OPTI 421/521: Introductory optomechanical engineering

Fall 2026 (Updated 08/24/2026)
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.

Instructors

Dr. Brandon Chalifoux

Associate Professor, College of Optical Sciences
Email: bchal@arizona.edu
Office hours: Thursdays 1:30-2:30pm MST, Room TBD
Office hours zoom link: TBD

Yexin Pei (teaching assistant)

Email: ypei18@arizona.edu
Office hours: TBD
Office hours zoom link: TBD

Chang Ge (teaching assistant)

Email: changge@arizona.edu
Office hours: TBD
Office hours zoom link: TBD

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 drawings for optomechanical components and 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.

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 7 homework assignments, a midterm exam, and a design project:

Element	Due date	Fraction of grade
Homework		20%
Homework 1	*9/8*	*3%*
Homework 2	*9/21*	*5%*
Homework 3	*10/5*	*1%*
Homework 4	*10/19*	*3%*
Homework 5	*10/26*	*1%*
Homework 6	*11/16*	*3%*
Homework 7	*12/7*	*4%*
Midterm exam 1	10/9	25%
Midterm exam 2	11/6	25%
Design project	12/17	30%

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.

Artificial Intelligence policy

AI is Sometimes Permitted. The following lists are not exhaustive, but they are representative of acceptable and unacceptable use of AI in this course. Contact me if you are in doubt as to whether you are misusing AI tools or want to discuss AI usage in this course.

You may use AI for:

- Seeking information akin to web searches,
- Debugging software tool issues,
- Reinforcing information learned in class,
- Fixing grammar on assignments (including the design project) prior to submission,
- Understanding the solution methodology for homework assignments,
- Debugging and checking spreadsheets, and
- Generating additional practice problems and their solutions.

You may NOT use AI for:

- Any part of the exams,
- Generating submitted assignments in their entirety,
- Generating calculation spreadsheets in their entirety.

AI support must be acknowledged per assignment expectations so as not to violate the Code of Academic Integrity: "I acknowledge the use of *[insert name of AI system(s)]* to *[describe specific use of AI]*."
See UA Libraries Guide: How to Cite AI.

Various AI models are available for your use at no cost: genai.arizona.edu

Artificial Intelligence **recommendation**

This is intentionally separate from policy and is only a recommendation. This course has a reputation for being challenging and time-consuming, but overall feedback from previous students is that they learn the material effectively as a result. AI has the potential to change this – it can quickly solve many of the homework problems in this course. The temptation is challenging to withstand because of the many demands on your time. If you read the AI-generated solution, you may even feel like you fully understand how to solve the problems. Unfortunately, using AI as a shortcut to submitting assignments will very likely not serve you well on the exams or in learning the material.

The goal of the course is for you to learn the fundamental principles underlying optomechanical engineering, so that you can apply them to future problems you encounter. Those problems will not be in the form of well-specified homework or exam problems, but you will be able to rely on your understanding to work through those real problems. Even if you use AI to help solve those problems, you own the solution you choose. Your strong understanding of the context of your problem and the fundamental principles will allow you to identify the most effective solutions AI tools propose, and to evaluate those potential solutions with confidence. Unfortunately, using AI as a shortcut to submitting assignments will not serve you well in learning the fundamental principles that can enable you to effectively solve real problems in the future.

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.

Acknowledgement

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

Tentative schedule

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

	Date	Suggested Reading*
Unit 1: Optical mount geometry		
Lecture 1: Optomechanical engineering	8/26	
Lecture 2: Rigid body motion of optical components	8/28	S&B: pp. 1-12 Lens motion notes (D2L)
Lecture 3: Lens mount geometry ***(PRE-RECORDED 8/31, 8am)***	9/2*	Watch SolidWorks tutorial Skim V&Y: §4.2.3, 4.3.2, 5.4, 5.7, 5.9, Ch. 7
Lecture 4: Lens tube design	9/4	Skim V&Y: §5.2, 6.3, 6.5-6.7
Homework 1 due	**9/8**	
Lecture 5: Threads, shims, and focus mechanisms	9/9	
Unit 2: Optomechanical design for survival		
Lecture 6: Statics	9/11	
Lecture 7: Statics and preload	9/16	
Lecture 8: Springs ***(PRE-RECORDED 9/17, 8am)***	9/18*	Springs and preload notes (D2L)
Homework 2 due	**9/21**	
Lecture 9: Stress and failure	9/23	S&B: pp. 14-20
Lecture 10: Beam bending	9/25	
Lecture 11: Flexures	9/30	V&Y: §11.1-11.3
Lecture 12: Point and line contacts	10/2	V&Y: §5.6, 5.8.1, 11.3.7
Homework 3 due	**10/5**	
Exam review	10/7	
Midterm exam 1	10/9	
Lecture 13: Lens interface	10/14	
Lecture 14: Thermal expansion	10/16	V&Y: §6.4.1-6.4.6
Homework 4 due	**10/19**	
Lecture 15: Thermal loss of contact	10/21	Review springs and preload notes (D2L)
Lecture 16: Retaining ring mount analysis	10/23	
Homework 5 due	**10/26**	
Lecture 17: Adhesive joints ***(PRE-RECORDED 10/23, 8am)***	10/28*	V&Y: §5.7, 7.5, 9.4
Lecture 18: Optical tolerancing	10/30	
Exam review	11/4	
Midterm exam 2	11/6	
Unit 3: Optomechanical tolerancing and design		
Lecture 19: Mechanical fabrication	11/13	Watch fabrication videos (D2L)
Homework 6 due	**11/16**	
Lecture 20: Tolerances and drawings	11/18	Recommended tolerances notes (D2L) S&B: pp. 110-117
Lecture 21: Optomechanical tolerancing ***(PRE-RECORDED 11/19, 8am)***	11/20*	
Lecture 22: Compensators ***(PRE-RECORDED 11/23, 8am)***	11/25*	Zernike polynomial notes (D2L)
Lecture 23: Thermal focus shift	12/2	V&Y: §6.4.4-6.4.7
Lecture 24: Athermalization	12/4	Athermalization notes (D2L)
Homework 7 due	**12/7**	
Unit 4: Advanced topics		
Lecture 25: TBD	12/7	
Lecture 26: TBD	12/9	

* S&B: Schwertz and Burge; V&Y: Vukobratovich and Yoder