



MATSCEN 5193.02 *Ultrafast Laser Materials Processing*

Instructor information

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Course Description

Course Title *Ultrafast Laser Materials Processing*: Students are expected to learn some basics of laser, non-linear optics, ultrafast lasers, ultrafast laser materials processing, and hands on experience on how an ultrafast laser works, laser safety and how to characterize it and use it to modify materials.

Credit hours: 3

Days, time, location: M W 11:30 a.m. – 12:50 p.m. [Mendenhall Labs 0174](#)

Undergrad Class #: 8501 Grad Class #: 8517

UG Pre/Co-requisite: Math/ Eng Math 1172, Physics II (1251, concurrent OK)

- Week 1: Basic optics review: E&M waves, laws of reflection and refraction, lens equation, imaging
- Week 2: Basics of what a laser is, how a laser works, simple mathematical formulation of laser amplification
- Week 3: *Two guest lectures on High power laser welding/cutting by Boyd Pantou (& perhaps a Lab demonstration?)*
- Week 4: Basics of non-linear optics, harmonic generation, Optical Kerr effect, etc.
- Week 5: Basic Fourier transform, concept of ultrashort pulses
- Week 6: Ultrashort pulses, how they are generated, mode-locking, how they are characterized
- Week 7: Ultrafast Laser safety, eye safety calculations, students take laser safety online course EHS
- Week 8: *Students study non-linear optics with ultrafast lasers, harmonic generation in various materials*
- Week 9: Midterm + Introduction to ultrafast laser materials interaction
- Week 10: Ultrafast laser damage and ablation
- Week 11: *(LAB) Ultrafast laser characterization, spectrum, pulse duration measurement with autocorrelator*
- Week 12: Ultrafast laser surface engineering
- Week 13: Ultrafast Laser machining
- Week 14: Ultrafast Laser material transformation + Thanksgiving Day (no classes)
- Week 15: *Lab: Ultrafast Laser materials modification and Analysis (optical microscopy, SEM, etc.)*
- Week 16: In class presentation of Laser materials modification lab results

Learning Objectives

- The students will have a working knowledge of
 - o what a laser is,
 - o how it works,
 - o what an ultrafast laser is,
 - o how it works and what are its engineering applications,
 - o how to use an ultrafast laser in real life for basic non-linear optics and materials modification.