\sim\sqrt{N}$ scaling). 12. To build the QFT circuit for 3 qubits and observe the transformation from the computational basis to the Fourier basis, drawing analogies to the classical FFT. 13. To use the QFT circuit to find the period of a modular exponentiation function (the core subroutine of Shor's algorithm). 14. To optimize a simple circuit (e.g., GHZ state or small Grover) using Qiskit Transpiler and run it on an actual IBM Quantum computer (free tier), comparing the real results with the ideal simulator. 15. Project.	

References:

- Quantum Computation and Quantum Information, Michael A. Nielson and Issac L. Chuang, 10th Anniversary Edition, Cambridge University Press.
- https://quantum.cloud.ibm.com/docs/en/guides
- Scientific Computation in Python (2nd Edition), Abhikit Kar Gupta, Techno World Publication

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Course Code: 24CpCopU6001	**Course Name: On Job Training**
Teaching Scheme: 8 Hours/Week	**Credit: 04**
Examination Scheme: CIA: 40 Marks	**End-Sem: 60 Marks**