



College of Engineering

Engineering Faculty Document

No.: 64-25

January 15, 2025

**TO:** The Engineering Faculty

**FROM:** The Faculty of the Weldon School of Biomedical Engineering

**RE:** New 500-level course – BME 50400: Engineering Analysis of Tissues

The Faculty of the Weldon School of Biomedical Engineering has approved the following new 500-level course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

**FROM:**

BME 59500: Engineering Analysis of Tissues

Offered Spring Semester

3 credit Lecture

Prerequisite: BME 21401 Fundamentals of Biomechanical Analysis

This course has been offered four times as a 3-credit hour BME 59500 course. It has been well received with steadily increasing enrollment. During the last offering in Spring 2022, 23 students enrolled in the class.

**TO:**

BME 50400: Engineering Analysis of Tissues

Offered Spring Semester

3 credit Lecture

Prerequisites:

Student Attribute: GR or

BME 21401 Fundamentals of Biomechanical Analysis

**Course description:**

This course covers the principles of a number of characterization methods used to assess the quantity and quality of tissues. The course will primarily focus on musculoskeletal tissues, although techniques are generally relevant to all tissues. General course topics include large scale mechanical testing and other methods.

**RATIONALE:**

The course is primarily designed for graduate students but is also open to senior undergraduate students. Given that the only prerequisite is an undergraduate course in mechanics of materials, the course is appropriate for both BME students and

students from other engineering disciplines. While BME has solid 200 and 300-level biomechanics courses, and a 300-level materials course, this is the only advanced course offered in the school related to the physical principles and use of analytical techniques to characterize tissues (and general materials). These concepts are necessary and critical to provide advanced training in normal and altered structure and function across the body's organ systems.

Signed by:

*Kevin John Otto*

Kevin Otto, Ph.D.

Dane A. Miller Head and Professor  
Weldon School of Biomedical Engineering

Link to Curriculog entry:

[New Proposal 3/20/2025 7:14 pm | Curriculum](#)



## Course Information

- **BME 50400 Engineering Analysis of Tissues**
- **CRN (tbd)**
- **Meeting day/time:** Tuesday and Thursday, 9:00 - 10:15 am
- **Instructional Modality:** Face-to-Face
- **Course credit hours:** 3-credit lecture
- **Prerequisites:** BME 21401 Fundamentals of Biomechanical Analysis or comparable mechanics course

## Instructor(s) Contact Information

**Instructor:** Professor Joseph Wallace ([jwalla78@purdue.edu](mailto:jwalla78@purdue.edu)) – **please email first**  
Office: SL220B; (317) 274-2448  
Office Hours: available by appointment – please contact by email

## Course Description

This course will cover the principles of a number of characterization methods used to assess the quantity and quality of tissues. The course will primarily focus on musculoskeletal tissues, although techniques are relevant to all tissues. General course topics include large scale mechanical testing and other methods.

### General course topics may include:

- Large scale mechanical testing
- Fracture toughness, fatigue, viscoelasticity
- X ray, microCT, pQCT, Synchrotron, DEXA
- SAXS/WAXS/XRD
- TEM/SEM/qBSEM
- Raman/FTIR
- Polarized light and SHG – tissue organization
- Contact mechanics, Indentation
- AFM-based imaging and mechanical testing (indentation, bending, pulling, friction)
- MRI and NMR

The course will be primarily discussion based, with some lecture content related to the various techniques. The remainder of the course is heavily based on the primary literature in each topic area. Students will be responsible for presenting 2-3 critical analyses of a journal articles within these topic areas (provided by the instructor). Grading will be based on participation in discussions, journal article presentations, and a semester-long research proposal project.

## Learning Resources, Technology & Texts

All required course readings will be provided by the instructor

### Purdue Libraries and School of Information Studies

- I encourage you to visit [Ask a Librarian](#) to connect with helpful resources and services provided by the Purdue Libraries and School of Information Studies for course assignments and projects.

### Software/web resources

- Word Processor (i.e. MS Word), remember that [MS Office is free for all students.](#)

## Academic Support

- The Helen Bass Williams [Academic Success Center](#), provides a variety of proactive, practical and approachable academic support services for you to strengthen your approaches and strategies for learning, including study skills consultations, peer coaching, workshops, and online handouts. [Visit the ASC website](#) for more information and to access resources.

## Brightspace learning management system (LMS)

- Access the course via Purdue's Brightspace learning management system. Begin with the Start Here tab, which offers further insight to the course and how you can be successful in it. It is strongly suggested that you explore and become familiar not only with the site navigation, but also with the content and resources available for this course. See the Student Services widget on the campus homepage for resources such as Technology Help, Academic Help, Campus Resources, and Protect Purdue.

## Learning Outcomes

Upon completion of the course, students should be able to:

- Recognize the physical operating principles of a variety of engineering tools [1]
- Master the application of techniques for the characterization of mechanical, organizational, and compositional properties of tissues [1,6]
- Devise appropriate tests to experimentally characterize tissue behavior [1,6]
- Critically analyze the scientific literature and communicate with peers [1,3]
- Develop a research question into a coherent and complete NIH-style research proposal [3,6]

## Assignments

**Overall class participation (10%):**

**Journal Club Presentation (30% total):**

All students registered for BME54600 will be grouped by the instructor into groups of 2 (or 3 depending on the number of students enrolled). Over the duration of the semester, each group will receive research articles related to specific topics covered in the class (2 for groups of 2, 3 for group of 3). The students will present the article to the class, provide a thorough critical analysis of the article, and lead the class in a discussion/debate of the strengths and weaknesses.

Scoring Items		Scoring Quantification Guidelines				
Item	Weight	Subtopic	Excellent	Good	Satisfactory	Unsatisfactory
Journal Club Presentations (30% of course grade)	100%	Organization	Comprehensive, logical, clear	Generally comprehensive and clear, major points covered	Some minor errors or minor missing components	Incomplete, lacks clarity
		Analysis of Background	Comprehensive	Generally complete	Just sufficient	Insufficient
		Explanation of Methods	Correctly described used	Well described. Generally correct use	Sufficiently described. Some errors	Poorly described. Errors
		Presentation of Results	Comprehensive	Generally complete	Just sufficient	Insufficient
		Critical Analysis of Discussion	Thought provoking coverage of strengths and weaknesses	Generally complete with most major points covered	Minor components of discussion missing	Insufficient
		Leading of Class Discussion	Clear command of article and able to answer all questions	Some minor deficiencies in understanding	Deficiencies in understanding 1 or more major components	Insufficient
		Spelling and Grammar	No errors	Some minor errors	Minor errors throughout	Errors throughout

**Exam Review Questions (10%):** Each student will be responsible for 5 review questions (with solutions) related to the topics covered in the course. These questions are expected to be detailed and thought

provoking, based on the information provided in class, and suitable for use on a graduate level discussion-based exam. These are due to me no later than 5 P.M. on Friday April 29<sup>th</sup>. No late questions will be accepted.

**Semester-long Research Proposal (50%):** Guidelines for the proposal (**worth 35% of final grade**) and oral presentation (**worth 15% of final grade**) will be discussed in greater detail in class. Student groups will define a research topic of their choice. Important dates for this project include:

- Proposal topics are due on February 10<sup>th</sup>. All students must meet with the instructor at least 1 time before this date to discuss their topic. This meeting must take place before Friday February 2<sup>nd</sup>.
- Students will develop a tenable and testable hypothesis and 2-3 specific aims. A draft of the specific aims page is due on March 1<sup>st</sup> and will be graded to ensure that the hypothesis is testable and that the aims are mechanistic and not simply descriptive.
- Students will turn in a draft of their proposal on Thursday March 24<sup>th</sup>. These drafts will be returned by Monday April 4<sup>th</sup> with comments. Though the draft is not graded, failure to turn in a draft on time will result in a significant point reduction for the assignment.
- A final draft of the proposal is due on Tuesday April 12<sup>th</sup> by the start of class. No exceptions will be made.
- Student presentations will begin on Tuesday, April 12<sup>th</sup> and will continue through April 28<sup>th</sup>. Presentation order will be determined by a random lottery beginning on April 12<sup>th</sup> unless students volunteer. All students are required to come prepared to present on the first day of presentations and each day thereafter until they present.
- Oral presentations will consist of a ~25-minute presentation followed by ~5 minutes of questions. The students will then leave the room and the rest of the class will discuss major strengths and weaknesses. The student will then meet with JW within the next week to discuss/summarize.

**Scoring Rubric for the written proposal (35% of total course grade for proposal, 15% for presentation)**

Scoring Items			Scoring Quantification Guidelines			
Item	Weight	Subtopic	Excellent	Good	Satisfactory	Unsatisfactory
Specific Aims	25%	Knowledge gap and need statement defined	Comprehensive	Generally complete	Sparse	Space poorly covered
		Clear and testable hypothesis	Clear and testable	Developed but unclear how testable	Somewhat developed	poorly developed or not testable
		Logical aims and methods	Clear and logical aims; not serial	Generally clear	Somewhat clear	Unclear
Significance	25%	Problem importance or critical barrier to progress defined	Comprehensive	Generally complete	Just sufficient	Insufficient
		Define how work will improve scientific knowledge, technical capability, and/or clinical practice	Comprehensive	Generally complete	Just sufficient	Insufficient
		Describe how concepts, methods, technologies, treatments, services, preventative interventions will be changed	Comprehensive	Generally complete	Just sufficient	Insufficient
Innovation	20%	Explain how work challenges and seeks to shift current research or clinical paradigms	Comprehensive	Generally complete	Just sufficient	Insufficient
		Describe novel concepts, approaches, instrumentation, or interventions; advantages over existing	Comprehensive	Generally complete	Just sufficient	Insufficient
Approach	25%	Describe overall strategy with preliminary studies from literature	Comprehensive	Generally complete	Just sufficient	Insufficient
		Description of methods and analysis	Correctly described used	Well described. Generally correct use	Sufficiently described. Some errors	Poorly described. Errors
		Power analysis/samples sizes, statistical analysis	Correctly described and correct use	Well described. Generally correct use	Sufficiently described. Some errors	Poorly described. Errors
		pitfalls, alternative strategies, benchmarks for success	pitfalls and alternatives complete	Generally complete	Just sufficient	Insufficient
References	5%	Format	Appropriate and consistent	Consistent, minor formatting issues	Some inconsistencies, minor formatting issues throughout	Inconsistent, major formatting issues
		Completeness	Complete without errors	Minor errors	Some errors or missing references	Many errors
Presentation (15% of course grade)	100%	Organization	Comprehensive, logical, clear	Generally comprehensive and clear, major points covered	Some minor errors or minor missing components	Incomplete, lacks clarity
		Spelling	No errors	Some minor errors	Minor errors throughout	Errors throughout
		Grammar	No errors	Some minor errors	Minor errors throughout	Errors throughout

**Description of Assessment Methods:** This course is heavily discussions-centered and relies on student participation for it to be successful. Depending on the size of the class, students will be responsible for 2-3 journal article presentations (individual or as a group). Over the duration of the semester, each student/group will receive research articles related to specific topics covered in the class. The students will present the article to the class, provide a thorough critical analysis of the article, and lead the class in a discussion/debate of the strengths and weaknesses. Each student will also be responsible for 5 review questions (with solutions) related to the topics covered in the course. These questions are expected to be detailed and thought provoking, based on the information provided in class, and suitable for use on a graduate level discussion-based exam. The largest assignment is a semester-long research proposal activity. Each student/group will define a research topic, develop a tenable and testable hypothesis related to this topic, and define 2-3 specific aims to test the hypothesis. The topic of choice can involve any area of biomedical research but must propose using engineering principles and analytical techniques. This project is meant to test the abilities of each student to integrate ideas from engineering and biology into a well-developed and vertically-oriented research proposal. There are multiple milestones with feedback along the way. The project culminates with a 25-minute oral presentation/defense of the proposal.

## Grading Scale

This class is graded on an absolute scale with no curve. Grades will be based on the following activities:

A = 4.0 95-100 98% work completed  
A- = 3.7 90-94 90% work completed  
B+ = 3.3 86-89 85% work completed  
B = 3.0 84-85 83% work completed  
B- = 2.7 80-83 80% work completed  
C+ = 2.3 76-79 75% work completed  
C = 2.0 74-75 73% work completed  
C- = 1.7 70-73 70% work completed  
F: <70 Unacceptable work

Grades above C- will be considered a passing grade. Degree-seeking students should be aware that a minimum GPA of 3.00/4.00 for the plan of study course work is required for graduation.

### Incomplete Grades:

Current policy stated in University Regulations states that an incomplete grade may be given under the following circumstances:

- The student's work was interrupted by unavoidable absence or other causes beyond a student's control.
- The student is passing the course at the time it was interrupted.
- The completion of the course does not require the student to repeat the class.
- The incomplete grade is not to be used as a substitute for a failing grade

The instructor may involve the Associate Dean for Academic Affairs to determine whether the unusual circumstances warrant a grade of Incomplete. Should the instructor agree to assign a grade of Incomplete, he or she must set a specific date (up to one year) by which all unfinished work must be completed and include a list of assignments to be completed. It is very important to put these requirements in writing and have the student agree to them via a signed hardcopy document called a Registrar Form 60. Upon submission of completed work, the instructor will change the student's Incomplete grade to the earned letter grade (A – F). If the work is not completed and a grade assigned within a year from the end of the semester in which the Incomplete was awarded, the Office of the Registrar will automatically change the grade to an F.

## Attendance Policy

### Attendance Policy: This is a small graduate-level course and you are expected to attend every session.

This course follows the [University Academic Regulations regarding class attendance](#), which state that students are expected to be present for every meeting of the classes in which they are enrolled. Attendance will be taken at the beginning of each class and lateness will be noted. When conflicts or absences can be anticipated, such as for many University-sponsored activities and religious observations, you should inform me of the situation as far in advance as possible. For unanticipated or emergency absences when advance notification is not possible, contact me as soon as possible by Purdue email or phone. For absences that do not fall under excused absence regulations (see below), this course follows the following procedures:

1. Do not come to class if you are feeling ill, but DO email me at [jmwalla@purdue.edu](mailto:jmwalla@purdue.edu), with the subject line: BME 504 absence. I do not need details about your symptoms. Just let me know you are feeling ill and cannot come to class. If it is an emergency, please follow the University regulations on medical care (see below).
2. Unless it falls under the University excused absence regulations (see below), any work due should be submitted on time via our course Brightspace.
3. If that day's class involves assessed work such as a test or presentation, you and I will plan if and how you can make up the work, following the assignment guidelines. This plan must be done before the next class period, so again, email me immediately when you know that you will miss class.
4. The most important consideration in any absence is how it will affect your achievement of the assignment objectives and the course learning outcomes.

For cases that fall under **excused absence regulations**, you or your representative should contact or go to the [Office of the Dean of Students \(ODOS\) website](#) to complete appropriate forms for instructor notification. Under academic regulations, excused absences may be granted by ODOS for cases of grief/bereavement, military service, jury duty, parenting leave, or certain types of medical care. The processes are detailed, so plan ahead.

## Course Schedule

Course Schedule for BME 50400 (at last offering)			
Wk	Date	Topics	Assignments / Presenters
1	T Jan 11	Class Introduction, Course expectations, Research Project Description	
	Th 13	How to read and critically analyze a paper; Basic experimental design	
2	T 18	JW Research Presentation	
	Th 20	Large Scale Mechanical Testing	
3	T 25	Large Scale Mechanical Testing	
	Th 27	Fracture Toughness, Fatigue, Viscoelasticity	
4	T Feb 1	Fracture Toughness, Fatigue, Viscoelasticity	
	Th 3	<b>NO CLASS – JW AT CONFERENCE</b>	Meet with JW by Feb 2 <sup>nd</sup> to discuss topic
5	T 8	<b>NO CLASS – JW AT CONFERENCE</b>	
	Th 10	X ray, microCT, pQCT, Synchrotron, DEXA	Proposal Topic Defined
6	T 15	X ray, microCT, pQCT, Synchrotron, DEXA	
	Th 17	SAXS/WAXS/XRD	
7	T 22	SAXS/WAXS/XRD	
	Th 24	TEM/SEM/qBSEM	

8	T	Mar 1	TEM/SEM/qBSEM	Draft of Specific Aims Due
	Th	3	Raman/FTIR spectroscopy	
9	T	8	Raman/FTIR spectroscopy	
	Th	10	Tissue Organization	
10	T	15	<b>NO CLASS SPRING BREAK</b>	
	Th	17	<b>NO CLASS SPRING BREAK</b>	
11	T	22	Tissue Organization	
	Th	24	Contact Mechanics, Indentation; Atomic Force Microscopy	Full Proposal Draft Due
12	T	29	Contact Mechanics, Indentation; Atomic Force Microscopy ( <b>Note JW Out of Town, class still meeting</b> )	
	Th	31	<b>JW Out of Town: work on proposal presentation</b>	
13	T	Apr 5	NMR/MRI	Draft returned with comments by Apr 4
	Th	7	NMR/MRI	
14	T	12	2 Group Presentations	Final Proposal Due
	Th	14	2 Group Presentations	
15	T	19	2 Group Presentations	
	Th	21	2 Group Presentations	
16	T	26	2 Group Presentations	
	Th	28	2 Group Presentations	

## Academic Integrity

Discussing course material, assignments, and approaches is encouraged, but rote copying, or paraphrasing, without contributing or fully understanding the material is prohibited.

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing [integrity@purdue.edu](mailto:integrity@purdue.edu) or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace under University Policies and Statements.

See the University Policies and Statements section of Brightspace for guidance on Use of Copyrighted Materials. Effective learning environments provide opportunities for students to reflect, explore new ideas, post opinions openly, and have the freedom to change those opinions over time. Students and instructors are the authors of the works they create in the learning environment. As authors, they own the copyright in their works subject only to the university's right to use those works for educational purposes. Students may not copy, reproduce, or post to any other outlet (e.g., YouTube, Facebook, or other open media sources or websites) any work in which they are not the sole or joint author or have not obtained the permission of the author(s).

**- If you are caught cheating on an assignment, you will receive a 0.**

**- If you are caught a second time, regardless of the severity of the first offense, you will fail the course**

## Nondiscrimination Statement

Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and



enriches campus life. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in our course Brightspace under University Policies and Statements.

## Accessibility

Purdue University strives to make learning experiences accessible to all participants. If you anticipate or experience physical or academic barriers based on disability, you are encouraged to contact the Disability Resource Center at: [drc@purdue.edu](mailto:drc@purdue.edu) or by phone: 765-494-1247, as soon as possible.

If the Disability Resource Center (DRC) has determined reasonable accommodations that you would like to utilize in my class, you must send me your Course Accommodation Letter. Instructions on sharing your Course Accommodation Letter can be found by visiting: <https://www.purdue.edu/drc/students/course-accommodation-letter.php> Additionally, you are strongly encouraged to contact me as soon as possible to discuss implementation of your accommodations.

## Mental Health/Wellness Statement

**If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try [Therapy Assistance Online \(TAO\)](#),** a web and app-based mental health resource available courtesy of Purdue Counseling and Psychological Services (CAPS). TAO is available to all students at any time by creating an account on the [TAO Connect website](#), or downloading the app from the App Store or Google Play. It offers free, confidential well-being resources through a self-guided program informed by psychotherapy research and strategies that may aid in overcoming anxiety, depression and other concerns. It provides accessible and effective resources including short videos, brief exercises, and self-reflection tools.

**If you need support and information about options and resources,** please contact or see the [Office of the Dean of Students](#). Call 765-494-1747. Hours of operation are M-F, 8 a.m.- 5 p.m.

**If you find yourself struggling to find a healthy balance between academics, social life, stress, etc.,** sign up for free one-on-one virtual or in-person sessions in West Lafayette with a [Purdue Wellness Coach at RecWell](#). Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is free and can be done on BoilerConnect. Students in Indianapolis will find support services curated on the [Vice Provost for Student Life website](#).

## Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday. Considering the significant disruptions caused by the current global crisis as it relates to COVID-19, students may submit requests for emergency assistance from the [Critical Need Fund](#). I am committed to your success in this class. If you are facing financial, housing, basic needs or other obstacles that get in the way of your success, please consider talking to me in private. I may have access to information and resources you are not aware of.

## Emergency Preparedness

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be

obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

A link to Purdue's Information on [Emergency Preparation and Planning](#) is located on our Brightspace under "University Policies and Statements." This website covers topics such as Severe Weather Guidance, Emergency Plans, and a place to sign up for the Emergency Warning Notification System. I encourage you to download and review the [Emergency Preparedness for Classrooms document](#).

The first day of class, I will review the **Emergency Preparedness plan for our specific classroom**, following Purdue's required [Emergency Preparedness Briefing](#). Please make note of items like:

- The location to where we will proceed after evacuating the building if we hear a fire alarm.
- The location of our Shelter in Place in the event of a tornado warning.
- The location of our Shelter in Place in the event of an active threat such as a shooting.

**Everyone deserves to be treated with dignity and respect. Within this classroom, civility involves mutual respect for all class members and their knowledge and expertise. Civility requires mutual respect on the part of both the student and the instructor. All members of this class are responsible for and expected to promote respectful and courteous language, demeanor, and actions. Behavior that is offensive, disruptive, intimidating, dismissive, or condescending will not be tolerated from either the instructor or the student.**

**Disclaimer:** As the instructor, I will do my best to follow this syllabus as closely as possible. However, I also reserve the right to make necessary changes as the need arises. Check Brightspace regularly.