Western University
Department of Mechanical & Materials Engineering

MME 4474A – Computational Biomechanics for Biomedical Applications

COURSE OUTLINE – 2025-2026

COURSE DESCRIPTION:

This is an undergraduate 4th year course suitable for MME / MSE students (with and without +BME). The objective of course is for students to achieve an advanced understanding of various computational methods applied in the field of biomechanics, and to provide hands-on experience using computational biomechanics software. Furthermore, this course aims to expose students to contemporary research literature related to the development or application of computational biomechanics techniques.

COURSE INFORMATION:

Instructor: Dr. Irene Yang, Biomed Eng (Hons I)/BMedSci, DPhil (Oxon)

Office/s & extensions:

Building E4, Room 128A, Victoria Hospital
800 Commissioners Rd E, London
Ontario, Canada
N6A 5W9

Extension: 53610

TEB 349
1151 Richmond Street North, London
Ontario, Canada
N6A 5B9

Extension: 88262

Email: irene.yang@uwo.ca

Lectures/tutorials/labs: See Class Schedule

Teaching Assistant (TA): Ms. Vivian Natalie Oparin

TA email: voparin@uwo.ca

CONSULTATION HOURS:

- For help with the course content, please contact the TA via email (cc the instructor in all email correspondence) or through messages in OWL. For all other assistance, please email the course instructor directly.
- If you are contacting via email, please use your Western email address. Include an academic signature with your full name, program, student ID. We encourage you to include your pronouns to facilitate respectful communication (e.g., he/him; she/her; they/them).
- Office hours: By appointment arrangement via email.
- A general FAQ section on the 'forums' section of OWL will be used for students to pose course-related questions. This will ensure that all students enrolled on the course have the same information.

PREREQUISITES:

One of MME 2202A/B or MSE 2212A/B and one of MME 3380A/B or MSE 3380A/B and MME 3360A/B, or enrollment in the Biomedical Engineering program.

Unless you have either the prerequisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course, and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees if you are dropped from a course for failing to fulfil the necessary prerequisites.

ANTIREQUISITES: None.

ACCREDITATION UNITS: Engineering Science = 100%

TOPICS:

1. Introduction to Computational Biomechanics
2. Medical Imaging, Image Processing
3. Model generation
4. Material assignment
5. Biomechanical Modeling using Finite Element Analysis (FEA)
6. Model Verification and Validation
7. Applications in industry

LEARNING OUTCOMES: The Mechanical and Materials Engineering Program has been accredited by Canadian Engineering Accreditation Board (CEAB) of Engineers Canada. Accredited programs provide the academic requirements for licensure as a professional engineer in Canada. Western Engineering has defined indicators of the 12 Graduate Attributes (GAs) that the CEAB expects graduating engineering students to demonstrate. The connections between course learning outcomes and Western Engineering's GA Indicators are identified below.

Upon successful completion of this course, students will be able to:

1. Create 3D computational models of geometric bodies as well as human anatomy from medical imaging data (KB4, ET2)
2. Use Python programming to manipulate medical image and prepare them for machine learning problems (KB1, KB3, ET2)
3. Use FEA software to design, validate and analyze a 3D computational model of human anatomy (KB1, KB3, KB4, ET2)
4. Develop experiments to evaluate bone and tissue mechanical properties including determining loading, and boundary conditions for various activities. (IN1, KB3, KB4, PA1, PA2, ITW2, ITW3, CS1, CS2, CS3)
5. Develop sound insight into the field of biomedical and biomechanical engineering, particularly in orthopedic surgery. (KB4, IESE1)

CONTACT HOURS: 3 lecture hours, half course

TEXTBOOK: Required reading will be provided by the instructor when appropriate.

UNITS: SI will be used; however, English units may be introduced through examples as required.

EVALUATION:

Assessment Type	**Material Covered**	**Tentative Due Date**	**Weight**
In-class mini quizzes	Each quiz will contain technical questions based on material covered previously.	*Assigned bi-weekly in-class* *Due in class*	**20%**
Homework Assignments (three)	Students will learn to manipulate images using Python, develop 3D anatomical models from medical imaging data (MIMICS/3D Slicer), create sophisticated musculoskeletal biomechanical models, and developing / solving structural finite element models of human anatomic systems (ABAQUS).		**30%**

	Assignment 1 *"Python coding assignment: basic image processing using Python"*	*Assigned Week 2* *Due Week 4 (Sept 26th 2025, 10:00 (EDT/GMT-4)*	*10%*
	Assignment 2 *"Python coding assignment: understanding basic machine learning"*	*Assigned Week 4* *Due Week 6 (Oct 10th 2025, 10:00 (EDT/GMT-4)*	*10%*
	Assignment 3 *"Creating 3D anatomical model using MIMICS, SolidWorks (if required) & FEM of a biomedical model exercise"*	*Assigned Week 7* *Due Week 9 (Oct 31st 2025, 10:00 (EDT/GMT-4)*	*10%*
Course Project	Work in teams of 2-3, students will design and complete a project to analyze a biomedical model and use the computational techniques taught in this class to tailor the model as required for the engineering problem, assign appropriate material properties (e.g. cortical and cancellous bone), apply a force and assess model response using FEA with/without other computational software if required. The project grade is further broken down into the following deliverables:		**50%**
	Teams formed	*Week 4 (Sept 26th 2025, 10:00 (EDT/GMT-4)*	*0%*
	Proposal, incl. literature review and methods (describing modelling techniques)	*Due Week 6 (Oct 10th 2025, 10:00 (EDT/GMT-4)*	*15%*
	Project presentation to class (during lecture)	*Due Week 13 (Nov 28th 2025, 10:00 (EDT/GMT-4)*	*15%*
	Project final report	*Due Week 14 (Dec 5th 2025, 10:00 (EDT/GMT-4)*	*20%*

COURSE POLICIES: The following course-specific policies will be strictly enforced throughout the course:

- Conduct/Class Demeanor
  - The instructor is committed to providing a respectful learning environment for all students involved in this course. This is a collective responsibility of the instructor and students, and therefore students enrolled in this course agree to abide by this criterion. This includes arriving at lectures on time and acting in a professional manner during class.

- Intellectual Property
    - This course contains the intellectual property of the instructor, TA, and/or Western University. Intellectual property includes items such as:
    - Lecture content, spoken and written (and any audio/video recording thereof).
    - Lecture handouts, presentations, and other materials prepared for the course (e.g., PowerPoint slides).
    - Questions or solution sets from various types of assessments (e.g., assignments, quizzes, labs, tests/final exams, whichever applicable); and
    - Work protected by copyright (e.g., any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner).
    - The material provided in this course is designed to enhance student learning. The lecture notes and online lecture videos are copyrighted to the instructor and legally protected. You are not permitted under any circumstances to share the course materials on any other website, online forums/ with students taking the same/similar courses in subsequent terms/years. Recording of any sessions delivered on the course without the permission from the instructor is prohibited. In many cases, instructors might be happy to allow distribution of certain materials if permission is sought. Posting and sharing the copyrighted course content without expressed permission from the owner is considered a violation of intellectual property rights and academic integrity and could be subjected to legal actions. Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online.

- Course specific AI policy:

  The course specific AI policy differs from the general Faculty AI policy (see below), and will override the Faculty AI policy where applicable:

  Students should be aware of the potential benefits and limitations of using AI as a tool for learning and research. AI systems can provide helpful information or suggestions, but they are not always reliable or accurate. Students should critically evaluate the sources, methods, and outputs of AI systems. Students must be aware that generative AI is based on input from other human authors, and therefore, may contain inaccuracies (e.g. fabricate facts, inaccurately express ideas, and is known to falsify references to other work), reflect biases.

  While the use of generative Artificial intelligence (GenAI) tools won't be discouraged *during individual student learning* in the Faculty of Engineering, students are NOT permitted to submit any course deliverable that has been generated by AI systems e.g. ChatGPT, Bing Chat, Claude, Google Bard, or any other automated assistance. That means that if GenAI tools are used to generate any ideas for submissions, they must be disclosed as a resource however final course deliverables must contain student generated content, human published references only. All submitted work must be the work of the student. This includes using AI to directly generate text

for the report, code for the projects, or using AI to complete any other project tasks. Using AI in this way undermines the student's ability to develop critical thinking, writing, or research skills that are essential for academic success. As the legal/copyright status of generative AI inputs and outputs remains unclear, in this course, students are accountable for the content and accuracy of all submitted work. This policy will be enforced to ensure equal opportunity and preservation of academic integrity,

In line with Faculty AI policy, if use of GenAI tools is detected by the instructor in these instances, academic offences penalties might be imposed against the student.

- In-class mini quizzes
  - Quiz questions will be released every other week in class only, beginning week 1.
  - Quizzes are delivered using an online platform. Instructions on how to take the quiz will be made clear to you in the lectures.
  - Quizzes will be open book, and you are encouraged to look through the lecture slides to identify the best answer/s. The quizzes are designed to test your understanding of the content covered thus far; questions will be based on content presented in lectures in preceding week/s.
  - If you fail to turn up to class for a quiz, you will receive a grade of 0 for that quiz. No make-up quizzes will be offered.
  - Deadlines: Quizzes will be timed and quiz responses will be due at the end of the timed quiz time. The lowest quiz mark across the term will be dropped.
    - Please note that given this flexibility, any academic consideration requests will be denied.
  - If a minimum of 50% is not obtained on term work (in class weekly quizzes, assignments 1, 2, 3), the student will fail the course irrespective of the mark obtained in the final group project.

- Assignments
  - Students are expected to use the computer labs to complete the assignments.
    - Engineering students have access to our computer labs (ACEB 1400, 2415, 3420, and TEB 454) 24/7. From 10 PM - 7AM the rooms are locked, however, engineering students can open the door using their UWO ID card. All software required for this course is deployed in AppsAnywhere, which is available on any of our lab computers.
  - Assignments must be submitted individually.
  - Deadlines: Assignments will be due as allocated.
    - Extended penalty-free deadline: Late submissions up to 48 hours after the deadline will not incur a penalty. Thereafter, a penalty of 20% per day will be applied, up to 3 days, after which students will receive a grade of 0.
    - Please note that given this flexibility, any academic consideration requests will be denied.
  - If a minimum of 50% is not obtained on term work (in class weekly quizzes, assignments 1, 2, 3), the student will fail the course irrespective of the mark obtained in the final group project.

- Group project
    - Teams must be formed by Week 4 (Sept 26th 2025, 10:00 (EDT/GMT-4). After this time, team members are locked and can no longer be altered.
    - It is expected that groups will self-delegate for the various aspects of the project, including problem identification, CAD (if applicable), FEA analysis, and report generation.
    - Students who do not choose a team will be assigned to one.
    - SolidWorks will be used for the design drawings and layouts, if applicable.
    - While the default assumption is that everyone contributes equally to the team effort and that everyone should therefore receive the same mark for the common team submission, if it is deemed by the course instructor or the teaching assistant that individual contributions to the team effort are not equitably shared by the team members, individual adjustment of the marks may occur, with allocation at the discretion of the instructor and teaching assistant.
    - The group presentation day is the designated assessment for this course. All students must be present at the group presentation day and each student must present their contribution portion to the group presentation.

      As the **designated assessment** for this course, you may not get academic consideration for the group presentation without providing supporting documentation.

      Failure to turn up without academic consideration will see an immediate individual deduction of 50% of the group presentation score achieved (assuming that there has been equal contribution to other group project components. If not, individual contribution across the group project will first be determined, in addition to the 50% reduction the group presentation score).
    - Deadlines: Project deliverables are due as allocated.
        - Extended penalty-free deadline (proposal and report ONLY): Late submissions up to 48 hours after the deadline will not incur a penalty. Thereafter, a penalty of 20% per day will be applied, up to 3 days, after which students will receive a grade of 0.
        - Please note that given this flexibility, any academic consideration requests will be denied.

Generally, students are required to contact the course instructor for any other concerns that are not covered by the non-exhaustive list of circumstances above.

General Faculty / University Policies

The Faculty of Engineering and Western University have overarching policies that prescribe how undergraduate courses should run. The course-specific policies described above should be considered *in addition to* those overarching policies, or as course-specific interpretations of them. In the event of contradictions or confusion between course-specific policies above and general Faculty / University policies, please contact your course instructor for clarification.

Western Engineering's undergraduate polices can be found by navigating to:
https://www.eng.uwo.ca/undergraduate/academic-support-and-accommodations/policies.html

and then clicking the "*Engineering Undergraduate Policies framework*" link.