Course name	**Biomedical Optical Microscopy**
Course number	**BIOENG 1383 / 2383**
Semester	**Spring 2025**
Course time	**9 am – 10:15 am, Tuesday – Thursday**
Location	# **318, Benedum Hall, 3700 O'Hara St**
Credits	**3**
Max class enrollment	**50 / 10**

Instructor	**Bistra Iordanova, PhD**
Contact information	**bei3@pitt.edu**
Office location	**Center for Bioengineering # 209** **300 Technology Drive** **Pittsburgh, PA15219**
Office hours	**By appointment**

Teaching Assistants	**Maryam Satarpour - MAS1338@pitt.edu** **Zahra Hosseini - ZAH54@pitt.edu**
TA Office hours	**Thursdays at noon**
Location	**# 317 Benedum Hall, 3700 O'Hara St**

Course Description

This course is designed to teach the basic physical concepts and working mechanisms of optical imaging devices and techniques commonly used in biomedical research. Light-based devices and microscopy systems have a broad range of applications in our daily life, clinical diagnosis and biomedical research. They can be used to capture an image of an object, visualize objects "invisible" to our naked eyes at cellular and molecular level and probe physiological parameters such as oxygen and temperature. This class incorporates many aspects of physical, engineering and biomedical sciences into the curriculum. We will introduce the basic physical principles of light and image formation (physics), the working mechanisms of light source and camera sensors (engineering), the underlying principles of light-tissue interactions (engineering) and how to apply them to solve real-world problems (biomedical optics).

Learning Objectives

Upon completion of the course, the students should have a basic understanding of light and how the image is formed and measured. The students are expected to understand the working principles underlying standard imaging devices and some advanced optical imaging systems. The students are also expected to be capable of designing simple imaging devices and identify a proper optical imaging technique to address a specific biological question.

Course Texts

"Fundamentals of Light Microscopy and Electronic Imaging", Douglas B. Murphy, 2nd Edition, 2012 (eBook available from University Library; Please note that the lectures do not strictly adhere to a single textbook. We use contents from slides, notes and reviews posted on canvas. Please keep review the posted readings before you come to class.

Software

ImageJ and MATLAB

Attendance

The attendance is in person. There is no zoom option. If you miss a class, you are responsible for the material you missed. Lecture recordings, lecture slides and readings will be posted on canvas.

Grading information

Class participation 10%
Homework 30%
Midterm 25%
Final 25%
Collaborative project 10%

Grade	Percent %
A	100 – 93
A-	92 – 90
B+	89-87
B	86-83
B-	82-80
C+	79-77
C	76-73
C-	72-70
D+	69-67
D	66-63
D-	62-60
F	<60

Class participation in the top hat quiz is worth 10%
During each class there will be a Top Hat quiz with one or two questions to reinforce the understanding of the current lecture. Participation credit is only given to those that attend in person. The goal is to engage with the material real time and to be present.

Each homework is worth 6% adding up to 30%
Ten days on average to complete each HW. Pay attention to the deadlines. Late submission will lose 20 % of the graded score any time after the deadline for the first 24 hours. No submissions will be considered 24 hours after the deadline.

Final project proposal is worth 10%
Assigned teams of 4 students will select a project topic that uses optical imaging concepts and devices to address an unmet clinical need or a biological question. They will write and submit one page outline the week prior to the group presentation. A 15-minute presentation will be given to the class. In the presentation, you will give an in-depth explanation of the technology (including principle, engineering implementation) and what solution it provides. **The graduate section** will present on the earliest date in smaller teams of 2 and may address the optical approaches employed their graduate research.

Midterm and final each worth 25% - total of 50%
Each exam to be completed within 24 hours. Includes questions on the theory covered in class and basic computations. Late submission will lose 20 points any time after the deadline for the first 24 hours (out of 100). No submissions will be considered 24 hours after the deadline.

Extra credit 1% - Final OMET filled at least by 90% of the class

Class schedule
Week 1-2: Course overview, physical basis of light, image formation, measures of microscopic images (e.g., aberration, resolution, image contrast)
Week 3-4: Imaging components (e.g., light sources, optics, cameras), and digital imaging
Week 5: Common non-fluorescent imaging techniques: bright-field, polarization and phase imaging
Week 6-9: Fluorescence based imaging systems, three-dimensional imaging microscopy (e.g., confocal and light-sheet), non-linear microscopy, multi-photon, second harmonic, super-resolution microscopy
Week 10-11: Intrinsic signals optical imaging (hemoglobin-based wide field imaging, near infrared signals). Optical coherence tomography
Week 12-13: Image Analysis
Weeks 14-15: Class presentations

R 01/01	L1 Intro	
T 01/14	L2 Light and geometrical optics	HW1 given
R 01/16	L3 Image formation	
T 01/21	L4 Optical aberrations	
R 01/23	L5 Optical resolution	HW1 due on Friday
T 01/28	L6 Anatomy of a microscope	HW2 given
R 01/30	L7 Digital imaging and sensors	
T 02/04	L8 Non-fluorescence microscopy	
R 02/06	L9 Phase contrast microscopy	HW2 due on Friday
T 02/11	L10 Differential interference contrast	HW3 given
R 02/13	L11 Fluorescence microscopy	
T 02/18	L12 Confocal microscopy	
R 02/20	L13 Dynamic fluorescence imaging	HW3 due on Friday
T 02/25	L14 Midterm Review	
R 02/27	Take home Midterm – no class	
	Spring break	
T 03/11	L15 Two-photon microscopy	HW4 given
R 03/13	L16 Second harmonic microscopy	
T 03/18	L17 Total internal reflection fluorescence (TIRF) and light sheet microscopy	
R 03/20	L18 Super-resolution microscopy	HW4 due on Friday
T 03/25	L19 Optical coherence tomography	HW5 given
R 03/27	L20 Image formation in OCT	
T 04/01	L21 Near infrared spectroscopy (NIRS)	HW5 due Tue 04/01
R 04/03	L22 Final review + Q & A on final – send questions by end of Tuesday 04/01 for extra credit	One page outline due Fri 04/04
08/10/15 /17	Presentations – graduate students going on 04/08	Presentation slides due Fri 04/18
T 04/22	Take home Final – no class	

Class Climate
All of us should feel responsible for creating a space that is both intellectually rigorous and respectful. Above all, be respectful (even when you strongly disagree) and be mindful of the ways that our identities position us in the classroom. I expect everyone to come to class prepared to discuss the readings in a mature and respectful way. You can approach your instructor or teaching assistant ahead of time if you need more information about a topic or reading. If you need to leave or miss class, you are still responsible for the material you missed.

Academic Integrity
Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. To learn more about Academic Integrity, visit the Academic Integrity Guide for an overview of the topic. For hands-on practice, complete the Understanding and Avoiding Plagiarism tutorial.

Disability Services
If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Diversity and Inclusion
The University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color, religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University's Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University's mission. For more information about policies, procedures, and practices, see: https://www.diversity.pitt.edu/civil-rights-title-ix-compliance/.

I ask that everyone in the class strive to help ensure that other members of this class can learn in a supportive and respectful environment. If there are instances of the aforementioned issues, please contact the Title IX Coordinator, by calling 412-648-7860, or e-mailing titleixcoordinator@pitt.edu. You may also choose to report this to a faculty/staff member; they are required to communicate this to the University's Office of Diversity and Inclusion. If you wish to maintain complete confidentiality, you may also contact the University Counseling Center (412-648-7930).

Take Care of Yourself
Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep, and taking time to relax. Despite what you might hear, using your time to take care of yourself will help you achieve your academic goals more than spending too much time studying. All of us benefit from support and guidance during times of struggle. There are many helpful resources available at Pitt. An important part of the college experience is learning how to ask for help. Take the time to learn about all that's available and take advantage of it. Ask for support sooner rather than later – this always helps. If you or anyone you know experiences any academic stress, difficult life events, or difficult feelings like anxiety or depression, we strongly encourage you to seek support. Consider reaching out to a friend, faculty or family member you trust for assistance connecting to the support that can help. The University Counseling Center is here for you: call 412-648-7930 and visit their website.
If you or someone you know is feeling suicidal, call someone immediately, day or night:
University Counseling Center (UCC): 412 648-7930
University Counseling Center Mental Health Crisis Response: 412-648-7930 x1
Resolve Crisis Network: 888-796-8226 (888-7-YOU-CAN)