Draft Syllabus

for

Four-Year (Eight Semester)

Undergraduate Program

in

Physics

Interdisciplinary/Disciplinary Minor

Course

(as per NEP 2020)

(Applicable for the Academic Session 2023-24)

University of Gour Banga

Malda-732103

West Bengal

Name of Minor Papers

Semester	Course Code	Course Name
III	PHS-MnC-03	Thermal Physics & Optics
IV	PHS-MnC-04	Electricity & Magnetism

Semester – III

Syllabus for Physics (Minor)

Title of the Course: Thermal Physics and Optics

Paper Code: PHS-MnC-03

Learning Objective for Thermal Physics

This course aims to provide a comprehensive understanding of the fundamental principles of thermodynamics and kinetic theory, with a focus on the behaviour 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 analyse gas behaviour.

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.

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 for Thermal Physics

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

Explain the Kinetic Theory of Gases: Articulate the assumptions and implications of the kinetic theory, including the behaviour of ideal and real gases, and calculate properties such as pressure, temperature, and velocity distributions.

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

Evaluate Real-World Applications: 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.

Learning Objective for Optics

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

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 behaviour, 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 behaviour of light, preparing them for advanced studies in physics, engineering, and related fields.

Learning Outcomes for Optics

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

Conduct Optical Experiments: 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.

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

Understand Polarization: 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.

Apply Theoretical Concepts: 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

Thermal Physics and Optics (Theory) Credits – 3

Module: -1

a) Thermal Physics (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.
b) Thermal Physics (Thermodynamic Description of system)- Zeroth Law of thermodynamics and temperature. First law of thermodynamics and internal energy, Applications of First Law: General Relation between C_P and C_V and Work Done during Isothermal and Adiabatic Processes.

Module: -2

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

b) Optics- Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

c) Optics (Interference)- Division of amplitude and division of wave-front. Young's Double Slit experiment. Fresnel's Bi-prism. Interference in Thin Films: parallel and wedge-shaped film, Newton's Rings: measurement of wavelength and refractive index.

Module: -3

(a) Optics (Fresnel Diffraction)- Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge.
(b) Optics (Fraunhofer diffraction)- Single slit; Double Slit. Multiple slits and Diffraction grating.
(c) Optics (Polarization)- Transverse nature of light waves. Plane polarized light, Production and analysis of circular and elliptically polarized light, Optical activity.

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. chandPublications.

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

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

Thermal Physics and Optics (Practical) Credits: 1

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

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

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

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

Suggestive Readings:

• Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.

• Advanced level Physics Practical, 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: Electricity and Magnetism

Paper Code: PHS-MnC-04

Learning Objectives of the Course:

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

Learning Outcomes of the Course:

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.

Course Content

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 Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11thEd.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.