

IBEHS 4B03

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

Biomechanics

Fall Term 2021

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 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 principals to biomechanical problems including cellular biomechanics, hemodynamics, the circulatory system, muscles and movement, the skeletal system, and the respiratory 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

Lectures: ["live" on MS Teams, lectures will be recorded, and links will be posted on Avenue]

Mon (12:30-1:20 PM),

Tue (1:30 PM-2:20 PM)

Thu (12:30-1:20 PM)

Tutorials: ["live" on MS Teams, tutorials will be recorded, and links will be posted on Avenue]

Thu (1:30-2:20 PM)

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Greg Wohl

ABB C313

wohlg@mcmaster.ca

ext. 21195

Office Hours:

Thursdays – 2:30-2:20 pm (on MS Teams)

or sent a chat message by Teams to arrange an appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

T.B.D.

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

All course materials will be available on Avenue to Learn <http://avenue.mcmaster.ca/>

Lectures will be delivered live (“synchronously”) via MS Teams and will be recorded. Recordings of lectures will be posted (links on Avenue) for students who are unable to attend live lectures or live stream lectures.

MATERIALS AND FEES

Recommended Text: [C.R. Ethier, C.A. Simmons Introductory Biomechanics: From Cells to Organisms, Cambridge University Press, 2007. ISBN: 978-0-521-84112-2](#)

Calculator: You will not need a calculator in exams for this course. If you feel you want it with you, the McMaster Standard Calculator is the only calculator that may be used on tests or exams.

COURSE OVERVIEW

Please note that this is the intended course plan. Deviations might occur due to delays or changes in topic coverage.

Date/Week	Topic	Readings
Sep 07-10	Course intro; Intro to the eukaryotic cell and extracellular matrix (ECM)	Chpt 2.1-2.4
Sep 13-17	Cell-ECM interaction; Cell mechanical loading; models of cell mechanics	Chpt 2.5-2.6
Sep 20-24	Cell: Models of cell mechanics	Chpt 2.6
Sep 27-Oct 1	Cell: Mechanotransduction; (e.g., Bone adaptation)	Chpt 2.7
Oct 04-08	Hemodynamics	Chpt 3.1-3.3
Oct 11-15	--- READING BREAK ---	
Oct 18-22	Circulatory system: the heart anatomy and PV relationship	Chpt 4.1-4.3
Oct 25-29	Circulatory system: arterial anatomy and pulse propagation; veins	Chpt 4.3-4.5
Nov 01-05	Muscles: skeletal muscle morphology; constitutive modeling	Chpt 8.1-8.3
Nov 08-12	Muscles: whole muscle mechanics / Skeletal Mechanics: connective tissues	Chpt 8.4, 9.1
Nov 15-19	Skeletal Mechanics: Ligaments and tendons, bone structure/function	Chpt 9
Nov 22-26	Joint Mechanics: joint loads and implant design / Terrestrial motion	Chpt 9/10
Nov 29-Dec 3	Terrestrial motion: 3D motion / injury mechanics	

ASSESSMENT (IBHES 4B03 / MECHENG 4BB3) - see next page for MECHENG 6BB3

Component	Weight
Quizzes (best 10 out of 12)	20% [10 x 2%]
Assignments (group assignments)	20% [4 x 5%]
Mid-term projects (effectively take-home tests)	30% [2 x 15%]
Final Exam	30%
Total	100%

ASSESSMENT (MECHENG 6BB3)

Component	Weight
Quizzes (best 10 out of 12)	20% [10 x 2%]
Assignments (group assignments)	20% [4 x 5%]
Mid-term projects (effectively take-home tests)	20% [2 x 10%]
Review Paper	15%
Final Exam	25%
Total	100%

COURSE OBJECTIVES / LEARNING OUTCOMES

Upon successful completion of the course, the student will be expected to have demonstrated the ability to:

1. Compare techniques for measuring the mechanical properties of cells and illustrate the key operating principles of these techniques.
2. Illustrate key characteristics of red blood cell behaviour that affect the viscosity of blood.
3. Derive the relationship between pressure and volume in the heart at key phases of the cardiac cycle.
4. Analyze the contributions of different muscles to a prescribed loading condition and determine the joint reaction force based on these muscle forces.
5. Assess the effect that skeletal loading plays in the mechanical properties of cortical and trabecular bone and analyze mechanisms of injury and treatment that can cause bone mechanical properties to be altered.
6. Develop and mathematically solve rudimentary lumped parameter model to explain viscoelastic behaviours of musculoskeletal tissues.
7. Illustrate how joint reaction forces are calculated based on data collected during walking and/or running activities and determine the key parameters that must be measured.
8. Consider physiological conditions and the implications for design of an engineered implantable device used to replace a biological function (e.g., heart valve, vascular stent, ligament graft, artificial joint)

ACCREDITATION LEARNING OUTCOMES

The Learning Outcomes 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.

Indicators	Learning Outcomes
1.02 – Competence in Natural Sciences	1-7
1.04 – Competence in Specialized Engineering Knowledge	1-8
3.01 – Recognizes and discusses applicable theory knowledge base	1-8
4.02 – Recognizes and follows engineering design principles including appropriate consideration of environmental, social and economic aspects as well as health and safety issues.	8
4.05 – Includes appropriate health and safety considerations in design	8
12.01 – Critically evaluates and applies knowledge, methods and skills procured through self-directed and self-identified sources, including those that lie outside the nominal course curriculum	1-8

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

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, WebEx or Zoom 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.

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, ability – 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 us of this preference early in the term.

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](#) located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster’s use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact [Student Accessibility Services \(SAS\)](#) 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 their 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 TERM 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".

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g., e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names 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 a course that uses on-line elements 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.