BMEG 330: Biomechanics II

2024W Syllabus

COURSE INFORMATION

Instructor:	Dr. Pawel Kudzia
Email:	pawel.kudzia@ubc.ca
Office Hours & Location:	TBD | Room 346 Wesbrook
Response Times:	The instructor and teaching assistants will make our best effort to respond within 24 hours (business days). We will post commonly asked questions on Canvas, Piazza or we will circulate an email.
Teaching Assistant Info:	Keili Shepherd: keili@student.ubc.ca Nima Ashjaee: nima.ashjaee@ubc.ca
Pre-Requisites:	BMEG 230; a sound working knowledge of calculus, statics, and basic knowledge of dynamics and human anatomy and physiology is essential

LECTURE DATES | TIMES | ROOMS

Lecture:	Monday 1:00pm-2:00pm Wednesday 1:00pm-2:00pm Friday 1:00pm-2:00pm Located either at CHBE-103 (UBC Chemical and Biological Engineering) or Wesbrook 302
Tutorial:	Biweekly Monday starting January 15th, 10:00am-12:00pm - Wesbrook 302

COURSE DESCRIPTION

Biomechanics is the application of the principles of mechanics in the analysis of biological systems. The field of biomechanics looks at the effect of external and internal forces acting upon the human body. Biomechanics aims to study and quantify the motion of body segments and the factors that influence that movement, the deformation of biological tissues and the factors that influence these deformations, and the biological effects of localized forces. In this course, we will focus on exploring the 3-dimensional kinematic and kinetics of human motion, computational and optimization techniques, mechanical responses of human tissues and implants/devices, and advanced biomechanical experimental methods.

LEARNING OBJECTIVES

- Identify and use the fundamental principles in mechanics and apply them to the musculoskeletal system
- Formulate and solve relevant equations governing 3-dimensional rigid-body statics and dynamics, including kinematics and kinetics, and its application to the body and human motion
- Formulate and solve the relevant equations of 3-dimensional gait analysis, internal and external joint loads, and identify the purpose and limitations of inverse dynamics analyses
- Identify indeterminate systems and solve for these using simplification or optimization approaches
- Identify the basic composition, morphology and mechanical behaviors of biological tissues, such as ligaments, tendons, bone, cartilage, and spinal discs
- Identify appropriate computational modeling approaches, such as musculoskeletal and finite element models, and identify limitations with each
- Perform some biomechanical experimental techniques, such as 3-dimensional motion capture and describe the purpose, basic function and limitations of the equipment and sensors used in these experiments
- Identify and apply appropriate assumptions and identify limitations associated with the application of mechanics to the human body
- Identify examples of the lack of representation and diversity in the context of biomechanics topics
- Describe the effect of biases on engineering design and population data sets in biomechanics

COURSE ORGANIZATION / STRUCTURE

This course will consist of the following main concepts:

1. Biological Movement
2. Anatomy
3. Muscle
4. Mathematical Modelling

The course will stress application of the course content to real-world problems in this area. There will also be a focus on the use and critical appraisal of current biomechanics techniques and literature.

Lectures: Lectures will consist of a combination of traditional lectures and flipped classroom style lectures. The flipped classroom style will require students to prepare before the class in order to participate in problem solving and group work activities.

Class Activities: These activates will include a presentation and distributing an anatomy handout for the class. More info to come. We will cover all the major joints in the lower limb and some joints in the upper body.

Tutorials/Labs: Tutorials will offer some hands-on activities and group discussions/interactions. During tutorials, we will conduct some laboratories where you will gain some hands-on experience with testing methods, computational methods, equipment, and experimental protocols. There will often be a class activity deliverable due shortly after the session (group or individual).

Project: The course will consist of a project that will be partially individual and partially conducted in the groups formed at the beginning of the term. The aim of the project is to provide the opportunity to apply concepts learned throughout the course and gain a deeper understanding on specific topics in biomechanics. There will be several project check-ins and deliverables through the term. The bulk of the project will be due near the end of the term. For any group deliverables, your team is expected to outline how each person contributed to the task. You will be given some class time for project work, although some is expected to be completed outside of class time.

Journal Clubs: There will be a series of Journal Clubs conducted through the term. The purpose of these is to conduct small group discussions and to engage in topics of discussion related to biomechanics and EDI in biomechanics .

Course assessments: You will be evaluated on your general comprehension of course material with both a midterm and a final exam.

Attendance/participation: Participation is important for your progress in this course as a great deal of learning will happen in the classroom, tutorials, laboratories, and group work. The instructional team is aware of the difficult circumstances some students may have with illness, etc. To accommodate this, there is no direct course mark for participation; however, if your grade is borderline (i.e., a 79% and you are arguing for an 80%) your participation throughout the course (such group work that has been handed in) will factor into this.

Peer evaluation: Students will also be asked to conduct peer-evaluations of their project group members throughout the semester. A multiplier on team-based grades will be applied based on the peer evaluation scores (this grade will either raise or lower your own team marks relative to the team average).

Discussion Boards: Piazza will be used for offline discussions of course related material. Students should feel free to have discussions and answer each other's questions if appropriate. The instructor and TAs will monitor the board and answer questions that are directed at us. Please allow for a reasonable response time. We will try our best to respond within 24 hours of the post (weekends may take longer). If your matter is urgent or personal, or your question is unanswered after a couple of days, please email us.

EDI in Biomechanics: We have developed course content to promote discussions and to reflect on the lack of representation and diversity in the field of biomechanics this term. We will address topics such as the lack of representation of various populations in biomechanics research and the effect of biases on engineering design in biomechanics. The teaching team wants to provide a safe environment for these difficult but important conversations. If you feel uncomfortable with any of the topics discussed, please feel free to reach out to the teaching team with your concerns.

STUDENT EVALUATION

The grading was determined with your help on the first day of class, with grade boundaries set by me. The following course elements will be used for evaluation for the course grade.

Evaluation Method	Percentage of Final Grade
Project *In groups, deliverables through the term graded*	*20%+1%*
Individual Assignments (3)	*10%*
Labs	*20%*
Class Anatomy Activities	*5%*
Journal Clubs	*5%*
Midterm Exam *Monday | Feb 26th 2024*	*15%*
Final Exam *Date TBD*	25%
TOTAL	**101%**

* A multiplier on team-based grades may be applied based on the peer evaluation scores and feedback (this grade will either raise or lower your own team mark relative to the team average).

NOTE: I reserve the right to make slight adjustments to your mark based on your overall participation in the course. For instance, I will collect group class activities and if you're consistently contributing, then this would factor into whether you may get a small bump in a borderline grade (i.e., if you're on the border between a B or a B+). This adjustment will only be slight and will be at my discretion.

LATE POLICY

Deliverable due dates will be communicated. For deliverables with a stricter deadline, such as project deliverables, 2%/day will be deducted from the mark of any work submitted late for each day after the submission deadline (up to a maximum of 3 days late) unless an exemption has been granted. **Work will not be accepted for marks after in-class discussions have occurred and/or the solutions have been posted.** Please note that we recognize that you may have a lot of stress in your life under current circumstances. If you find yourself having major difficulties in this course (e.g., making deadlines), please talk to the instructional team as soon as you can, and we can discuss solutions and provide support to you.

Feel free to email the course instructor Pawel Kudzia (pawel.kudzia@ubc.ca) please include BMEG 330 in the emails subject. Such as …. Subject: BMEG 330 | ….etc.

COURSE MATERIALS

The course will not follow any specific text. Throughout the term, there may be some required and suggested readings from other sources. These will be posted for your access on Canvas. In addition, I can provide further help in finding other resources on a particular biomechanical topic.

The following texts are not required; however, they are good resources and are freely available online through the UBC library:

- Winter DA. Biomechanics and motor control of human movement. Wiley; 2009
- Özkaya N, et al. Fundamentals of biomechanics: Equilibrium, motion, and deformation. Springer; 2012.
- Fung YC. Biomechanics - Mechanical Properties of Living Tissues. Springer New York; 1981
- Carter DR, Beaupre GS. Skeletal Function and Form: Mechanobiology of skeletal development, aging and regeneration. Cambridge University Press; 2001
- Winkelstein BA. Orthopaedic biomechanics. Taylor & Francis; 2013

Underlying mechanical principles (without the biomechanics applications) can also be found in a general mechanics text. Some recommendations of texts include the Mechanics Map Digital Textbook (open source, http://mechanicsmap.psu.edu) and Mechanics of Materials by Hibbeler (2005, available online through UBC library). These texts are not required; however, they are valuable supplemental texts.

The following are good resources for anatomy and are available free through UBC:
Clinical Anatomy: http://www.clinicalanatomy.ca
AnatomyTV: http://resources.library.ubc.ca/1839
Acland's Video Atlas of Anatomy (http://aclandanatomy.com.ezproxy.library.ubc.ca/)

Students must be able to access the course content online via Canvas. The class activities and course project require specialized software, such as MATLAB. Accommodations may be made if you do not have sufficient computer specifications for either software. Please speak to the instructor or TAs as early as possible in the term so other options can be pursued. Note: do not leave it to the last minute to verify software as accommodations may be impossible on short notice.

APPROXIMATE COURSE SCHEDULE

APPROXIMATE SCHEDULE

The following topics will be covered, subject to course progress.

Week	Week Start	Topics Covered

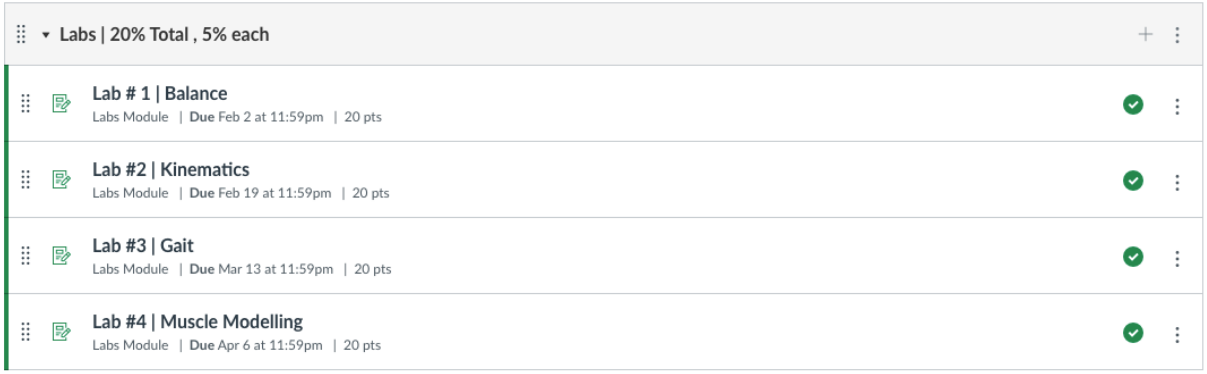
1	Jan 8th	Course Introduction, Programming, Writing, Review of 2D kinematics
2	Jan 15th	Balance and Control | Review of 2D kinematics cont'd
3	Jan 22nd	Gait Cycles and 3D Kinematics
4	Jan 29th	Gait Cycles and 3D Kinematics| Hip Anatomy
5	Feb 5th	Gait Cycles and 3D Kinematics |Knee Anatomy | Guest Lecturer Emily Bliven
6	Feb 12th	3D Kinematics | Ankle Anatomy
7	Feb 19th	**Reading Week**
8	Feb 26th	Kinetics | Guest Lecturer Dr. Kelvin Kuo
9	Marth 4th	Field Trip | Kinetics
10	March 11th	Ligaments, Tendon, Muscle and Ordinary Differential equations
11	March 18th	Muscle modelling and Optimization
12	March 25th	Muscle modelling and Optimization | Glenohumeral Joint Anatomy
13	April 1st	Machine Learning in Biomechanics
14	April 8th	Project presentations and course review

Approximate course schedule

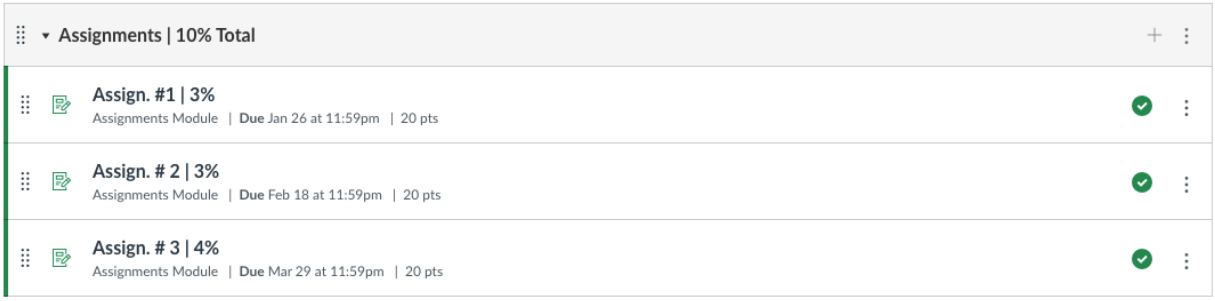
		Monday's | Wesbrook Lab 10-12pm	Monday Lecture 1-2pm	Wednesday Lecture 1-2pm	Friday Lecture 1-2pm
Week	Week Start	Labs/Tutorial	Lecture	Lecture	Lecture
1	8-Jan-24	-----	Intro / Programming / Writing		Review of External Forces and Kinematics
2	15-Jan-24	Lab 1 # Balance Lab	Centre of Pressure / Balance Control		2D Kinematics Review
3	22-Jan-24	OPEN LAB MATLAB | PROJECT ASSIGNEMENT | WORK HOURS	Gait Cycles| Intro to 3D kinematics		
4	29-Jan-24	Lab # 2 Kinematics Lab	Hip Joint	3D Kinematics	3D Kinematics
5	5-Feb-24	OPEN LAB MATLAB | PROJECT ASSIGNEMENT | WORK HOURS	3D Kinematics	Knee Joint	Guest : Emily Bliven PhD Candidate
6	12-Feb-24	Lab #3 Gait Lab	Journal Club | Attendance Required | Wesbrook	3D Kinematics	Ankle Joint
7	19-Feb-24	Reading Week			
8	26-Feb-24	Midterm Exam	Kinetics	Kinetics	Guest : Dr. Kelvin Kuo Assitant Professor
9	4-Mar-24	Field trip | Anatomy Lab	OPEN LAB MATLAB | PROJECT ASSIGNEMENT | WORK HOURS	TBD	Kinetics
10	11-Mar-24	Journal Club | Attendance Required	Ligaments, Tendons, Muslce and Ordinary Diff Equations (ODEs)		MTP Joint
11	18-Mar-24	Lab # 4 Muscle Modelling	Journal Club | Attendance Required | Wesbrook	Muslce Modelling and Optimization	
12	25-Mar-24	OPEN LAB MATLAB | PROJECT ASSIGNEMENT | WORK HOURS	Muslce Modelling and Optimization		Glenohumeral joint
13	1-Apr-24	Journal Club | Attendance Required	Machine Learning in Biomechanics		
14	8-Apr-24	OPEN LAB MATLAB | PROJECT ASSIGNEMENT | WORK HOURS	Project Presentation	Project Presentation	Summary , Careers, Grad School

DELIVERABLES

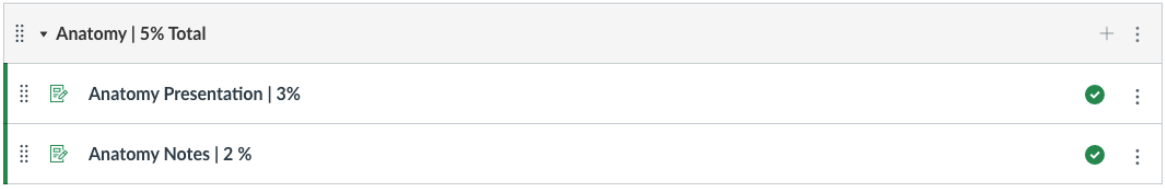
Labs



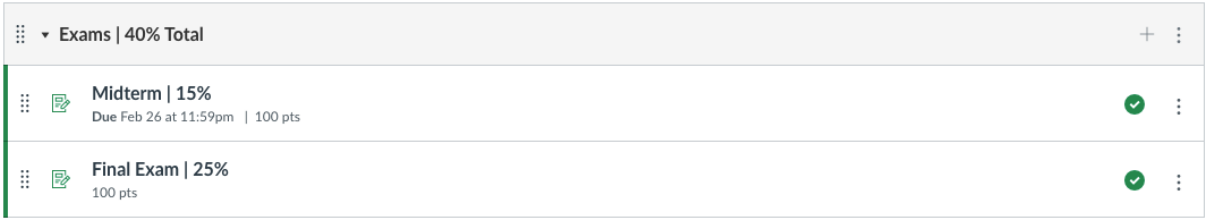
Assignments



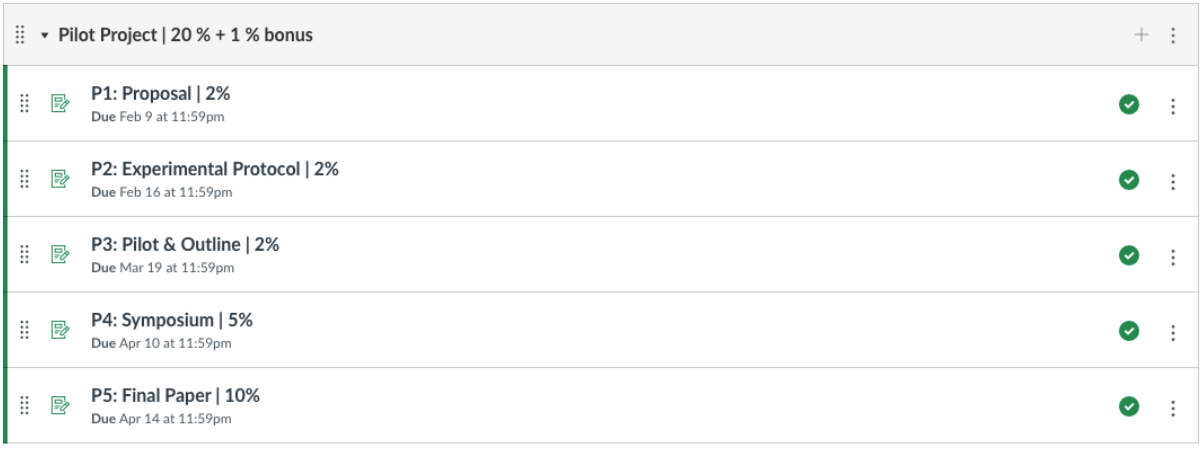
Anatomy



Exams



Project



NOTE: As instructor, I reserve the right to slightly modify this course schedule based on how the course is progressing. Assignments and project timelines may shift depending on course progress and guest lectures may shift depending on the lecturer's schedule. Any changes to the deliverables will be communicated to the entire class in lectures and on Canvas.

COURSE POLICIES

ATTENDANCE

Although attendance is not mandatory, participation is very important for your progress in this course as a great deal of learning will happen with the in-class activities, tutorials, laboratories, and group work. There is no course mark for attendance; however, if your grade is borderline (i.e., a 79% and you are arguing for an 80%) your participation throughout the course (such as group work that has been handed in) will factor into this. Students that cannot attend lectures synchronously will be provided opportunities to engage and participate in other ways, such as reflections submitted after class. The course involves group work; thus, you are expected to meet with your group (at a time that works for all members) to complete the tasks assigned. You are expected to communicate with your group members if you cannot attend meetings. Remember that you will be graded by your peers on your involvement in group work so a lack of engagement could affect your course grades.

ACCOMMODATIONS AND CONCESSIONS

Concessions will be made for assessments when the grounds for academic concession (http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,329,0,0) have been met. These can include things such as medical circumstances, conflicting responsibilities, and compassionate grounds. Please discuss possible concessions with your instructor as soon as possible in addition to filling out the following form:

https://academicservices.engineering.ubc.ca/form-request-for-academic-concession-in-term-work/

Please contact the Center for Accessibility as early as possible for disability-related accommodations (https://students.ubc.ca/about-student-services/centre-for-accessibility).

Accommodations and concessions that may be made available include exemptions from an activity/deliverable, shifting the weight of a missed activity to another portion of the grading scheme, adjusting expectations for the activity (including teamwork if necessary), or submitting an alternate deliverable (e.g., a recorded video).

STAY HOME WHEN YOU'RE FEELING SICK

Do not attend in-person class activities if you are feeling sick - but do let us know as soon as possible so we can excuse attendance and arrange alternatives. Coming in sick is a violation of the student code of conduct and you may be asked to leave if you are showing viral-like symptoms. Your (and our) health is paramount - you can catch up with your team later.

UBC POLICY ACADEMIC INTEGRITY

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should

not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

For more information, see: http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,286,0,0

ACADEMIC CONCESSION

The University is committed to supporting students in their academic pursuits. Students may request academic concession in circumstances that may adversely affect their attendance or performance in a course or program. Students who intend to, or who as a result of circumstance must, request academic concession must notify their instructor, dean, or director as specified in the link below. http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,48,0,0

Students seeking academic concession due to absence from the final exam for any reason must apply to Engineering Student Services (ESS) within 72 hours of the missed exam. This is a standard practice for all final examinations at UBC.

For more information, see: http://students.engineering.ubc.ca/enrolment/faq/

STATEMENT ON UNIVERSITY'S VALUES AND POLICIES

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious, spiritual and cultural observances. UBC values academic honesty and students ae expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available here: senate.ubc.ca/policies-resources-support-student-success.

LAND ACKNOWLEDGMENT

This course is held on the UBC Point Grey (Vancouver) campus, which sits on the traditional, ancestral, unceded territory of the xʷməθkʷəy̓əm (Musqueam) First Nation.