Engineering Faculty Document No. 28-22

November 2, 2021

TO: The Faculty of the College of Engineering

FROM: The Faculty of the Weldon School of Biomedical Engineering

RE: New Undergraduate Course, BME 31400, Experimental Methods in Biomechanics

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

BME 31400: Experimental Methods in Biomechanics
Term Offered: Spring, Lecture 3, Cr. 3
Prerequisite: BME 21400
Major Restriction: Biomedical Engineering only

Description: This course focuses on the concepts and applications of mechanics, imaging, and instrumentation methods towards evaluating experimental biomechanics at multiple length scales. Core concepts include mechanics of materials, dynamics, contact theory, and the simplifying assumptions and standardizations often needed to conduct experiments on biomaterials and living systems. Experimental methods may include atomic force microscopy, digital image correlation, and motion analysis.

Reason: This course is a new offering that is required for students who select the new Engineered Biomaterials and Biomechanics pathway in the BME undergraduate curriculum redesign. This course will be taught for the first time in Spring 2022 as BME 49500-010 Experimental Methods in Biomechanics (CRN 25582) with enrollment count to be determined.

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

Course Information

- BME 31400 – Experimental Methods in Biomechanics
- Prerequisite: BME 21400

Instructor Contact Information

- **Professor Deva Chan** *(Pronouns: she/her)*
- **Office:** MJIS 3023
- **Email:** chand@purdue.edu
- Student Hours: TBD

Course Description

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Learning Resources, Technology & Texts

Resources, texts, and other references will be provided for the course via Purdue's Brightspace learning management system. Begin with the Start Here tab, which describes how the course Brightspace is organized. It is strongly suggested that you explore and become familiar not only with the site navigation but with 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

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

1. Understand solid mechanics and dynamics principles and concepts underlying experimental methods
2. Apply mathematical equations and underlying assumptions of biomechanics to experimental methods
3. Analyze selected biomechanical systems and measurements at a range of biologically relevant length scales
4. Evaluate quality and reliability of assumptions and methods used in selected biomechanics applications

Assignments

You will get feedback on your progress through a combination of worksheets, homework, quizzes, and exams spread throughout the academic period. Participation is expected throughout the course to enhance learning, particularly through in-class active learning assignments. You will earn your final grade through the following assignments:

Homework (5%): Problem sets will assess understanding and application of biomechanics concepts and equations.

Worksheets (15%): Activity- and applications-focused worksheets will support application of biomechanical concepts, analysis of experimental data, and evaluation of experimental methods.

Quizzes (20%): Quizzes evaluate the ability to explain concepts learned from resources, homework, and activities and to apply this knowledge independently.

Exams (60%): Exams will assess learning of biomechanics concepts, mathematical equations, simplifying assumptions, experimental methods, and knowledge synthesis. These exams include two in-semester exams (15% each) and a final exam (30%), which will be cumulative. *However*, if your in-semester exam average is higher than your final exam score, the three exams will instead count 20% each.

Grading Scale

In this class, grades reflect the sum of your achievement throughout the semester. You will accumulate points as described in the assignments portion above, with each assignment graded according to a rubric. Total points will be rounded to the *nearest* 0.1 point to assign grades according to the standard rubric below. It is possible that there will be a curve, but this decision cannot be made until all on-time assignments have been graded. If there is a curve, the grade thresholds may be lowered but not raised.

A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
97 - 100	94 - 96.9	90 - 93.9	87 - 89.9	84 - 86.9	80 - 83.9	77 - 79.9	74 - 76.9	70 - 73.9	67 - 69.9	64 - 66.9	60 - 63.9	0 - 59.9

If suspected academic dishonesty occurs near the end of the course or cannot be resolved before final grade submissions, the instructor may assign a grade of Incomplete until investigations conclude.

Attendance Policy

Students are expected to attend all classes in-person unless they are ill or otherwise unable to attend class. If they feel ill or feel that they have been exposed to a contagious disease, students should stay home and contact the Protect Purdue Health Center (496-INFO). Notes and/or outlines will be posted from each lecture to help students who are not able to attend class. But it is also recommended that you contact other students to ensure that you are aware of any changes to assignments or due dates.

Classroom engagement is extremely important and associated with your overall success in the course. The importance and value of course engagement and ways in which you can engage with the course content even if you are in quarantine or isolation, will be discussed at the beginning of the semester. Students need to inform the instructor of any conflict that can be anticipated and will affect the timely submission of an assignment or the ability to take an in-person exam.

Only the instructor can excuse a student from a course requirement or responsibility. When conflicts can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency conflicts, when advance notification to an instructor is not possible, the student should contact the instructor/instructional team as soon as possible by email, through Brightspace, or by phone. In cases of bereavement, quarantine, or isolation, the student or the student's representative should contact the Office of the Dean of Students via email or phone at 765-494-1747. Our course Brightspace includes a link to the Dean of Students under 'Campus Resources.

Academic Guidance in the Event a Student is Quarantined/Isolated

If you must quarantine or isolate at any point in time during the semester, please reach out to me via email so that we can communicate about how you can continue to learn remotely. Work with the Protect Purdue Health Center (PPHC) to get documentation and support, including access to an Academic Case Manager who can provide you with general guidelines/resources around communicating with your instructors, be available for academic support, and offer suggestions for how to be successful when learning remotely. Your Academic Case Manager can be reached at acmq@purdue.edu. Importantly, if you find yourself too sick to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation.

Course Schedule

Week †	Topic
1	Introduction
	Vectors and Vector Operations
	Vectors and Vector Operations
2	Matrices and Linear Combinations
	Coordinate System Transformations
	Coordinate System Transformations *
3	Tensors
	Accuracy, Precision, Resolution, Sensitivity
	Accuracy, Precision, Resolution, Sensitivity *
4	Particle / Marker Tracking
	Particle / Marker Tracking *
	Load Measurement
5	Displacement and Deformation Measurement

	Load-Deformation to Stress-Strain Relationships
	Stress- Stress-Strain Relationships, Elasticity *
6	Principal Stresses and Strains
	Review
	Exam 1
7	Bernoulli-Euler Beam Theory, Microcantilevers
	Contact Theory
	Contact Theory *
8	AFM and Nanoindentation
	AFM and Nanoindentation
	AFM and Nanoindentation *
9	Anisotropy, Viscoelasticity
	Anisotropy, Viscoelasticity *
	Material Heterogeneity and Continuum Assumptions
10	Uniaxial and Biaxial Mechanical Testing
	Torsional and Shear Mechanical Testing
11	Digital Image Correlation
	Digital Image Correlation
	Digital Image Correlation *
12	Strain Measurement with Medical Imaging
	Strain Measurement with Medical Imaging *
	Review
	Exam 2
13	Intro to Dynamics
	Gait Analysis
	Gait Analysis *
14	Forward vs Inverse Dynamics Approaches
	Forward vs Inverse Dynamics Approaches
	Force Plates and Pressure Sensors
15	Electromyography and Maximum Isometric Force
	Human Motion Mechanics
	Human Motion Mechanics *
16	Review
	Final Exam

† Schedule and assignments subject to change. Any changes will be posted in the learning management system.

Classroom Guidance Regarding Protect Purdue

The Protect Purdue Plan, which includes the Protect Purdue Pledge, is campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Required behaviors in this class include: staying home and contacting the Protect Purdue Health Center

(496-INFO) if you feel ill or know you have been exposed to the virus, properly wearing a mask in classrooms and campus building, at all times (e.g., mask covers nose and mouth, no eating/drinking in the classroom), disinfecting desk/workspace before and after use, maintaining appropriate social distancing with peers and instructors (including when entering/exiting classrooms), refraining from moving furniture, avoiding shared use of personal items, maintaining robust hygiene (e.g., handwashing, disposal of tissues) prior to, during and after class, and following all safety directions from the instructor.

Students who are not engaging in these behaviors (e.g., wearing a mask) will be offered the opportunity to comply. If non-compliance continues, possible results include instructors asking the student to leave class and instructors dismissing the whole class. Students who do not comply with the required health behaviors are violating the University Code of Conduct and will be reported to the Dean of Students Office with sanctions ranging from educational requirements to dismissal from the university.

Any student who has substantial reason to believe that another person in a campus room (e.g., classroom) is threatening the safety of others by not complying (e.g., not properly wearing a mask) may leave the room without consequence. The student is encouraged to report the behavior to and discuss the next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights.

Academic Integrity

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 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 table of contents, under University Policies.

Policy on Presentations, Materials, and Notes: The instructor's presentations and course materials are subject to the instructor's copyright. In addition, notes are "considered to be 'derivative works' of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials." As such, they cannot be sold or bartered without express written permission from the instructor.

Policy on Academic Dishonesty: Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty" (Section B.2.a of the *Student Regulations*). Furthermore, "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of ghostwritten papers, the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest" (University Senate Document 72-18, December 15, 1972).

Suspected academic misconduct will be addressed by the instructor and referred to the Office of Student Rights and Responsibilities (OSRR) for review at the university level. Any violation of course policies as it relates to academic integrity will result minimally in a zero grade for that particular assignment, and at the instructor's discretion may result in a failing grade for the course. In addition, all incidents of academic misconduct will be forwarded to OSRR, where university penalties, including removal from the university, may be considered. Students can report issues of academic integrity that they observe, and may do so anonymously, through the OSRR by calling 765-494-8778 or emailing *integrity@purdue.edu*.

Nondiscrimination Statement

Purdue University is committed to maintaining a community which 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 the full Nondiscrimination Policy Statement is included in our course Brightspace under University Policies and can also be found here.

Accessibility

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247."

Mental Health/Wellness Statement

If you find yourself beginning to feel some ***stress, anxiety and/or feeling slightly overwhelmed***, try WellTrack. Sign in and find information and tools at your fingertips, available to you at any time.

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 am- 5 pm.

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 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 completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're ***struggling and need mental health services***: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals

should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Emergency Preparation

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 instructor via email or office phone. You are expected to read your @purdue.edu email on a frequent basis.