

IBEHS 4B03

(cross-listed with MECHENG 4BB3 / MECHENG 6BB3)

Biomechanics

Fall Term (2025-26)

Course Outline

Calendar/Course Description

Biomechanics is the study of how physical forces interact with living systems. The aim of this course is to provide an introduction to biomechanics for Engineering students and an introduction to mechanics for students in the Health Sciences. It is assumed that the students will have either an understanding of engineering principles including solid mechanics and fluid mechanics or background in cell biology and mammalian physiology. The course will teach students how to apply mechanical engineering principles to biomechanical problems, including cellular biomechanics, the circulatory system, muscles and movement, and the skeletal system.

Pre-Requisites and Anti-Requisites

Prerequisite(s): Registration in the Integrated Biomedical Engineering and Health Sciences (IBEHS) program

Antirequisite(s): MECHENG 4BB3

Course Schedule

This course is delivered by **3 lectures** and **1 tutorial** per week.

LECTURES:

- Mondays **1:30-2:20 PM**
- Wednesdays **1:30-2:20 PM**
- Thursdays **1:30-2:20 PM**

Lectures are in-person, and attendance is expected. The lecture content will be captured using Echo360 and available for review if you need to be absent from lecture.

TUTORIALS:

- Mondays **12:30-1:20 PM**

Tutorials are in-person. Attendance is optional except on the two Mondays scheduled for midterms (see midterm schedule on page 4).

Instructor Office Hours and Contact Information

Dr. Greg Wohl
wohlg@mcmaster.ca

Office Hours:
Wednesdays 2:30 – 4:20 PM
• or, send a chat message via MS Teams to request an appointment.

Teaching Assistants

- TBD

Course Delivery

[Avenue-to-Learn](#) will be the online management system for the course. Through **Avenue**, you will be able to:

- Find the assigned rooms for the course
- Find all course materials (lecture slides, lab materials, project documents, etc.)
- View course-related announcements
- Complete online quizzes
- Submit course work (assignment, project deliverables) for grading
- View your gradebook

Materials and Fees

Textbooks

There is *no required textbook* for the course. All required reading materials will be made available for free as online documents through the course management system (**Avenue-to-Learn**).

The following are textbooks that were used in the development of the course materials. They are *optional* for students to purchase or take out from the library (hyperlinks are to available McMaster library resources where available):

[C.R. Ethier, C.A. Simmons Introductory Biomechanics: From Cells to Organisms, Cambridge University Press, 2007. ISBN: 9780521841122](#)

[V.C. Mow, R. Huiskes eds. Basic Orthopaedic Biomechanics & Mechano-biology. Lippincott Williams & Wilkins, 2005. ISBN: 0781739330 \[WE 103 .B3125 2005\]](#)

D.L. Bartel, D.T. Davy, T.M. Keaveny. Orthopaedic Biomechanics: Mechanics and Design in Musculoskeletal Systems. Pearson Prentice Hall, 2006. ISBN: 9780130089090

Software

No required software

Hardware

No required hardware

Course Objectives and Learning Outcomes (LO)

Upon successful completion of the course, the student should be able to:

LO.01	Calculate the static load across a simplified diarthrodial joint subject to applied forces and moments.
LO.02	Identify and recognize limitations of assumptions for simplified loading conditions compared to real-world conditions (including anthropometric diversity and sex differences)
LO.03	Demonstrate an understanding of how extracellular matrix components affect tissue mechanical properties and behaviours.
LO.04	Calculate normal stress in a tissue due to combined axial and bending loads.
LO.05	Demonstrate an understanding of how the components of a lumped parameter contribute to the model's mechanical response.
LO.06	Perform the mathematical solution of a lumped parameter model.
LO.07	Demonstrate an understanding of different tissue types in the musculoskeletal system including how their hierarchical structure contributes to their mechanical properties and their roles in the musculoskeletal system.
LO.08	Demonstrate an understanding of the pressure-volume loop of the left ventricle and how different valve pathologies affect work in the heart.
LO.09	Demonstrate an understanding of vascular wall properties and the effect on pressure pulse propagation through the circulatory system.
LO.10	Demonstrate an understanding of mass transfer in capillaries and the role of Starling forces.
LO.11	Demonstrate an understanding of the role of the cell in tissue adaptation.
LO.12	Demonstrate an understanding of cell specialization by tissue.
LO.13	Demonstrate an understanding of how an implantable device can affect tissue adaptation.

Assessments

The course is assessed as follows.

IBEHS 4B03 / MECHENG 4BB3

ASSESSMENTS	WEIGHT
Quizzes (best 10 out of 12) [10 x 1%]	10%
Assignments [4 x 5%]	20%
Midterm tests [2 x 15%]	30%*
Final Exam	40%*

***Important note:** The final grade will be calculated by one of two possible methods for each student depending on which method gives the best grade outcome:

- 1) **Standard method:** Midterm tests (2 x 15%) + Final exam (40%) = 70%
- 2) **Alternate method:** Midterm tests (2 x 0%) + Final exam (70%) = 70%

If the grade on your final exam is better than the grade on your midterm tests, the final exam can be worth 70% of your grade

I strongly recommend not using an MSAF for the midterm tests! (see MSAF policy on p. 8)

Write both term tests as practice and get feedback on your understanding of material before writing the final exam.

MECHENG 6BB3

ASSESSMENTS	WEIGHT
Quizzes (best 10 out of 12) [10 x 1%]	10%
Assignments [4 x 5%]	20%
Midterm tests [2 x 10%]	20%
Review paper	15%
Final Exam	35%

Important Dates

IBEHS 4B03 / MECHENG 4BB3 Fall 2025										
Deliverable dates										
Week			Quizzes			Assignments			Tests	
#	Start	End	#	Start	Due	#	Start/Due	Date	#	Date
1	01-Sep	05-Sep								
2	08-Sep	12-Sep	1	08-Sep	14-Sep	1	Start	10-Sep		
3	15-Sep	19-Sep	2	15-Sep	21-Sep		Due	18-Sep		
4	22-Sep	26-Sep	3	22-Sep	28-Sep	2	Start	24-Sep		
5	29-Sep	03-Oct	4	29-Sep	05-Oct		Due	02-Oct		
6	06-Oct	10-Oct	5	06-Oct	19-Oct				1	06-Oct
Break	13-Oct	17-Oct								
7	20-Oct	24-Oct	6	20-Oct	02-Nov					
8	27-Oct	31-Oct	7	27-Oct	02-Nov	3	Start	29-Oct		
9	03-Nov	07-Nov	8	03-Nov	09-Nov		Due	06-Nov		
10	10-Nov	14-Nov	9	10-Nov	16-Nov				2	17-Nov
11	17-Nov	21-Nov	10	17-Nov	23-Nov	4	Start	19-Nov		
12	24-Nov	28-Nov	11	24-Nov	30-Nov		Due	27-Nov		
13	01-Dec	04-Dec	12	01-Dec	07-Dec					
	06-Dec	19-Dec								Final Exam date TBD

Notes:

- **Quizzes:** 12 weekly quizzes - best 10 of 12; posted Mondays; due Sundays (before midnight); reviewed in tutorial on Mondays.
- **Assignments:** 4 assignments; due as indicated by midnight
- **Midterm Tests:** 2 individual tests; in person, during class & tutorial time on dates as indicated.
***Important note:** See the MSAF policy (p. 8). **Do not use an MSAF for the midterm tests if at all possible!**
The weight of the final exam can be worth up to 70% (final plus midterm tests) if it benefits your final grade.
Write both midterm tests as practice and get feedback on your understanding of the material.

Completion and Submission of Work

It is the student's responsibility to ensure assessments are correctly submitted to the correct location, on time, and in the specified format. **Failure to correctly submit an assignment will result in a mark deduction** (see below).

Submission Penalties

Please be aware of the following submission due dates and penalties for Assignments:

- All assignments have a posted due date. (see table above). An automatic grace period extension of three days past the posted due date will be granted with no need for MSAF submission. Assignments submitted after the 3-day extension will be subjected to a **late penalty of 20% per day**.
- Submissions must be in the correct format, or they will be subject to a **10% deduction**.
 - It is your responsibility to ensure any electronic submissions can be opened by the TA
- **Any submissions deemed to be partially or fully copied will be considered an academic offence and be subject to terms laid out under the [Academic Integrity Policy](#).**

Grading Concerns

Grades for assignments and mid-term exams will be posted to Avenue as soon as possible upon completion.

You will have 7 days from the date your grade is posted to address any concerns you may have with the instructor.

- Any questions/concerns must be addressed electronically through an MS Form* that will be made available on Avenue (*An MS Form is like a Google Form, but it is Microsoft and not Google).
- Concerns regarding grading will not be considered without submitting through the appropriate channels (i.e., the posted MS Form).
- Any concerns or appeals brought to the attention of the instructor after 7 days from the day the grade was posted to Avenue will not be processed.

Use of AI tools in the course.

*Students may use generative AI in this course in accordance with the guidelines outlined for each assessment and so long as the use of generative AI is referenced and cited following citation instructions given in the syllabus. **Use of generative AI outside assessment guidelines or without citation will constitute academic dishonesty.** It is the student's responsibility to be clear on the limitations for use for each assessment and to be clear on the expectations for citation and reference and to do so appropriately*

Communication Policy

The best way to connect with the instructor is by the following methods:

1. Send a chat message through Teams
2. Send an email to wohlg@mcmaster.ca

I will try to respond within 24 hours (excluding weekends).

Emails must be sent from your McMaster email account.

Please include a subject prefix of "IBEHS 4B03" or "MECHENG 4BB3"

Please provide sufficient detail in your email or chat message so that I can understand your request but also try to be succinct and clear in your message or request.

Inclusive Environment Statement

We consider this classroom to be a place where you will be treated with respect, and we welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, abilities, and other visible and non-visible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

We will gladly honour your request to address you by an alternate name or gender pronoun. Please advise of this preference early in the semester so that we may make appropriate changes to our records.

Accreditation

The Graduate Attributes defined in this section are measured for Accreditation purposes only and will not be directly taken into consideration in determining a student's actual grade in the course. For more information on Accreditation, please visit: <https://www.engineerscanada.ca>. Mapping of the course **Learning Outcomes (LO)** to the Canadian Engineering Accreditation Board (CEAB) **Graduate Attributes (GA)** are outlined in the table below:

GRADUATE ATTRIBUTE	LEARNING OUTCOME(S)
GA01 – Knowledge Base for Engineering	
1.1 – Competence in mathematics	1, 4, 6
1.2 – Competence in natural sciences	2,3,7-13
1.3 – Competence in engineering fundamentals	1,4,5,6,13
1.4 – Competence in specialized engineering knowledge	1,3,6-13
GA10 – Ethics and Equity	
10.2 – Applies the principles of equity and universal design to ensure equitable treatment of all stakeholders.	1, 2, 7, 11, 13
GA12 – Lifelong learning	
12.2 – Seeks and acquires appropriate external information as required, including showing awareness of sources of information and the ability to critically evaluate them.	1,3,7-13

For more information on Accreditation, please visit: <https://www.engineerscanada.ca>

CEAB Accreditation Units: Natural Science 25%, Engineering Science 75%

McMaster Approved Policy Statements

Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in university activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g., use of Avenue 2 Learn or Teams for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

- Plagiarism, e.g., submission of work not one’s own or which other credit been obtained.
- Improper collaboration in group work.
- Copying or using unauthorized aids in tests and examinations.

On all work submitted for credit by students at McMaster University, the following pledge is either required or implied: *“I understand and believe the main purpose of McMaster and of a university to be the pursuit of knowledge and scholarship. This pursuit requires my academic integrity; I do not take credit that I have not earned. I believe that academic dishonesty, in whatever form, is ultimately destructive to the values of McMaster, and unfair to those students who pursue their studies honestly. I pledge that I completed this assessment following the guidelines of McMaster’s academic integrity policy.”*

Authenticity / Plagiarism Detection

In this course we will be using a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. Students will be expected to submit their work electronically either directly to Turnitin.com or via Avenue to Learn (A2L) plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish to submit their work through A2L and/or Turnitin.com must still submit an electronic and/or hardcopy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com or A2L. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). To see the Turnitin.com Policy, please go to the following website: www.mcmaster.ca/academicintegrity.

Academic Accommodations for Students with Disabilities

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](mailto:sas@mcmaster.ca) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University’s [Academic Accommodation of Students with Disabilities](#) policy.

Academic Accommodation for Religious, Indigenous, or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or

to the Registrar's Office prior to examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Academic Accommodations for Relief for Missed Academic Work: McMaster Student Absence Form (MSAF)

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "[Requests for Relief for Missed Academic Term Work](#)".

- All MSAFs are to be directed to the instructor at wohlg@mcmaster.ca. Sending to another email address will delay processing.
- It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in his/her course.

- **Note:** If an MSAF is applied to either midterm, the weight of the midterm exam **will be applied to the final exam.** (i.e., there will be no make-up midterm exam).

I strongly recommend that you do not use an MSAF for midterm tests if possible.

The final grade will be calculated by one of two possible methods for each student, depending on which method gives the best grade outcome:

$$3) \text{ Midterm tests } (2 \times 15\%) + \text{ Final exam } (40\%) = 70\%$$

$$4) \text{ Midterm tests } (2 \times 0\%) + \text{ Final exam } (70\%) = 70\%$$

If your grade on the final exam is better than the grades on your midterm tests, the final exam can be worth 70% of your grade.

- **It is important to write the midterm tests as practice and to get feedback on your understanding of the material before writing the final exam.**

Courses with an On-Line Element

In this course, we will be using **Avenue-to-Learn** and **Microsoft Teams**. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, usernames for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

Reference to Research Ethics

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to <https://reo.mcmaster.ca/>.

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

Notice Regarding Possible Course Modification

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

Integrated Biomedical Engineering & Health Sciences (IBEHS) Labs/Design Studio Safety

Information for Laboratory Safety and Important Contacts

This document is for users of IBEHS instructional laboratories at the following locations:

- ABB C104 (Design Studio)
- ETB 533 (Medical Imaging/Biomaterials Lab)
- ETB 534 (Medical Instrumentation/Robotics Lab)
- HSC 4N72 (Genetic Engineering Lab)

This document provides essential information for the healthy and safe operation of IBEHS instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in IBEHS. It is expected that revisions and updates to this document will be done continually. At McMaster University, HR maintains Health & Safety information that is also available at https://hr.mcmaster.ca/employees/health_safety_well-being/our-safety/lab-safety/.

Details on Standard Operating Procedures (SOPs), Health and Safety videos and other resources can be found online at the [iBioMed Health and Safety webpage](#).

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following:

- Food and beverages are not permitted in the instructional laboratories.
- A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
- Laboratory equipment should only be used for its designed purpose.
- Proper and safe use of lab equipment should be known before using it.
- The lab tech or course TA leading the lab should be informed of any unsafe conditions.
- The location and correct use of all available safety equipment should be known.
- Potential hazards and appropriate safety precautions should be determined, and the sufficiency of existing safety equipment should be confirmed before beginning new operations.
- Proper waste disposal procedures should be followed.
- [Personal ergonomics](#) should be practiced when conducting lab work.
- [Current University health and safety](#) issues and protocols should be known.

Location of Safety Equipment

Fire Extinguisher: on walls in halls outside of labs or within labs

First Aid Kit: ABB C104, ETB 533, ETB 534, HSC 4N72 or dial “88” after 4:30 p.m.

Telephone: on the wall of every lab near the door

Fire Alarm Pulls: Near all building exit doors on all floors

Who to Contact?

Emergency Medical / Security:

On McMaster University campus, call Security at extension **88** or **905-522-4135** from a cell phone.

Hospital Emergency Medical / Security:

For McMaster HSC, call Security at extension **5555** or **905-521-2100** from a cell phone.

Non-Emergency Accident or Incident: Immediately inform the Lab Tech, TA on duty or Course Instructor.

University Security (Enquiries / Non-Emergency):

Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.

See Lab Tech, TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs.

Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.

IBEHS Specific Instructional Laboratory Concerns: For non-emergency questions specific to the IBEHS laboratories, please contact appropriate personnel below from a McMaster phone:

- Leela Pilli, Laboratory Technician – 26888
- Parmveer Bola, Instructional Assistant – 23521
- Andrej Rusin, Wet Laboratory Technician – 28347
- Alexa Behar-Bannelier, Program Manager – 24548

In Case of a Fire (Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "**Fire!**" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people.

1. Douse with water from safety shower immediately or
2. Roll on the floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if a blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents. Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In Power Lab, press the wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol for Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you are not sure, ask!

Defined Roles

IBEHS Lab Technician	Leela Pilli, pillil@mcmaster.ca
IBEHS Instructional Assistant	Parmveer Bola, bolap1@mcmaster.ca
IBEHS Wet Lab Technician	Andrej Rusin, rusina@mcmaster.ca
IBEHS Co-Directors	Dr. Colin McDonald, cmcdona@mcmaster.ca Dr. Michelle MacDonald, macdonml@mcmaster.ca
IBEHS Program Manager	Alexa Behar-Bannelier, alexa.behar@mcmaster.ca
IBEHS Course Instructor	Please contact your specific course instructor directly