BIOE 572: Biological Measurement II

ILLINOIS Bioengineering

Meeting time: Monday/Wednesday, 2:00 – 3:20 PM
Location: 3117 Everitt Laboratory
Credit hours: 4
Semester: Spring 2026 (02/20/26 – 05/06/26)

Instructor Information

Name: Xing Wang, Ph.D.
Email: xingw@illinois.edu
Phone: 217-333-9278
Office: 0250 Everitt Lab
Office hours: Wednesday 3:30-5 PM or by appointment (In person or Zoom meeting)

Course Overview

This course has a special focus on medical imaging and learning about advanced techniques relating to state-of-the-art bioinstrumentation technologies. Topics will broadly include fluorescence, genomic and proteomic diagnostics, biosensors, ultrasound imaging, microscopy, and their uses relevant to physiological changes related to major human diseases.

Course Learning Objectives

By the end of this course, you will be able to:

- Understand the physics and technology of commonly used biomedical imaging techniques.
- Apply techniques of instrumentation to characterize underlying health and disease at multi-scale.
- Use statistical measures to assess the quality of a measurement.
- Identify the most appropriate biomedical imaging techniques for particular applications.
- Understand and explain endogenous and exogenous probes for clinical and pre-clinical applications.

Academic Calendar

A course week is defined as the period between Monday, 12:00 AM Central Time and Sunday, 11:55 PM Central Time. For more information, see the University's Academic Calendar.

The course is **16 weeks long**. You should dedicate approximately 8-10 hours per week to working on the course itself, but actual time commitments will vary depending on your input, needs, and personal study habits. You are highly suggested to log on to the course website and check your email a minimum of 4 days per week.

Course Components

This course will consist of the following components:

Case Study:
You will learn through real case studies related with the medical and bioengineering challenges.

Lectures and Readings:
There is a list of recorded lectures. In some cases, required or optional readings may be listed for further study. Lectures cover major topics from the readings but do not necessarily include all important information from the readings or case study.

Quiz:
There are four (4) quizzes in this course. Each quiz has 10 questions related to the cases and lectures. Each question is worth 1 point, for a total of 10 points. This is an individual assignment. You have one (1) attempt to finish the quiz, the quiz should be completed during the timeline proposed.

Learning Issues:
Throughout the course, you will complete **#** learning issues that are presented by the cases. Learning Issues Rubric:

Item	Exemplary (exceeds expectations; performance is outstanding) 7-10 points	Proficient (meets expectations; performance is satisfactory) 4-6 points	Novice (does not meet expectations; performance is substandard) 0-3 points
Learning Issues	The learning issue details are correct and adequately address all questions clearly.	The learning issues address most, but not all the questions.	The learning issues are lacking or do not answer the questions.
Citations	The citations are listed and clearly presented.	The citations are partially listed and not clearly presented.	The citations are missing or not presented.
Understanding	The list of learning issues does an excellent job demonstrating an accurate understanding of the text and/or course materials.	The learning issues exhibit basic understanding of the text and/or course materials but need improvement in this area.	The learning issues exhibit very little understanding of the text and/or course materials.

Projects:
Projects will reinforce concepts presented in the lectures and readings and give you an opportunity to explore these concepts in greater depth. Project Rubric:

Item	Exemplary (exceeds expectations; performance is outstanding) 7-10 points	Proficient (meets expectations; performance is satisfactory) 4-6 points	Novice (does not meet expectations; performance is substandard) 0-3 points
Content	Capture audience's attention Introduce yourself and the team State intent of presentation Outline what the team will cover in the presentation Introduce the problem	Partially capture audience's attention Introduce yourself and the team Partially state intent of presentation Partially outline what the team will cover in the presentation Partially introduce the problem	Fail in capture audience's attention Does not state intent of presentation Does not outline what the team will cover in the presentation Does not introduce the problem
Core Knowledge	Demonstrate an understanding of the power of engineering and recognize its applications towards biological problems.	Partially demonstrate an understanding of the power of engineering and recognize its applications towards biological problems.	Demonstrate lack of an understanding of the power of engineering and recognize its applications towards biological problems.
Organization	Clear ordering of presentation and topics, easy to follow Smooth transition between topics	Ordering of presentation is partially clear and topics are not as easy to follow Partially transition between topics	Ordering of presentation is not clear and topics are not easy to follow No transition between topics
Delivery	Length, energy, voice fluctuation Eye contact; not just reading from slides or notecards Professional language used	Length is too long or too short Partial eye contact; reading from slides or notecards	Length is too long or too short No eye contact, just reading from slides or notecards

	Smooth transitions from one speaker to the next Engaging the audience	Professional language is used most of the times Smooth transitions from one speaker to the next most of the time Partially engaging the audience	Unprofessional language is used most of the times Lack of smooth transitions from one speaker to the next most of the time Does not engage the audience
Visual Aids	Can be seen clearly (font size) Enhance presentation Font/colors are visible, and slides are professional Right amount of information per slide Practiced in the technology (be sure links to videos work)	Can be partially seen clearly (font size) Font/colors are visible; slides are professional Too much information per slide Partially practiced in the technology (be sure links to videos work)	Can't be seen clearly (font size) Does not enhance presentation Font/colors are not visible, or slides are not professional Too much information per slide Did not practice in the technology (be sure links to videos work)

Case Summary:
Case Summary is a final report after the end of each case. You will have to write 2 Case Summaries. There is no specific format or word limit. You will summarize what you learned based on the case discussions, learning issues, videos and projects.

Case Summary Rubric

Item	Exemplary (exceeds expectations; performance is outstanding) 7-10 points	Proficient (meets expectations; performance is satisfactory) 4-6 points	Novice (does not meet expectations; performance is substandard) 0-3 points
Case Summary	The case brief details and procedural history are correct and adequately addresses all parts of	The case brief addresses most, but not all, of parts of the details and history, but the procedural	Case citation and procedural history is evident, but the details are lacking, or the procedural

	clearly and in proper chronological sequence.	history is out of sequence or difficult to discern	history of the case is incomplete.
Mechanics of Writing	The case brief is nearly perfect with respect to grammar, citations, spelling, and style.	The case brief needs a good deal of improvement with respect to grammar, citations, spelling, and/or style.	The grammar of the case brief greatly impedes understanding of content, and/or the paper contains no citations.
Understanding	The case summary does an excellent job demonstrating an accurate understanding of the text and/or course materials.	The case brief exhibits basic understanding of the text and/or course materials but needs improvement in this area.	The case brief exhibits very little understanding of the text and/or course materials.

Assignment and Late Submission
Assignment will reinforce concepts presented in the lectures and readings and give you an opportunity to explore these concepts in greater depth. If a student submits an assignment after the due date without having arrangements with the instructor (at least 24 hours before the submission), a minimum of 10% of your total grade will be deducted for each day, or part thereof, that the assignment is late.

Participation
As you prepare for your career as a working engineer, it is critical to develop professional habits. The following professional behaviors are strongly encouraged in all class activities. I reserve the right to add up to 5% to the final grade for demonstrated excellence in professional behavior.

- Responding helpfully to questions from other students in class or on the discussion forum.
- Assisting other students with homework, class activities, or study groups.
- Working as an excellent team member on all group projects and reports.
- Participating in class discussions and actively seeking knowledge.
- Taking responsibility for your own decisions in class and class materials

Final Exam
This course includes a final project.

Course Schedule

Tentative and subject to change

Week	Date	Topic	Assignment
1	Jan 19	No in person class	

		Martin Luther King Day	
	Jan 21	Case 1- Day 1 – “Patient 1: The Huang Family: The Mysterious Flu”	Watch: Week 1 Video Lectures: • “Point Spread Function” • “Super Resolution Microscopy” • “Super Resolution Microscopy 2” • “Multi-Photon Microscopy” • “Light Sheet Microscopy”
2	Jan 26	Case 1- Day 2– Findings from Day 1- “Patient 1: The Huang Family: The Mysterious Flu”	• Quiz 1 (Starting from this day and remaining open for 1 week) • Preparation of Project 1 Watch: Week 2 Video Lectures: • “Super Resolution Microscopy Techniques” • “Fourier Optics in Microscopy”
	Jan 28	Case 1 – Day 3 Findings from Day 2 and Project Presentations	• Project 1 Submission by Jan 29
3	Feb 2	No in person class Watch Week 3 Video Lectures: • “Photoactivated Localization Microscopy (PALM)” • “Super Resolution Microscopy 3” • “FRET, FLIP and FRAP”	
	Feb 4	Case 1 – Day 4 – “Unlocking the Secrets”	• Preparation of project 2
4	Feb 9	Case 1 – Day 5 Findings from Day 4 and Project Presentations	• Project 2 Submission by Feb 10
	Feb 11	Case 1 – Day 6 – “Scientists develop COVID testing”	

5	Feb 16	No in person class Watch: Week 5 Video Lectures Part 1: • "Light Interaction with Matter Part 1, 2 and 3" • "Interactions of Materials with Light" Watch: Week 5 Video Lectures Part 1: • "Theory of IR Imaging"	• Quiz 2 (starting from this day remains open for 1 week)
	Feb 18	No in person class Watch: Week 5 Video Lectures: • "Understand Needs to Design and Optimize Instrumentation" • "High Performance Proof of Concept in the Laboratory"	• Week 5 Reading: Spectroscopy as a Tool for Detection and Monitoring of COVID-19 (Read before next class)
6	Feb 23	Case 1 – Day 7 Findings from Day 6 and "Spectroscopy as a tool for monitoring and detection of COVID-19"	
	Feb 25	No in person class	• Group time to discuss ideas focused on the problem and the 3Cs (curiosity, creativity, and connections) • Preparation of Project 3
7	Mar 2	Case 1 – Day 8 Debrief session Findings from Day 7 and Project Presentations	• Project 3 Submission by Mar 3
	Mar 4	Case 1 – Day 9	• End case 1

		"Raman Technology and Breast Cancer" End case 1	• Write case summary due on Mar 19
8	Mar 9	Case 2 – Day 1 "Patient 2: Ms. Smith -Neuro Issues."	
	Mar 11	No in person class Watch: Week 8 Video Lectures: • "Introduction to MRI" • "Basic MRI Physics" • "MRI Physics Examples" • "MRI: From Basic Physics to Image Components"	Quiz 3 (starting from March 23 and it remains open for 1 week)
9	Mar 16	No class (Spring break)	
	Mar 18		
10	Mar 23	Case 2 – Day 2 Findings from Day 1 "Innovation for COVID Times"	• Preparation of Project 4
	Mar 25	No in person class	
11	Mar 30	Case 2 – Day 3 Project Presentations "Innovation for COVID Times"	• Project 4 Submission by Mar 31 • Watch Week 11 video lectures
	Apr 1	Case 2 – Day 4 Presentations "Ms. Smith is back!"	
12	Apr 6	Case 2 – Day 5 Findings from Day 4	• Quiz 4 (starting from this day and it remains open for 1 week)

		"Patient 2: Ana Ramirez"	
	Apr 8	Case 2 – Day 6 Findings from Day 5 "Patient 3: Jermaine Jackson"	• Preparation of Project 5
13	Apr 13	No in person class Watch Week 13 Video Lectures: • "MRI: Gradients to Imaging" • "MRI: Pulse Sequence Design" • "MRI: Fast, Single-Shot Imaging" • "MRI: Image Reconstruction" • "MRI: Functional MRI"	
	Apr 15	No in person class Watch Week 13 Video Lectures: • "Interaction of Radiation with Matter" • "Image Noise and Filtering" • "Properties of Imaging Systems" • "Detecting Radiation" • "PET Imaging Quantification", • "Selected PET Applications" • "Selected SPECT Applications"	
14	Apr 20	Case 2 – Day 8 Project 5 presentations End Case 2	• Project 5 submission by Apr 21
	Apr 22	No in person class Watch Week 13 Video Lectures:	

		• "New Developments in Nuclear Imaging" • "Module Summary"	
15	Apr 27	Final Project – Task Part I Group time and office hours	
	Apr 29	Final Project – Task Part II Group time and office hours	• Final Project Part 1 submission by Apr 29
16	May 4	Group time and office hours	• Final Project Part 2 submission by May 4
	May 6	Last day of class Final Project Presentations	• Project 6 (Final Project) submission by May 7 • Case Summary II (due on May 10)

Course Materials

- Lecture slides and recordings.
- Primary research papers, review articles, and book chapters.
- No specific textbook is required (a few books are recommended below) and students are encouraged to read books related to bioengineering and bioinstrumentation.
  - Bioinstrumentation text by Webster Link
  - Medical Instrumentation: Application and Design Link
  - Measurement, instrumentation, and sensors handbook Link
  - Handbook of biomedical instrumentation Link

Grading

Grading Distribution:

- Learning Issues 40%
- Projects and Case Summary 40%
- Quizzes 20%

Grading Scale:

Percentage	Letter Grade
93-100	A
90-92.99	A-
87-89.99	B+
83-86.99	B
80-82.99	B-
77-79.99	C+

73-76.99	C
70-72.99	C-
67-69.99	D+
63-66.99	D
60-62.99	D-
Below 60	F

Course Policies

Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students should contact both the instructor and the Disability Resources and Educational Services (DRES) as soon as possible. You can contact DRES at 1207 S. Oak Street, Champaign, (217) 333-1970, or via email at disability@illinois.edu.

Participation

Active participation in the online learning environment is vital to your success in this course. Depending on your course, you may be asked to engage in online discussions and other interactive learning environments that invite your active participation and involvement with other students and your instructor.

Deadlines

If you are unable to meet a particular deadline, it is your responsibility to make prior arrangements with the instructors for that given week.

Instructor Responses

Instructor Feedback Turnaround Time: Questions posted to the course Q&A Forum generally will be answered within 48 hours. If possible, students are encouraged to answer questions posted by other students to the Q & A Forum, rather than waiting for an instructor's response. Assignments submitted online will be reviewed and graded by the course instructor within a week. If your instructor is unable to meet this timeline, students will be notified.

Responding to Emails: The instructor will respond to email messages within 48 hours of receiving them unless the instructor notifies you ahead of time of an inability to do so. When sending e-mail, include a subject line that identifies the course number and nature of your question. The instructor may not respond to questions sent to him that should be posted in the Q & A Forum. Please do not be offended if you are asked to forward your question to this location.

Use of Generative AI Technology

Generative AI, such as ChatGPT, Bard, and Microsoft Copilot/Bing Chat, can answer questions and generate text, images, and other media. The appropriate use of generative AI varies from course to course. In BIOE 572, there are times when generative AI may be useful in the course. If you choose to use generative AI as permitted below, you must

document and attribute all AI contributions to your coursework and take full responsibility for the contributions including the accuracy of the information and reliability of sources. When using generative AI, keep a journal documenting prompts, AI responses, and your usage. Your instructor may ask you to provide this documentation.

You may use generative AI in BIOE 572 for the following:

- Revising your own text for spelling and grammar
- Creating study aids (e.g., flashcards) for quizzes or exams
- Testing and practicing your knowledge of course topics
- Conducting basic research on the course and assignment topics

You MAY NOT use generative AI in BIOE 572 for the following:

- Writing entire sentences, paragraphs, or papers to complete class assignments
- Creating power point slides and projects
- Solving technical design problems, coding, solving equations

If you have a question about the use of Generative AI, please reach out to your instructors. Failure to abide by these guidelines is a violation of academic integrity. We will investigate suspected uses of generative AI that do not follow these guidelines and apply sanctions as outlined in the Illinois Student Code.

Copyright

Student Content: Participants in University of Illinois courses retain copyright of all assignments and posts they complete; however, all materials may be used for educational purposes within the given course. In group projects, only the portion of the work completed by a particular individual is copyrighted by that individual. The University of Illinois may request that students' materials be shared with future courses, but such sharing will only be done with the students' consent. The information that students submit during a course may, however, be used for the purposes of administrative data collection and research. No personal information is retained without the students' consent.

Non-Student Content: Everything on this site and within University of Illinois courses is copyrighted. The copyrights of all non-student work are owned by the University of Illinois Board of Trustees, except in approved cases where the original creator retains copyright of the material. Copyrights to external links are owned by or are the responsibility of those external sites. Students are free to view and print material from this site so long as

- The material is used for informational purposes only.
- The material is used for noncommercial purposes only.
- Copies of any material include the respective copyright notice.

These materials may not be mirrored or reproduced on non-University of Illinois websites without the express written permission of the University of Illinois Board of Trustees. To request permission, please contact the academic unit for the program.

Student Behavior

Student Conduct: Students are expected to behave in accordance with the penal and civil statutes of all applicable local, state, and federal governments, with the rules and regulations of the Board of Regents, and with University regulations and administrative rules. For more information about the student code and handbook, see the CITL Course Policies page.

Netiquette: In any social interaction, certain rules of etiquette are expected and contribute to more enjoyable and productive communication. The following are tips for interacting online via email or discussion board messages, adapted from guidelines originally compiled by Chuq Von Rospach and Gene Spafford (1995):

- Remember that the person receiving your message is someone like you, deserving and appreciating courtesy and respect.
- Be brief; succinct, thoughtful messages have the greatest effect.
- Your messages reflect on you personally; take time to make sure that you are proud of their form and content.
- Use descriptive subject headings in your e-mails.
- Think about your audience and the relevance of your messages.
- Be careful when you use humor and sarcasm; absent the voice inflections and body language that aid face-to-face communication, Internet messages are easy to misinterpret.
- When making follow-up comments, summarize the parts of the message to which you are responding.
- Avoid repeating what has already been said; needless repetition is ineffective communication.
- Cite appropriate references whenever using someone else's ideas, thoughts, or words.

Communications

Daily Contact: Your daily contact should be via the discussion forums in our Learning Management System and via e-mail.

Course Questions: Questions pertaining to the course should be posted in our Q & A Forum. You can get to this forum from the course home page. Posting questions here allows everyone to benefit from the answers. If you have a question, someone else is probably wondering the same thing. Anyone submitting a question via e-mail will be directed to resubmit the question to the Q & A discussion forum. Also, participants should not hesitate to answer questions posed by peers if they know the answers and the instructor has not yet responded. This not only expedites the process but also encourages peer interaction and support.

Personal and Grade-related Questions: Questions of a personal nature should first be sent to the instructor's e-mail address (listed on the Instructor Information page). When sending e-mail, include a subject that identifies the course number and nature of your question.

Emergencies: If you have an emergency that will keep you from participating in the course, please notify your instructor by using the instructor's e-mail address (listed on the Instructor Information page). Provide callback information in your e-mail (if necessary). You should also notify your program director of any emergencies.

Zoom: Zoom is a tool that allows multiple people to join simultaneously via a computer to text chat, audio chat, video chat, collaborate on a digital whiteboard, and even share their computer desktops with one another. The Live Sessions make use of Zoom.

Announcements: The Announcements forum serves as a way for your instructor and University of Illinois administrators to make announcements within our online learning environment. Announcements posted here will also be sent to your Illinois e-mail address, so be sure to check your e-mail or the Announcements forum at least once a day to see whether any new announcements have been made.

Disability Statement and Resources

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to the DRES website. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available on campus that can help diagnosis a previously undiagnosed disability by visiting the DRES website and selecting “Sign-Up for an Academic Screening” at the bottom of the page.

If you are interested in obtaining information to improve writing, study skills, time management or organization, the following campus resources are available to all students:

- Writer’s Workshop, https://www.cws.illinois.edu/workshop
- https://www.disability.illinois.edu/strategies
- https://www.counselingcenter.illinois.edu/self-help-brochures/

Also, most college offices and academic deans provide academic skills support and assistance for academically related and personal problems. Links to the appropriate college contact can be found by going to this website and selecting your college or school: https://illinois.edu/colleges/colleges.html

If you are experiencing symptoms of anxiety or depression or are feeling overwhelmed, stressed, or in crisis, you can seek help through the following campus resources:

- Counseling Center, 206 Fred H. Turner Student Services Building, 7:50 a.m.-5:00 p.m., Monday through Friday Phone: 333-3704.
- McKinley Mental Health, 313 McKinley Health Center, 8:00 a.m.-5:00 p.m., Monday through Friday Phone: 333-2705.
- McKinley Health Education offers individual consultations for students interested in learning relaxation and other stress/time management skills, call 333-2714.

Diversity, Equity, and Inclusion Statement

It is my intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and

that the diversity that the students bring to this class be viewed as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally, or for other students or student groups.

Important note: Given the sensitive and challenging nature of the material discussed in class, it is imperative that there will be an atmosphere of trust and safety in the classroom. I will attempt to foster an environment in which each class member is able to hear and respect each other. It is critical that each class member show respect for all worldviews expressed in class. It is expected that some of the material in this course may evoke strong emotions, please be respectful of others' emotions and be mindful of your own. Please let me know if something said or done in the classroom, by either myself or other students, is particularly troubling or causes discomfort or offense. While our intention may not be to cause discomfort or offense, the impact of what happens throughout the course is not to be ignored and is something that I consider to be very important and deserving of attention. When this occurs, there are several ways to alleviate some of the discomfort or hurt you may experience:

- Discuss the situation privately with me. I am always open to listening to students' experiences and want to work with students to find acceptable ways to process and address the issue.
- Discuss the situation with the class. Chances are there is at least one other student in the class who had a similar response to the material. Discussion enhances the ability for all class participants to have a fuller understanding of context and impact of course material and class discussions.
- Notify me of the issue through another source such as your academic advisor, a trusted faculty member, or a peer. If for any reason you do not feel comfortable discussing the issue directly with me, I encourage you to seek out another, more comfortable avenue to address the issue.

Academic Integrity

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: https://studentcode.illinois.edu/

The Grainger College of Engineering uses the FAIR system to document and track academic integrity violations across courses. Multiple violations, even across multiple units, may be cause for dismissal. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Educate yourself on all policies here:
https://provost.illinois.edu/policies/policies/academic-integrity/students-quick-reference-guide-to-academic-integrity/

Please do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.