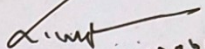
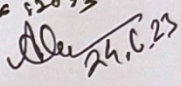
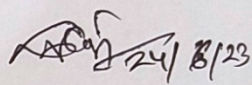
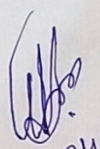
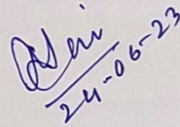
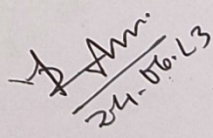


# FYUGP SYLLABUS (UNDER NEP-2020) of Department of Physics for PHYSICS as MINOR MADHABDEV UNIVERSITY

DEPARTMENT OF PHYSICS  
MADABDEV UNIVERSITY  
NARAYANPUR, ASSAM-784164

A meeting of Board of Studies of the Department of Physics, MDU was held on 24-06-2023 at 12:00 PM in offline mode.

The following members were present-

1. Dr. Limpon Bora Academic Registrar MDU   
24.6.2023
2. Dr. Arindam Phukan HOD, Dept. of Physics, MDU & Chairman   
24.6.23
3. Dr. Lakhinath Borah Member, Dept. of Physics, MDU   
24/6/23
4. Prof. Mrinal Kumar Das External member  
Head  
Dept. of Physics  
Tezpur University   
24-6-2023
5. Dr. Nilamoni Saikia External member  
Associate Professor  
Dept. of Physics  
Chaiduar college   
24-06-23
6. Dr. Lakhi Buragohain External member  
Associate Professor  
Dept. of Physics  
Chaiduar college   
24-06-23

For Minor in Physics, there will be in total eight (8) papers of 32 credits (each of 4 credits), one in each semester. Each paper will be of 70 marks in End semester examination. There will be another 30 marks for internal assessment for each paper. The Internal Assessment marks can be evaluated by conducting Sessional Examinations (2 times for each paper), conducting Seminars, Attendance of the students etc.

**Semester I**  
**Paper Name: Physics I**  
**Paper code: PHYN-101**

**Credit:4**

Course Objectives: The course will enable the student to

1. To have a conceptual understanding of frame of references and related transformations.
2. To realize the reduction of a two body problem to a one body problem in central force system.
3. To appreciate the theory of relativity for particles having relativistic speed.
4. To understand the physics of rigid body.
5. To have a conceptual realization of elastic behavior of matter and to have a theoretical and practical understanding of surface tension and viscosity.
6. To have a detailed analytical understanding of vector algebra with proper knowledge of curvilinear co-ordinate.

**Unit-I: Newtonian Mechanics**

Concept of frame of references (Inertial and non-inertial), Review of Newton's laws of motion, Galilean Transformation and Galilean invariance, two body problem, reduction of two body problem to one body problem, Centre of mass, angular momentum and torque, angular momentum of a system of particles about their Centre-of mass, principle of conservation of angular momentum, Impulse.

Force, Work and Energy and Gravitation: Conservative and Non conservative force, Work-Energy Theorem, Work done in conservative field, conservative force as potential gradient, Elastic and Inelastic collisions. Laboratory and Centre-of-mass reference frames.

Central force, Motion of a particle under central force field, Gravitational field and potential, calculation of gravitational field and potential due to spherical shell and solid sphere. Kepler's laws, satellites in a circular orbit and applications, Geosynchronous orbits, Weightlessness, Basic idea of Global Positioning System (GPS).

Special Theory of Relativity: Michelson-Morley experiment and its outcomes, postulates of special theory of relativity, Lorentz Transformation, Length contraction, Time dilation, variation of mass with velocity, Mass-Energy Equivalence, Relativistic addition of velocities. **(35 Marks 30L)**

**Unit-II: Properties of Matter**

Equation of motion of rotating rigid bodies, moment of inertia, theorems of Moment of Inertial, Calculation of M.I of a circular lamina, a solid cylinder, a hollow sphere and a solid sphere. Kinetic Energy of Rotation, Motion involving both translation and rotation. Theory of compound pendulum and determination of 'g'.

Elasticity: Hooke's law- Stress Strain diagram, Young modulus, Bulk modulus and Modulus of Rigidity, Poisson's ratio, relation between elastic constants, bending of beam, the cantilever, work done in stretching and work done in twisting a wire-Twisting couple on a cylinder.

Surface Tension and Surface Energy, angle of contact, rise of liquid in a capillary tube. Viscosity: Streamline flow, turbulent flow, equation of continuity, determination of co-efficient of viscosity by Poiseuille's method, Stoke's method. **(17Marks 15L)**

### **Unit-III: Mathematical Physics**

Vector Calculus: Properties of vectors under rotations, Elements of vector calculus, Scalar and Vector fields.

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

**(18 Marks 15L)**

#### **Recommended readings:**

- Mechanics D.S.Mathur, S. Chand & Co
- Elements of Properties of Matter, D.S.Mathur, S. Chand & Co
- Properties of Matter, Brijlal and Subramaniam.
- Mechanics (In SI Units): Berkeley Physics Course Vol 1 Charles Kittel, Walter Knight, et al Tata McGrawHill 2007
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons
- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- Mathematical Physics, Dass and Verma. S. Chand & Co

Expected learner outcome: This course will

1. Introduce the students to the basic concepts of mechanics.
2. Enable students to get a vast idea of conservation laws and its correlation with nature and symmetry.
3. Enable the students to understand different properties of matter with realization.
4. Develop analytical skills to solve vector algebra with application to physics.
5. Develop knowledge of special relativity to understand relativistic formulation of modern theories.

## Semester II

### Paper Name: Physics II

**Paper code: PHYN-201**

**Credit:4**

Course Objectives: The course will enable the student to

1. To have a detailed knowledge about electric and magnetic field.
2. To have an idea about formulation and application of dielectric properties of matter.
3. To acquire a clear understanding of magnetic properties of matter.
4. To understand origin of the Maxwell equations.
5. Apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity, Maximum Power Transfer, etc. and their applications in electronics, electrical circuit analysis, and electrical machines.

#### **Unit-I: Electric Field and Electric Potential**

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to (1) Plane Infinite Sheet and (2) Sphere. **(22 Marks 20 L)**

#### **Unit-II: Dielectric Properties of Matter**

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector  $D$ . Relations between  $E$ ,  $P$  and  $D$ . Gauss' Law in dielectrics. **(12 Marks 10 L)**

#### **Unit-III: Magnetic Field and Magnetic Properties of Matter**

Magnetic force between current elements and definition of Magnetic Field  $B$ . Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of  $B$ : curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic, Field.

Magnetization vector ( $M$ ). Magnetic Intensity ( $H$ ). Magnetic Susceptibility and permeability. Relation between  $B$ ,  $H$ ,  $M$ . Ferromagnetism.  $B$ - $H$  curve and hysteresis. **(16 Marks 14L)**

#### **Unit-IV: Electromagnetic Induction**

Faraday's Law. Lenz's Law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.

**(5 Marks 4L)**

## Unit-V: Electrical Circuits

AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCRCircuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. ParallelLCR Circuit.

Network theorems:Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Nortontheorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem.Applications to dc circuits. Ballistic Galvanometer:Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagneticdamping.Logarithmic damping.CDR. (15 Marks 12 L)

### Recommended readings:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H.Fewkes&J.Yarwood. Vol. I, 1991, Oxford Univ. Press

Expected learning outcome:

1. Students will have a theoretical as well as practical knowledge about different electrical and magnetic properties of matter.
2. Develop the basic theoretical knowledge as well as experimental skills of the students on electrical networking.
3. Train the students to handle and repair instruments based on electric and magnetic field effects.

## Semester III

### **Paper Name: Thermal Physics and Statistical Mechanics**

**Paper code: PHYN-301**

**Credit:4**

Course objective: At the completion of this course, a student will be able to

1. Develop the working knowledge of the laws and methods of thermodynamics and elementary statistical mechanics.
2. Provide insight to the postulates of Statistical Mechanics and statistical interpretation of thermodynamics
3. Understand the laws of radiation and acquire knowledge for their applications in various disciplines in Physics, Chemistry, Biology, Earth and Atmospheric Sciences.
4. Develop application oriented knowledge on laws of statistical mechanics in selected problems
5. Use the methodologies, conventions and tools of thermal and statistical physics to test and communicate ideas and explanation

### **Unit-I:Laws of Thermodynamics Thermodynamic**

Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and

Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero. **(24 Marks 22 L)**

### **Unit-II: Thermodynamic Potentials**

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for  $(C_P - C_V)$ ,  $C_P/C_V$ , TdS equations. **(12 marks 10 L)**

### **Unit-III: Kinetic Theory of Gases**

Derivation of Maxwell's law of distribution of velocities and its experimental verification, mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono- atomic and diatomic gases. **(12 marks 10L)**

### **Unit-IV: Theory of Radiation**

Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law. **(8 marks 6 L)**

### **Unit-V: Statistical Mechanics**

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics. **(14 marks 12 L)**

### **Recommended readings:**

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Heat and Thermodynamics, M.W. Zemansky and R. Dittman, 1981, McGraw Hill
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W. Sears and G.L. Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications

Expected Learning outcome:

1. Students will acquire a sound knowledge of laws Thermodynamics, different process and thermodynamic potentials and understand the use of thermodynamics in day to day life and in technology. Students will also learn Kinetic Theory of Gases, Transport Phenomena and Specific heat laws and about the Radiation theories.
2. The last paragraph is all about statistical mechanics and applications.

## Semester-IV

### **Paper name: Lab-I**

**Paper code: PHYN-401**

**Credit-4**

#### **Course objective:**

This paper is experimental one, accordingly students must perform experiments in the departmental labs, through the experiments they will find applications of physics in engineering, mechanics and in the fields of electricity and magnetism. They will learn how to take measurements, will learn the underlying physics principles in every experiments they perform and can be able to calculate the errors etc.

#### **Group A: Mechanics**

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b)  $g$  and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine  $g$  and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of  $g$  using Bar Pendulum.
12. To determine the value of  $g$  using Kater's Pendulum.

#### **Group B: Electricity & Magnetism**

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) 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, and Maximum power transfer theorems.
9. To determine self-inductance of a coil by Anderson's bridge.
10. To study 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.
11. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor  $Q$ .
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

### **Group C: Thermal Physics**

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

#### **Expected Learning outcome:**

Students will learn precise measurement techniques in mechanics and in electricity using instruments, they will be able to verify physical laws in mechanics, E & M and in Thermal physics, calculation of elastic constants using different mechanical techniques and also perform experiments to calculate acceleration due to gravity using complex pendulums etc. Also students will be familiar with electrical bridges (both DC & AC) to calculate inductance/capacitance etc, RC,LC and LCR circuits to study the characteristics and may be able to study ballistic galvanometers and network theorems using trainer kits. In thermal physics section, students will perform different experiments to calculate Thermal conductivity & mechanical equivalent of heat and also use of thermo couple.

#### **Recommended readings:**

- A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal,1985, Vani Pub.
- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House

## **Semester-V**

### **Paper name: Waves and Optics**

**Paper code: PHYN-501**

**Credit-4**

Course objective: At the completion of this course, a student will be able to

1. To understand superposition of waves, formation of Lissajous figures under different conditions.
2. Physics of sounds, intensity and about engineering aspects of acoustic of building.
3. Learn the basic ideas of the behaviour of light based on its wave nature.
4. Develop the knowledge of the different phenomena due to the interaction of light among them and with matter.
5. Learn about some fundamental principles of light which is used in different optical instrument which very essential for Physics student.

#### **Unit-I: Superposition Harmonic oscillations**

Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats)., Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **(7 marks 6L)**

## **Unit-II:Waves Motion- General**

Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity.Plane waves. Spherical waves, Wave intensity. **(9 marks 7 L)**

## **Unit-III: Sound**

Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria. **(12marks 10 L)**

## **Unit-IV:Wave Optics**

Electromagnetic nature of light.Definition and Properties of wave front.Huygens Principle. **(4 marks3 L)**

## **Unit-V:Interference**

Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment.Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel andwedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. Michelson's Interferometer:Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes. **(16 marks 15 L)**

## **Unit-VI: Diffraction**

Fraunhofer diffraction- Single slit; Double Slit.Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate.Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **(16 marks14 L)**

## **Unit-VII: Polarization**

Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. **(6marks 5 L)**

## **Recommended readings:**

- Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill
- Principles of Optics, B.K. Mathur, 1995, Gopal Printing
- Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications
- University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986.

Expected learner Outcomes: This course will enable the students to

1. Understand Physical laws of sound, intensity and mechanism of acoustic of buildings
1. Justify different phenomena due to light and the interaction of light among them and with matter.
2. Understand underlying physics phenomena in different optical instruments.

## Semester-VI

### Paper name: Elements of Modern Physics

Paper code: PHYN-601

Credit:4

Course Objectives: At the completion of this course, a student will be able to

1. Understand the theoretical basis for the understanding of quantum Physics as the basis for dealing with microscopic phenomena.
2. Apply concepts of 20th Century Modern Physics to deduce the structure of atoms.
3. Explain the wave-particle duality of the photon.
4. Analyze the structure of matter at its most fundamental.
5. Develop insight into the key principles and applications of Nuclear Physics

#### **Unit-I: Basics of Quantum Theory**

Planck's quantum theory, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer 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. **(12 marks 10L)**

#### **Unit-II: Wave-particle duality:**

Wave-particle duality, Heisenberg uncertainty principle, estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. **(16marks 15 L)**

#### **Unit-III: Nuclear Physics**

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, N-Z graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions). **(35marks 30L)**

#### **Unit-IV: Lasers**

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. Basic lasing. **(7 marks 5 L)**

#### **Recommended Readings:**

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002,
- Tata McGraw Hill Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
- Quantum Mechanics: Theory & Applications, A.K.Ghatak&S.Lokanathan, 2004, Macmillan
- Additional recommended readings:
- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2 ndEdn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.

Expected learner outcome: This course will enable the students to :

1. Understand and appreciate the theory of modern physics
2. Develop the ability to apply it in solving simple problems in Quantum Mechanics (QM), structure of atoms, Laser, and Nuclear Physics.

### **Semester-VII**

#### **Paper name: Solid State Physics and Electronics**

**Paper code: PHYN-701**

**Credit:4**

Course objective: At the completion of the course, a student will be able to

1. Understand the basics of crystals and X-Ray crystallography and Reciprocal lattice concepts.
2. Band theory and its use to distinguish among conductors, insulators and semiconductors.
3. To learn about superconductivity and related topics.
4. Semiconductors and Transistors and their characteristics
5. Introductory idea of Digital electronics, Boolean algebra, Gates and about IC's.

#### **Unit-I: Crystal Structure**

Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis, Unit Cell, Miller Indices, Types of Lattices, Diffraction of X-rays by Crystals, Bragg's Law. Concept of Reciprocal Lattice and Brillouin Zone. **(6 marks 5L)**

## Unit-II: Elementary band theory

Free electron theory and its limitations, Kronig Penny model, Band Gap, Conductor, Semiconductor and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. **(12marks 10 L)**

## Unit-III: Superconductivity

Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation). **(5marks 5 L)**

## Unit-IV: Semiconductor Devices

P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity, Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode, Current Flow Mechanism in Forward and Reverse Biased Diode.

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation and (3) Tunneling Diode

n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains  $\alpha$  and  $\beta$ , Relations between  $\alpha$  and  $\beta$ . **(23marks 20L)**

## Unit-V: Digital Circuits

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs **(24marks 20L)**

## Recommended readings:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications
- Elementary Solid-State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Elements of Solid-State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
- Solid State Electronic Devices, B.G. Streetman & S.K. Banerjee, 6th Edn., 2009, PHI Learning
- 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
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate, 2010, Oxford University Press

## Expected Learner outcome:

The course will enable the students to get some basic ideas of Solid State Physics and Electronics, in the first part, the physics of Condensed Matter Physics, where X-Ray Crystallography, Band Theory, Hall Effect and

Super conductivity are incorporated and in the later part the students may expect to learn all about Semi conducting devices like Diodes, Transistors and its uses as Amplifiers etc and IC's.

### Semester-VIII

#### **Paper name: Lab-II**

#### **Paper code: PHYN-801**

**Credit-4**

Course Objective:

This is a Lab paper, so a student may be expected to learn some underlying physical phenomena by hands on experience in the fields of Waves and Optics (Group A), in the field of modern physics (group B) and in electronics (Group C)

#### **Group-A: Wave and optics**

2. To investigate the motion of coupled oscillators
3. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify  $\lambda^2 - T$  Law.
4. To study Lissajous Figures
5. Familiarization with Schuster's focussing; determination of angle of prism.
6. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
7. To determine the Refractive Index of the Material of a Prism using Sodium Light.
8. To determine Dispersive Power of the Material of a Prism using Mercury Light
9. To determine the value of Cauchy Constants.
10. To determine the Resolving Power of a Prism.
11. To determine wavelength of sodium light using Fresnel Biprism.
12. To determine wavelength of sodium light using Newton's Rings.
13. To determine the wavelength of Laser light using Diffraction/Interference of Single Slit.
14. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
15. To determine the Resolving Power of a Plane Diffraction Grating.
16. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits

#### **Group-B: Elements of modern Physics**

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 the Planck's constant using LEDs of at least 4 different colours.
4. To determine the value of  $e/m$  by (a) Magnetic focusing or (b) Bar magnet.
5. To setup the Millikan oil drop apparatus and determine the charge of an electron.
6. To show the tunneling effect in tunnel diode using I-V characteristics.
7. To determine the wavelength of laser source using diffraction of single slit.
8. To determine the wavelength of laser source using diffraction of double slits.
9. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane 1 diffraction grating.

#### **Group-C: Electronics**

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator
3. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
4. To study the frequency response of voltage gain of a RC-coupled transistor amplifier

5. To verify and design AND, OR, NOT and XOR gates using NAND gates.
6. To design a combinational logic system for a specified Truth Table.
7. To convert a Boolean expression into logic circuit and design it using logic gate IC

**Recommended readings:**

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
- Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.
- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.

Expected Learner outcome:

After performing a good number of practical of this paper the student will acquire a sound experimental knowledge in the fields of Sound and Optics, in Quantum Physics and LASER and also in the fields of both analog and digital electronics.