Draft Syllabus

for

Four-Year (Eight Semester)

Undergraduate Program

in

Physics

Interdisciplinary/Disciplinary Minor

Course

(as per NEP 2020)

(Effective from Academic Session 2024-25)

University of Gour Banga

Malda-732103

West Bengal

Name of Minor (Core) Papers

(Each carries 4 credits)

Semester	Course Code	Course Name
I.	PHS-IDC/DC-MN-101	Mechanics
II.	PHS-IDC/DC-MN-201	Electricity & Magnetism
III.	PHS-IDC/DC-MN-301	Thermal Physics
IV.	PHS-IDC/DC-MN-401	Optics
V.	PHS-IDC/DC-MN-501	Electronics
VI.	PHS-IDC/DC-MN-601	Modern Physics -I
VII.	PHS-IDC/DC-MN-701	Astrophysics
VIII.	PHS-IDC/DC-MN-801	Modern Physics -II

Semester – I

Syllabus for Physics (Minor)

Title of the Course: Mechanics

Paper Code: PHS-IDC/DC-MN-101

Learning Objectives:

The primary objective of this course is to introduce the basic knowledge about some topics of Physics (like, Mathematical methods, Laws of Motion, Work and Energy, Gravitation, Rotational Motion, Elasticity, Surface Tension and Viscosity). This course gives students preliminary ideas about physics in the beginning.

Learning Outcomes:

On completion of this course, the students will be able to

1. Understand the vector algebra and vector analysis to solve problems, and solve various problems based on Vector.

2. Familiar with the frames of reference, Newton's laws of motion, dynamics of a system of particles, conservation of momentum and centre of mass.

3. Understand the work-energy theorem, conservative forces, concept of potential energy and conservation of energy.

4. Acquire knowledge about the motion of a particle in a central force field, conservation of angular momentum leading to restriction of the motion to a plane and constancy of areal velocity. Understand the Kepler's law and GPS.

5. Understand the rotation of a rigid body about a fixed axis, angular velocity and angular momentum, moment of inertia, torque, conservation of angular momentum.

6. Understand the Hooke's Law, elastic constants, relation between them, beam, cantilever, strain energy and elasticity in liquid and gas.

7. Acquire knowledge about the synclastic and anticlastic surface, excess of pressure within a curved surface-application to spherical drops and bubbles, variation of surface tension with temperature.

8. Understand about the Newton's law of viscosity, rate of liquid flow in a capillary tube - Poiseuille's formula and Reynold's number.

Course Content

Mechanics (Theory) Credits – 3

Module: -1

(a) Vector Algebra and Vector Calculus: Vectors as directed line segments. Addition of vectors and multiplication by a scalar. Scalar and vector products. Basis and representation of vectors. Derivatives of a vector with respect to a parameter. Gradient, divergence and curl. Vector integration, line, surface and volume integrals of vector fields. Gauss' divergence theorem and Stoke's theorem of vectors (Statement only).

(b) Frames of reference. Newton's laws of motion. Dynamics of a system of particles. Conservation of momentum. Centre of mass.

(c) Work-energy theorem. Conservative forces. Concept of potential energy. Conservation of energy.

Module: -2

(a) Rotational Motion: Rotation of a rigid body about a fixed axis. Angular velocity and angular momentum. Moment of inertia. Torque. Conservation of angular momentum.

(b) Gravitation: Motion of a particle in a central force field. Conservation of angular momentum leading to restriction of the motion to a plane and constancy of areal velocity. Newton's law of Gravitation. Kepler's laws (statement only). Satellite in circular orbits. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness.

Module: -3

(a) Elasticity: Hooke's law, Stress-strain diagram, elastic moduli-relation between elastic constants. Poisson's ratio. Expression for Poisson's ratio in terms of elastic constants. Beams. Bending of beams. Internal bending moment. Cantilever. Torsion of a cylinder. Strain energy. Elasticity in liquid and gas.

(b) Surface Tension: Synclastic and anticlastic surface. Excess of pressure within a curved surface-application to spherical drops and bubbles. Variation of surface tension with temperature.

(c) Viscosity: Newton's law of viscosity. Rate of liquid flow in a capillary tube - Poiseuille's formula. Reynold's number.

Suggestive Readings:

- University Physics. FW Sears, MW Zemanski and HD Young13/e, 1986. Addison- Wesley
- Mechanics Berkeley Physics course, v.1: Charles Kittel, et. Al. 2007, Tata McGraw- Hill.
- Physics - Resnick, Halliday & Walker 9/e, 2010, Wiley.
- Physics for Degree Students (For B.Sc. 1st Year); C.L. Arora &P.S. Hemme; S.Chand Publishing.
- Snatok padarthabigyan, Vol- 1 & 2, C. R. Dasgupta, 2010, Booksyndicate Pvt. Ltd.
- A Handbook of degree Physics, Vol- 1 & 2, C. R. Dasgupta, 2010, Book syndicate Pvt. Ltd.
- Sanatak Padarthavidya, Semester-1, D. Jana, S. K. Bera, S. Pal,2021, Santra Publication.
- Snatikiyo Padarthavidya, Vol-1. A. Bhattacharjee, R. Bhattacharjee, 2018, New Central Book Agency.

Module:- 4 Mechanics (Practical) Credit - 1

List of Experiments:

1. To determine the Moment of Inertia of a metallic cylinder/rectangular bar about an axis passing through its centre of gravity.

2. To determine the Young's Modulus of the material of a beam by the method of flexure.

3. To determine the Modulus of Rigidity of the material of a wire by static method.

4. To determine the Modulus of Rigidity of the material of a wire by dynamic method.

5. To determine the Young's modulus of the material of a wire by Searle's method.

6. To determine g by bar pendulum.

7. To determine g by Kater's pendulum.

8. To study the motion of a spring and calculate (a) Spring Constant and (b) g.

Suggestive Readings:

- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11thEdn, 2011, Kitab Mahal
- Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
- Parikhagare Padarthavidya (Practical Physics), S. das & M. das,2021, Santra Publication.
- Snatok Baboharik Padarthabigyan, C. dasgupta, S. Maity, 2014, Books Syndicate Pvt. Ltd.
- Baboharik Padarthavidya, S. K. Ghosh, 2014. New Central Book Agency.

Semester – II

Syllabus for Physics (Minor)

Title of the Course: Electricity and Magnetism

Paper Code: PHS-IDC/DC-MN-201

Learning Objectives:

The primary objective of this course is to introduce electrostatics, magnetism, electro-magnetic induction and linear network.

Learning Outcomes:

On completion of this course, the students will be able to

1. Understand about Coulombs law. Principle of superposition. Electrostatic field, Divergence of an electrostatic field. Flux. Gauss's theorem of electrostatics. Applications of Gauss theorem. Curl of an electrostatic field. Electric potential and its applications, Electric field and charge density, Electric fields inside matter and its related problem and its solution.

2. Learn Biot-Savart's law and the Lorentz force law and its applications, divergence and curl of the magnetic field, Ampere's circuital law, determination of the magnetic field in various cases, Know about potential and field due to a magnetic dipole, magnetic dipole moment, force and torque on a magnetic dipole, Magnetic fields inside matter and brief introduction different types of magnetic materials.

3. Learn the Ohm's law, E.M.F, Faraday's laws, Lenz's law, self-inductance, mutual inductance and energy stored in magnetic field

4. Learn about the different types of Linear Network, Thevenin & Norton's theorem. Maximum power transfer theorem and superposition theorem and De Sauty's bridge.

<u>Course Content</u>

Electricity & Magnetism (Theory) **Credits – 3**

Module: -1

(a) Coulombs law. Principle of superposition. Electrostatic field.

(b) Divergence of an electrostatic field. Flux. Gauss's theorem of electrostatics. Applications of Gauss theorem to determine electric field due to- (i) point charge, (ii) infinite line of charge, (iii) uniformly charged spherical shell (iv) solid sphere, (v) plane charged sheet, and (vi) charged conductor.

(c) Curl of an electrostatic field. Electric potential as line integral of electric field. Potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Electric potential and field due to an electric dipole. Electric dipole moment. Force and torque on a dipole.

(d) Conductors: Electric field and charge density inside and on the surface of a conductor. Force per unit area on the surface. Capacitance of a conductor. Capacitance an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field.

(e) Electric fields inside matter: Electric Polarization. Bound charges. Displacement vector. Gauss's theorem in dielectrics. Linear Dielectric medium. Electric susceptibility and permittivity. Parallel plate capacitor completely filled with dielectric.

Module: -2

(a) Biot-Savart's law and the Lorentz force law. Application of Biot-Savart's law to determine the magnetic field due to: (i) a straight conductor, (ii) circular coil, and (iii) solenoid carrying current. Force between two straight current carrying wires.

(b) Divergence of the magnetic field. Magnetic vector potential.

(c) Curl of the magnetic field. Ampere's circuital law. Determination of the magnetic field of a straight current carrying wire. Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole.

(d) Magnetic fields inside matter: Magnetization. Bound currents. The magnetic intensity - H. Linear media. Magnetic susceptibility and permeability. Brief introduction of dia, para and ferromagnetic materials.

Module: -3

(a) Ohm's law and definition of E.M.F. Faraday's laws of electromagnetic induction. Lenz's law. Self-inductance (L) of a coil, mutual inductance (M) of two coils. Energy stored in magnetic field. Kirchhoff's law in AC circuit. Series and parallel L-C-R circuits.

(b) Ideal current and voltage source. Thevenin & Norton's theorem. Maximum power transfer theorem and superposition theorem. De Sauty's bridge.

Suggestive Readings:

- Introduction to Electrodynamics, David J Griffiths 3rd Edn, 1998, Benjamin Cummings.
- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I,1991, Oxford Univ. Press.
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks.
- Electricity and Magnetism; R. Murugeshan; S. Chand Publishing.
- Snatok padartha bigyan, Vol- 1 & 2, C. R. Dasgupta, 2010, Book syndicate Pvt. Ltd.
- A Handbook of degree Physics, Vol- 1 & 2, C. R. Dasgupta, 2010, Book syndicate Pvt. Ltd.
- Sanatak Padartha vidya, Semester-2, D. Jana, S. K. Bera, S. Pal,2021, Santra Publication.
- Snatikiyo Padarthavidya, Vol-2. A. Bhattacharjee, R. Bhattacharjee, 2018, New Central Book Agency.

Module:- 4 Electricity and Magnetism (Practical) Credit - 1

List of Experiments:

1. To compare capacitances using De Sauty's bridge.

2. To study the I-V Characteristics of a series RC circuit.

3. To study a series LCR circuit and determinants(a) Resonant frequency(b) Quality factor

4. To study a parallel LCR circuit and determine its:(a) Anti-resonant frequency and (b) Quality factor Q

5. To determine a Low Resistance by Carey Foster's Bridge.

Suggestive Readings:

- Advanced Practical Physics for students, B.L. Flint & 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, 11^{th}Ed.2011, Kitab Mahal.
- Parikhagare Padarthavidya (Practical Physics), S. Das & M. Das,2021, Santra Publication.
- Snatok Baboharik Padarthabigyan, C. Dasgupta, S. Maity, 2014, Books Syndicate Pvt. Ltd.
- Baboharik Padartha vidya, S. K. Ghosh, 2014. New Central Book Agency.

Semester – III

Syllabus for Physics (Minor)

Title of the Course: Thermal Physics

Paper Code: PHS-IDC/DC-MN-301

Learning Objectives:

This course aims to provide a comprehensive understanding of the fundamental principles of thermodynamics and kinetic theory, with a focus on the behavior of gases and the laws governing thermal processes. The objective of the course is to

Understand the Kinetic Theory of ideal and real gases, by deriving gas laws, and apply concepts such as mean free path and Maxwell's distribution to analyze gas behavior.

Understand the Thermodynamic Laws: Explain the zeroth, first, second, and third laws of thermodynamics, including concepts of internal energy, work, heat transfer, and entropy, and illustrate their applications in various thermodynamic processes.

Utilize Thermodynamic Potentials: Analyze and differentiate between thermodynamic potentials (enthalpy, Gibbs free energy, Helmholtz free energy) and apply Maxwell's relations to solve problems related to energy transformations.

Explore Radiation Theory: Understand blackbody radiation, derive and apply Planck's law, and relate various laws of radiation to thermal radiation phenomena.

Through theoretical insights and practical applications, students will gain the necessary skills to critically evaluate thermodynamic systems and understand their implications in real-world scenarios.

Learning Outcomes:

Upon successful completion of this course, students will be able to:-

1. Articulate the assumptions and implications of the kinetic theory, including the behavior of ideal and real gases, and calculate properties such as pressure, temperature, and velocity distributions.

2. Apply the Laws of Thermodynamics: Demonstrate proficiency in applying the zeroth, first, second, and third laws of thermodynamics to analyze and solve problems related to energy transfer, work, and heat in various thermodynamic processes.

3. Utilize thermodynamic potentials (enthalpy, Gibbs free energy, Helmholtz free energy) to determine system behaviour and energy changes during chemical reactions and phase transitions, and employ Maxwell's relations effectively.

4. Explain the principles of blackbody radiation and derive key equations such as Planck's law, Wien's law, and the Stefan-Boltzmann law, applying these concepts to real-world thermal radiation problems.

5. Integrate theoretical knowledge with practical applications in engineering, physics, and other fields, demonstrating an ability to approach complex thermodynamic and kinetic systems critically and innovatively.

By achieving these outcomes, students will be well-prepared for advanced studies in physics, engineering, and related disciplines, as well as for practical applications in research and industry.

Course Content

Thermal Physics (Theory): Credits: 3

Module: -1

(a) Kinetic Theory of Gases: Perfect gas, the pressure exerted by an ideal gas, deduction of ideal gas laws, mean free path, Maxwell's law of distribution of velocities (deduction not required), rms, mean and most probable velocities, degrees of freedom, principle of equipartition of energy, specific heats of monatomic and polyatomic gases.

(b) Continuity of State: defects of ideal gas equation, equation of state for real gases, critical constants, law of corresponding states.

Module: -2

(a) Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamically Processes, Applications of First Law: General Relation between C_P and C_V and Work Done during Isothermal and Adiabatic Processes. Compressibility and Expansion Coefficients.

(b) Reversible and irreversible processes. Second law and Entropy, Carnot's cycle & Carnot's theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, un-attainability of absolute zero.

Module: -3

(a) 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 and TDS equations.

(b) 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.

Suggestive 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. Zemasky and R. Dittman, 1981, McGraw Hill.
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W. Sears and G.L. Salinger. 1988, Narosa.

• Heat, Thermodynamics and Statistical Physics; B. Lal, N. Subramanyam and P.S. Hemme; S. Chand Publishing.

• Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

• University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole

Module:- 4 Thermal Physics (Practical) Credits: 1

List of Experiments:

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 a bad conductor by Lee and Charlton's disc method.

3. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.

4. To study the variation of thermo-emf across two junctions of a thermocouple with temperature.

5. To determine the co efficient of linear expansion by optical lever method.

Suggestive Readings:

- Advanced Practical Physics for students, B.L. Flint & 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, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

Semester – IV

Syllabus for Physics (Minor)

Title of the Course: Waves and Optics

Paper Code: PHS-IDC/DC-MN-401

Learning Objectives:

The objective of the "Waves and Optics" course is to provide students with a foundational understanding of wave motion and optical phenomena, emphasizing both theoretical principles and practical applications.

Understand Wave Motion: Explain the principles of wave motion, including the superposition of waves, the nature of harmonic oscillations, and the characteristics of transverse waves, including traveling and standing waves.

Analyze Wave Phenomena: Apply concepts such as phase velocity, group velocity, and wave intensity to analyze different types of waves, including plane and spherical waves.

Explore Wave Optics: Describe the electromagnetic nature of light, and apply Huygens' principle and the principles of interference to various optical experiments, such as Young's double slit and Newton's rings.

Investigate Diffraction: Understand the concepts of Fraunhofer and Fresnel diffraction, and analyze diffraction patterns using principles of wave behavior, including the effects of slits and diffraction gratings.

Examine Polarization: Discuss the transverse nature of light waves, and explore the methods of producing and analyzing polarized light, as well as the implications of optical activity.

Through a combination of theoretical exploration and practical experimentation, students will develop critical thinking skills and a deeper appreciation for the behavior of waves and light, preparing them for advanced studies in physics, engineering, and related fields.

Learning Outcomes:

Upon successful completion of the "Waves and Optics" course, students will be able to:

1. Clearly articulate the principles of wave motion, including the superposition principle, harmonic oscillations, and the characteristics of both traveling and standing waves.

2. Calculate relevant properties of waves, such as phase velocity, group velocity, and wave intensity, and apply these calculations to real-world scenarios.

3. Explain and analyze the results of classic optical experiments, including Young's double slit and Newton's rings, demonstrating a clear understanding of interference and wavefront concepts.

4. Use analytical methods to interpret Fraunhofer and Fresnel diffraction patterns, and understand their implications in optical systems, including diffraction gratings.

5. Identify and describe the methods for producing and analyzing polarized light, and differentiate between plane, circular, and elliptical polarization, along with their applications in optical technology.

6. Integrate theoretical knowledge with practical applications, demonstrating the ability to approach complex wave and optical phenomena critically and solve related problems effectively.

By achieving these outcomes, students will be equipped with a solid understanding of wave and optical principles, preparing them for further studies in physics, engineering, and applied sciences.

Course Content

Waves and Optics (Theory): Credits: 3

Module: -1

(a) Superposition of Two Collinear Harmonic Oscillations Linearity & Superposition Principle. Oscillations having equal and different frequencies, Beats, Dopler effect.

(b) Superposition of Two Perpendicular Harmonic Oscillation Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

(c) 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.

Module: -2

(a) Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

(b) Interference: Division of amplitude and division of wave-front. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Bi-prism. Phase change on reaction: Stoke's treatment. Interference in Thin Films: parallel and wedge-shaped film. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness. Newton's Rings: measurement of wavelength and refractive index.

Module: -3

(a) Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating.

(b) Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

(c) Polarization: Transverse nature of light waves. Plane polarized light - production and analysis. Circular and elliptical polarization. Optical activity.

Suggestive Readings:

• Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill.

• Principles of Optics, B.K. Mathur, 1995, Gopal Printing.

• University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley.

• Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications.

Module:- 4 Waves and Optics (Practical): Credits: 1

List of Experiments:

1. To determine the frequency of an electrically maintained tuning fork by Melde's experiment and to verify λ^2 – T law.

2. Familiarization with Schuster`s focussing; determination of angle of prism.

3 To determine the Refractive Index of the Material of a Prism using Sodium Light.

4. To determine wavelength of sodium light using Newton's Rings.

5. To determine the refractive index of a liquid by the travelling microscope.

6. To determine the focal length of a concave lens by auxiliary lens method.

Suggestive Readings:

• Advanced Practical Physics for students, B.L. Flint & 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, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

• A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

Semester – V

Syllabus for Physics (Minor)

Title of the Course: Electronics

Paper Code: PHS-IDC/DC-MN-501

Learning Objectives:

The main objectives of this course are to understand the fundamentals, analyze and design simple circuits of diodes and transistors, and other feedback circuits, understand the role of electronics in day-to-day life.

Learning Outcomes:

After completing this course of Electronics, the students will be able to

1. Understand electronic components.

2. Learn the basic concepts and techniques of digital electronics.

3. Learn about the basic electrical and electronics terminology and definitions, and apply theorems and laws to circuit analysis.

4. Learn how to apply math, science and engineering knowledge to solve complex problems.

Course Content

Electronics (Theory): **Credit = 03**

Module: - 1

(a) P and N type semiconductors. Energy level diagram. Conductivity and Mobility, Concept of Drift velocity. PN junction fabrication (simple idea). Barrier formation in PN junction diode. Static and dynamic resistance. Current flow mechanism in forward and reverse biased diode.

(b) Rectifier diode: Half-wave rectifiers. Centre-tapped and Bridge full-wave rectifiers, Calculation of Ripple factor and rectification efficiency, C-filter. Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.

(c) Bipolar Junction Transistors: 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. Load line analysis of transistors. DC load line and Q-point. Physical mechanism of current flow. Active, Cut-off and Saturation regions.

Module: -2

(a) Transistor biasing and stabilization circuits. Fixed bias and Voltage divider bias. Transistor as 2-port network. h-parameter equivalent circuit. Analysis of a single-stage CE amplifier using hybrid model. Input and Output impedance. Current, voltage and power gains. Classification of class A, B & C amplifiers.

(b) Two stage RC-coupled amplifier and its frequency response.

(c) Feedback in amplifiers: Effects of positive and negative feedback on input impedance, Output impedance, and Gain.

(d) Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillation. Elementary idea of Hartley oscillator (Calculations in detail not required).

(e) Operational Amplifiers (Black Box approach): Characteristics of an ideal and practical Op-Amp (IC 741). Open-loop and Closed-loop Gain. Frequency response. Common Mode Rejection Ratio (CMRR). Slew rate and concept of Virtual ground.

(f) Applications of Op-Amps: (1) Inverting and Non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Wein bridge oscillator.

Module:- 3

(a) Difference between Analog and Digital circuits. Binary Numbers. Conversion between Binary and Decimal numbers. Octal and Hexadecimal numbers. AND, OR, and NOT Gates (Realization using Diodes and Transistors). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

(b) 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 an Equivalent Logic Circuit by (1) Sum of products method, and (2) Karnaugh Map.
(c) Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. Arithmetic Circuits: Binary addition. Binary Subtraction using 2’s complement method. Half Adders and Full Adders. Half and Full Subtractors, 4-bit binary Adder/Subtractor.

Suggestive Readings:

- J. Millman and C.C. Halkias, Integrated Electronics, 1991, Tata Mc-Graw Hill.
- J.D. Ryder, Electronics: Fundamentals and Applications, 2004, Prentice Hall.
- B. G. Streetman & S. K. Banerjee, Solid State Electronic Devices, 6/e ,2009, PHI Learning.
- S. Salivahanan & N. S. Kumar, Electronic Devices & Circuits, 3/e, 2012, Tata Mc-Graw Hill.
- R. A. Gayakwad, OP-Amps and Linear Integrated Circuit, 4/e, 2000, Prentice Hall.
- Chattopadhyaya and Rakshit, Foundation of Electronics.
- P. Malvino, D. P. Leach & Saha, Digital Principles and Applications, Tata Mc-Graw Hill.
- OP-AMP and Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.

Module: 4 Electronics (Practical): Credit = 01

List of Experiments:

1. To study the I-V characteristics of a PN junction diode, and LEDs.
2. To study the I-V characteristics of a Zener diode and its use as voltage regulator.

3. To study the characteristics of a BJT in CE configuration and determine the value of β.
4. To verify and design AND, OR, NOT, and XOR Gates using NAND Gates.
5. Half Adder, Full Adder, and 4-bit Binary Adder.
6. Study the use of OPAMP as an Inverting amplifier using d.c. source.
7. Study the use of OPAMP as a Non-Inverting amplifier using d.c. source.
8. To design inverting amplifier using Op-amp (741,351) and study its frequency response.
9. To add two d.c. voltages using Op-Amps in inverting and non-inverting mode.
10. Study the use of an OPAMP as Differential amplifier using d.c. source.

Suggestive Readings:

- Advanced Practical Physics, B. Ghosh and K. G. Mazumdar, Sreedhar Publishers.
- Basic Electronics: A Text Lab Manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill. Electronic Devices & circuit Theory, R.L. Boylestad & L.D.

Semester – VI

Syllabus for Physics (Minor)

Title of the Course: Modern Physics I

Paper Code: PHS-IDC/DC-MN-601

Learning Objectives:

The main objectives of this course are to understand the fundamental physical principles of the universe including the special relativity, elementary quantum mechanics and atomic physics. The two pillars of modern physics are quantum theory and the theory of relativity. The aim of modern physics is to cover these topics in sufficient depth.

Learning Outcomes:

Upon successful completion of this subject, students should:

1. Develop an understanding on the concepts of Atomic and Modern Physics, basic elementary quantum mechanics.
2. Develop critical understanding of concept of Matter waves and Uncertainty principle.
3. Get familiarized with the principles of elementary quantum mechanics.
4. Understand postulates of Special theory of relativity and its consequences such as length contraction, time dilation, relativistic mass and mass-energy equivalence.

Course Content

Modern Physics I (Theory): **Credit = 03**

Module: - 1

a) Galilean Transformations, Newtonian Relativity and its limitations,
b) Michelson Morley Expt and its consequences,
c) Postulates of special Theory of Relativity, Lorentz Transformation (deduction not required), length contraction, simultaneity, time dilation,
d) Relativistic addition of velocities, relativistic mass and momentum, mass energy Relation

Module: -2

a) Inadequacy of classical physics, Photoelectric effect, Compton effect, black body radiation, Einstein's explanation, Planck's Radiation Law (statement only)
b) Dual nature of radiation, wave nature of particles, De-broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, wave particle duality, velocity of de Broglie wave.
c) Heisenberg Uncertainty Principle, Illustration of the Principle through thought Experiments of Gamma ray microscope.

Module: -3

a) Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle.
b) Rutherford Model of atom and its limitations.

c) Bohr's model of H atom, explanation of atomic spectra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model
d) Discrete energy exchange by atom, Frank Hertz Expt.
e) Concept of quantum numbers, Pauli exclusion Principle

Suggestive Readings:

- Concept of Modern Physics by A.Beiser , Mc Graw Hill
- Introduction to Modern Physics by H.S. Mani and G.K. Mehta
- Atomic and Nuclear Physics by S.N. Ghosal (S. Chand & Co.)
- Introduction to Special Theory of Relativity by R. Resnick (Wiley Eastern ltd)
- Modern Physics by R. Murugeshan (S. Chand & Co.)
- Introduction To Quantum Mechanics by S. N. Ghosal (Calcutta Book House)
- Quantum Mechanics by A. K. Ghatak And S. Lokenathan (Macmillan, Delhi)
- Quantum Mechanics by Powell And Craseman

Module:- 4 Modern Physics I (Practical): Credit = 01

List of Experiments:

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 H-alpha emission line of Hydrogen atom.

Suggestive 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 Edn, 2011,Kitab Mahal

Semester – VII

Syllabus for Physics (Minor)

Title of the Course: AstroPhysics I

Paper Code: PHS-IDC/DC-MN-701

Learning Objectives:

To familiarize students with Classification of stars, Evolution of stars, types of galaxies and the notion of the Universe. Details of our star, the Sun, and our galaxy, the Milky way, is included to arouse curiosity of our stellar neighbourhood.

Learning Outcomes:

At the end of the course, students will have basic knowledge of
1. What we know about some of the constituents (stars and galaxies) of the Universe, and
2. How we know what we know.

<u>Course Content</u>

Astrophysics: **Credit = 04**

Module: -1

a) Basics of atomic spectra; Electromagnetic radiation from stars reach the Earth in the visible and radio frequency ranges; Radiations received provide information about the size, temperature, composition etc. of stars.
b) Astronomical measures: Brightness - the measure of stellar magnitude; Radiant flux and Luminosity and their relation with surface temperature; Astronomical scales: (a) Distance - Astronomical unit, parsec and light year; (b) Time - 1 Earth day (c) Mass - the Solar mass.
c) Astronomical Coordinate system- Geographical coordinate system, horizontal coordinate system, equatorial coordinate system, ecliptic coordinate system.

Module: -2

a) Astronomical telescopes- refracting telescope, Galilean telescope, refelcting telescope .
b) Spectral classification of stars - Hertzsprung Russel diagram - a relation between luminosity and spectral type of stars (and surface temperature).
c) Our solar system, origin of or solar system, planets, extrasolar planets, tidal forces.

Module: -3

a) Physics of Stellar Evolution: Thermonuclear processes in the core, hydrogen fusion in main sequence stars, proton-proton chain and the CNO cycle; Hydrostatic equilibrium; Chandrasekhar mass limit (derivation not required).

b) The process: formation of a main sequence star - evolution to a Red Giant as helium core collapses - small stars become stable white dwarfs - role of electron degeneracy (qualitative); large stars (typically greater than 5 times solar mass) end in explosion - the Supernova - the inert core further collapses to form a neutron star or a black hole.

Module: -4

a) Sun, solar parameters, structure of the sun-Core, radiative zone, convection zone, Photosphere, Chromosphere, Corona; solar activities, Sunspots.
b) Component of a galaxy, Hubble classification of galaxies, the milky way galaxy, intergalactic medium, nebula, star formation from a nebula
c) The universe, Big Bang theory, Hubble’s law, Fate of our universe, dark energy and dark matter.

Suggestive Readings:

- "Introducing the stars: formation, structure and evolution", M. Beech, Springer (2019)
- "The Physics of Stars", A. C. Philips, Wiley (2013)
- "An Introduction to Astrophysics", Baidyanath Basu, Tanuka Chattopadhyay and Sudhindra Nath Biswas, Prentice Hall of India (2010)

Semester – VIII

Syllabus for Physics (Minor)

Title of the Course: Modern Physics II

Paper Code: PHS-IDC/DC-MN-801

Learning Objectives:

The main objectives of this course are to understand the fundamental concepts of crystal structure and **fundamental physical principles of the universe** including the Nuclear Physics, quantum mechanics and solid-state physics. The aim of modern physics is **to cover these topics in sufficient depth**.

Learning Outcomes:

Upon successful completion of this subject, students should:

1. Develop an understanding on the concepts of Nuclear Physics, quantum mechanics and basic solid state physics.
2. Get familiarized with the principles of quantum mechanics and the formulation of Schrodinger wave equation and its applications.
3. Examine the basic properties of nuclei, characteristics of nuclear forces, salient features of nuclear reactions and different nuclear radiation detectors.
4. Know as pre-requisite for understanding materials science, nano science.
5. Understand the magnetic properties of crystalline structures.

Course Content

Modern Physics II (Theory): **Credit = 03**

Module: -1

a) Properties of Atomic nucleus, charge, size, spin, magnetic moment, mass, mass defect, binding energy and binding fraction
b) Nuclear force-its characteristic features
c) Radioactive Decay law, half life average life
d) Nuclear Reactions: Types of reactions, Conservation Laws, kinematics of reactions, Q- value, reaction cross section, Concept of Compound Reaction
e) Nuclear fission, Nuclear fusion
f) linear accelerator, cyclotron, Basic principle of GM counter, Semi conductor detectors, Scintillation Detectors
g) Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion, Ruby Laser

Module: -2

a) The wave function, Normalization of wave function, probability density and probability current density in one dimension, Expectation value of an observable. Boundaryconditions on wave functions.

b) Eigen value Equation, degeneracy, Time independent Schrodinger Eqn, stationary state solutions,
c) Application of time independent Schrodinger Eqn in one dimension infinite well, Boundary conditions, Energy Eigen values

Module: -3

a) Crystal:Amorphous and Crystalline Materials. Crystal Lattice. Unit Cell. Miller Indices. Interplaner spacing.
b) Diffraction of X-rays by Crystals. Laue Spot, Bragg's Law.
c) Magnetic Properties of Matter: (a) Dia, Para, and Ferromagnetic Materials. Domains. Curie's law (Only statement), Hysteresis in Ferromagnetic Materials, Hysteresis Loss.
d) Band gap, Conductor, Semiconductor (P and N type) and insulator

Suggestive Readings:

- Introduction To Quantum Mechanics byS. N. Ghosal (Calcutta Book House)
- Quantum Mechanics byA. K. Ghatak And S. Lokenathan (Macmillan, Delhi)
- Quantum Mechanics by Powell And Craseman
- Introduction To Solid State Physics by C. Kittel (Wiley Eastern Ltd)
- Solid State Physics by S. O. Pillai (New Age Publication)
- Atomic and Nuclear Physics by S.N. Ghosal (S. Chand & Co.)
- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).

Module:- 4 Modern Physics II (Practical) Credit - 1

List of Experiments:

1. To determine the ionization potential of mercury.

2. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.

3. To determine the wavelength of laser source using diffraction of single slit.

4. To determine the wavelength of laser source using diffraction of double slits.

5. To determine (1) wavelength and (2) angular spread of He-Ne or any type of laser source

using plane diffraction grating.

Suggestive 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 Edn, 2011,Kitab Mahal