Darrang College (Autonomous), Tezpur-784001

Syllabus for FYUGP B.Sc. Physics (Minor)

Approved by :

Board of Studies meeting held on 20-12-2025
&
Academic Council vide Resolution no. 2, dated 29-12-2025

FYUGP PHYSICS MINOR SYLLABUS

(The syllabus is approved in the Board of Studies meeting held on 20th December, 2025)

DEPARTMENT OF PHYSICS

DARRANG COLLEGE (AUTONOMOUS)

Tezpur, Assam

W.e.f. January 2026

The syllabus is subject to modifications as deem fit by the Academic Council, Darrang College (Autonomous)

TEACHING LEARNING PROCESS

The method and practice of teaching for FYUGP in Physics is based on the L+T+P model, where L, T, and P stand for Lecture, Tutorial, and Practical respectively. Lecture classes are aided with prescribed textbooks, e-learning resources, and self-study materials. This approach recognizes the importance of a well-rounded education that includes theoretical knowledge, practical experience, and personal development. Tutorials are interactive sessions where students can ask questions, clarify their doubts, and engage in discussions with their peers and teachers. Tutorials are designed to encourage active learning and to promote critical thinking. The practical courses are designed to provide hands-on experience to students and to help them develop the necessary skills for conducting experiments and record results.

TEACHING AND LEARNING TOOLS

Traditional Learning Tools like blackboard, textbook, hand notes, visual aids, model etc.

DIGITAL LEARNING TOOLS

Virtual Labs, Educational Videos and Animations, E-books and E-readers etc.

COURSE STRUCTURE

Semester	Course Title	Course Code	Course Type	Credit (Th+P)	Marks Distribution				Total
					Th	Th IA	P	P IA	
I	Mathematical Physics and Mechanics	PHY-MN-01014	Theory + Practical	3+1	45	30	20	05	100
II	Electricity and Magnetism	PHY-MN-02014	Theory + Practical	3+1	45	30	20	05	100
III	Waves and Oscillations	PHY-MN-03014	Theory + Practical	3+1	45	30	20	05	100
IV	Thermal Physics	PHY-MN-04014	Theory + Practical	3+1	45	30	20	05	100
V	Optics	PHY-MN-05014	Theory + Practical	3+1	45	30	20	05	100
VI	Condensed Matter Physics & Electronics	PHY-MN-06014	Theory + Practical	3+1	45	30	20	05	100
VII	Atomic and Nuclear Physics	PHY-MN-07014	Theory	4+0	60	40	0	0	100
VIII	Quantum Mechanics	PHY-MN-08014	Theory + Practical	3+1	45	30	20	05	100

EVALUATION/ASSESSMENT

Paper	Internal (40 marks)			End-Semester (60 marks)			Grand Total Marks
	Activity	Marks	Total Marks	Examination	Marks	Total Marks	
Minor (with practical)	Sessional Examination	15	30	Theory	45	70	100
	Seminar/presentation, assignment, quiz, class test, regularity, classroom activity.	15		Practical	25		
Minor (without practical)	Sessional+ Seminar/presentation, assignment, quiz, class test, regularity, classroom activity.		40	Theory	60	60	100
	Seminar/presentation, assignment, regularity, classroom activity etc.	15					

*1 Credit= 1 hour of Lecture per week

*1 Credit= 2 hours of Practical class per week

Abbreviations: L: Lecture; T: Tutorial; P: Practical; Th: Theory; IA: Internal Assessment

SEMESTER: FIRST

Subject: Physics (Minor)

Course Name: Mathematical Physics and Mechanics

Paper Code: PHY-MN-01014

Credit: 4 (3 Theory+ 0 Tutorial+ 1 Practical)

COURSE OBJECTIVES

This course introduces mathematical physics and mechanics. The basic objectives of the course are:

- To introduce essential primary concepts in mathematical physics such as vectors and scalar fields, vector products, calculus of vectors, differential operators which are required for developing insight of the theories of physics.
- To introduce basic concepts of matrix algebra.
- To introduce the concepts of dynamics of particles, energy, oscillation and basic properties of matter which will equip students with the tools required for applying the concepts of physics in practical problems.
- To train the students with concept visualisation through some laboratory practices.

COURSE OUTCOME

On successful completion of the course, students will be able to understand the calculus of vectors and different operators which will be helpful in understanding theories of physics. Through matrix algebra students will be able to compute various matrix operations which are required for solving physical problems. Students will be able to understand and apply the concepts of dynamics of particles, simple harmonic oscillations, basic properties of matter in various problems of physics, technology and engineering. They will be trained in concept realisation through laboratory practices.

Title of the course Course code	**Mathematical Physics and Mechanics** **PHY-MN-01014**
Total Credit	4 (3 Theory+ 0 Tutorial+ 1 Practical)
Contact hours	45 (L)+0 (T)+30 (P)
Distribution of Marks	Internal Assessment: 30 End Semester: Theory=45; Practical=25

Course Summary

Unit	Topic	Lecture (hours)	Tutorial (hours)	Practical (hours)	Total (hours)
Part A: Mathematical Physics I				30	75
I	Vector and scalars	2	0		
II	Vector differentiation	3			
III	Vector differential operator	5			
IV	Vector Integration	3			
V	Matrices	2			
Part B: Mechanics					
I	Reference frames	3	0		
II	Central force motion	5			
III	Conservation laws	4			
IV	Dynamics of rigid bodies	6			
V	Work and energy	4			
VI	Properties of matter	6			
VII	Oscillations	2			

DETAILED SYLLABUS

Theory: 3 Credit **Lecture: 45; Tutorial: 0**

Part A: Mathematical Physics I **(Credit - 1; Lectures: 15; Tutorial: 0)**

Unit I: Vector and scalars **(Lectures: 2)**

Scalar and vector fields, dot and cross products including triple products, their physical significance.

Unit II: Vector differentiation **(Lectures: 3)**

Ordinary derivative of vectors. Continuity and differentiability, the partial derivative of vectors, applications to problems in Physics.

Unit III: Vector differential operator **(Lectures: 5)**

Gradient. Divergence and curl - definitions and physical meaning.

Unit IV: Vector Integration **(Lectures 3)**

Ordinary integrals of vectors - line integral, surface integral and volume integral. Gauss's theorem, Stoke's theorem and Green's theorem (statements only).

Unit V: Matrices **(Lectures: 2)**

Review of basic concepts. Types of matrices: Hermitian, anti - Hermitian, Unitary, orthogonal, symmetric and skew-symmetric. Diagonalisation of matrices, inverse of a matix, Eigen values and Eigen vectors, Caley -Hamilton theorem (statement only).

Part B: Mechanics: 2 Credit (Lectures: 30, Tutorial: 0)

Unit I: Reference frames **(Lectures: 3)**

Inertial and non- inertial frames of reference, e.g., rotating frames, laws of Physics in rotating coordinate system. Fictitious forces: Coriolis force and its application, centrifugal force.

Unit II: Central force motion **(Lectures: 5)**

Motion under central force. Two-body problem and its reduction to one body problem. Kepler's laws of planetary motion, Gravitational Law and Field, Conservative and Non-conservative forces.

Unit III: Conservation laws **(Lectures: 4)**

Dynamics of a system of particles. Centre of mass. Principle of conservation of momentum. Torque. Impulse. Elastic and inelastic collisions between particles. Centre of mass and laboratory frames.

Unit IV: Dynamics of rigid bodies **(Lectures: 6)**

Translation and rotational motion, torque, angular momentum. Moment of inertia -general theorem of the moment of inertia, moment of inertia calculation in particular cases - disk, cylinder, and sphere. Kinetic energy of rotation. Motion involving both translation and rotation.

Unit V: Work and energy **(Lectures: 4)**

Work and kinetic energy theorem. Conservative and non-conservative forces. Potential energy. Force as gradient of potential energy. Work done by non- conservative forces.

Unit VI: Properties of matter **(Lectures: 6)**

Elasticity: Hook's law, elastic constants, Poisson's ratio, relation among the elastic constants. Twisting torque on a cylinder or wire. Bending of beam: Bending moment, cantilever, depression of a cantilever considering the weight of the beam. Fluid dynamics: Equation of continuity, types of flow, viscosity, Poiseuille's equation for flow of a liquid through a capillary tube.

Unit VII: Oscillations **(Lectures: 2)**

Simple Harmonic Motion, Characteristics of SHM, Differential equation of SHM, Energy of SHO, Types of SHM – free, damped and forced oscillations (qualitative only), Compound Pendulum.

Suggested Reading:

- Essential Mathematical Methods for the Physical Sciences; K.F. Riley and M.P. Hobson, Cambridge University Press.
- Advanced Engineering Mathematics; E. Kreyszic, John Wiley & Sons (New York).
- Mathematical Methods for Physicists; G. B. Arfken, H. J. Weber and F.E. Harris, Elsevier.
- Mathematical Physics-I, K. K Pathak and S. Parasher, Vishal Publication, Jalandhar (Delhi).

- Theoretical Mechanics, M. R. Spiegel, Tata McGraw Hill.
- Mechanics; D. S. Mathur, S. Chand & Company Limited.
- An Introduction to Mechanics, D. Kleppner and R. J. Kolenkow, Tata McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et. al., Tata McGraw-Hill.
- Physics, R. Resnick, D. Halliday and J. Walker, John Wiley & Sons.
- Analytical Mechanics, G. R. Fowles and G. L. Cassiday, Cengage Learning.

Practical: 1 Credit **(Contact hours: 30)**

At least five experiments to be performed from the following:

1. To study the motion of spring and calculate (a) spring constant and (b) rigidity modulus.
2. To determine the moment of inertia of a cylinder about two different axes of symmetry by torsional oscillation method.
3. To determine coefficient of viscosity of water by capillary flow method (Poiseuille's method).
4. To determine the Young's modulus of the material of a wire by Searle's apparatus.
5. To determine the modulus of rigidity of a wire (static method).
6. To determine the value of g using bar pendulum.
7. To determine the value of g using Kater's pendulum.
8. To determine the height of a building using a sextant.
9. To determine g and velocity for a freely falling body using digital timing technique.

Suggested Reading:

- Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Engineering Practical Physics, S. Panigrahi and B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
- B. Sc. Practical Physics, C. L. Arora, S. Chand, and Company.
- A Text Book on Practical Physics, K. G. Mazumdar, and B. Ghosh.

Course designed by:

- Dr. Saiful Islam, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Dr. Shyamalima Chowdhury, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Dr. Barsha Borgohain, Assistant Professor, Department of Physics, Darrang College (Autonomous)

****

SEMESTER: SECOND

Subject: Physics (Minor)

Course Title: Electricity and Magnetism

Course Code: PHY-MN-02014

Credit: 4 (3 Theory+0 Tutorial+1 Practical)

COURSE OBJECTIVES

- To provide foundational knowledge of electrostatics, magnetostatics, and current electricity.
- To introduce fundamental laws, field concepts, and circuit analysis methods.
- To develop students' ability to apply theoretical principles to practical scenarios.
- To familiarize students with electric and magnetic properties of matter.
- To build competence through laboratory exercises using measurement and analytical tools.

COURSE OUTCOME

On successful completion, students will be able to

- Analyze and solve problems in electrostatics and magnetostatics using core laws and principles.
- Apply circuit theorems and explain the properties of dielectrics and magnetic materials.
- Interpret interactions between electric and magnetic fields in physical systems.
- Perform laboratory measurements and verify experimental principles.
- Use basic electrical instrumentation effectively in practical tasks.

Title of the course Course code	**Electricity and Magnetism** **PHY-MN-02014**
Total Credit	4 (3 Theory+ 0 Tutorial+ 1 Practical)
Contact hours	45 (L)+0 (T)+30 (P)
Distribution of Marks	Internal Assessment: 30 End Semester: Theory=45; Practical=25

COURSE SUMMARY

Unit	Topic	Lecture (hours)	Tutorial (hours)	Practical (hours)	Total (hours)
I	Electric field	3	0	30	75
II	Electric Potential	6			
III	Work and Energy in Electrostatics	2			
IV	Dielectric properties of matter	4			
V	Electric Current	4			
VI	Circuit Theorem	3			
VII	Transient Current	3			
VIII	Alternating Current	5			
IX	Magnetic Field	4			

X	Divergence and Curl Magnetic Field	4			
XI	Magnetic potential	2			
XII	Magnetic properties of matter	5			

DETAILED SYLLABUS

Theory: 3 Credit **Lectures: 45; Tutorial: 0**

Unit I: Electric field **(Lecture: 3)**

Electrostatic field, electric flux. Gauss's law. Application of Gauss's law to charge distributions with planar, spherical and cylindrical symmetries. Conservative nature of electrostatic field.

Unit II: Electric Potential **(Lectures: 6)**

Electrostatic potential. Laplace's and Poisson's equations. Electrostatic boundary conditions. Uniqueness theorem. Application of Laplace's equation involving planar, spherical and cylindrical symmetries. Potential and electric field of a dipole. Force and torque on a dipole. Parallel plate capacitor.

Unit III: Work and Energy in Electrostatics **(Lectures: 2)**

Work done in moving a point charge, Electrostatic energy of a system of charges. Electrostatic energy of continuous charge distribution

Unit IV: Dielectric properties of matter **Lectures: 4)**

Electric field in matter. Polarisation, polarisation charges. Electrical susceptibility and dielectric constant. Capacitor (parallel plate, spherical and cylindrical) filled with dielectric. Displacement vector D. Relation between E, P and D. Gauss's law in dielectrics.

Unit V: Electric Current **(Lectures: 4)**

Electric current density, continuity equation, Ohm's law, Applications of Kirchoff's law to solve electrical network problem,

Unit VI: Circuit Theorem **(Lectures: 3)**

Thevenin and Norton Theorems. Superposition theorem, maximum power transfer theorems.

Unit VII: Transient Current **(Lectures: 3)**

Transient growth and decay of current in LR, CR and LCR circuits, oscillatory discharge

Unit VIII: Alternating Current **(Lectures: 5)**

Phasor (complex number method) method of analyzing a.c. circuits, current and potential across resistive, inductive and capacitive elements and their phase relationships, power factor, LR, CR and LCR (series and parallel) circuits, quality factor, resonance.

Unit IX: Magnetic Field **(Lectures: 4)**

Magnetic field definition and properties, Magnetic force on a point charge, Lorentz force.

Biot-Savart law, Magnetic field due to a steady current in (a) straight conductor and (b) a circular coil.

Unit X: Divergence and Curl Magnetic Field **(Lectures: 4)**

Divergence and Curl of a magnetic field. Ampere's circuital law and it's application to its application to (i) long straight conductor, (ii) solenoid and (iii) torus.

Unit XI: Magnetic potential **(Lectures: 2)**

Magnetic vector potential, Magnetostatic boundary conditions.

Unit XII: Magnetic properties of matter **(Lectures: 5)**

Force and torque on a current loop in a uniform magnetic field, Current loop as a magnetic dipole. Magnetization vector $\vec{M}$, Magnetic intensity $\vec{H}$. Magnetic susceptibility and permeability. Relation between $\vec{B}$, $\vec{H}$ and $\vec{M}$. Ferromagnetism, B-H curve and hysteresis (basics only).

Practical: 1 Credit **Contact hours: 30**

(Minimum six experiments must be performed from the following)

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) Checking electrical fuses.
2. To study the characteristics of a series RC circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De' Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
7. To verify the Thevenin and Norton Theorems.
8. To verify the superposition
9. To verify maximum power transfer theorems.
10. To determine the self-inductance of a coil by Anderson's bridge.
11. To study the response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
12. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q.

Suggested Reading List

- Introduction to Electrodynamics, D. J. Griffiths. Prentice Hall Inc., 2013, New Jersey
- Electricity and Magnetism [With electromagnetic theory and special theory of relativity], D. Chattopadhyay and P. C. Rakshit, 2013, New Central Book Agency (P) Limited.
- Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and S. R. Choudhury, 2012, Tata Mcgraw.
- Schaum's outline of Theory and Problems of Electromagnetics, J. A. Edminister.
- Electromagnetics, B. B. Laud, New Age International Publishers.
- Feynman Lectures Vol. 2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
- Elements of Electromagnetics, M. N. O. Sadiku, 2008. Pearson Education.

- Electricity and Magnetism, J. W. Fewkes and J. Yarwood, Vol. I, 1991, Oxford Univ. Press.

Course designed by:

- Dr. Rajib Kr. Basumatary, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Prof. Arup Kr. Deka, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Dr. Dibya Jyoti Sivananda, Assistant Professor, Department of Physics, Darrang College (Autonomous)

****

SEMESTER: THIRD

Subject: Physics (Minor)

Course Title: Waves and Oscillations

Course Code: PHY-MN-03014

Credit: 4 (3 Theory+0 Tutorial+1 Practical)

COURSE OBJECTIVE

- To learn SHM and derive equation of SHM
- To learn superposition of harmonic waves and oscillations, different types of wave
- motions, formation of standing waves and velocity of waves in media.
- To study damped and forced oscillations
- To study progressive wave ,velocity of waves, intensity of sound, Acoustics of halls, reverberation
- To get hands on experience of operating CRO and other practical apparatus

COURSE OUTCOME

After successful completion of this course, students will be able to

- Explain the differential equation of simple harmonic motion and its solution, and discuss energy relations (kinetic, potential, total) and anharmonic oscillations.
- Apply the principle of superposition to study beats, Lissajous figures, and perform basic Fourier analysis of periodic functions.
- Analyze damped and forced oscillations, resonance conditions, Q-factor, and energy dissipation mechanisms.
- Derive and interpret the wave equation for longitudinal and transverse waves, and relate phase velocity, group velocity, dispersion, and energy transport.
- Determine the velocity of transverse and longitudinal waves in different media, and explain Newton's formula and Laplace's correction for sound velocity.
- Examine the formation of stationary waves, normal modes in strings and pipes, and understand experimental verification using Melde's experiment.
- Describe the characteristics and production of ultrasonic waves and understand principles of architectural acoustics, reverberation, and Sabine's formula.

Title of the course Course code	**Waves and Oscillations** **PHY-MN-03014**
Total Credit	4 (3 Theory+ 0 Tutorial+ 1 Practical)
Contact hours	45 (L)+0 (T)+30 (P)
Distribution of Marks	Internal Assessment: 30 End Semester: Theory=45; Practical=25

Course Summary

Unit	Topic	Lecture (hours)	Tutorial (hours)	Practical (hours)	Total (hours)
I	Oscillations	4	0	30	75
II	Superposition of Harmonic Oscillations	6			
III	Damped and forced Oscillations	8			
IV	Waves	6			
V	Velocity of waves	6			
VI	Superposition of Two Harmonic Waves	9			
VII	Sound	6			

DETAILED SYLLABUS

Theory: 3 Credit **Lecture: 45; Tutorial: 0**

Unit I: Oscillations **(Lectures 4)**

Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Anharmonic or nonlinear oscillation

Unit II: Superposition of Harmonic Oscillations **(Lectures 6)**

Linearity and Superposition principle, Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats), Lissajous figures and their use. Fourier series and Fourier coefficients, Fourier analysis in some simple cases.

Unit III: Damped and forced Oscillations **(Lectures 8)**

Damped oscillation, critical, damping, logarithmic decrement, energy of a damped harmonic oscillator, power dissipation, Q-factor of an oscillator, forced vibration, amplitude and velocity resonance, Sharpness of resonance.

Unit IV: Waves **(Lectures 6)**

Progressive Waves, wave equation, plane wave and spherical wave, Longitudinal and Transverse Waves, dispersion, group velocity, phase velocity, energy density and intensity of waves

Unit V: Velocity of Waves **(Lectures 6)**

Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid, in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Unit VI: Superposition of Two Harmonic Waves **(Lectures 9)**

Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes

Unit VII: Sound **(Lectures 6)**

Intensity and loudness of sound, ultrasonic wave, production of ultrasonics, piezo electric generator. Acoustics of halls, reverberation and Sabines formula.

Practical: 1 Credit **Contact Hours: 30**

At least four experiments must be performed from the following:

1. To study damping effect of simple harmonic motion using simple pendulum.
2. To determine torsional rigidity of a wire.
3. To determine the frequency of AC main by sonometer using non-magnetic wire.
4. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2-T law
5. Study of Lissajous figure of two different waves using CRO and find out the unknown frequency of an electrical signal.

Suggested Reading:

1. Chattopadhyay, D., *Vibration, Waves and Acoustics*, 2010, New Central Book Agency
2. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
3. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
4. A Textbook of Sound, 3rd Edition, A. B. Wood, 1955, Bell & Sons
5. Vibrations and Waves in Physics, 2nd edition, I. G. Main, 1984, Cambridge University Press.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
7. Geeta Sanon, BSc Practical Physics, 1st Edn. 2007, R. Chand & Co.
8. Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
9. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
10. Engineering Practical Physics, S. Panigrahi and B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
11. B. Sc. Practical Physics, C. L. Arora, S. Chand, and Company.
12. A Text Book on Practical Physics, K. G. Mazumdar, and B. Ghosh.

Course designed by:

- Dr. Shyamalima Chowdhury, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Dr. Barsha Borgohain, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Prof. Arup Kr. Deka, Assistant Professor, Department of Physics, Darrang College (Autonomous)

SEMESTER: FOUR

Subject: Physics (Minor)

Course Title: Thermal Physics

Course Code: PHY-MN-04014

Credit: 4 (3 Theory+0 Tutorial+1 Practical)

COURSE OBJECTIVE

- To understand principles of thermodynamics
- To provide concepts of thermodynamic functions
- To address the basic framework of kinetic theory of gases

COURSE OUTCOME

Upon completion of this course, students will be able to

- Describe Maxwell–Boltzmann velocity distribution, mean free path, and transport phenomena in ideal gases.
- Explain real gas behavior using Virial and Van der Waals equations and analyze the Joule–Thomson effect.
- Apply the laws of thermodynamics to study heat, work, and efficiency of engines and refrigerators.
- Define and evaluate entropy changes in reversible and irreversible processes and interpret thermodynamic laws in terms of entropy.
- Use thermodynamic potentials and Maxwell's relations to relate various thermodynamic parameters and phase changes.

Title of the course Course code	**Thermal Physics** **PHY-MN-04014**
Total Credit	4 (3 Theory+ 0 Tutorial+ 1 Practical)
Contact hours	45 (L)+0 (T)+30 (P)
Distribution of Marks	Internal Assessment: 30 End Semester: Theory=45; Practical=25

Course Summary

Unit	Topic	Lecture (hours)	Tutorial (hours)	Practical (hours)	Total (hours)
I	Distribution of Velocities and Molecular Collisions	9			
II	Real Gases	8	0	30	75
III	Principles of Thermodynamics	16			
IV	Entropy	6			
V	Thermodynamic Potentials and Thermodynamic Relations	6			

DETAILED SYLLABUS

Theory: 3 Credit **Lecture: 45; Tutorial: 0**

Unit I: Distribution of Velocities and Molecular Collisions **(Lectures 9)**

Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Mean Free Path. Collision Probability. Transport Phenomenon in Ideal Gases: (1) Viscosity, and (2) Thermal Conductivity. Brownian Motion (qualitative idea only).

Unit II: Real Gases **(Lectures 8)**

Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapor and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. Joule- Thomson Porous Plug Experiment. Joule- Thomson Effect, Joule-Kelvin coefficient for Ideal and Van der Waal Gases. Temperature of Inversion.

Unit III: Principles of Thermodynamics **(Lectures 16)**

Thermodynamic preliminaries: Extensive and intensive properties, Thermodynamic Variables, Thermodynamic Equilibrium, P-V indicator diagram. Work done in terms of P and V, Zeroth Law of Thermodynamics & Concept of Temperature, Internal energy and First Law of Thermodynamics, Applications of First Law: General Relation between *C*P and *C*V. Reversible and Irreversible process with examples. Heat & work, state function, Conversion of heat into work and vice versa, Work Done during Isothermal and Adiabatic Processes, Heat Engines, second Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence, Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Unit IV: Entropy **(Lectures 6)**

Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Entropy Changes in Reversible and Irreversible processes with examples. Principle of Increase of Entropy. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics.

Unit V: Thermodynamic Potentials and Thermodynamic Relations **(Lectures 6)**

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Derivations and applications of Maxwell's Relations, Maxwell's Relations: (1) Clausius Clapeyron equation, (2) Values of *Cp-Cv*, (3) TdS Equations, (4) Energy equations, (5) Change of Temperature during Adiabatic Process.

Practical: 1 Credit **Contact hours: 30**

At least four experiments must be performed from the following

1. To determine mechanical equivalent of heat, J, by Callender and Barne's constant flow method.
2. To determine the mechanical equivalent of heat, J using calorimeter.
3. To determine specific heat of a liquid using calorimeter.
4. To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
5. To determine the coefficient of thermal conductivity of an insulator by Lee and Charlton's disc method.
6. To determine the temperature coefficient of resistance by Platinum Resistance Thermometer (PRT).

7. To study the variation of thermo-emf of a thermocouple with difference of temperature of its two junctions.
8. To determine the change of entropy of universe for an AC circuit consists of a thermally insulated resistor.
9. To calibrate a thermocouple to measure temperature in a specified range using (1) Null method, (2) Direct measurement using OPAMP and to determine neutral temperature.

Suggested Reading list

1. Heat and Thermodynamics, M. Zemansky, R. Dittman, McGraw-Hill Education, 2017.
2. A Treatise on Heat, Meghnad Saha and B. N. Srivastava, Indian Press, 1973.
3. Thermal Physics: Kinetic Theory, Thermodynamics and Statistical Mechanics, S. C. Garg, R. M. Bansal and C . K. Ghosh, Tata McGraw Hill Education Pvt Ltd, 2 0 1 3 .
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, F. W. Sears & G. L. Salinger, Narosa Publishing House, 1998.
5. Thermal and Statistical Physics, R. B. Singh, New Academic Science, 2011.
6. Theory and Experiment on Thermal physics, P K. Chakrabarti, New Central Book Agency (P) Ltd, 2011.

Course designed by:

- Dr. Saiful Islam, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Prof. Manoj Kr. Sarma, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Prof. Arup Kr. Deka, Assistant Professor, Department of Physics, Darrang College (Autonomous)

****

SEMESTER: FIVE

Subject: Physics (Minor)

Course Title: Optics

Course Code: PHY-MN-05014

Credit = 4 (3 Theory + 0 Tutorial+ 1 Practical)

COURSE OBJECTIVES

The present course offers an all-encompassing survey of the basic principles of optics and Laser, building upon the fundamental knowledge gained in previous educational endeavors. Furthermore, the present course explores the creation of innovative ideas within this particular area of study.

COURSE OUTCOME

At the end of the course students will be able to understand

- The origin of ray optics and its applications
- Understand Interference as superposition of waves from coherent sources derived from same parent source
- Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from aperture, understand Fraunhoffer and Fresnel Diffraction
- Understand polarization of light

- Fundamental principles of lasing mechanism and identifying various types of lasers
- Basics of Holography and its applications

Title of the course Course code	**Optics** **PHY-MN-05014**
Total Credit	4 (3 Theory+ 0 Tutorial+ 1 Practical)
Contact hours	45 (L)+0 (T)+30 (P)
Distribution of Marks	Internal Assessment: 30 End Semester: Theory=45; Practical=25

Course Summary

Unit	Topic	Lecture (hours)	Tutorial (hours)	Practical (hours)	Total (hours)
I	Ray Optics	7			
II	Defects of Image	7	0	30	75
III	Introduction to Wave Optics	3			
IV	Interference	8			
V	Diffraction	8			
VI	Polarization	5			
VII	Lasers	4			
VIII	Holography	3			

DETAILED SYLLABUS

Theory: 3 Credit **Lecture: 45; Tutorial: 0**

Unit I: Ray Optics **(Lectures: 7)**

Fermat's principle and its application in establishing laws of reflection and refraction at spherical and plane boundaries, Sign convention, conjugate foci, relation for refraction of paraxial rays at single spherical surface, interrelation among lateral, longitudinal and angular magnification, Lagrange's law and Helmholtz equation and its modification for telescopic system.

Unit II: Defects of Image **(lectures: 7)**

Spherical aberration and its magnitude for thin lens for object at finite distance and condition for minimum aberration when object is at infinity, Minimization of spherical aberration by using suitable lens of different radii of curvature and by aplanatic surface, Qualitative idea about coma, astigmatism and distortion, Chromatic aberration, circle of least confusion, achromatism of two thin lenses separated by a distance.

Unit III: Introduction to Wave Optics **(Lectures: 3)**

Wave optics: Electromagnetic nature of light, definition and properties of wave front, Huygens principle, Temporal and Spatial coherence.

Unit IV: Interference **(Lectures: 8)**

Superposition principle, Intensity distribution in an interference pattern, Division of wave front and amplitude, Young's double slit experiment, Fresnel's Biprism. Phase change on reflection: Stokes' treatment, Interference in Thin Films: parallel and wedge-shaped films, Newton's Rings: Measurement of wavelength and refractive index, Michelson interferometer.

Unit V: Diffraction **(Lectures: 8)**

Fresnel and Fraunhofer diffraction, Fresnel's Half-Period Zones for Plane Wave, Fresnel diffraction pattern of a straight edge and at a circular aperture, Fraunhofer diffraction: Single slit and Double slit, Diffraction grating, Resolving power of grating.

Unit VI: Polarization **(Lectures: 5)**

Polarized light and its mathematical representation, Production of polarized light by reflection, refraction and scattering, Polarization by double refraction and Huygen's theory, Calcite Crystal and Optic axis, Polarizer: Nicol prism, Retarding Plates, Production and analysis of circularly and elliptically polarized light.

Unit VII: Lasers **(Lectures: 4)**

Einstein's A and B coefficients, Metastable states, Spontaneous and Stimulated emissions, Optical Pumping and Population Inversion, Three-Level and Four-Level Lasers, Ruby Laser and He-Ne Laser.

Unit VIII: Holography **(Lectures: 3)**

Principle of Holography, Recording and Reconstruction Method, Theory of Holography as Interference between two Plane Waves, Point source holograms.

Practical: 1 Credit **Contact Hours: 30**

At least four experiments to be performed from the following:

1. Familiarization with: Schuster's focusing, determination of angle of prism.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
4. To determine wavelength of sodium light using Fresnel Biprism.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
7. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
8. To determine dispersive power and resolving power of a plane diffraction grating.

Suggested Reading List:

- Fundamentals of Optics, F. A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- A textbook of Light, Ghosh and Mazumder
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.

Course designed by:

- Dr. Barsha Borgohain, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Prof. Manoj Kr. Sarma, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Dr. Archana Haloi, Assistant Professor, Department of Physics, Darrang College (Autonomous)

*****

SEMESTER: SIX

Subject: Physics (Minor)

Course Title: Condensed Matter Physics & Electronics

Course Code: PHY-MN-06014

Credit: 4 (3 Theory+ 0 Tutorial+ 1 Practical)

COURSE OBJECTIVES

- To provide the elementary idea about crystal structure, bonding and lattice dynamics in solids. To make the students understand the concepts of transport properties, dielectric properties, ferroelectric properties and magnetic properties in solids. To familiarise the students with nanomaterials, thin film, soft matter and superconductivity.
- Develop foundational understanding of analog and digital electronics, focusing on basic devices, circuit analysis, and applications. To impart the basic principles of Boolean algebra, combinational and sequential digital circuits, and circuit simplification.

COURSE OUTCOME

On successful completion of the course students will be able to

- Acquire the basic knowledge of crystal structure, bonding in solids and elementary idea lattice dynamics of materials, dielectric, ferroelectric and magnetic properties of solids, the physics of electrons in solids, basic idea about nanomaterials, thin film and soft matter and understand the basic concept in superconductivity.
- Interpret and understand the working principles of basic semiconductor devices and their roles in analog and digital circuits, apply Boolean algebra for circuit simplification and implement combinational logic circuits, build basic logic circuits and explain their applications

Title of the course Course code	**Condensed Matter Physics & Electronics** **PHY-MN-06014**
Total Credit	4 (3 Theory+ 0 Tutorial+ 1 Practical)
Contact hours	45 (L)+0 (T)+30 (P)
Distribution of Marks	Internal Assessment: 30 End Semester: Theory=45; Practical=25

Course Summary

Unit	Topic	Lecture (hours)	Tutorial (hours)	Practical (hours)	Total (hours)
Part A: Condensed Matter Physics			0	30	75
I	Crystal Structure and Bonding in Solids	10			
II	Transport Properties of Materials	7			
III	Nanophysics and Soft Matter	3			
IV	Magnetic Materials	3			
Part B: Electronics					
I	Semiconductor Diodes and their Applications	7			
II	Bipolar Junction Transistors	4			
III	Digital Circuits	6			
IV	Boolean Algebra	5			

DETAILED SYLLABUS

Theory: 3 Credit **Lecture: 45; Tutorial: 0**

Part A: Condensed Matter Physics **Lecture: 23**

Unit I: Crystal Structure and Bonding in Solids **(Lectures: 10)**
Amorphous, crystalline and polycrystalline materials, lattice translation vectors, unit cell, types of crystal lattice, Bravais Lattice, Miller Indices, inter planer spacing. Ionic, covalent, metallic, van-der-Waal and hydrogen bondings, cohesive energy of ionic crystal, Madelung constant.

Unit II: Transport Properties of Materials **(Lectures: 7)**
Free Electron Theory of Metals, Electrical and thermal conductivity of metals, preliminary idea of band theory, band gap, conductor, semiconductor (p and n type) and insulator, conductivity of semiconductor, mobility.

Unit III: Nanophysics and Soft Matter **(Lectures: 3)**
Basic idea about nanomaterials, thin film physics and soft matter.

Unit IV: Magnetic Materials **(Lectures: 3)**
Dia, para, ferri, ferro and anti-ferromagnetic materials.

Part B: Electronics **Lecture: 22**

Unit I: Semiconductor Diodes and their Applications **(Lecture: 7)**
Introduction to P-N junction diode, Volt-ampere relation of P-N junction diode (deduction not necessary), Energy band diagram of P-N diode. Special purpose diodes (introduction only). . Zener diode and its application as voltage regulator

Unit II: Bipolar Junction Transistors **(Lecture: 4)**
n-p-n and p-n-p Transistors. Characteristics of CB, CE, and CC Configurations. Current gains α and β. Relations between α and β

Unit III: Digital Circuits **(Lecture: 6)**

Difference between Analog and Digital Circuits. AND, OR, and NOT Gates. NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.

Unit IV: Boolean Algebra **(Lecture: 5)**

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra, Binary addition.

Practical: 1 Credit **Contact Hours: 30**

At least five experiments must be performed from the following

1. Measurement of susceptibility of a paramagnetic solution (Quinck's Tube Method).
2. To measure the magnetic susceptibility of solids.
3. To Study V-I characteristics of PN junction diode and determine cut-in voltage using breadboard.
4. To draw the forward and reverse bias characteristic of a Zener diode and hence determine DC, AC resistances and breakdown voltage (Using Breadboard).
5. To design voltage regulator using Zener diode and study the load and line regulation (Using Breadboard).
6. To verify De Morgan's theorem using IC 7400 and 7402. (Using Breadboard).
7. To design (a) OR, (b) AND, and (c) NOT gate with resistance, diode and transistors and verify their truth table. (Using Breadboard).
8. To design OR, AND and NOT gates using universal gates and verify their truth table. (Using breadboard)

Suggested reading list

- Introduction to Solid State Physics, C Kittel
- Lattice Dynamics, A K Ghatak and L S Kothari
- Solid State Physics, A J Dekker.
- Introductory Solid State Physics, H P Myers.
- Solid State Physics, N W Ashcroft and N D Mermin
- Magnetism in solids, D H Martin
- Physics of Magnetism, S Chikazumi. 8. Solid State Physics, S O Pillai
- Introduction to Nanotechnology, C. P. Poole, J. F. J. Owens
- Electronics: Fundamentals and Applications, J. D. Ryder, 2004, Prentice Hall.
- Electronic Devices & circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- Semiconductor Devices: Physics and Technology, S. M. Sze, 2nd Ed., 2002, Wiley India
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
- Electronics Fundamentals and Applications, D. Chattopadhyay and P. C. Rakshit, 17th Ed, 2023, New Age International Publishers
- Principles of Electronics, V. K. Mehta, Rohit Mehta, 11th Ed. 2008, S. Chand.
- Digital Principles and Applications, A. P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.

Course designed by:

- Dr. Rajib Kr. Basumatary, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Dr. Barsha Borgohain, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Prof. Arup Kr. Deka, Assistant Professor, Department of Physics, Darrang College (Autonomous)

******

SEMESTER: SEVEN

Subject: Physics (Minor)

Course Title: Atomic and Nuclear Physics

Course Code: PHY-MN-07014

Credit: 4 (3 Theory+ 1 Tutorial+ 0 Practical)

COURSE OBJECTIVE

The objective of Atomic Physics is

- To learn the development of atom models.
- To learn the origin of atomic spectra and their modifications under different physical conditions.

The objective of Nuclear Physics course is to impart

- Basic knowledge about the nucleus and other subatomic particles and their properties.
- Knowledge about the radioactive disintegration of a nucleus and the laws of radioactive decays.
- Knowledge on basic nuclear instrumentation and experimental techniques of nuclear physics.
- Basic knowledge of particle physics.

COURSE OUTCOME

- Students will be able to understand the atomic spectra of one and two valance electron atoms and will also understand the change in behavior of atoms and corresponding modification of their spectra in external applied electric and magnetic field.
- Students will also be able to understand the structure and properties of a nucleus. They will also know about the properties of strong nuclear force that keeps the nuclei bound. They will learn about the radioactive decays and various laws of radioactive disintegration. Students will have adequate knowledge on the construction and working principles of particle accelerators and detectors. Moreover, students will be introduced to the world of particle physics – types and interactions.
- The acquired knowledge can be applied in the areas of nuclear medicine, medical physics, archaeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.

Title of the course Course code	**Atomic and Nuclear Physics** **PHY-MN-07014**
Total Credit	4 (3 Theory+ 1 Tutorial+ 0 Practical)
Contact hours	45 (L)+15 (T)+0 (P)
Distribution of Marks	Internal Assessment: 40 End Semester: Theory=60; Practical=0

Course Summary

Unit	Topic	Lecture (hours)	Tutorial (hours)	Practical (hours)	Total (hours)
Part A: Atomic Physics			15	0	60
I	Atom Model	8			
II	X-rays	4			

III	Multi Electron Atoms	5			
Part B: Nuclear Physics					
I	Basic Properties of Nuclei	6			
II	Radioactivity and Radioactive Laws	4			
III	Nuclear Instrumentation	8			
IV	Fission and Fusion	6			
V	Elementary Particles	4			

DETAILED SYLLABUS

Theory: 4 Credit **Lecture: 45; Tutorial: 15**

Part A: Atomic Physics **Lecture: 17; Tutorial: 5**

Unit I: Atom Model **(Lectures: 8)**

The Bohr model of the hydrogen-like atom. Orbital magnetic dipole moment: Bohr Magneton. Gyromagnetic Ratio, Larmor precession, Space Quantization, Electron Spin.

Vector Atom Model: Quantum numbers associated with vector atom model, spin-orbit interaction, Coupling Schemes: L-S Coupling and j-j Coupling, Spectroscopic term and their notation, Stern-Gerlach experiment and its conclusion. Normal and Anomalous Zeeman Effect, Paschen Back and Stark Effect (Qualitative Discussion only).

Unit II: X-rays **(Lectures: 4)**

Ionizing Power, X-ray Diffraction, Bragg's Law, X-ray Spectra: Continuous and characteristic X-rays Mosley's law, Compton effect.

Unit III: Multi Electron Atoms **(Lectures: 5)**

Hund's rule, Periodic table: Pauli's exclusion principle, explanation of the periodic classification of the elements, Building up or Aufbau Principle, Broad features of Alkali atom (Na etc.), spectra and its explanation.

Part B: Nuclear Physics **Lecture: 35; Tutorial: 10**

Unit I: Basic Properties of Nuclei **(Lecture: 6)**

Constituents of a nucleus: proton-electron hypothesis. Properties of nucleus - mass, radius, volume, matter density of nuclei and their units. Mass defect and Binding energy, binding energy per nucleon, stability of a nucleus- neutron to proton ratio, stability line; Nuclear models: Liquid drop model, Shell model (qualitative only)

Unit II: Radioactivity and Radioactive Laws **(Lecture: 4)**

Types of Radioactivity – alpha, beta, and gamma decay. Laws of radioactive decay, disintegration constant, half-life and mean life. Activity of a radioactive source, units of radioactivity.

Unit III: Nuclear Instrumentation **(Lecture: 8)**

Interaction of Radiation with Matter: Interaction of photon with matter – Photoelectric effect, Compton effect and Pair production.

Detectors: Gas filled detectors – Pulse height Vs applied voltage graph. Construction and working principle of G. M. counter.

Particle Accelerators: Need of charged particle accelerators, Linear accelerator (LINAC) Construction and working principle, Cyclotron.

Unit IV: Fission and Fusion **(Lecture: 6)**

Mass defect and Q-value of a nuclear reaction, Einstein's mass-energy equivalence principle and generation of nuclear energy. Nuclear Fission: Spontaneous and induced fission. Fission chain reactions and nuclear reactor. Fusion and thermonuclear reactions: Energy production in stars, P-P cycle and CNO cycle (brief qualitative discussions).

Unit V: Elementary Particles **(Lecture: 4)**

Types of interactions – strong, electro-magnetic, weak interactions and gravitational interactions. Elementary particle and their classification. Quantum numbers and conservation laws. Allowed and forbidden reactions.

Suggested Reading List:

- Introduction to Atomic spectra, H. E. White, Tata McGraw Hill (1934)
- Atomic and Molecular Spectra, Raj Kumar
- Concepts of Modern Physics, Arthur Beiser (McGraw-Hill Book Company, 1987)
- Atomic physics, J. B. Rajam & foreword by Louis De Broglie (S. Chand & Co., 2007)
- Physics of Atoms and Molecules, B. H. Bransden and C. J. Joachein.
- Basic ideas and concepts in Nuclear Physics: An introductory approach by K Heyde, third edition, IOP Publication, 1999. 87
- Nuclear Physics by S N Ghoshal, First edition, S. Chand Publication, 2010.
- Introductory Nuclear Physics by K S Krane, Wiley-India Publication, 2008.
- Nuclear Physics: principles and applications by J Lilley, Wiley Publication, 2006.
- Radiation detection and measurement, G F Knoll, John Wiley & Sons, 2010.
- Schaum's Outline of Modern Physics, McGraw-Hill, 1999.
- Concept of Modern Physics by Arthur Beiser, McGraw Hill Education, 2009.
- Nuclear Radiation Detector by S S Kapoor and V S Ramamurthy , 1st edition, New Age international publisher.

Course designed by:

- Dr. Saiful Islam, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Dr. Rajib Kr. Basumatary, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Prof. Manoj Kr. Sarma, Assistant Professor, Department of Physics, Darrang College (Autonomous)

******

SEMESTER: EIGHT

Subject: Physics (Minor)

Paper Name: Quantum Mechanics

Paper Code= PHY-MN-08014

Total Credit: 4 (3 Theory + 0 Tutorial+ 1 Practical)

COURSE OBJECTIVE

The objective of the course is to impart broad overview of the history of quantum mechanics and its gradual development. Schrödinger equation has been discussed along with its applications.

COURSE OUTCOME

CO 01: The learner will receive a broad overview of the history of quantum mechanics and its gradual development. Schrödinger equation which is one of the important equation for studying quantum mechanical systems will be learned along with other aspects like operator formulism of quantum mechanics, principle of uncertainty and complementarity, etc.

CO 02: They will learn to apply the formulism learned so far to investigate quantum mechanical systems like simple harmonic oscillator, hydrogen atom, etc.

CO 03: This knowledge will help in understanding other branches in Physics like Solid State Physics, Nuclear Physics, Spectroscopy, Astrophysics, optics, etc.

Title of the course Course code	**Quantum Mechanics** **PHY-MN-08014**
Total Credit	4 (3 Theory+ 0 Tutorial+ 1 Practical)
Contact hours	45 (L)+0 (T)+30 (P)
Distribution of Marks	Internal Assessment: 30 End Semester: Theory=45; Practical=25

Course Summary

Unit	Topic	Lecture (hours)	Tutorial (hours)	Practical (hours)	Total (hours)
I	Origin of Quantum Theory	15	0	30	75
II	Schrödinger's Equation	12			
III	Postulates of Quantum Mechanics	5			
IV	Application of Schrödinger's equation in one dimensional potential	13			

DETAILED SYLLABUS

Theory: 3 Credit **Lecture: 45; Tutorial: 0**

Unit I: Origin of Quantum Theory **(Lectures: 15)**

Origin of Quantum Theory - Inadequacy of classical physics, Planck's quantum hypothesis, Photo electric effect, Compton Effect, Wave-particle duality - de-Broglie hypothesis and genesis of Quantum Mechanics, Verification of matter wave - Davisson-Germer's experiment. Wave description of particles by wave packets. Group and phase velocities and relation between them. Two-slit experiment with electrons. Probability. Wave amplitude and wave functions. Uncertainty and complementarity - Heisenberg's uncertainty principle and complementarity principle of Neil Bohr, limitations on experiment.

Unit II: Schrödinger's Equation **(Lectures 12)**

Development of the wave equation, time dependent Schrödinger's equation, Time independent Schrödinger Equation; Statistical interpretation wave function, Continuity of a wave function, Conditions for physical acceptability of wave functions. Normalization. Linearity and Superposition Principles. Boundary conditions, probability and probability current density, expectation value of position and momentum, operator, Ehrenfest's theorem,

Time independent Schrödinger's equation, Hamiltonian, stationary states, energy quantisation, expansion of an arbitrary wave function as a linear combination of energy Eigen functions; General solution of the time dependent Schrödinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle.

Unit III: Postulates of Quantum Mechanics **(Lectures: 5)**

Postulates of quantum mechanics, observables, hermitian operators, eigenvalues and Eigen function, uncertainty principle (including time and energy), commuting observables and compatibility.

Unit IV: Application of Schrödinger's equation in one dimensional potential well **(Lectures: 13)**

Schrödinger's equation in one dimensional step potential, potential barrier - reflection and transmission coefficients and tunneling effect, square well potential with infinite depth, one dimensional harmonic oscillator. Quantum mechanics of simple harmonic oscillator-energy levels and energy Eigen functions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle.

Practical: 1 Credit **Contact Hours: 30**

At least four experiments to be performed from the following

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect: Photo current versus intensity and wavelength of light; maximum energy of photo -electrons versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of Hα emission line of hydrogen atom.
6. To determine the ionisation potential of mercury.
7. To determine the absorption lines in the rotational spectrum of iodine vapour.
8. To determine the value of e/m by (a) magnetic focusing or (b) bar magnet.
9. To setup the Millikan's oil drop apparatus and determine the charge of an electron.
10. To show the tunnelling effect in tunnel diode using I-V characteristics.

11. To determine the wavelength of laser source using diffraction from single slit.
12. To determine the wavelength of laser source using diffraction from double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.

Suggested Reading list

1. N. Zettili, Quantum Mechanics, John Wiley & Sons (2001).
2. J. J. Sakurai and J. Napolitano, Modern Quantum Mechanics, Cambridge Univ. Press, 2020.
3. Y. R.Waghmare, Fundamentals of Quantum Mechanics, Wheeler publishing (2014).
4. P. A. M. Dirac, Principles of Quantum Mechanics, Oxford University Press (1981).
5. B. H. Bransden and C. J. Joachain, Quantum Mechanics, Pearson Education 2nd Ed. (2004).
6. K. Gottfried and T-M Yan, Quantum Mechanics: Fundamentals, 2nd Ed., Springer (2003).
7. R. Shankar, Principles of Quantum Mechanics, Springer (India) (2008).
8. D. J. Griffiths, Introduction to Quantum Mechanics, Pearson Education (2005).
9. L. Schiff, Quantum Mechanics, Mcgraw-Hill (1968).
10. A. K. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer (2002).
11. A. Bieser, Concepts of Modern Physics, McGraw Hill (2002).
12. Arno Bohm, Quantum Mechanics: Foundations and Applications, 3rd Edition, Springer (1993).
13. H. C. Verma, Quantum Mechanics, TBS publications (2019).
14. P M Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd Edition, McGraw Hill (2010).
15. Satya Prakash, Quantum mechanics, 4th Edition, Pragati prakashan (2009).

Course designed by:

- Dr. Archana Haloi, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Dr. Rajib Kr. Basumatary, Assistant Professor, Department of Physics, Darrang College (Autonomous)
- Dr. Dibya Jyoti Sivananda, Assistant Professor, Department of Physics, Darrang College (Autonomous)

******