

OPTI BME 630: Biomedical Optics and Biophotonics

Effective Semester 2022

Course Description:

This course covers the basic optical principles, techniques and instruments used in biomedical research and clinical medicine. It includes in-depth coverage of optical imaging and spectroscopy systems for biomedical research and clinical diagnosis, details of light interaction with tissue. This course is intended for graduate students in optical sciences or engineering with a suitable background in optics and imaging.

Pre-requisites:

N/A

Number of Units/ component:

3

Locations and Times:

Meinel 432

Tu, Th 8:00-9:15 am

Instructor Information:

Dongkyun Kang

Meinel 621

Office hours: By appointment only.

Expected Learning Outcomes:

Upon completion of this course students will be able to

- 1) Understand working principles and key performance specifications of biomedical optical instruments,
- 2) Identify biomedical applications, specify the performance requirements, and find adequate optics solutions.

Course Objectives:

During this course students will

- 1) Review geometrical optics, wave optics, digital imaging concepts relevant to biomedical applications,
- 2) Learn optical imaging technologies used in life science research,
- 3) Learn optical imaging technologies used in medical applications.

Required Texts:

NA

Recommended books:

Optical System Design (Robert E. Fischer): Available online through the UA library.
Optics (Hecht)
Fourier optics (Goodman)

Topics and/or general calendar:

Part 1: Optics and Microscopy

- Geometrical optics
- Wave optics
- Digital imaging
- Microscopy (bright field, dark field, DIC, fluorescence)

Part 2: Optics in basic life science research

- Confocal microscopy
- Structured illumination microscopy
- Multi-photon microscopy
- STED
- Light sheet microscopy
- STORM
- FLIM, CARS
- Intravital imaging
- Tissue clearing, Expansion microscopy, Deep learning.

Part 3: Optics in medical diagnosis

- Tissue optics
- In vivo confocal microscopy
- Optical coherence tomography
- Laser speckle imaging
- Photoacoustic imaging
- Spectroscopy
- Diffuse optical imaging
- Clinical applications (Dermatology, Gastroenterology, Cardiology, Ophthalmology, Ex vivo fresh tissue imaging)

Number of Exams and Papers:

2 Mid-term exams

4 Homeworks

2 Lab reports

1 Final report and presentation

Course Policies:

Grading Policy

Midterm exam	30%
Presentation	15%
Final report	15%
Homework (4 assignments total)	20%
Lap reports (2 lab reports total)	10%
<u>Class Participation</u>	<u>10%</u>
Total	100%

The grade will be determined according to the cumulative percentage earned such that 90-100% = A, 80-89% = B, 70-79% = C, 60-69% = D, below 60% = E.

Face coverings are required in our classroom (pending the COVID situation)

Per UArizona's Administrative Directive, face coverings that cover the nose, mouth, and chin are required to be worn in all learning spaces at the University of Arizona (e.g., in classrooms,

laboratories and studios). Any student who violates this directive will be asked to immediately leave the learning space, and will be allowed to return only when they are wearing a face covering. Subsequent episodes of noncompliance will result in a Student Code of Conduct complaint being filed with the Dean of Students Office, which may result in sanctions being applied. The student will not be able to return to the learning space until the matter is resolved.

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>

According to the Arizona Code of Academic Integrity, "Integrity is expected of every student in all academic work. The guiding principle of academic integrity is that a student's submitted work must be the student's own." Unless otherwise noted by the instructor, work for all assignments in this course must be conducted independently by each student. Co-authored work of any kind is unacceptable. Misappropriation of exams before or after they are given will be considered academics misconduct.

Misconduct of any kind will be prosecuted and may result in any or all of the following:

- Reduction of grade
- Failing grade
- Referral to the Dean of Students for consideration of additional penalty, i.e. notation on a student's transcript re. academic integrity violation, etc.

Attendance Policy

It is important to attend all classes, as what is discussed in class is pertinent to adequate performance on assignments and exams. If you must be absent, it is your responsibility to obtain and review the information you missed. This is especially important in this course where a substantial amount of course material will emerge through class discussion.

"All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion. Absences pre-approved by the UA Dean of Students (or Dean's designee) will be honored."

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.).

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>

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.

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>.

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.

If our class meets at a campus location: 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.

Additional Resources for Students

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies>
Student Assistance and Advocacy information is available at <http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>

Confidentiality of Student Records

<http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa>

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.