Semester	IV
Course	Major I
Paper Code	C2PH230411T
Paper Title	Optics – I & Modern Physics
No. of Credits	2 + 2
Theory / Practical / Composite	Theory
Minimum No. of preparatory hours per week a student has to devote	4
Number of Modules	2
Syllabus	**MODULE – A, OPTICS – I** Matrix method in paraxial optics for translation, reflection, refraction; simple lens systems. Dispersive power of prisms, Chromatic aberration, Seidel aberrations (qualitative discussion). Fermat's principle, Differential equation of light rays in media with varying refractive index. Reduced wave equation (scalar Helmholtz equation) and its solutions. Plane and spherical wave solutions. Huygens principle for light propagation. [**9 Lectures**] Temporal coherence and spatial coherence: Coherence length and time, Visibility measure. Interference by division of wavefront, Young's double slit experiment, displacement of fringes due to thin plate, Fresnel's biprism. [**7 Lectures**] Interference by division of amplitude, Stokes' relation, Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings. Interferometer: Michelson Interferometer-(1) Shape of fringes (2) Determination of Wavelength, (3) Visibility of Fringes (qualitative); Introduction to Fabry-Perot interferometer. [**8 Lectures**] **MODULE – B, MODERN PHYSICS** Blackbody radiation: experimental findings. Planck's quantum hypothesis. Average energy of a simple harmonic oscillator. Planck's radiation formula. Photoelectric effect: Einstein's interpretation. Compton effect: Observation and Interpretation. Franck-Hertz experiment: demonstration of discrete energy states of atoms. de Broglie hypothesis. Wave-particle duality. Feynman's discussion of the two-slit experiment. Wave description of particles by wave packets (superposition of waves). Probability interpretation. Davisson-Germer experiment. [**12 lectures**] Heisenberg uncertainty principle (from wave-packet description). Time-Energy and position-momentum uncertainty relations. Gamma ray microscope (hypothetical experiment). Applications: e.g. finding the energy of a particle confined to a region of a certain dimension, impossibility of an electron to exist in a nucleus as a consequence of the uncertainty principle, determination of 1^{st} Bohr

	radius & the zero-point energy of a simple harmonic oscillator using uncertainty principle. **[6 lectures]** Lasers: Interaction of Radiation with Matter: Absorption, Spontaneous Emission, Stimulated Emission. Einstein's A and B coefficients. Coherence: temporal and spatial. Metastable states. Optical Pumping and Population Inversion. Ruby Laser and He-Ne Laser. Characteristics of Laser Beams. **[6 lectures]**
Learning Outcomes	**<u>MODULE – A</u>** 1. The students learn how to use matrix method in paraxial optics and apply them to simple lens systems. They also learn about dispersive power of prism and aberrations. 2. Arriving at the reduced wave equation and finding its solutions. Understanding of wavefronts, plane waves and spherical waves 3. Understanding the concepts of temporal and spatial coherence. 4. Interference by division of wavefront using Young's double slit experiment, Fresnel biprism 5. Interference by division of amplitude in thin films: Parallel and wedge shaped (includes the understanding of formation of Newton's rings) 6. Understanding interferometry: Michelson interferometer and Fabry-Perot interferometer

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<u>MODULE – B</u>

1. The students will learn the concepts of wave-particle duality through discussions regarding the particle properties of waves and the wave properties of particles.

2. The students will learn the properties of waves associated with a particle (i.e., matter waves), through an elaborate discussion of de Broglie hypothesis.

3. The students will learn the characteristics of matter waves, through discussions on experiments showing the diffraction of this wave. Such discussions include the experimental verification of de Broglie hypothesis.

4. The students will learn the uncertainties (originating from wave nature) in the simultaneous determination of two canonically conjugate variables, through an elaborate discussion of Heisenberg's uncertainty principle.

5. The students will understand the importance of Heisenberg's uncertainty principle by learning its applications.

6. The students will learn the basic principle of LASER. They will also be acquainted with lasers of different types and their operation mechanisms.

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<tr><td>Reading/Reference Lists</td><td colspan="2">

<u>MODULE – A</u>

1. Optics, E. Hecht, Pearson
2. Optics A. Ghatak, McGraw Hill
3. Fundamentals of Optics, F. A. Jenkins & H. E. White, Mc. Graw Hill Education
4. Geometrical and Physical Optics, P. K. Chakrabarti, New Central Book Agency

<u>MODULE – B</u>

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill
2. Modern Physics; R.Murugeshan & K.Sivaprasath; S. Chand Publishing
3. Theory and Problems of Modern Physics, Schaum’s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd
4. An Introduction to Lasers, M. N. Avadhanulu (Author), P. S. Hemne, S. Chand Publication
5. Laser Physics and Spectroscopy, P.N.Ghosh, Levant Books
6. Modern Physics for Scientists and Engineers, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning
7. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, R. M. Eisberg and R. Resnick, Wiley

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<tr><td>Evaluation</td><td>Theory CIA: 30 (2 x 10 + 5/assgn.+ 5/attn.). Semester Exam:70</td><td>Practical (if applicable) CA:
Semester Exam:</td></tr>
<tr><td>Paper Structure for
Theory Semester Exam</td><td colspan="2">For each module of 35 Marks:
15 Marks from 3 marks questions (5 out of 7)
20 Marks from 10 marks questions (2 out of 3)</td></tr>
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