OPTI 421/521: Introductory optomechanical engineering

Fall 2023 (Updated 08/29/2023)
Lectures: Wednesday/Friday 9:30am-10:45am MST, Room 307.

Course Description

This course covers the basic principles of optomechanical engineering. This course is taught for students who are familiar with optical systems and covers those mechanical engineering concepts necessary for optomechanical engineering. Topics include optics mounting, alignment, thermo-mechanical disturbances, drawings, specifications, and fabrication of mechanical components.

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Teaching assistants:

Email:
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Learning outcomes

After taking this course, students should be able to:

- Determine optomechanical tolerances for basic optical systems
- Design static and adjustable mounts for small optical components
- Read and create component and assembly drawings for optomechanical systems
- Analyze effects of thermal and mechanical loads on performance and survival of optical systems
- Make mechanical design choices that facilitate optical system fabrication, assembly, and testing

400/500 Co-convened Course information

Graduate students will complete a more complex design project than undergraduate students, and will be assigned additional problems.

Acknowledgement

Course materials were adapted from those generously provided by Dr. James H. Burge, Dr. Daewook Kim, and Dr. Jonathan D. Ellis.

Recommended Texts and Materials

- *Fundamentals of Optomechanics*, by Daniel Vukobratovich and Paul Yoder, CRC Press, 2018.
- *Field Guide to Optomechanical Design and Analysis,* by Katie Schwertz and James Burge, SPIE, 2012.

These are available at **no cost to you** through UA libraries. In D2L, go to Library Tools and click on the links under Unlimited-Use Ebooks. You may download and keep both books.

Assessment

Grading will be based on 9 homework assignments, a midterm exam, and a design project:

Element	Due date	Fraction of grade
Homework		
Homework 1	9/5	5%
Homework 2	9/11	5%
Homework 3	9/18	5%
Homework 4	9/25	5%
Homework 5	10/2	5%
Homework 6	10/9	5%
Homework 7	10/16	5%
Homework 8	10/23	5%
Homework 9	10/30	5%
Midterm exam	11/8	25%
Design project	12/6	30%

Project details and guidance will be outlined in a separate document.

Grading scale and policies

Grading will be on a regular scale: A (>=90%), B (>=80%), C (>=70%), D (>=60%), E (<60%)

Late assignments (without prior approval) will lose 25% per day, to a minimum value of 0.

All deadlines are 11:59pm MST. All assignments must be uploaded to D2L.

University policies

All university policies related to a syllabus are available at: https://academicaffairs.arizona.edu/syllabus-policies.

Subject to change notice

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

Graduate student resources

University of Arizona's Basic Needs Resources page: http://basicneeds.arizona.edu/index.html

Accessibility and accommodations

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu) to establish reasonable accommodations.

Tentative schedule

Deadlines (in bold) subject to change with advance notice. Lecture topics subject to change without notice.

	Date	Suggested Reading*
Unit 1: Introduction		
Lecture 1: Optomechanical engineering overview ***(RECORDED)***	8/23	
Lecture 2: Rigid body motion of optical components ***(RECORDED)***	8/25	S&B: pp. 1-12
Lecture 3: Basic lens, prism, and mirror mounts	8/30	[skim] V&Y: §4.2.3, 4.3.2, 5.4, 5.7, 5.9, Ch. 7
Unit 2: Optomechanical tolerances and mechanical design		
Lecture 4: Optical mounts and their geometry	9/1	V&Y: §5.2, 6.3, 6.5-6.7
Homework 1 due (11:59pm MST)	**9/5**	
Lecture 5: Optical tolerancing	9/6	
Lecture 6: Tolerancing and compensators	9/8	
Homework 2 due (11:59pm MST)	**9/11**	
Lecture 7: Tolerancing examples and lens tube basic design	9/13	
Lecture 8: Machining technologies and lens tube details	9/15	Videos (see D2L)
Homework 3 due (11:59pm MST)	**9/18**	
Lecture 9: Mechanical tolerancing	9/20	
Lecture 10: Mechanical and optical drawings	9/22	
Homework 4 due (11:59pm MST)	**9/25**	
Unit 3: Mechanical engineering concepts		
Lecture 11: Screws and stages	9/27	S&B: pp. 27-40
Lecture 12: Statics, stress, strain, strength and springs	9/29	
Homework 5 due (11:59pm MST)	**10/2**	
Lecture 13: Springs, preload	10/4	
Lecture 14: Stiffness of beams and plates	10/6	S&B: pp. 14-20
Homework 6 due (11:59pm MST)	**10/9**	
Lecture 15: Structural analysis examples	10/11	V&Y: Ch. 3
Lecture 16: Optomechanical materials and failure criteria	10/13	
Homework 7 due (11:59pm MST)	**10/16**	
Lecture 17: Point and line contacts	10/18	V&Y: §5.6, 5.8.1, 11.3.7
Lecture 18: Optomechanical interface	10/20	
Homework 8 due (11:59pm MST)	**10/23**	
Lecture 19: Thermal expansion, loss of contact	10/25	V&Y: §11.1-11.3
Unit 4: Thermal, vibration, shock effects		
Lecture 20: Flexures, **Practice exam released**	**10/27**	V&Y: §5.7
Homework 9 due (11:59pm MST)	**10/30**	
Lecture 21: Analyzing lens mounts	11/1	V&Y: §6.4.1-6.4.6
Exam review	11/3	
Midterm exam	**11/8**	
Lecture 22: Thermal focus shift	11/10	V&Y: §6.4.4, 6.4.7
Lecture 23: Athermalization, adhesives ***(RECORDED)***	11/15	V&Y: §7.5,9.4
Lecture 24: Bonded joints ***(RECORDED)***	11/17	
Lecture 25: Vibration and shock	11/22	
Unit 5: Basics of finite element analysis		
No lecture – Thanksgiving break	11/24	
Lecture 26: Mitigating stray light	11/29	
Lecture 27: Introduction to finite element analysis (FEA)	12/1	
Final project report due	**12/6**	
Lecture 28: Extracting optical information from FEA	12/6	

* S&B: Schwertz and Burge; V&Y: Vukobratovich and Yoder; SW: SolidWorks; SME: Society of Manufacturing Engineers