Course Description

This course covers the basic principles of optomechanical engineering. It is taught from the perspective of student who are familiar with optical components and design, yet may have little experience with interfacing those aspects to other elements necessary to design, build, and execute a complete system. Much of the course emphasizes practical multi-disciplinary engineering issues. For all students, but particularly those without an Optical Engineering background, the assigned readings are given largely to review paraxial properties of optical systems, optical materials, and aberrations. While there will be lectures on this material, it is meant to summarize those topics.

Much of the information for this course has been cultivated by others, including Professor Jim Burge (and his students and research program) and Dr. Daniel Vukobratovich. Students will have access to a repository of information that has been collected over many years that will (hopefully) be highly relevant for their future careers.

The overall course topics are as follows (although this is not the order in which lectures are presented):

1. Review of Geometrical Optics
   a. First-order Optics
   b. Fold Mirrors & Prisms
   c. Optical Fabrication Methods
   d. Specifications
   e. Optical Tolerancing
   f. ISO10110 drawings
   g. Basic Zemax Modeling

2. Engineering Mechanics & Mechanical Design
   a. Statics & Free-Body Diagrams
   b. Beam Deflection & Buckling
   c. Thermal effects
   d. Motion, Vibration, & Vibration Isolation
   e. Mechanical Properties of Materials
   f. Mechanical Fabrication Methods
   g. Mechanical Tolerancing and Geometrical Dimensioning & Tolerancing (GD&T)
   h. Introduction to Solidworks and simplistic FEA

3. Optomechanical Engineering
   a. Degrees of Freedom
   b. Kinematics & Hertzian Contacts
   c. Failure Mechanics
   d. Adjustments & Motion Control
   e. Mounting of Single Optical Components
   f. Alignment & Aberrations
   g. Thermal Aspects in Optomechanical Design
   h. (Problems with) Simplistic Optomechanical FEA
Course Prerequisites or Co-requisites

OPTI 421: must be Senior Standing in Optical Sciences & Engineering, or permission of the instructor.
OPTI 521: must be taken concurrently with or have previously passed OPTI 502, or permission of the instructor.

Instructor and Contact Information

Instructor:

Jonathan D. Ellis, PhD
Associate Professor of Optical Sciences
Meinel 733
jdelis@optics.arizona.edu
520-621-4929

Office Hours: I will be having office hours three times per week at the following times. During those times, I will set up a Zoom Video Conference line for screen sharing and video chat with students enrolled via distance learning. For Distance Learning students, if you are not able to make the those times, please contact me and I will set up a time that it outside of work hours.

MWF: 1 PM – 2:30 PM Mountain Standard Time (733 Meinel Building)

Zoom Video Conference: Join URL: https://arizona.zoom.us/j/5852871136

Teaching Assistant:

Jilian Nguyen
jiliannguyen@email.arizona.edu

Office Hours: Location: TBD
DAY: XXpm - XXpm
DAY: XXpm - XXpm
DAY: XXam - XXpm

If you can't make the office hour times, please send Jilian an email with your questions or a proposed time to meet in person. Please make sure you have "Opti 421" or "Opti 521" somewhere in your email subject line.

Course Website: D2L

Course Format & Teaching Methods

This course is primarily a lecture course that has a semester long iterative design project and homeworks as the main educational thrusts. Lectures, directed readings, and homework assignments will be used to provide foundational instruction for the semester project. This course is taught twice per week with recorded lectures for Distance Learning Students in two 75 minute session.

Course Communications

Students are required to check D2L and their formal University of Arizona email address regarding announcements for the class once per day. This is the easiest and most effective communication for the instructors and teaching assistants to reach the whole class.

Instructor Email Policy: You should only use email as a tool to schedule a meeting with me if office hours conflict with your schedule or to ask a short question that requires a <2 sentence answer. Use the subject line “OPTI: Meeting Request” so that I may auto-sort your emails. Your message should include at least two times when you would like to meet and a brief (one-two sentence) description of the reason for the meeting. Emails sent for any other reason should be done so with caution. Emails that would take 20 minutes to type an answer rather than having a 2 minute conversation are strongly discouraged. I strongly encourage you to ask questions about the syllabus, labs, and assignments during class and office hours. For more in-depth discussions (such as guidance on assignments) please plan to meet in person or call my office. Our conversations should take place in person or over the phone rather than via email, thus allowing us to get to know each other better and fostering a more collegial learning atmosphere. [Adapted from Duvall, Salem College]
**Distance Learning Students are exempted from this**, given the nature of their enrollment. However, the expectation is that I would seek to use email communication to establish a separate conference call, rather than continually typing out messages.

**Required Texts or Readings**

**Required Readings:**

- *Fundamentals of Optomechanics*, Vukobratovich & Yoder [link];
- *Opto-Mechanical Systems Design*, Yoder & Vukobratovich (two volume set) [link]

**Recommended Readings:**

- *Optics*, Hecht [link] (If you have a non-Optical Engineering background, this is required text)
- *Shigley’s Mechanical Engineering Design*, Budynas & Nisbett [link]

All books are available at the UA Libraries. Additionally, they can likely be checked out in digital versions for reading on computers and electronic devices.

**Assignments and Examinations: Schedule/Due Dates**

**Undergraduate students** will have the following scheme:
- Participation: 10%
- Homework: 20%
- Design Iteration 1: 10%
- Design Iteration 2: 10%
- Final Design: 50%

No late assignments will be accepted!

**Graduate students** will have the following scheme:
- Participation: 10%
- Homework: 10%
- Design Iteration 1: 10%
- Design Iteration 2: 10%
- Final Design: 60%

No late assignments will be accepted!

**Scheduled Topics**

A calendar will be placed on D2L within the first week of the semester with a tentative outline for lecture topics, recommended readings, and assignments. The expectation is that there are 1-2 homework assignments per week and a semester long design project that is to be submitted at the end of the semester. There are two assigned due dates for Design Reviews for the project that will have fixed due dates. These are to be submissions of your work in progress and are intended to force you to start early on the project.

**Expected Learning Outcomes**

- **Medium**: Have a good understanding of the basic physics and mathematics underlying optical phenomena and optical systems
- **High**: Are able to apply their understanding of physics and mathematics to solve technical and engineering problems
- **High**: Are able to effectively use optical components, optical and electronic instruments, and computers to perform experiments and do testing in an optics laboratory
- **High**: Are able to design optical systems and components as needed in their professional careers
- **High**: Are able to effectively communicate with others both orally and in writing

For more information regarding Expected Learning Outcomes and ABET Accreditation, please see more resources on the Wyant College of Optical Sciences Accreditation Website.
**Final Examination or Project**
Students will submit their Final Design Report in lieu of having a final exam.

**Grading Scale and Policies**
The grading system for this course will result in grades from A (excellent) through E (failure).

**This course is a 400/500 split level course.** In addition to the weighting differences between the assignments, graduate students will have additional material to include in the design project as noted specification document and on individual homework assignments.

**Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at [http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete](http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete) and [http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal](http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal) respectively.**

**Lecture Lateness Policy**
*The lecture part of this course has a zero-tolerance lateness policy!* Students are not required to come to class. However, late students pose a disruption to the lecturer and their fellow students. Once class has begun, no students may be admitted unless they have prior permission from the instructor. Students arriving late will politely, but firmly, be asked to leave.

**Code of Academic Integrity**
Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See:

[http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity](http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity).

*Selling class notes and/or other course materials to other students or to a third party for resale is not permitted under any circumstances.* Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

Also, students using images from the internet without citation is considered an act of plagiarism. If you have any questions regarding this, please see the instructor. The University Libraries have some excellent tips for avoiding plagiarism. See:

[http://new.library.arizona.edu/research/citing/plagiarism](http://new.library.arizona.edu/research/citing/plagiarism).

**Accessibility and Accommodations**
At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520-621-3268) to explore reasonable accommodation.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

**Absence & Class Participation Policy**
Participating in the course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all lectures and laboratory sessions. Students who miss class due to illness or emergency are required to bring documentation from their health-care provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

The UA’s policy concerning Class Attendance, Participation, and Administrative Drops is available at: [http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop](http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop)

The UA policy regarding absences for any sincerely held religious belief, observance or practice
will be accommodated where reasonable, [http://policy.arizona.edu/human-resources/religious-accommodation-policy](http://policy.arizona.edu/human-resources/religious-accommodation-policy).

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See [https://deanofstudents.arizona.edu/absences](https://deanofstudents.arizona.edu/absences).

**Threatening Behavior Policy**

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See [http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students](http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students).

**UA Nondiscrimination and Anti-Harassment Policy**

The University is committed to creating and maintaining an environment free of discrimination; see [http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy](http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy).

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

**Classroom Behavior Policy**

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

**Additional Resources for Students**

UA Academic policies and procedures are available at [http://catalog.arizona.edu/policies](http://catalog.arizona.edu/policies).

Student Assistance and Advocacy information is available at [http://deanofstudents.arizona.edu/student-assistance/students/student-assistance](http://deanofstudents.arizona.edu/student-assistance/students/student-assistance).

**Confidentiality of Student Records**


**Subject to Change Statement**

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.