EC 763: Nonlinear & Ultrafast Optics

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Course information, handouts, homework assignments, etc. available at https://learn.bu.edu/
(for students registered for credit or audit only)

Background & Content: A key feature of electromagnetic radiation and light is the principle of superposition, which implies that two distinct light beams either do not interact at all (weak coherence limit), or completely interfere with each other (strong coherence). But when the intensity of light is high enough, it can *alter* the material in which it is propagating, which leads to a myriad of interesting effects, from the ability to yield photonic states in quantum superpositions, to the ability to change the colour, shape (in space) and shape (in time!) of light, with light itself.

This course will introduce the physics of nonlinear optical interactions, and describe the multitude of applications it has found in science and technology today.

Topics to be covered:

1) Nonlinear susceptibility & its tensor nature (Boyd, Chapter 1)
2) Wave equations & phase matching (Boyd, Chapter 2)
3) Nonlinear index ($\chi^{(3)}$) and its ramifications (Boyd, Chapter 4)
4) $\chi^{(3)}$ Processes (Boyd, Chapter 7)
5) Applications of nonlinear guided waves ($\chi^{(3)}$ processes): (Agrawal, Stegeman, others)
6) Complex $\chi^{(3)}$: Brillouin & Raman scattering (Boyd, Chapter 9, 10)
7) Applications in quantum science & engineering (notes, including brief QED introduction)
8) Applications in imaging & microscopy (overview from misc. sources)
9) Nonlinear & Dispersive wave propagation: ultrafast optics (Boyd, Chapter 11)
10) High-harmonic generation & High-field science (overview from misc. sources)

Prerequisites: EC 565, a similar course, or consent of instructor.

Textbooks and References:

Required: Print copy available on reserve *and* e-book available from BU library to all BU students/staff.

- Boyd, "Nonlinear Optics," 3rd Edition; Elsevier/Academic Press (2008)

References: All reference books are available on reserve at the library:

- Stegeman & Stegeman: Nonlinear Optics: Phenomena, Devices & Materials (e-book available @ library)
- Agrawal: Nonlinear Fiber Optics (e-book available @ library)
- Agrawal: Applications of Nonlinear Fiber Optics

Grading Policy:

- 50% Homework. Late HW will incur 20% grade reduction/day late (genuine emergencies excepted).
- 40% Oral presentation + written report*
- 10% Class Participation

* You will be assigned journal papers to review, and present in class in detail, in lieu of exams.