Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NPHD503	NONLINEAR OPTICS	3	0	0	3

Prerequisites:

Optics, Electrodynamics, Mathematical Physics, and Quantum Mechanics.

Course Objective

The course Objective is to teach students about the propagation of the electromagnetic wave in nonlinear media and the corresponding effects.

Learning Outcomes

After completing the course, students will:

- Learn different nonlinear processes as an outcome under light-matter interaction in nonlinear media classically as well as quantum mechanically.
- Have knowledge about the working principle of many optical devices based on nonlinear phenomena.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Introduction:** Origin of nonlinearity, Brief review of electromagnetic waves, Polarization, Diffraction, Anisotropic media, Light propagation through anisotropic media, Nonlinear polarization, Nonlinear susceptibility, Wave equation.	07	Here students will learn about the concept of nonlinear optics and the requirement of a suitable light source and medium
2	**Nonlinear Processes:** ***Second order nonlinear effects***: Second harmonic generation (SHG), Phase matching techniques, Periodically poled materials and their applications in nonlinear optical devices, Parametric fluorescence, Parametric amplification, Three wave mixing, Sum and Difference frequency generation, Parametric oscillation.	13	This unit will help students to learn different second order nonlinear processes as an outcome under light matter interaction in nonlinear media, Classically.
3	***Third order nonlinear effects***: Third harmonic generation (THG), Self-phase modulation, Cross-phase modulation, Four wave mixing, Optical phase conjugation, Kerr effect, Self-focusing and Self-defocusing. Spontaneous and Stimulated Raman Scattering, Hyper-Raman effect, Higher-order Raman processes,	12	From this unit students will learn different third order nonlinear processes as an outcome under light matter interaction in nonlinear media, Classically.
4	**Quantum-mechanical description**: Use of Density matrix and Perturbative approach to nonlinear optical susceptibilities. Multiphoton processes.	05	Here students will learn the Quantum mechanical description of different nonlinear processes.
5	**Devices**: Electro-optic effect, Electro-optic modulators. Photorefractive effect, Acousto-optic effect, Acousto-optic modulators. Magneto-optic effect. Faraday effect, Magneto-optic modulator, Quantum detectors.	05	From this unit students will understand the working principle of many optical devices based on nonlinear phenomena.
	Total	**42**	

Text Books:

1. Nonlinear Optics, R.W. Boyd, Academic press, Elsevier, 2008.
2. Quantum Electronics, Amnon Yariv, John Wiley and Sons, 1989.
3. Fundamentals of Nonlinear Optics, P. E. Powers, CRC Press, 2011.

Reference Books:

1. Nonlinear Optics; Nicolaas Bloembergen; World Scientific Pub Co Inc; 1996
2. Laser and Nonlinear Optics; B. B. Laud; New Age; 1991
3. Principles of Nonlinear Optics, Y. R. Shen, A Wiley Inter-science Publication, 1984.
4. Light-Matter Interactions, W. T. Hill and C. H. Lee, Wiley-VCH, 2007.
5. Essentials of Nonlinear Optics, Y. V. G. S. Murthy and C. Vijayan, Wiley, 2014.
6. Handbook of Nonlinear Optics, R. L. Sutherland, 2003.
7. Essentials of Lasers and Nonlinear Optics; Baruah; Pragati Prakashan; 2000.