

Course Outline (W2024)

BME423: Biomaterials

Instructor(s)	Dr. Muhammad Hasibul Hasan [Coordinator] Office: EPH 312 E Phone: email instructor Email: hasibulhasan@torontomu.ca Office Hours: TBA
Calendar Description	The principles of materials science and engineering with particular attention to topics most relevant to biomedical engineering. The structure-property relationships of metals, ceramics, polymers, and composites as well as skin, bone, cartilage, ligament, and vasculature; extensive treatment of the properties unique to materials' surfaces. Behavior of materials in the physiological environment.
Prerequisites	BLG143 and BME323
Antirequisites	None
Corerequisites	None
Compulsory Text(s):	1. Please obtain the BME423 laboratory manual from the Ryerson bookstore before attending your first lab.
Reference Text(s):	<ol style="list-style-type: none"> 1. Biomaterials: An Introduction, J. Park and R.S. Lakes, Springer, 2007 2. Biomaterials: A Basic Introduction, Q. Chen and G. Thouas CRC Press, 2016 3. Advanced Biomaterials: Fundamentals, Processing, and Applications, B. Basu, D.S. Katti and A. Kumar - John Wiley and Sons 2009 4. Introduction to Dental Materials - 3rd Edition R. van Noort - Mosby, 2008 5. An Introduction to tissue-Biomaterial Interactions, K.C. Dee, D.A. Puleo and R. Bizios - John Wiley and Sons, 2002 6. Introduction to Biomedical Engineering - 2nd Edition M.M. Domach - Pearson/Prentice Hall, 2009
Learning Objectives (Indicators)	<p>At the end of this course, the successful student will be able to:</p> <ol style="list-style-type: none"> 1. Apply a basic knowledge of science, conduct experiments on science principles and interpret the obtained results, develop further knowledge of science in support of application to engineering problems. (1a) 2. Interpret the results both qualitatively and quantitatively and check conclusions against objectives. (2a) 3. Make valid assumptions based on available information. (2b) 4. Make accurate use of technical literature and other information sources, determine the data that are appropriate to collect. recognize the characteristics of, and distinguish between experimental and investigations and theory. (3a) 5. Interpret experimental data using scientific technique and analysis. (5a)

	<p>6. Develop the understanding of the regulatory body and they shared responsibility for sustainable development (9a)</p> <p>7. Source and Use up to date information for evaluation. (12a)</p> <p>NOTE: Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).</p>														
Course Organization	<p>3.0 hours of lecture per week for 13 weeks</p> <p>2.0 hours of lab per week for 12 weeks</p> <p>0.0 hours of tutorial per week for 12 weeks</p>														
Teaching Assistants	TBA														
Course Evaluation	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td colspan="2" style="text-align: center;">Theory</td> </tr> <tr> <td>assignment</td> <td style="text-align: right;">20 %</td> </tr> <tr> <td>Midterm Exam</td> <td style="text-align: right;">20 %</td> </tr> <tr> <td>Final Exam</td> <td style="text-align: right;">40 %</td> </tr> <tr> <td colspan="2" style="text-align: center;">Laboratory</td> </tr> <tr> <td>Practicum</td> <td style="text-align: right;">20 %</td> </tr> <tr> <td>TOTAL:</td> <td style="text-align: right;">100 %</td> </tr> </table> <p>Note: In order for a student to pass a course, a minimum overall course mark of 50% must be obtained. In addition, for courses that have both "Theory and Laboratory" components, the student must pass the Laboratory and Theory portions separately by achieving a minimum of 50% in the combined Laboratory components and 50% in the combined Theory components. Please refer to the "Course Evaluation" section above for details on the Theory and Laboratory components (if applicable).</p>	Theory		assignment	20 %	Midterm Exam	20 %	Final Exam	40 %	Laboratory		Practicum	20 %	TOTAL:	100 %
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Examinations	<p>Final exam, During exam period, 3 hours, closed-open book (covers weeks 1-13).</p> <p>Midterm exam 2 hrs (7th week of the semester, covers weeks 1-6)</p> <p>Term report (due on the 13th week of the semester)</p> <p>All the tests, term report and Final exam will be conducted in person.</p>														
Other Evaluation Information	<p>Note: In order to pass the course, a student must: (1) achieve an overall score for the course of 50% or higher AND (2) obtain a passing grade (ie 30/60) on the midterm and final examination.</p> <p>All of the required course-specific written reports/assignments/labs will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through them.</p>														
Other Information	<p>COURSE LEARNING OUTCOMES: When students successfully complete this course they will understand the concepts behind developing medical materials and processes, the accreditation procedures that are used to ensure device and process safety and efficacy and how these procedures are applied using laboratory and clinical techniques.</p> <p>TOPICS COVERED: (1) history of medical and dental science, (2) bacteria, (3) medical devices, (4) medical processes, (5) tissue engineering, (6) introduction to FDA accreditation.</p>														

Course Content

Week	Hours	Chapters / Section	Topic, description
1-7	21		<p>Introduction to biomaterials, biological response to biomaterials, types of biomaterials, processing of biomaterials, biomaterial product testing, important properties of biomaterials, principles of chemistry including atomic structure and bonding.</p> <p>Chemical structure of biomaterials: crystal structure, point defect and diffusion of metals, structure and point defect of ceramics, structure and synthesis of polymers, methods of polymerization, copolymer, material characterization techniques, X-ray diffraction.</p> <p>Physical properties of biomaterials: crystallinity, linear, planar and volume defects, polymer crystallinity, thermal transitions of crystalline and non-crystalline materials, thermal analysis techniques, differential scanning calorimetry.</p>
7	2		Mid-Term Assignment
7-13	16		<p>Mechanical properties of biomaterials: mechanical testing modes methods results and calculations hardness impact tests fracture fatigue methods to improve mechanical properties mechanical analysis techniques.</p> <p>Degradation of biomaterials: corrosion/degradation of metals and ceramics fundamentals of electrochemistry and corrosion contributions of processing parameters mechanical and biological environments means of corrosion control degradation of polymers biodegradable materials.</p> <p>Surface properties of biomaterials: concepts in surface chemistry and biology physicochemical surface modification techniques biological surface modification techniques surface properties and degradation patterning techniques for surfaces.</p> <p>Polymer composite materials cortical bone and trabecular bone skin cartilage ligament and vaculature.</p>

Laboratory(L)/Tutorials(T)/Activity(A) Schedule

Week	L/T/A	Description
2-3	Lab 1	Construction of atomic models

4-5	Lab 2	Identification of materials by X-ray diffraction
6-7	Lab 3	Corrosion experiments of materials
8-9	Lab 4	Impact and hardness testing
10-11	Lab 5	Tensile properties of polymeric materials.

University Policies & Important Information

Students are reminded that they are required to adhere to all relevant university policies found in their online course shell in D2L and/or on [the Senate website](#)

Refer to the [Departmental FAQ page](#) for further information on common questions.

Important Resources Available at Toronto Metropolitan University

- [The Library](#) provides research [workshops](#) and individual assistance. If the University is open, there is a Research Help desk on the second floor of the library, or students can use the [Library's virtual research help service](#) to speak with a librarian.
- [Student Life and Learning Support](#) offers group-based and individual help with writing, math, study skills, and transition support, as well as [resources and checklists to support students as online learners](#).
- You can submit an [Academic Consideration Request](#) when an extenuating circumstance has occurred that has significantly impacted your ability to fulfill an academic requirement. You may always visit the [Senate website](#) and select the blue radio button on the top right hand side entitled: **Academic Consideration Request (ACR)** to submit this request.

For Extenuating Circumstances, Policy 167: Academic Consideration allows for a once per semester ACR request without supporting documentation if the absence is less than 3 days in duration and is not for a final exam/final assessment. Absences more than 3 days in duration and those that involve a final exam/final assessment, require documentation. Students must notify their instructor once a request for academic consideration is submitted. See Senate [Policy 167: Academic Consideration](#).

- If a student is requesting accommodation due to a religious, Aboriginal and/or spiritual observance, they must submit their request via the online [Academic Consideration Request \(ACR\) system](#) **within the first two weeks of the class or, for a final examination, within two weeks of the posting of the examination schedule**. If the required absence occurs within the first two weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these requests should be submitted with as much lead time as possible in advance of the required absence.
- If taking a remote course, familiarize yourself with the tools you will need to use for remote learning. The [Remote Learning Guide](#) for students includes guides to completing quizzes or exams in D2L Brightspace, with or without [Respondus LockDown Browser and Monitor, using D2L Brightspace](#), joining online meetings or lectures, and collaborating with the Google Suite.
- Information on Copyright for [Faculty](#) and [students](#).

Accessibility

- Similar to an [accessibility statement](#), use this section to describe your commitment to making this course accessible to students with disabilities. Improving the accessibility of your course helps minimize the need for accommodation.
- Outline any technologies used in this course and any known accessibility features or barriers (if applicable).

- Describe how a student should contact you if they discover an accessibility barrier with any course materials or technologies.

Academic Accommodation Support

Academic Accommodation Support (AAS) is the university's disability services office. AAS works directly with incoming and returning students looking for help with their academic accommodations. AAS works with any student who requires academic accommodation regardless of program or course load.

- Learn more about [Academic Accommodation Support](#).
- Learn [how to register with AAS](#).

Academic Accommodations (for students with disabilities) and Academic Consideration (for students faced with extenuating circumstances that can include short-term health issues) are governed by two different university policies. Learn more about [Academic Accommodations versus Academic Consideration and how to access each](#).

Wellbeing Support

At Toronto Metropolitan University, we recognize that things can come up throughout the term that may interfere with a student's ability to succeed in their coursework. These circumstances are outside of one's control and can have a serious impact on physical and mental well-being. Seeking help can be a challenge, especially in those times of crisis.

If you are experiencing a mental health crisis, please call 911 and go to the nearest hospital emergency room. You can also access these outside resources at anytime:

- **Distress Line:** 24/7 line for if you are in crisis, feeling suicidal or in need of emotional support (phone: 416-408-4357)
- **Good2Talk:** 24/7-hour line for postsecondary students (phone: 1-866-925-5454)
- **Keep.meSAFE:** 24/7 access to confidential support through counsellors via [My SSP app](#) or 1-844-451-9700

If non-crisis support is needed, you can access these campus resources:

- **Centre for Student Development and Counselling:** 416-979-5195 or email csdc@torontomu.ca
- **Consent Comes First - Office of Sexual Violence Support and Education:** 416-919-5000 ext 3596 or email osvse@torontomu.ca
- **Medical Centre:** call (416) 979-5070 to book an appointment

We encourage all Toronto Metropolitan University community members to access available resources to ensure support is reachable. You can find more resources available through the [Toronto Metropolitan University Mental Health and Wellbeing](#) website.