

# OPTI 421/521: Introductory optomechanical engineering

Fall 2025 (Updated 08/28/2025)

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.

## Instructor: Dr. Brandon Chalifoux

Assistant Professor, College of Optical Sciences

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**Office:** GCRB 021

**Office hours:** Thursdays 2-3:30pm MST, Room 654

**Office hours zoom link:** <https://arizona.zoom.us/j/81396611419?pwd=trSsMUvOjTmAmZuHRA3cfvFi0uXrHq.1>

## Teaching assistant: Brody McElwain

**Email:** [bmcelwain@arizona.edu](mailto:bmcelwain@arizona.edu)

**Office hours:** Fridays 1-2pm MST, Room 554

**Office hours zoom link:** <https://arizona.zoom.us/j/85338100518> (Password: Opt0mech)

## 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.

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

| Element           | Due date     | Fraction of grade |
|-------------------|--------------|-------------------|
| Homework          |              | 45%               |
| <i>Homework 1</i> | <i>9/2</i>   | <i>3%</i>         |
| <i>Homework 2</i> | <i>9/10</i>  | <i>7%</i>         |
| <i>Homework 3</i> | <i>9/22</i>  | <i>7%</i>         |
| <i>Homework 4</i> | <i>10/1</i>  | <i>7%</i>         |
| <i>Homework 5</i> | <i>10/13</i> | <i>7%</i>         |
| <i>Homework 6</i> | <i>10/22</i> | <i>7%</i>         |
| <i>Homework 7</i> | <i>11/24</i> | <i>7%</i>         |
| Midterm exam      | 11/5         | 25%               |
| Design project*   | 12/10        | 30%               |

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

## Grading scale and policies

Grading will be on a regular scale: A ( $\geq 90\%$ ), B ( $\geq 80\%$ ), C ( $\geq 70\%$ ), D ( $\geq 60\%$ ), 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*                                                         |
|-------------------------------------------------------|--------------|----------------------------------------------------------------------------|
| <b>Unit 1: Optical mount geometry</b>                 |              |                                                                            |
| Lecture 1: Optomechanical engineering                 | 8/27         |                                                                            |
| Lecture 2: Rigid body motion of optical components    | 8/29         | S&B: pp. 1-12<br>Lens motion notes (D2L)                                   |
| <b>Homework 1 due</b>                                 | <b>9/2</b>   |                                                                            |
| Lecture 3: Lens mount geometry                        | 9/3          | Watch SolidWorks tutorial<br>Skim V&Y: §4.2.3, 4.3.2, 5.4, 5.7, 5.9, Ch. 7 |
| Lecture 4: Lens tube design                           | 9/5          | Skim V&Y: §5.2, 6.3, 6.5-6.7                                               |
| <b>Homework 2 due</b>                                 | <b>9/10</b>  |                                                                            |
| Lecture 5: Mechanical fabrication                     | 9/10         | Watch fabrication videos (D2L)                                             |
| Lecture 6: Lens tube fabrication, mechanical drawings | 9/12         | Recommended tolerances notes (D2L)<br>S&B: pp. 110-117                     |
| <b>Unit 2: Optomechanical design for survival</b>     |              |                                                                            |
| Lecture 7: Statics and preload                        | 9/17         |                                                                            |
| Lecture 8: Preload and springs                        | 9/19         | Springs and preload notes (D2L)                                            |
| <b>Homework 3 due</b>                                 | <b>9/22</b>  |                                                                            |
| Lecture 9: Point and line contacts                    | 9/24         | V&Y: §5.6, 5.8.1, 11.3.7                                                   |
| Lecture 10: Thermal expansion                         | 9/26         | V&Y: §6.4.1-6.4.6                                                          |
| Lecture 11: Thermal loss of contact                   | 10/1         | Review springs and preload notes (D2L)                                     |
| <b>Homework 4 due</b>                                 | <b>10/1</b>  |                                                                            |
| Lecture 12: Stress and failure                        | 10/3         | S&B: pp. 14-20                                                             |
| Lecture 13: Retaining ring mount analysis             | 10/8         |                                                                            |
| Lecture 14: Beam bending                              | 10/10        |                                                                            |
| <b>Homework 5 due</b>                                 | <b>10/13</b> |                                                                            |
| Lecture 15: Flexures                                  | 10/15        | V&Y: §11.1-11.3                                                            |
| Lecture 16: Adhesive joints                           | 10/17        | V&Y: §5.7, 7.5, 9.4                                                        |
| <b>Unit 3: Optomechanical tolerancing</b>             |              |                                                                            |
| Lecture 17: Motion control                            | 10/22        | S&B: pp. 27-40                                                             |
| <b>Homework 6 due</b>                                 | <b>10/22</b> |                                                                            |
| Lecture 18: Optical tolerancing I                     | 10/24        |                                                                            |
| Lecture 19: Optical tolerancing II                    | 10/29        |                                                                            |
| Lecture 20: Compensators                              | 10/31        | Zernike polynomial notes (D2L)                                             |
| Lecture 21: Exam review                               | 11/5         |                                                                            |
| Midterm exam <b>(No lecture)</b>                      | 11/7         |                                                                            |
| Lecture 23: Thermal focus shift                       | 11/12        | V&Y: §6.4.4-6.4.7                                                          |
| Lecture 24: Athermalization                           | 11/14        | Athermalization notes (D2L)                                                |
| <b>Unit 4: Advanced topics</b>                        |              |                                                                            |
| Lecture 25: Vibration                                 | 11/19        |                                                                            |
| <b>(No lecture)</b>                                   | 11/21        |                                                                            |
| <b>Homework 7 due</b>                                 | <b>11/24</b> |                                                                            |
| Thanksgiving recess <b>(No lecture)</b>               | 11/26        |                                                                            |
| Thanksgiving recess <b>(No lecture)</b>               | 11/28        |                                                                            |
| Lecture 26: Temperature gradients and film stress     | 12/3         |                                                                            |
| Lecture 27: Finite element analysis                   | 12/5         |                                                                            |
| Lecture 28: Finite element analysis                   | 12/8         |                                                                            |

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