Course title	**Nonlinear Optics**
Number of units	3
Prerequisite	Electromagnetic Fields and Waves
Objective	The major objective of this course is to present the underlying physical concepts and mechanisms of miscellaneous nonlinear optical phenomena. The course provides a comprehensive presentation on most of the major topics in nonlinear optics, which includes topics such as Pockels effect, parametric processes, Raman and Brillouin effects, four-wave mixing, and Kerr effect. Explanations are given in either classical or semi-classical terms and thus detailed treatment of processes necessitating quantum theory is avoided when possible.
Course description	- **Conventional Linear Optics versus Nonlinear Optics:** Nonlinearity in electric susceptibility, absorption, and scattering processes - **The Physics of Electric Susceptibility:** The semi-classical model of interaction between light and matter, harmonic and anharmonic oscillator model, symmetry properties of susceptibility tensors, Kramers-Kronig relations - **Wave Propagation in Anisotropic and Nonlinear Media:** Wave propagation in anisotrpic media: Fresnel's equations, index ellipsoid, normal surface; wave propagation in nonlinear media: Power balance and Manley-Rowe equations, wave equation and slowly varying amplitude approximation, phase matching and conservation of momentum - **Pockels Effect and Related Phenomena:** The linear electro-optic effect, optical rectification, magneto-optic effect - **Parametric Effects:** Basic equations, parametric amplification, parametric oscillator - **Raman and Brillouin Effect:** Qualitative discussion of the Raman effect, induced Raman scattering, Brillouin effect - **Optical Kerr effect:** General theory of the optical Kerr effect, applications - **Four-wave Mixing:** General theory of four wave mixing, degenerate four-wave mixing, two photon absorption - **Resonant Nonlinear Interaction in the Two Level Approximation:** Density matrix equations for a two-level atom, Rabi oscillations and dressed atomic states, optical wave mixing in two-level systems
References	[1] Nonlinear Optics, E. G. Sauter, Wiley, 1996 [2] Nonlinear Optics, R. W. Boyd, Academic Press, 2008 [3] Nonlinear Optics and Photonics, G. S. He, Oxford Press, 2015.