



### Modern Optics Physics

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**Institute:** IIT Kharagpur

**Department:** Physics

**Course Intro:** : Optics is a core discipline in science. There has been a remarkable upsurge in Optics in view of technological advancement, rapidly growing applications in the broad area of optics and photonics encompassing all sectors of civil, defense, biomedical research, signal processing and instrumentation. In the proposed course we plan to bring up the basic characteristics of electromagnetic propagation in material media of isotropic/anisotropic/linear/nonlinear nature, propagation in layered structures and waveguides. The interaction of light waves with intervening media that give rise to various phenomena, namely the electro-optic, magneto-optic, acousto-optic effects will be discussed in the platform of the underlying physics. The course will offer a comprehensive background in understanding several device applications based on these light-matter interaction properties. The course is designed for the graduate students having a basic background of the electromagnetic theory. The course is also useful for the M. Tech and Ph.D students aiming at research and developmental projects in the broad area of Optics and Photonics.

**Pre Requisites:** : Knowledge of Basic Electromagnetic Theory and Basic Optics

**Core/Elective:** : Core

**UG/PG:** : Both

**Industry Support** : None

**Reference** : 1.Introduction to Modern Optics by Grant R. Fowles 2.Optics by Eugene Hecht 3.Fundamentals of Photonics by E.A. Saleh and M.C. Teich 4.Optical Electronics by A. K. Ghatak & K. Thyagarajan

**About Instructor:** I completed my PhD from the Fiber Optics Group of Indian Institute of Technology Delhi. Then I pursued postdoctoral research in the Kyoto Institute of Technology, Japan, as a Japanese Government Fellow where I worked on various optical waveguides and components. Later, in 2002, he moved to the Institute for Communications Research, NUS, as a Research Scientist G3 and remained engaged in experimental research with photonic crystal fibers and components. In 2004, I joined the Faculty of Physics at IIT Kharagpur where I am currently working as an Associate Professor. My current research interests are in the area of micro-structured optical fibers/photonic crystal waveguides and devices and nano-structures/nano-photonics.



### COURSE PLAN

| SL.NO | Week | Module Name  |
|-------|------|--|
| 1     | 1    | Maxwell's equations and electromagnetic waves: plane waves, spherical waves, cylindrical waves, wave propagation in isotropic dielectric, Poynting vector, waves in absorbing medium   |
| 2     | 2    | Wave propagation in anisotropic media: planewaves in anisotropic media, wave refractive index, uniaxial and biaxial crystal, index ellipsoid, permittivity tensor  |
| 3     | 3    | Wave propagation in layered structures: waves at interfaces, total internal reflection, evanescent wave, concept of wave guiding, reflection and transmission by film, transfer matrix, multilayers, Fabry-Perot etalon, interference filter |
| 4     | 4    | Waves in guided structures and modes: waves in planar structures, TE and TM modes, power, orthogonality, graded index planar structures, channel guides  |
| 5     | 5    | Coupling of waves and optical couplers: coupled-mode theory, grating waveguide coupler, directional coupler, surface input-output coupler  |
| 6     | 6    | Electro-optic effects: Pockel effect, Kerr effect, electro-optic effects of longitudinal modes, phase and amplitude modulation, electro-optic effect of transverse modes   |
| 7     | 7    | Electro-optic devices and modulators: Electro-optic modulators, guided-wave modulators, traveling wave modulators  |
| 8     | 8    | Acousto-optic effects: Elastic waves, photo-elastic effect, acousto-optic diffraction, Raman-Nath and Bragg diffraction, theory and experimental setup of Raman-Nath diffraction,  |
| 9     | 9    | Acousto-optic Bragg diffraction: Theory of Bragg diffraction, small Bragg angle diffraction and coupled-wave analysis, large Bragg-angle diffraction, application to periodic media  |



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| 10 | 10 | Acousto-optic devices and modulators: acousto-optic modulators, Raman-Nath, Bragg modulator, deflectors, tunable filters, guided-wave acoustic-optic devices |
| 11 | 11 | Magneto-optic effects: magneto-optic effects, Faraday effect, magneto-optic Kerr effect, optical isolators, circulators                                      |
| 12 | 12 | Magneto-optic devices: magneto-optic modulators and sensors, magneto-optic recording, guided-wave magnet-optic devices                                       |