

**Objectives**

- (1) Understanding how light interacts with macro-properties of materials and their surfaces;
- (2) Understanding the interaction of light-waves at atomic level;
- (3) Energy exchange in light matter interaction, basics of spectroscopy;

**Keywords:** Material properties, wave-optics, laser, refractive-index.

**Course Contents**

Quantum Mechanics background: density operator, two level systems, second quantization of electromagnetic fields; Maxwell's Equations and the Dielectric Function: free charge, meaning of susceptibility and polarization response, bound electron polarization, causality & Kramers-Kronig relations; Optical Properties of Solids Liquids, and Gases: molecules, liquids, metals, insulators, semiconductors; Classical Treatment of Light-Matter Interaction: Lorentz oscillator, Drude model, Debye model, calculation of susceptibility and complex refractive index, Sellmeier equations and Abbe number, electronic transitions in atoms, anharmonic classical oscillator model, second order effects, third order effects, molecular rotational/vibrational transitions in molecules, dipole-active and Raman-active modes, phonons in solids, acoustic modes, optical modes, magneto-optic effects; Quantum mechanical description of light matter interaction: time dependent Schrödinger equation, Fermi Golden Rule, Kronig-Penney Model and Energy bands, Band gaps, Excitons, impurities (n- and p-type), Thermal distributions (Bose-Einstein, Fermi-Dirac, Maxwell-Boltzmann)

**TEXT BOOKS/ REFERENCES:**

1. Optical Properties of Solids by M. Fox (Academic Press, 22-Oct-2013)
2. Quantum Mechanics for Scientists and Engineers by D. A. B. Miller (Cambridge) Course notes (online PDF)
3. Optical Materials by J. Simmons and K. S. Potter (Academic Press, 2000)
4. Introduction to Solid State Physics by C. Kittel (John Wiley & Sons, 2007)
5. Optical Electronics in Modern Communications by A. Yariv (Oxford University Press, 2007)
6. Light-Matter Interaction: Physics and Engineering at the Nanoscale by John Weiner, Frederico Nunes (Oxford University Press, 02-Feb-2017)
7. An Introduction To Graphene Plasmonics by Goncalves Paulo Andre Dias, Peres Nuno Miguel Machado Reis (World Scientific, 25-Apr-2016)
8. Modern Optical Spectroscopy: With Exercises and Examples from Biophysics and Biochemistry by William W. Parson (Springer, 09-Jun-2015)
9. Progress in Analytical Atomic Spectroscopy, Volume 5 by C L Chakrabarti (Elsevier, 03-Jun-2016)