Progressive Education Society's
Modern College of Arts, Science and Commerce,
Shivajinagar, Pune - 5

T.Y.B.Sc. Physics
(2023 Course under NEP 2020)

Course Code: 23ScPhyU5101 **Course Name: Classical mechanic and Mathematical Methods of Physics I**

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**
Examination Scheme: CIA : 40 Marks **End-Sem : 60 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus
- Completed first year course 23ScPhyU1101

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.
- 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)	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. Define and Understand the terms: vector operators, vector spaces, complex numbers, differentiation equations	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. 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	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 Apply vector operators and Matrix representations	3
CO 4	Analyze scattering processes in laboratory and center-of-mass frames. Examine constraints, degrees of freedom, and D'Alembert's principle. Estimate/Calculate line and area integrations of given one- and two-dimensional simple function respectively	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. Predict the Eigenvalues, solutions of the differential equations using various methods	5
CO 6	Formulate equations of motion using Lagrangian and Hamiltonian mechanics. Design models and computational simulations of mechanical systems. Apply Fourier series and Fourier transforms	6

Course Contents

Section 1: Classical Mechanics		
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	Langrangian and Hamiltonian formulation:	8 Lectures
	● Limitations of Newtonian formulation ● Types of constraints, degrees of freedom, generalized coordinates, configuration space ● D'Alembert's principle of virtual work ● Langrangian equation from D'Alembert's principle, Hamilton's equations.	
Section 2: Mathematical Methods in Physics I		
Unit 5	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 6	Complex numbers	8 Lectures
	● Definition of complex numbers, real and imaginary parts ● Algebraic operators (addition, subtraction, multiplication, division) ● Complex conjugate ● Polar form ● Eulers' Equations ● Roots of Unity ● Functions of Complex Numbers: Roots, Exponential, Logarithmic, Trigonometric.	
Unit 7	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 8	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:

14. Classical Mechanics, J.C. Upadhyaya, Himalaya publishing Houses, 2nd Edition of 2005.
15. Introduction to Classical Mechanics, R. G. Takawale, P. S. Puranik, Tata McGraw Hill publishing Company Ltd., New Delhi.
16. Classical Mechanics, NC Rana and PS Joag, Tata McGraw Hill Education Private Limited, New Delhi, 1991.
17. Classical Mechanics by P.V.Panat.
18. Classical Mechanics, Herbert Goldstein, Narosa Publishing House.
19. Mathematical methods for physicists, Arfken and Weber, Acadmic Press Newyork.
20. Mathematical methods in the physical sciences – Marry L. Boas, John Willy and sons publication.
21. Mathematical Physics, H. K. Dass and Rama Verma, S Chand and Sons Publications.
22. Mathematical Physics, S.Prakash, S Chand and Sons Publications.

Progressive Education Society's
Modern College of Arts, Science and Commerce,
Shivajinagar, Pune - 5
Third Year of B.Sc.
(2023 Course under NEP 2020)
Course Code: 23ScPhyU5102

Course Name: Quantum Mechanics I and Atomic and Molecular Physics

Teaching Scheme: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA : 40 Marks **End-Sem : 60 Marks**

Prerequisite Courses:
- Familiarity with 10+2 level physics syllabus

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.
- To Study the composition of atoms with the help of different atomic models.
- Understand the one valence electron and two electron spectroscopy.
- To study the behaviour of spectral lines in electromagnetic fields.
- Understand the molecular spectroscopy.

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive level
CO 1	Study the Schrodinger equation and its simple applications. Study different atomic models and the atomic structure	1
CO 2	Understand the physical interpretation of wave function. Interpretation of different atomic and molecular spectra.	2
CO 3	Apply quantum mechanics for simple 1D, 2D and 3D cases. Apply quantum mechanical principles to analyze atomic and molecular systems	3
CO 4	Analyze the difference between classical mechanics and similar quantum mechanical systems. Analyzing the complexities of multi-electron atoms by considering concepts like Pauli's Exclusion principle	4
CO 5	Evaluate expectation values for given wavefunction. Evaluate different energy states in one valence and two valence electron systems.	5
CO 6	Solve simple problems in quantum mechanics. Solve quantitative problems related to atomic and molecular systems	6

Course Contents

Section 1: Quantum Mechanics I		
Unit 1	The Wave Function	05 Lectures
	• The Schrodinger Equation • Statistical Interpretation of Wave Function • 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	
Section 2 Atomic and Molecular Physics		
Unit 1	Atomic structure	07 Lectures
	• Thomson’s and Rutherford’s atomic models • Electron orbits • Bohr atomic model • Energy levels and spectra • 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:

23. Introduction to Quantum Mechanics; 3rd Edition David J. Groffiths and Darrell F. Schroeter
24. Principles of Quantum Mechanics; 2nd Edition; R. Shankar
25. Quantum Mechanics: Theory and Applications; Ajoy Ghataka and S. Lokanathan
26. Sear's and Zimansky's University Physics with Modern Physics, Young and Freedman
27. Fundamentals of Physics, Resnick and Halliday
28. Quantum Physics, Eisberg and Resnick
29. Concept of Modern Physics, Arthur Beiser
30. Molecular spectroscopy, C. N. Banwell

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Third Year of B.Sc.

(2023 Course under NEP 2020)

Course Code: 23ScPhyU5103 Course Name: Lab Course on 23ScPhyU5101 and 23ScPhyU5102

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. 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. Surface tension of liquid by Ferguson methods 6. Energy gap of semiconductor (Ge diode) 7. Planck's constant using photocell/LDR/photodiode 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. Thermal conductivity of Graphite 12. Determination of resolving power of grating 13. Determination of refractive index of liquid using hollow prism 14. Determination of Hall coefficient by varying magnetic field. 15. Determination of Hall coefficient by varying Probe current 16. Resistivity by Four Probe method 17. Thermal conductivity by Forbe's method 18. e/m by Thomson's Method 19. Characteristics of LASER beam 20. Simulation of Finite Potential Well 21. Calculating Fourier Coefficients for Square Wave using Numerical Integration	

	22. Generating Square Wave using Fourier Coefficients	

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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Third Year of B.Sc.
(2023 Course under NEP 2020)

Course Code:23ScPhyU5201 **Course Name: Electronics and Instrumentation(T+P)**

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 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	Relate electronics and instrumentation with engineering that focuses on the design, development, and application of measuring instruments, control systems, and automation technologies for various processes and applications	1
CO2	Illustrate use of encoders, decoders, multiplexers in various circuits.	2
CO3	Identify the various parameters that are measurable in electronic instrumentation.	3
CO4	Describe the working principle, selection criteria and applications of various transducers used in measurement systems.	4
CO5	Explain working of flip flops, counters, and registers.	5
CO6	Design digital circuits for dedicated applications.	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 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 Education

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Third Year of B.Sc.
(2023 Course under NEP 2020)
Major Electives Practical

Course Code:23ScPhyU5201 **Course Name: Lab Course on Electronics and Instrumentation**

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) Regulated power circuit using IC 7805 3) Computer interface : Chcaracetristcs of LEDCounters 3 expts 4) LVDT 5) Instrumentational amplifiers using three Op-Amps. 6) Self induction by Anderson's bridge 7) Characteristics of JFET 8) Astable multivibrator using IC 555 9) Schmitt trigger: DC and AC operation 10) Measurement of inductance by using Maxwell's bridge. 11) To determine the temperature coefficients of Pt resistance thermometer 12) Study of various Flipflops 13) Study of Differentiator and Integrator (using op-Amp) 14) Inverting and non-inverting amplifier using op-Amp 15) Study of combinational circuits (encoder and decoder) 16) Study of 4 bit DAC (R-2R ladder) 17) Study of ADC	

	18) Study of IC 7495 as shift register 19) Study of Strain gauge 20) Decade counter using IC 7490 21) Op-Amp as a comparator 22) transistor as switch 23) Study of ON OFF controller 24) Study of line and load regulation of standard power supply 25) Study of optical sensors (opto-coupler)	

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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Modern College of Arts, Science and Commerce (Autonomous)
Shivajinagar, Pune - 5
Third Year of B.Sc.
(2023 Course under NEP 2020)

Course Code: 23ScPhyU5202 **Course Name: Physics of Semiconductor Devices (T+P)**

Teaching Scheme: 4 Hours/Week **Credit: 04**

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	7 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	8 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

<table>
<tr><td></td><td>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, unijuction transistor.
Schottky diode, semiconductor controlled rectifier,
Junction field effect transistor.
Basic characteristics: static characteristics and Dynamic characteristics, current limiter.</td><td></td></tr>
<tr><td>Unit 4</td><td>Metal & Metal Insulator Semiconductor Devices</td><td>8 Lectures</td></tr>
<tr><td></td><td>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.</td><td></td></tr>
</table>

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

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Third Year of B.Sc.

(2023 Course under NEP 2020)

(Major Elective Practical)

Course Code: 23ScPhyU5202 **Course Name: Lab Course on Physics of Semiconductor Devices**

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
- 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

Progressive Education Society's
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Shivajinagar, Pune - 5

T.Y.B.Sc. Physics
(2023 Course under NEP 2020)

Course Code : 23ScPhyU5301 **Course Name : Physics Minor III (Thermodynamics)(T+P)**

Teaching Scheme: TH: 2 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.

Successful completion of this course students will able to:

CO No	Course Outcomes (COs)	Blooms Cognitive level
CO 1	Defining laws of thermodynamics and thermodynamics processes.	1
CO 2	Understanding the concepts of work done for different thermodynamics processes.	2
CO 3	Examining Otto cycle and Diesel cycle.	3
CO 4	Explaining principle construction and working off thermometers.	4
CO 5	Evaluating T-dS equations and Clausius- Clapeyron latent heat equations.	5
CO 6	Adapting the knowledge of Carnot's cycle.	6

Course Contents

Unit 1	Temperature and Heat	7 Lectures
	● Temperature and Thermal Equilibrium ● Thermometers and Temperature Scales ● Gas Thermometers and Kelvin Scale ● Thermal Expansion ● Quantity of Heat ● Calorimetry and Phase changes ● Mechanism of Heat Transfer	
Unit 2	Thermal Properties of Matter	7 Lectures
	● Equations of State ● Molecular Properties of Matter ● Kinetic-Molecular Model of an Ideal Gas ● Heat Capacities ● Molecular Speeds ● Phases of Matter	
Unit 3	The First Law of Thermodynamics	8 Lectures
	● Thermodynamic Systems ● Work Done During Volume Changes ● Paths Between Thermodynamic States ● Internal Energy and the First Law of Thermodynamics ● Kinds of Thermodynamic Processes ● Internal Energy of an Ideal Gas ● Heat Capacities of an Ideal Gas ● Adiabatic Processes for an Ideal Gas	
Unit 4	The Second Law of Thermodynamics	8 Lectures
	● Directions of Thermodynamic Processes ● Heat Engines ● Internal-Combustion Engines ● Refrigerators ● The Second Law of Thermodynamics ● The Carnot Cycle ● Entropy ● Microscopic Interpretation of Entropy	

References:

1. Sear's and Zimansky's University Physics with Modern Physics, Young and Freedman
2. Fundamentals of Physics, Resnick and Halliday

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T.Y.B.Sc. Physics
(2023 Course under NEP 2020)

Course Code : 23ScPhyU5301 **Course Name : Lab Course on Physics Minor 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.

Successful completion of this course students will able to:

Any 6

1) Study of different types of thermometers
2) Thermal Conductivity by using Lee's method (rubber)
3) Thermal Conductivity by using Lee's method (plywood/cardboard sheet/acrylic)
4) Study of Thermistor - Temperature Coefficient of Resistance
5) Study of Thermocouple
6) Temperature coefficient of Platinum resistance thermometer
7) Thermal conductivity of steel by Forbes Method
8) Thermal Conductivity of rubber Tube
9) Specific heat of water
10) J by calorimeter
11) Newton's law of cooling
12) Determination of Stefan's constant
13) Verification of Wein's displacement law
14) Determination of specific and latent heat of water

Any 6

15) Characteristics of a Diode
16) Study of Logic gates
17) Verification of De-Morgan's theorem
18) Construction of AND, OR, NOT gates using NAND gates
19) Construction of AND, OR, NOT gates using NOR gates
20) Ex-OR using AND, OR and NOT gates

21) Binary half adder

Any 4

22) Virtual lab: Capacitor lab
23) Virtual lab: Ohm's law
24) Virtual lab: Resistance in wire
25) Virtual lab: Ideal gas law

Virtual lab: Kinematic equation

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

Progressive Education Society's
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Third Year of B.Sc.
(2023 Course under NEP 2020)

Course Code: 23ScPhyU5501 Course Name: Experimental Techniques in Physics

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

	Experimental Techniques in Physics	
	1 Elasticity 2 Acceleration due to gravity 3 Surface Tension 4 Sound 5 The mechanical equivalent of Heat 6 Thermoelectric Effect 7 Refraction and Dispersion of Light 8 Interference of Light 9 Diffraction of Light 10 Polarization of Light 11 Resolving Power	

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.
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Course Code:23ScPhyU5002 **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

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(2023 Course under NEP 2020)

Course Code:23ScPhyU6101 **Course Name: Electrodynamic and Statistical Mechanics**

Teaching Scheme: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 40 Marks **End-Sem: 60 Marks**

Prerequisite Courses:
- Familiarity with 10+2 level physics syllabus
- Completed first year course 23ScPhyU2101
- Topics covered in 23ScPhyU4101

Course Objectives:
- To understand the fundamental concepts of electrostatics, magnetostatics, and electrodynamics.
  To study thermodynamics of particles from statistical point of view
- To solve boundary value problems using Poisson's and Laplace's equations.
  To study Binomial and Gaussian probability distributions
- To analyze the behavior of dielectric and magnetic materials in the presence of electric and magnetic fields.
  To study Binomial and Gaussian probability distributions
- To study Maxwell's equations and their applications to electromagnetic wave propagation.
  To study statistical ensembles
- To develop problem-solving skills in classical electrodynamics and its applications.
  To study quantum statistics

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

	Define different concepts and applications of statistical mechanics in physics.	
CO2	Explain the physical significance of Maxwell’s equations and their role in describing electromagnetic phenomena. Understand throttling process.	2
CO3	Apply boundary conditions, Poisson’s and Laplace’s equations and the method of image charges to solve electrostatic problems. Examine Binomial and Gaussian probability distributions. Distinguish Maxwell-Boltzmann, Fermi-Dirac, Bose-Einstein statistics.	3
CO4	Analyze the behavior of electromagnetic waves in different media, including reflection, refraction, and polarization effects. Review the basic knowledge of thermodynamic systems.	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. Solve the problems based on the statistical mechanics and thermodynamics.	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($J=\sigma. E$) ● Introduction to Special theory of Relativity ● Problems	
Unit 4	Kinetic Theory of Gases	5 Lectures
	● Revision- Assumptions of kinetic theory of gases ● Mean free path ● Transport phenomena- Viscosity, Thermal conductivity, Diffusion ● Problems	
Unit 5	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 6	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 7	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 8	Statistical Ensembles	5 Lectures
	● Micro-canonical ensemble (Isolated system) ● Canonical ensembles ● Simple application of canonical ensembles ● Calculation of mean values in canonical ensemble	
Unit 9	Quantum Statistics	5 Lectures
	● Quantum Distribution Function ● Maxwell-Boltzmann's statistics ● Bose-Einstein Statistics ● Fermi-Dirac Statistics	

	● Comparison of the distributions	

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; Ninteenth 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.

(2023 Course under NEP 2020)

Course Code: 23ScPhyU6102 **Course Name: Solid-State Physics and Nuclear Physics**

Teaching Scheme: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 40 Marks **End-Sem:60 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 behavior 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 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.

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Course Outcomes:

CO No.	Course Outcomes (COs)	Bloom's Cognitive Level
CO1	Define and describe basic properties of the nucleus. Recall fundamental concepts of crystal structures, including lattices, unit cells, symmetry, and Miller indices.	1
CO2	Explain the concept of radioactivity. Classify different radiation detectors and nuclear models Explain Bragg's law, reciprocal lattice properties, and X-ray diffraction principles..	2
CO3	Solve problems related to nuclear and particle physics. Apply free electron theory and band theory to classify solids into conductors, semiconductors, and insulators.	3
CO4	Analyze nuclear reaction dynamics, nuclear reactors and accelerators. Analyze the Hall Effect, density of states, and Fermi energy to interpret electronic properties of materials.	4
CO5	Interpret the nuclear changes or processes including fission, fusion and decay reactions. Evaluate different magnetic phenomena, including diamagnetism, paramagnetism, and ferromagnetism, using Langevin and domain theories.	5
CO6	Compile knowledge of elementary particles to understand nuclear phenomena. Formulate models for superconductivity, magnetic properties, and their applications in modern technology.	6

Course Contents

Section 1- Solid-State Physics		
Unit 1	The Crystalline Structures and X ray Diffraction	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	
Section 2- Nuclear Physics		
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, and Spin and Parity limitations. • Liquid drop model: Assumptions • Semi-empirical B.E. formula • Problems	
Unit **5**	**Nuclear forces and Nuclear Models**	**6 Lectures**

	• Nuclear Reaction, 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:

- 1. 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
- Solid State Physics S.O.Pillai, 6th Edition, New Age International (P) Ltd, Publisher, (2010).
- Solid State Physics – Kakani S.L. and Hemrajani C, 4th Edition, S. Chand Publication (2005).
- 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.
- Solid State Physics, P.K. Palanisamy, Scitech Publications(India) Pvt Ltd, Chennei, 1st Edition (2004)
- Solid State Physics: Essential Concepts, David W. Snoke, 2nd Edition, Cambridge University Press

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Third Year of B.Sc.

(2023 Course under NEP 2020)

Course Code: 23ScPhyU6103   Course Name: Lab Course on 23ScPhyU6101 and 23ScPhyU6102

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) Characteristics of GM Counter 2) GM Counter- Counting Statistics 3) GM Counter- End point energy 4) Virtual lab-Nuclear Physics 5) Determination of Hall carrier concentration by varying magnetic field. 6) Determination of carrier concentration by varying Probe current 7) Resistivity of a semiconductor using Four probe method 8) Directional characteristics of Yagi Antennas 9) Directional characteristics of Parabolic Antennas 10) Directional characteristics of Dipole antenna 11) Magnetic susceptibility of a material by Guoy's method 12) Magnetic susceptibility of a material of $FeCl_3$ 13) e/m ratio by Thomson's method 14) Pin diode 15) Magnetic properties of material using hysteresis loop 16) Simulation of random walk	

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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T.Y.B.Sc. Physics
(2023 Course under NEP 2020)

Course Code: 23ScPhyU6201 **Course Name: Material Science and Physics of Nanomaterials (T+P)**

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **ESE: 30 Marks**

Prerequisite Courses:

- Familiarity with 10+2 level physics syllabus and basic concepts of solid-state physics
- Completed first year course 23ScPhyU1101 & 23ScPhyU4101

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

Unit 1	Defects in Solids and Diffusion	6 Lectures
	● Classification of Materials ● Material Properties – Mechanical, Electrical and Thermal ● Impurities in solids ● Solid solutions in metals ● Rules of solid solubility ● Imperfection in crystals ● Defects in solids - point, line, surface and volume ● Atomic diffusion: Definition, mechanism, Fick's laws	
Unit 2	Phase Diagrams	6 Lectures
	● Basic terms System, Surrounding, Component, Coordinates, Phase, Equilibrium. ● Phase Diagram - definition, importance and objective ● Lever rule ● Gibb's phase rule ● Phase diagram of a) Sugar water b) NaCl water ● Types of phase diagrams with construction ● Isothermal cuts	
Unit 3	Introduction to Nanomaterials	4 Lectures
	● Introduction to nano-sized materials and structures ● Brief history of nanomaterials ● Challenges in nanotechnology ● Significance of nano-size and properties	

	• Classification of nanostructured materials	
Unit 4	Methods of Synthesis of Nanomaterials	7 Lectures
	• Bottom-up and Top-down approaches • Physical methods: High energy ball milling, Physical vapour deposition, Ionized cluster beam deposition, Sputter deposition, Ultrasonic spray pyrolysis • Chemical methods: colloidal method, co-precipitation, sol-gel method • Hybrid method: Electrochemical and chemical vapour deposition.	
Unit 5	Characterization Techniques	7 Lectures
	• UV- visible spectroscopy • FTIR spectroscopy • X-ray diffraction • Scanning electron microscopy • Transmission electron microscopy • Scanning tunneling microscopy • X-ray and UV photoelectron spectroscopy	

References:

1) Elements of materials science and Engineering I. H. Van Vlack (4th Edition)
2) Materials science and Engineering - V. Raghavan
3) Solid state physics – S. O. Pillai
4) Material Science and Engineering – W. D. Callister
5) Nanotechnology: Principles & Practices. Sulbha K. Kulkarni, Capital Pub.
6) Nanostructures & Nanomaterials Synthesis, Properties & Applications. Guozhong Cao, Imperial college Press London.
7) Introduction to Nanotechnology. C. P. Poole Jr. & F. J. Owens, Wiley Student Ed.
8) Nano: The Essentials. T. Pradeep, McGraw Hill Education.
9) Nanomaterials: Synthesis, Properties & Applications. Edited by A. S. Edelstein & R. C. Commorata. Institute of Physics Publishing, Bristol & Philadelphia

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T.Y.B.Sc. Physics
(2023 Course under NEP 2020)

Course Code: 23ScPhyU6201 **Course Name: Lab Course on Material Science and Physics of Nanomaterials**

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 and basic concepts of solid-state physics
- Completed first year course 23ScPhyU1101 & 23ScPhyU4101

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) Yield point and breaking point of a (eutectic material) wire 6) Synthesis of nanomaterials using Chemical route method 7) Analysis of SEM images using imageJ software 8) Deposition of ZnO thin film using Spin coater. 9) Study of FTIR 10) Study of UV-Visible/UV-DRS spectrophotometer. 11) Study of imperfections in crystals 12) Study of Raman spectroscopy 13) Study of cyclic voltammetry. 14) Synthesis of nanoparticles using hydrothermal method 15) THin film deposition using Electrochemical deposition 16) Simulation of Fick's laws using python 17) Study of phase diagrams	

	18) Virtual lab: Poisson’s ratio and Young’s modulus (Amrita University) 19) Study of Energy storage systems	

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
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6. Fundamental of Optics, Francis Jenkins, Harvey White

23ScPhyU6202 (T+P): Medical and Biophysics

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T.Y.B.Sc. Physics
(2023 Course under NEP 2020)

Course Code : 23ScPhyU6301 **Course Name : Physics Minor IV (Modern Physics)(T+P)**

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**
Examination Scheme: CIA : 20 Marks **ESE : 30 Marks**

Prerequisite Courses:
• Familiarity with 10+2 level physics syllabus.
• Familiarity with 23ScPhyU3301

Course Objectives:
• To Learn Dual Nature of Waves and Matter
• To Study Historical Evolution of Atomic Models
• To Learn Basics of Concept of Quantization of Energy Levels in Atoms
• To Study Basics of LASER
• To enrich knowledge of modern physics through problem solving

Successful completion of this course students will able to:

CO No	Course Outcomes (COs)	Blooms Cognitive level
CO 1	Discuss the De Broglie wavelength of matter waves, wave particle duality	1
CO 2	Compare Dual Nature of Waves and Matter	2
CO 3	Apply the Bohr's Atomic Model to Hydrogen Atom	3
CO 4	Explaining wave functions and 1D Schrodinger's equation	4
CO 5	Reviewing Concept of Quantization of Energy Levels in Atoms	5
CO 6	Solve simple problems on wave particle duality and atomic models, Uncertainty principle	6

Course Contents

Chapter 1	Photons: Light Waves Behaving as a Particles	12 Lectures
	● Light absorbed as photons: The photoelectric Effect ● Light emitted as photons: X-Ray production ● Light scattered as photons: Compton Scattering ● Wave particle Duality, Probability and Uncertainty ● Problems	

Chapter 2	Particle Behaving as waves	12 Lectures
	• Electron Waves • Nuclear Atom and Atomic Spectra • Energy Levels and the Bohr Model of the atom • The LASER • Continuous Spectra • Problems	
Chapter 3	**Quantum Mechanics I: Wave functions**	**6 Lectures**
	• Wave Functions and 1D Schrodinger equation(both time dependent and independent) • Particle in 1D infinite potential well	

References

1. Sear's and Zimansky's University Physics with Modern Physics, Young and Freedman
2. Concepts of Modern Physics Arthur Beiser, Shobit Mahajan, S Rai Choudhury, Mc-Graw Hill
3. Fundamentals of Physics, Haliday, Resnick and Walker
4. Perspective of Modern Physics- Arthur Beiser
5. Introduction to Quantum Mechanics: David J. Griffiths
6. Quantum Physics: Eisberg and Resnick

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T.Y.B.Sc. Physics
(2023 Course under NEP 2020)

Course Code : 23ScPhyU6301 **Course Name : Lab course on Physics Minor IV**

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**
Examination Scheme: CIA : 20 Marks **ESE : 30 Marks**

Prerequisite Courses:
• Familiarity with 10+2 level physics syllabus.
• Familiarity with 23ScPhyU3301

Course Objectives:
• To Learn Dual Nature of Waves and Matter
• To Study Historical Evolution of Atomic Models
• To Learn Basics of Concept of Quantization of Energy Levels in Atoms
• To Study Basics of LASER
• To enrich knowledge of modern physics through problem solving

Successful completion of this course students will able to:

CO No	Course Outcomes (COs)	Blooms Cognitive level
CO 1	Discuss the De Broglie wavelength of matter waves, wave particle duality	1
CO 2	Compare Dual Nature of Waves and Matter	2
CO 3	Apply the Bohr's Atomic Model to Hydrogen Atom	3
CO 4	Explaining wave functions and 1D Schrodinger's equation	4
CO 5	Reviewing Concept of Quantization of Energy Levels in Atoms	5
CO 6	Solve simple problems on wave particle duality and atomic models, Uncertainty principle	6

Course Contents

	1. Study of Photoelectric effect 2. Planck's constant using photocell/LDR/photodiode	

	3. Energy gap of semiconductor (Ge diode) 4. Angle of Prism 5. Calibration of spectrometer 6. Verification of laws of reflection and refraction 7. Determination of resolving power of grating 8. Determination of refractive index of liquid using hollow prism 9. Plane diffraction grating 10. Newton's ring 11. Resistivity by Four Probe method 12. e/m by Thomson's Method 13. Characteristics of LASER beam 14. Study of Frank-Hertz experiment 15. Virtual lab: Verification of Stefan's law 16. Virtual lab: Study of Blackbody radiation 17. Virtual lab: Millikan's oil drop method 18. Virtual lab: Rutherford scattering (PhET)	

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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T.Y.B.Sc. Physics
(2023 Course under NEP 2020)

Course Code : 23ScPhyU6004 **Course Name : On Job Training**

Teaching Scheme: TH: 8 Hours/Week **Credit: 04**
Examination Scheme: CIA : 40 Marks **ESE : 60 Marks**