

Course Outline (W2023)

BME809: Biomedical Systems Modelling

Instructor(s)	Dr. Dafna Sussman [Coordinator] Office: Phone: (416) 979-5000 x 553767 Email: dafna.sussman@torontomu.ca Office Hours: Wednesday 12-1pm by appointment only
Calendar Description	Mathematical modeling of biomedical systems. Lumped and distributed models of electrical, mechanical, and chemical processes applied to cells, tissues, and organ systems.
Prerequisites	BLG 601 and BME 229 and BME 639 and BLG 701
Antirequisites	None
Corerequisites	None
Compulsory Text(s):	1. Signals and Systems in Biomedical Engineering: Physiological Systems Modeling and Signal Processing (Third Edition), Suresh R. Devasahayam. Springer Singapore, 2019 (ebook ISBN 978-981-13-3531-0, hardcover book ISBN 978-981-13-3530-3)
Reference Text(s):	1. Modeling and Simulation in Biomedical Engineering, Applications in Cardiorespiratory Physiology, Willem Van Meurs, McGrawHill, 2011 2. Cardiac Electrophysiology Methods and Models, Daniel C. Sigg, Paul A. Laizzo, Yong-Fu Xiao and Bin He (Editors), Springer, 2010
Learning Objectives (Indicators)	At the end of this course, the successful student will be able to: <ul style="list-style-type: none"> 1. Apply numerical and analytical methods to generate computational models of physiological systems and simulate physiological signals (using Simulink and Matlab) to address biomedical problems (e.g. effect of pathologies or drugs on a system). (1b), (4b) 2. Understand the underlying physiological, electrical, mechanical and chemical processes of human cells, tissues and organ systems that result in physiological signal generation and their role in generating biophysical models. (1c), (12b) 3. Apply and evaluate the suitability of various signal processing techniques to different types of physiological measurements (e.g. action potentials, ECG, EMG) for analysing signal characteristics and improving signal quality using Matlab. (2b), (3b), (5a) 4. Learn to identify and evaluate the implications of different approaches to addressing/modelling a biomedical problem and develop decision making criteria to determine the optimal solution under different conditions. (8b) <p>NOTE:Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).</p>

Course Organization	3.0 hours of lecture per week for 13 weeks 2.0 hours of lab per week for 12 weeks 0.0 hours of tutorial per week for 12 weeks																
Teaching Assistants	Karl Magtibay karl.magtibay@torontomu.ca Alejo Costanzo acostanzo@torontomu.ca Section # Day of the Week Time Slot Location TA for Section 1 Thursday 12:00 PM - 2:00 PM ENG413 Karl 2 Wednesday 12:00 PM - 2:00 PM ENG413 Karl 3 Wednesday 4:00 PM - 6:00 PM ENG408 Alejo 4 Tuesday 10:00 AM - 12:00 PM ENG408 Karl 5 Monday 6:00 PM - 8:00 PM ENG413 Alejo																
Course Evaluation	<table border="1"> <thead> <tr> <th colspan="2">Theory</th> </tr> </thead> <tbody> <tr> <td>Midterm Exam</td> <td>25 %</td> </tr> <tr> <td>Quizzes (2*7.5%)</td> <td>15 %</td> </tr> <tr> <td>Final Exam</td> <td>30 %</td> </tr> <tr> <th colspan="2">Laboratory</th> </tr> <tr> <td>Lab (4 x 5%)</td> <td>20 %</td> </tr> <tr> <td>In-Class Assignments and Participation</td> <td>10 %</td> </tr> <tr> <td>TOTAL:</td> <td>100 %</td> </tr> </tbody> </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		Midterm Exam	25 %	Quizzes (2*7.5%)	15 %	Final Exam	30 %	Laboratory		Lab (4 x 5%)	20 %	In-Class Assignments and Participation	10 %	TOTAL:	100 %
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Examinations	<p>Midterm Exam: The midterm exam will be in week 9 of the course (week of March 13th). It will be 1-hour, closed book, and will cover material from weeks 1-6.</p> <p>Quizzes: In week 7 (week of Feb. 27th) and week 11 (week of March 27th) of the course, will be of 30 minute duration at the start of tutorials 2 and 3, respectively. Quizzes are closed book and will cover lecture material from the previous 2-4 weeks.</p> <p>The final exam will be during the exam period, and will be 3 hours, closed book, and will cover all course material.</p>																
Other Evaluation Information	<p>Laboratory manuals will be posted on the course shell on D2L. The lab will run every week beginning week 2. All labs will involve simulating and/or processing physiological signals and systems using Matlab and/or Simulink software.</p> <p>Each lab is worth 5%, and will be marked based on completion of the lab report and answering TA questions during and at the end of the lab session. A lab report must be submitted for each of the four labs, one lab report per group, submitted within 1 week of completing the lab (emailed to the TA before the start of the next lab). Late submissions will be penalized over the first 3 days, after which a grade of zero will be assigned.</p>																

	<p>Lab reports will Not be accepted from students who did not attend a lab session.</p> <p>Lectures will involve in-class assignments that are to be submitted through D2L.</p> <p>** Laboratory attendance and lecture attendance are both mandatory. Attendance will be taken within the first 15min of the lecture / lab start time. Late admission will not count towards one's attendance grade.</p> <p>The TAs are responsible for managing all quizzes and labs; kindly direct any related inquiries to them.</p>
Other Information	Lecture Time: Wednesdays 9AM -12PM, Location: TRS 1067

Course Content

Week	Hours	Chapters / Section	Topic, description
1	3	1.1, 1.2, 3.1, 3.2, 3.5, 5.1, 5.4, 5.5	Lecture topics: Introduction to systems and modeling and physiological signals and noise. Review of signals and systems basics statistical description of a random process, continuous and discrete signals and digitization.
2	3	3.3, 4.1, 4.2, 6.1-4	Lecture topics: Review of frequency decomposition of signals. Fourier series, Fourier Transform (discrete-time discrete fast short-time), wavelet transform, Laplace transform, filtering
3	3	1.3, 15	Lecture topics: Differential equations and numerical methods, Modeling of the cardio-respiratory system
4	3	6, 8	Lecture topics: Time series modeling, system identification, model validation, Modelling nerve action potentials
5	3	8, 9	Lecture topics: Modelling nerve action potentials, Stimulation of excitable tissue
6	3	13	Lecture topics: Neural firing rate analysis sensory receptors frequency modulation/demodulation
7	3	3.4, 4.5, 12.1	Lecture topics: Feedback systems, control systems, system stability

8	2	14	Lecture topics: Model validation, FEM, Immune System
8	1		Review for midterm exam (material from weeks 1-6)
9	3		Midterm exam (in class, closed book)
10	3	15	Lecture topics: Linear model of blood flow
11	3	10	Lecture topics: Modelling skeletal muscle contraction
12	3	11	Lecture topics: Modelling skeletal muscle contraction, Myoelectric activity
13	3	7	Lecture topics: Metabolism, Graphical and numerical tools Real-time data acquisition and signal processing
14	3		Practice and review for final exam

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

Week	L/T/A	Description
2-3	1	Lab 1: Wavelet transformation applied to EEG
4	T1	Tutorial 1: Introduction to Simulink
5,6	3	Lab 2: Windkessel model of blood circulation
7	T2	Tutorial 2: Review of course concepts problem solving

8-9	T1	Lab 3: System Identification
10-11	4	Lab 4: Immune System
12	T3	Tutorial 3: Skeletal Muscles
13	T4	Tutorial 4: Real-time data acquisition and signal processing

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](#)

1. In accordance with the Policy on TMU Student E-mail Accounts (Policy 157), Toronto Metropolitan University (TMU) **requires** that any electronic communication by students to TMU faculty or staff be sent from their official university email account;
2. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented;
3. Assignments, projects, reports and other deadline-bound course assessment components handed in past the due date will receive a mark of ZERO, unless otherwise stated. Marking information will be made available at the time when such course assessment components are announced.
4. Familiarize yourself with the tools you will need to use for remote learning. The [Continuity of Learning Guide](#) for students includes guides to completing quizzes or exams in D2L or Respondus, using D2L Brightspace, joining online meetings or lectures, and collaborating with the Google Suite.
5. The University has issued a minimum technology requirement for remote learning. Details can be found at: <https://torontomu.ca/covid-19/students/minimum-technology-requirements-remote-learning>. Please ensure you meet the minimum technology requirements as specified in the above link.
6. Toronto Metropolitan University COVID-19 Information and Updates (available <https://www.torontomu.ca/covid-19/students>) for Students summarizes the variety of resources available to students during the pandemic.
7. Refer to our **Departmental FAQ** page for information on common questions and issues at the following link: <https://www.ecb.torontomu.ca/guides/Student.Academic.FAQ.html>.

Missed Classes and/or Evaluations

When possible, students are required to inform their instructors of any situation which arises during the semester which may have an adverse effect upon their academic performance, and must request any consideration and accommodation according to the relevant policies as far in advance as possible. Failure to do so may jeopardize any academic appeals.

1. **Academic Consideration Requests for missed work** (e.g. missing tests, labs, etc) - According to [Senate Policy 134](#), Section 1.2.3, if you miss any exams, quizzes, tests, labs, and/or assignments for health or compassionate reasons you need to inform your instructor(s) (via email whenever possible) in advance when you will be missing an exam, test or assignment deadline. When circumstances do not permit this, you must inform the instructor(s) as soon as reasonably possible". *In the case of illness, a [Toronto Metropolitan Student Health Certificate](#), or a letter on letterhead from an appropriate regulated health professional with the student declaration portion of the Student Health Certificate attached. For reasons other than illness, proper documentation is also required (e.g. death certificate, police report, TTC report). ALL supporting documentation for illness or compassionate grounds MUST be submitted within three (3) working days of the missed work.* **NOTE: You are required to submit all of your pertinent documentation through the University's online Academic Consideration Request system at the following link: prod.apps.ccs.torontomu.ca/senateapps.**

2. **Religious, Aboriginal and Spiritual observance** - If a student needs accommodation because of religious, Aboriginal or spiritual observance, they must submit a Request for Accommodation of Student Religious, Aboriginal and Spiritual Observance AND an Academic Consideration Request form within the first 2 weeks of the class or, for a final examination, within 2 weeks of the posting of the examination schedule. If the requested absence occurs within the first 2 weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these forms should be submitted with as much lead time as possible in advance of the absence. Both documents are available at www.torontomu.ca/senate/forms/reobservforminstr.pdf. **If you are a full-time or part-time degree student, then you submit the forms to your own program department or school;**
3. **Academic Accommodation Support** - Before the first graded work is due, students registered with the [Academic Accommodation Support office](http://www.torontomu.ca/academic-accommodation-support) (AAS - prod.apps.ccs.torontomu.ca/senateapps) should provide their instructors with an Academic Accommodation letter that describes their academic accommodation plan.

Virtual Proctoring Information (if used in this course)

Online exam(s) within this course may use a virtual proctoring system. Please note that your completion of any such virtually proctored exam may be recorded via the virtual platform and subsequently reviewed by your instructor. The virtual proctoring system provides recording of flags where possible indications of suspicious behaviour are identified only. Recordings will be held for a limited period of time in order to ensure academic integrity is maintained and then will be deleted.

Access to a computer that can support remote recording is your responsibility as a student. The computer should have the latest operating system, at a minimum Windows (10, 8, 7) or Mac (OS X 10.10 or higher) and web browser Google Chrome or Mozilla Firefox. You will need to ensure that you can complete the exam using a reliable computer with a webcam and microphone available, as well as a typical high-speed internet connection. Please note that you will be required to show your Toronto Metropolitan University OneCard prior to beginning to write the exam. In cases where you do not have a Toronto Metropolitan University OneCard, government issued ID is permitted.

Information will be provided prior to the exam date by your instructor who may provide an opportunity to test your set-up or provide additional information about online proctoring. Since videos of you and your environment will be recorded while writing the exam, please consider preparing the background (room / walls) so that personal details are not visible, or move to a room that you are comfortable showing on camera.

Academic Integrity

Toronto Metropolitan University's [Policy 60 \(the Academic Integrity policy\)](#) applies to all students at the University. Forms of academic misconduct include plagiarism, cheating, supplying false information to the University, and other acts. The most common form of academic misconduct is plagiarism - a serious academic offence, with potentially severe penalties and other consequences. It is expected, therefore, that all examinations and work submitted for evaluation and course credit will be the product of each student's individual effort (or an authorized group of students). Submitting the same work for credit to more than one course, without instructor approval, can also be considered a form of plagiarism.

Suspensions of academic misconduct may be referred to the Academic Integrity Office (AIO). Students who are found to have committed academic misconduct will have a Disciplinary Notation (DN) placed on their academic record (not on their transcript) and will normally be assigned one or more of the following penalties:

1. A grade reduction for the work, ranging up to and including a zero on the work (minimum penalty for graduate work is a zero on the work);
2. A grade reduction in the course greater than a zero on the work. (Note that this penalty can only be applied to course components worth 10% or less, and any additional penalty cannot exceed 10% of the final course grade. Students must be given prior notice that such a penalty will be assigned (e.g. in the course outline or on the assignment handout);
3. An F in the course;
4. More serious penalties up to and including expulsion from the University.

The unauthorized use of intellectual property of others, including your professor, for distribution, sale, or profit is expressly prohibited, in accordance with Policy 60 (Sections 2.8 and 2.10). Intellectual property includes, but is not limited to:

1. Slides
2. Lecture notes

3. Presentation materials used in and outside of class
4. Lab manuals
5. Course packs
6. Exams

For more detailed information on these issues, please refer to the [Academic Integrity policy](https://www.torontomu.ca/senate/policies/pol60.pdf) (<https://www.torontomu.ca/senate/policies/pol60.pdf>) and to the Academic Integrity Office website (<https://www.torontomu.ca/academicintegrity>).

Academic Accommodation Support

Toronto Metropolitan University acknowledges that students have diverse learning styles and a variety of academic needs. If you have a diagnosed disability that impacts your academic experience, connect with Academic Accommodation Support (AAS). Visit the [AAS website](#) or contact aasadmin@torontomu.ca for more information.

Note: All communication with AAS is voluntary and confidential, and will not appear on your transcript.

Important Resources Available at Toronto Metropolitan University

1. [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 at <https://library.torontomu.ca/ask> to speak with a librarian.
2. [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](#).
3. 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 radial button on the top right hand side entitled: Academic Consideration Request (ACR) to submit this request).

Please note that the Provost/Vice President Academic and Deans approved a COVID-19 statement for Fall 2022 related to academic consideration. This statement will be built into the Online Academic Consideration System and will also be on the [Senate website \(www.torontomu.ca/senate\)](http://www.torontomu.ca/senate) in time for the Fall term:

Policy 167: Academic Consideration for Fall 2022 due to COVID-19: Students who miss an assessment due to cold or flu-like symptoms, or due to self-isolation, are required to provide a health certificate. All absences must follow Senate [Policy 167: Academic Consideration](#).

Also NOTE: Policy 167: Academic Consideration does allow for a once per term academic consideration request without supporting documentation if the absence is less than 3 days in duration and is **not for a final exam/final assessment**. If the absence is more than 3 days in duration and/or is for a final exam/final assessment, documentation is required. For more information please see Senate [Policy 167: Academic Consideration](#).

4. [TMU COVID-19 Information and Updates for Students](#) summarizes the variety of resources available to students during the pandemic.
5. [TMU COVID-19 Vaccination Policy](#).
6. 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.
7. Information on Copyright for [students](#).
8. At Toronto Metropolitan University (TMU), 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: 553596 or email osvse@torontomu.ca

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](#).