

**Instructor:** Randy A. Bartels

**Office:** B213 Engineering Research Center (ERC); C103B Engineering (Main Campus)

**Office Hours:** M: 10:05 - 11:25 am (B213 ERC); Th: 8:00 - 9:20 am (B213 ERC); by appointment

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**Lecture:** MWF, 10:00 - 10:50 am; Engineering, E106

**Required Text:** *Nonlinear Optics*, Third Edition by Robert W. Boyd, Academic Press 2008, ISBN 978-0-12-369470-6.

**References:**

- *The Principles of Nonlinear Optics* (Wiley Classics Library) by Y. R. Shen, ISBN

**Background:** Electromagnetics.

**HW Policy:** Due at beginning of class on due date. Graded only if *legible* (as judged by grader). Highly recommended to do it in latex. A correct homework solution is a narrative that describes the physical situation, the equations and variables used and their physical importance, and finally draws a conclusion in a way that build intuition about the topic under study. **A list of equations will not be graded and will be returned.** Although late or improperly done homework will not be accepted, one “redo” will be allowed during the semester.

**Course Description:** Nonlinear optical science has revolutionized laser sources of radiation. With nonlinear optics, a bright, coherent radiation source at a particular frequency can be transferred to a new frequency through nonlinear interactions in matter. This course will introduce the principles of nonlinear optics, symmetry properties and various order nonlinear phenomenon. Upon completion of the course, students will be able to design an experimental apparatus that will produce efficient frequency conversion.

**Grading:** Homework, 25%; Numerical Simulations, 25%; Midterm Paper, 20%; Final Paper and Presentation, 30%

**Topics and Schedule:**

1. Introduction to Nonlinear optical phenomenon and their applications.
2. Classical description of nonlinear optics: the anharmonic classical electron oscillator
3. Nonlinear optical tensors (macroscopic properties), symmetry properties, macroscopic time-domain response
4. Electrodynamics of nonlinear optics: energy density; Kramers=Kronig; Nonlinear wave propagation
5. Second-order nonlinear phenomenon: SHG, SFG, OPA/OPOs, phase matching, quasi-phase matching, and second order nonlinear optics of ultrafast pulses.
6. Third-order nonlinear phenomenon: THG, FWM, nonlinear index effects.
7. Nonlinear phenomena in optical fibers.
8. Models of nonlinear optical susceptibilities
9. Nonlinear optical spectroscopy: a case study

**0.0.1 Web Resources**

Nonlinear Optics Freeware: SNLO from Sandia (do a web search)