

Faculty of Engineering**McMaster University**

Term 1 (September - December 2025)

**MECH ENG 4N03**
NanoBioEngineering

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Lectures: Mondays 7 pm-10 pm
Tutorials: none
Laboratories: none

Course website: via Avenue to Learn (avenue.mcmaster.ca)

Course Objectives:

This course presents an overview of the field of nano-bio engineering and its applications for developing devices for diagnostics and therapeutics technologies in biomedical sciences and has been designed based on “experiential learning” and “problem-based” learning approach. The main goal of this course is to familiarize students with nano-bioengineering and to discuss recent advances in the field of nanotechnology for developing novel coatings, biomaterials and biomedical devices. Several case studies from recently developed technologies and current biomedical devices in the field will be discussed and students will also be engaged in group projects related to the topic.

Course Topics:

As the main focus of the course will be on case studies, the proposed topics will be discussed based on the case studies and not necessarily in order. Major topics to be covered will include:

- Introduction to nanotechnology
- Evolution of NanoBioTechnology
- Nanomaterials and their interactions with living systems
- Nanotechnology and Nanostructures in living systems
- Nanotechnology for developing bio-functional interfaces
- Characterization of bio-functional interfaces in nanoscale
- Applications of nanotechnology in biomedical devices
- Nanotechnology for developing biomaterials
- Assembly of bio-functional interfaces into biomedical devices
- Nanotechnology for biosensing and diagnostics
- Organs-on-Chips and nanotechnology for drug discovery

Audience:

This course has been designed for 4th and 5th year undergraduate students in science and engineering who are interested in learning about the applications of micro/nanotechnology in biological and biomedical applications. The course will be of particular interest to students in the iBiomed program. The course will be of particularly interest to graduate students in the following departments: biomedical Engineering, Mechanical and Biomedical Engineering, Chemical Engineering, Chemical and Biomedical Engineering, Electrical and Biomedical Engineering, Materials Science and Engineering, and Chemistry and Chemical Biology. Students from the Faculty of Health Sciences are also welcome to register for the course.

Email Policy:

- Any emails directed to the instructor or TA should include a subject prefix of “ME [course number]-[subject]?”.

Course Materials:**Textbook:**

There is not a specific textbook for this course, however the instructor will provide reading material including course slides (which will be uploaded on Avenue), books/book chapters, articles and videos. Following are some examples of the useful references for the course:

- Classification and Fabrication In Nanoscale Science and Technology, Brydson, R. M.; Hammond, C., Generic Methodologies for Nanotechnology: John Wiley & Sons, Ltd: 2005; pp 1-55. 2.
- Micro and Nanotechnologies for Biotechnology, InTech, 2016.
- Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology, Brydson, R. M.; Hammond, C., John Wiley & Sons, Ltd: 2005; pp 56-129. 3.
- Bionanotechnology. In Nanoscale Science and Technology, Leggett, G. J.; Jones, R. A. L., John Wiley & Sons, Ltd: 2005; pp 419-445.
- “Nanobiotechnology: concepts, applications and perspectives”, edited by Christof M. Niemeyer and Chad A. Mirkin. (2004) Weinheim: Wiley-VCH.

The Course Management System is Avenue to Learn (avenue.mcmaster.ca).

Students are required to check the system daily for assignment release/submission, course-related material, and posted announcements. It is also highly recommended that students forward their email from Avenue to their regular email (see *Avenue Mail* settings) to receive any important email broadcasts.

Lecture Content:

The course material will be designed to maximize student participation through problem-based learning approach (short case studies) and topics discussed during the lectures. Student participation will contribute to the final evaluation. There will also be guest lecturers throughout the semester to familiarize students with selected topics in Nano-bioengineering.

Detailed Topics for the course:

1. Introduction to nanobiotechnology
 - Introduction to micro and nanotechnology
 - Bioengineering
 - Emerging field of nanobioengineering
2. Design in Nanoscale
 - Introduction to engineering design
 - Design in micro and nano scale
 - Top-down and bottom-up approach in design
 - Bio-inspired design
3. Nanomaterials
 - Nanomaterials fabrication and characterization
 - Nanostructures in living systems
 - Nano coatings
 - Nanoparticles
4. Nanobio-functional interfaces
 - Elements of a bio-functional interface
 - Design and fabrication of bio-functional interfaces
 - Biocompatibility and bio-functionality
 - Characterization of bio-functional interfaces
5. Nanotechnology for biosensing and diagnostics
 - Introduction to biosensors
 - Specificity vs sensitivity
 - Nanotechnology in biosensing
6. Lab on Chip (LOC) technology
 - Introduction to micro and nano fluidics
 - Micro/nano fabrication
 - Designing LOCs
7. Organs-on-Chips (OOC)
 - Introduction to OOC
 - Fabrication of OOC
 - Disease models and drug testing using OOCs

Evaluation:

First project report:	10% (Written report to describe the course project by the team)
First presentation:	15% (20 min presentation on the project idea and definition)
Assignments:	10 %
Quizzes:	15% (3 quizzes, each one 5% of the final mark)
Final project report:	20% (review article or research proposal-guidelines will be provided)
Final presentation:	25% (20 min presentation and 15 min question period)
Attendance:	5% (attendance will be taken)

The percentage marks will be converted to a final letter grade using the standard conversion scale shown in the McMaster Undergraduate Calendar.

Projects:

This course is based on performing team projects. Projects will be done in the form of teams (2-3 students in each group). List of project topics will be presented to students at the beginning of semester. Students can also propose projects related to the course topic. All projects must have a micro/nanotechnology approach to study or solve a biological/biomedical problem.

Project reports: Each group will submit two project reports. First one will be due mid October and will describe the idea behind the project, description and the problem to be addressed through out the project. Second report will be the final project report which will be in the form of a review article/research proposal.

Presentations: Each group will present two presentations: first one following the submission of the first report (Mid October) and the last presentation at the end of the semester following the final project report submission.

Evaluation will be for each individual student. Although students will do a team project but each will equally present parts of their project and will be separately asked questions. Also, assignments and quizzes will be on individual bases. Students must also mention their detailed contribution to the team projects in both reports. Formation of teams will be discussed and formed at the beginning of the semester based on the instructor's approval and the main emphasis will be on forming interdisciplinary groups preferably with backgrounds from different disciplines/departments. Evaluation forms will be distributed among the class for each project and students will be able to criticize and evaluate other projects based on their presentations and answers to questions.

Guidelines for the project reports, presentations and rubrics for evaluating them will be presented to students at the beginning of semester.

Learning Outcomes:

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

1. Understand the fundamental concepts of nanotechnology and nanobiotechnology
2. Analyze and apply micro/nanofabrication processes for designing biomedical devices
3. Characterize bio-functional interfaces and interpret the interaction between nanostructured materials and biological system
4. Develop a big picture of how to apply nanotechnology in the fields of diagnostics and therapeutics
5. Through their project, practice how to apply micro/nanotechnologies principles to solve problems in biomedical sciences
6. Gain more experience for team work, technical writing, problem analysis and technical presentations

Mapping to Graduate Attributes:

<i>Graduate Attribute</i>		<i>Learning Outcomes</i>
A01 – A Knowledge Base for Engineers		
1.02	Competence in Natural Sciences	1-6
1.04	Competence in Specialized Engineering Knowledge	1-5
A02 – Problem Analysis		
2.01	Demonstrates an ability to identify reasonable assumptions (including identification of uncertainties and imprecise information) that could or should be made before a solution path is proposed.	2,4,5,6
A03 – Investigation		
3.02	Selects appropriate model and methods and identifies assumptions and constraints.	4,5,6
3.03	Estimates outcomes, uncertainties and determines appropriate data to collect.	1-6

Policy Reminders: Students are reminded of the following Policies, which could be relevant to activities in this course.

Adverse Discrimination: The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem that cannot be resolved by discussion among the persons concerned, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.

Academic Integrity (Ethics and Dishonesty) Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and 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.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at: http://www.mcmaster.ca/senate/academic/ac_integrity.htm

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work
3. Copying or using unauthorized aids in tests and examinations.

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.

EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Mechanical Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the Equity and Inclusion Office.

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the Student Wellness Centre.

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:

1. plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. improper collaboration in group work.
3. 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

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

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.

SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

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".

1. **Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:**
 - Use the McMaster Student Absence Form (MSAF) on-line self-reporting tool. No further documentation is required.
 - Students may submit requests for relief using the MSAF once per term.
 - An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.
 - The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
 - The MSAF cannot be used for academic work that has already been completed attempted.
 - An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
 - The MSAF cannot be used to apply for relief for any final examination or its equivalent. See *Petitions for Special Consideration* above.
2. **For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has been used previously in that term:**
 - Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate **supporting documentation**.
 - If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief.

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.