McMaster University | ENGINEERING Chemical Engineering

CHEMICAL ENG 4T03/6T03: Applications of Chemical Engineering in Medicine

January – April 2026

INSTRUCTOR:	Alex Sotra	
	Email: sotraa@mcmaster.ca	
TEACHING ASSISTANTS:	Ekaterina Kvitka	mkvitkae@mcmaster.ca
	Rutika Shelar	shelarr@mcmaster.ca
	Marianna Switchuk	switchum @mcmaster.ca
	Nhi Tran	trant50@mcmaster.ca
	Brenda Truong	truonb3@mcmaster.ca

LECTURE HOURS:	Wednesday 7:00-10:00 PM
LOCATION:	CNH B107

COURSE OBJECTIVE:
To impart some detailed knowledge and an overall appreciation of the contributions, actual and potential, of chemical engineering to medicine and biotechnology.

SPECIAL INSTRUCTIONS FOR COURSE DELIVERY:
The course will be delivered in person. Students will form their own groups and are encouraged to work together in-person for all of their group assignments. All major announcements will be posted on Avenue-to-Learn (A2L). All assignments, course materials, grades will also be posted on A2L for record-keeping purposes. Although in-class participation is not required, you should review all class lectures and work with your group members to complete all in-class assignments. The Design Project presentation will be done in person and during class time. The midterm exam will be in person during class time unless specified otherwise in announcements. The final exam will be in person unless specified otherwise in announcements.

TOPICAL OUTLINE:
Unit 1: Biomaterials - definitions, types (metals, ceramics, polymers), applications, properties, characterization; how to choose the best biomaterial for specific applications
Unit 2: Biological Responses to Biomaterials – protein adsorption, thrombosis, immune/inflammatory responses, proliferation/initial repair, resolution
Unit 3: Tissue Engineering – tissue organization, intracellular communication, scaffold design and preparation, cell selection and culturing, stem cells
Unit 4: Drug Delivery – materials, transport aspects, reservoir vs. matrix systems, degradable systems, commercially available drug delivery systems, "personalized medicine"

Course Schedule: Please note that this schedule is subject to change based on weather cancellations. Any changes to this schedule affecting evaluations will be announced at least one week in advance via A2L.

Date	Wednesday (7:00-10:00 PM)		
Week 1 (Jan 7)	Introduction	Biomaterials (metal and ceramics)	Biomaterials (polymers part 1)
Week 2 (Jan 14)	Biomaterials (polymers part 2)	Biomaterials (polymers part 3)	Biomaterials surface modification
Week 3 (Jan 21)	Biomaterials characterization	Host response to biomaterials (part 1)	Biomaterials design workshop (5% mark)
Week 4 (Jan 28)	Host response to biomaterials (part 2)	Host response to biomaterials (part 3)	Biomaterial paper workshop 1 (5% mark)
Week 5 (Feb 4)	Host response to biomaterials (part 4)	Host response to biomaterials (part 5)	Biomaterials characterization workshop (5% mark)
Week 6 (Feb 11)	Tissue engineering (part 1)	Midterm exam review session	Host response to biomaterials workshop (5% mark)
Week 7 (Feb 18)	Midterm Recess		
Week 8 (Feb 25)	**Midterm Exam (15% mark)**		
Week 9 (Mar 4)	Tissue engineering (part 2)	Tissue engineering (part 3)	Tissue engineering design workshop (5% mark)
Week 10 (Mar 11)	Patents lecture	Drug delivery (part 1)	Patent workshop (5% mark)
Week 11 (Mar 18)	Drug delivery (part 2)	Drug delivery (part 3)	Drug delivery design workshop (5% mark) & Design Project informal feedback (Entire day)
Week 12 (Mar 25)	**Design Project Presentations (20% mark)**		
Week 13 (Apr 1)	**Design Project Presentations (20% mark)**		
Week 14 (Apr 8)	No class		
Week 15 (Apr 14-20)	**Final Exam (30% mark)**		
Week 16 (April 21-26)			

ASSESSMENT:

In-class workshops (Group of 4 students)	35%
Design project final presentation (Same group of 4 students)	20%
Midterm and Final examinations (Individual)	(15% + 30%) = 45%

NOTES ON ASSESSMENTS:

In-class workshops are mandatory and are intended to give practical experience in understanding professional issues in biomedical engineering (patents, reading literature, etc.) as well as making design decisions (biomaterial choice and characterization, tissue engineering, drug delivery). The students can work in a group of 4 (Sign up here). Missed

workshops will be evaluated upon presentation of a McMaster Student Absence Form (MSAF). The weighting for excused absences will be transferred to other workshops, not the final exam. A maximum of one excused absence (of the seven workshops presented) will be considered for accommodation via an MSAF, except in exceptional circumstances. Further missed workshops will result in a mark of zero being applied to that workshop. All in-class workshop assignments will be **due on A2L at 11:59 PM Wednesday of the following week.**

- **Midterm and final exams** will be open book (i.e., you may bring notes and any other reference material you wish to bring). The midterm test is *optional*, with no make-up tests to be arranged (and no MSAFs considered). If you write the midterm test and do better on the final exam, your final mark will be calculated ignoring the midterm mark (i.e., the final exam will account for 45% of the course mark). Alternatively, if you do better on the midterm than the final exam, the midterm exam will count for 15% of your mark and the final exam will count for 30% of your mark. The midterm exam will be during class time as indicated on the course schedule.

- **For the design project**, students will be responsible for proposing and presenting a novel biomedical product to address one of the clinical challenges provided using concepts from any part of the course (biomaterials, material surface modification, host body response, tissue engineering, and drug delivery). This project will be done in the same group of 4 students (Sign up here). **The design presentation (10 minute presentation + 2-3 minutes of Q&A) will be scheduled in weeks 12 and 13 of class.** Each group will present its technical design idea within 10 minutes (visual aids are allowed). Technical questions will be asked to ensure the group understands the fundamental technical concepts behind their proposal, and to ensure the proposed solution is both appropriate and feasible. The students will be tested on their understanding and knowledge of the proposed product and topic. **The final presentation PPT slides are to be submitted on A2L under the assignment section at least 24 hours before your group's scheduled presentation.** For more details, please check the instructions sheet.

RESOURCES:

There is no single textbook is available to cover all aspects of the course. In addition to course notes, available online, the sources in the accompanying list may be found generally useful.

D. Williams, "Essential Biomaterials Science" (2014)

S. Ramakrishna, "Biomaterials: a nano approach" (2010)

J. Park, R.S. Lakes, "Biomaterials: an Introduction" (2007) – available as an e-book

J. Enderle, S. Blanchard, J. Bronzino "Introduction to Biomedical Engineering" (2005).

B.D. Ratner, "Biomaterials Science: An Introduction to Materials in Medicine", 2nd Ed. (2004) – particularly useful for biological response to materials section

L. Di Silvio (ed.), "Cellular Response to Biomaterials" (2009)

J.D. Bronzino (ed.), "The Biomedical Engineering Handbook" (1995)

R. Baker, “Controlled Release of Biologically Active Agents” (1987)

W. Mark Saltzmann, “Drug Delivery: Engineering Principles for Drug Therapy” (2001)

D.A. Lauffenburger and J.J. Linderman, “Receptors: Models for Binding, Trafficking and Signaling” (1993).

D.O. Cooney, “Biomedical Engineering Principles” (1976)

T.E. Creighton, “Proteins: Structure and Function” (1992)

A.L. Shrier and T.G. Kaufmann (eds.), “Mass Transfer in Biological Systems” CEP Symposium Series No. 99 (1970)

R.C. Seagrave, “Biomedical Applications of Heat and Mass Transfer” (1971)

C.W. Patrick, A.G. Mikos, L.V. McIntire (eds) “Frontiers in Tissue Engineering” (1998)

R.P. Lanza, R. Langer and W.L. Chick (eds) “Principles of Tissue Engineering” (1997)

The following Faculty of Engineering and University Senate policies will be followed in this course:

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.

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.

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.

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.

REQUESTS 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".

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.

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.

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

POLICIES ADDENDUM

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.

The P.R.O.C.E.S.S.

As some of you may already be aware, the department of Chemical Engineering has a storied history of education. In addition to teaching and learning, the department is proud of our graduates not only for their academic success, but their more intrinsic traits that make them respected members of the engineering community.

Recently, several high-ranking graduates from the McMaster Chemical Engineering Program employed in various industries (oil/gas, financials, biotech, etc.) were interviewed to ask what traits they look for when hiring for engineering positions. Using this information, the department would like to present to you the **PROCESS**: a code of conduct that we hope will guide our students throughout this program and their careers to come.

- **P**rofessionalism
- **R**esponsibility
- **O**wnership
- **C**uriosity
- **E**mpathy
- **S**elflessness
- **S**ervice

It is up to YOU to interpret these traits and apply them to your time at McMaster and your career as you see fit. These traits will not be assessed for grades but will be strongly encouraged throughout your time at McMaster. We hope that you identify with these character traits and what they mean to you, and that you **trust the process**.