OPTI 423/523: Optomechanical Design and Analysis

Updated 1/26/2026

Spring 2026
Lecture Monday/Wednesday 11:00am-12:15pm MST.

Course Description

This course will focus on the optomechanical engineering design process, building on material covered in OPTI 421/521 and filling in some gaps. We will cover detailed analysis using finite element modeling and coupling with optical analysis software. Students will complete a design project on an optomechanical topic of their choosing.

Instructor information

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TA information

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Learning outcomes

After taking this course, students should be able to:

- Construct error budgets for optomechanical systems
- Identify design aspects that require detailed analysis
- Evaluate numerical models for accuracy using several approaches
- Integrate numerical and optical simulation tools

400/500 Co-convened Course information

Graduate students will complete a design project with wider scope than undergraduate students, and will be assigned additional problems.

Required Texts and Materials

Doyle, Genberg, Michels, "*Integrated Optomechanical Analysis,"* 2nd Edition, SPIE Press, 2012

Opto-Mechanical Systems Design, Volume 2: Design and analysis of large mirrors and structures, edited by Paul Yoder and Daniel Vukobratovich, Taylor & Francis Group, 2015.

These are available at **no cost to you** through UA libraries.
https://ebookcentral.proquest.com/lib/UAZ/detail.action?docID=1693413

https://www-spiedigitallibrary-org.ezproxy4.library.arizona.edu/ebooks/PM/Integrated-Optomechanical-Analysis-Second-Edition/eISBN-9780819492494/10.1117/3.974624?SSO=1

Software

The following software will be used: Microsoft Excel, SolidWorks, Zemax OpticStudio, Matlab.

Students are free to use finite element analysis or ray tracing software of their choice, with the understanding that there is little or no support for software other than the packages listed above.

All software is available from UArizona or the College of Optical Sciences at no cost to you.

Assessment

Grading will be based on three Analysis Reports and a Design Project:

Element	Due date	Fraction of grade
Analysis Reports		45%
Report 1	1/30	*15%*
Report 2	3/6	*15%*
Report 3	4/17	*15%*
Design Project		55%
Proposal and preliminary requirements	2/11	*5%*
Midterm report	3/27	*7.5%*
Midterm review	3/30 – 3/31	*7.5%*
Final report	5/6	*30%*
Presentation and participation	4/27-5/6	*5%*

Project details and guidance are 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

Detailed schedule and **deadlines**	Date	Suggested reading*
Unit 1: Fundamentals of optomechanical system design		
Lecture 1: Review of optomechanical effects	1/14	
Analysis Report 1 requirements released	**1/16**	
Lecture 2: Requirements and error budgeting *[Recorded 1/16]*	1/21	
Lecture 3: Preliminary design, Surface errors and fitting	1/26	
Lecture 4: First-order flexure design	1/28	DGM 3.1, DGM Ch. 4
Analysis Report 1 due (11:59pm MST)	**1/30**	
Lecture 5: More flexure design	2/2	
Lecture 6: Stiffness matrices	2/4	DGM 6.2, 6.4.2
Lecture 7: Rigid body vibration modes and mirror bending *[Recorded 2/6, 9:30-10:45am in Meinel 307]*	2/9	DGM 1.2-1.4
Analysis Report 2 requirements released	**2/9**	
Unit 2: Introduction to Finite Element Analysis (FEA)		
Project proposal and requirements due (11:59pm MST)	**2/11**	
Lecture 8: Static structural and modal FEA *[Recorded 2/9, 8-9:15am in Meinel 307]*	2/11	
Lecture 9: Modeling adhesive bonds	2/16	DGM 6.1
Lecture 10: FEA theory	2/18	DGM 1.5, 5.1.3-5.1.4
Lecture 11: Simplified models	2/23	
Lecture 12: Connections, linearity	2/25	
Unit 3: Thermal and dynamic FEA		
Lecture 13: Thermal analysis	3/2	
Lecture 14: Thermal effects on ray tracing	3/4	DGM 1.4.4-1.4.5, 9.1-9.2
Analysis Report 2 due (11:59pm MST)	**3/6**	
Spring recess	3/7-3/15	
Lecture 15: STOP analysis	3/16	DGM 9.3-9.6
Lecture 16: STOP analysis examples	3/18	DGM 8.4-8.5
Lecture 17: Stress birefringence	3/23	
Lecture 18: Introduction to dynamic analysis	3/25	DGM 7.1-7.3
Design Project midterm report due	**3/27**	
Design Project midterm reviews [Zoom, No lecture on 3/30]	**3/30-3/31**	
Lecture 19: Evaluating response to vibration	4/1	DGM 7.4, 7.7, 7.11
Analysis Report 3 requirements released	**4/3**	
Lecture 20: Simulating shock loading	4/6	DGM 7.6
Unit 4: Large and flexible mirrors		
No lecture	4/8	
Lecture 21: Large mirror architectures	4/13	Y&V 2.1-2.2, 3.2, 3.7-3.8, 4.5-4.6, 5.6
Lecture 22: Lightweight mirror models	4/15	
Analysis Report 3 due	**4/17**	
Lecture 23: Optical fabrication	4/20	DGM 5.2
Lecture 24: Deformable mirrors	4/22	DGM 10.1-10.7
Student presentations [Zoom]	**4/27-5/6**	
Design Project final report due	**5/6**	

* DGM: Doyle, Genberg, Michels; Y&V: Yoder and Vukobratovitch, volume 2.