

IBEHS 4QZ3

Modelling of Biological Systems

Term (2022-23)

Course Outline

Calendar/Course Description

Introduction to experimental design and variance associated with biological systems and analysis of biological data, mathematical and engineering methods for describing and predicting the behaviour of biological systems; statistical models of biological functions as well as machine learning techniques

Pre-Requisites and Anti-Requisites

Prerequisite(s): Registration in the Integrated Biomedical Engineering and Health Sciences (IBEHS) program
Antirequisite(s): Elec Eng 4BC3

Course Schedule

Online Lectures: Monday 7-10pm

- *Location: MS Teams.* Lectures will be approx. 1 hour in length, rest of time will be for questions/office hours
- *Lectures will be recorded and available for viewing afterwards.*
- *Objective:* Review topics from pre-recorded lectures and go over examples

Online Pre-recorded Lectures:

- *Location: MS Teams/Avenue*
- *Objective:* Introduce topics, allow students to watch at own speed

Tutorials: Tuesdays 11:30-12:20

- *Location: In person PGCLL 124*
- *Objective:* Review lecture topics, go over examples

Instructor Office Hours and Contact Information

Taylor deVet, MASC

McGill University/Shriners Hospital for Children Montreal
devett@mcmaster.ca

Office Hours:

- Monday 7-10 or by appointment

Instructional Team

TAs:

- Noor Abu Jarad, abujaran@mcmaster.ca

- Mason Kadem, kademm@mcmaster.ca
- Cole Dennis, dennic3@mcmaster.ca

Additional Instructional Support

Instructional Coordinator: coordinates scheduling and accommodations

Dayna Wingfield

Office: MDCL-3510

Email: wingfied@mcmaster.ca

Course Delivery

[Avenue-to-Learn](#) will be the online management system for the course. Through **Avenue**, you will be able to:

- Find all course materials (lecture slides, lab materials, project documents, etc.)
- View course-related announcements
- Complete online quizzes
- Submit course work (assignment, project deliverables) for grading
- View your gradebook

Materials and Fees

Textbooks

There is *no required textbook* for the course. All required reading materials will be made available for free as online documents through the course management system (**Avenue-to-Learn**).

The following texts may be helpful:

Modeling and Simulation in Medicine and the Life Sciences 2nd Edition – Frank Hoppensteadt, Charles S. Peskin

Dynamic Systems, Biology Modeling and Simulation – Joseph DiStefano III

Biosignal and Medical Image Processing 3rd Edition - John L. Semmlow, Benjamin Griffel

Physiological Control Systems – Michael C.K. Khoo

Lecture Information: All lecture notes will be posted on the course web page the day before lecture.

NOTE: This course (this year) is will run on a hybrid online format. Lectures will be presented synchronously, with subsequent lecture videos posted on the class Avenue page. Tutorials will be held in person, taught by Teaching Assistants.

Both Taylor and the TAs will often use a 'virtual white board' in lectures / tutorials. Students will also be responsible for understanding any such materials detailed on the board.

Software

The use of software will be required to complete the assignments for this course, the language chosen is up to the students.

Course Objectives and Learning Outcomes (LO)

The purpose of this course is to understand mathematical approaches to modelling biological systems and the challenges associated with it. Linear time invariance (LTI) will be discussed as it applies to biological modelling. The shortcomings of LTI will be described and a thorough analysis using other approaches including short-time Fourier transform (STFT) wavelets, PCA/ICA and nonlinear dynamics (fractal and chaotic models). Real life examples will be presented using real data acquired from various imaging and physiological recording systems, and students will be able to identify which modelling systems work best for data types.

Upon successful completion of the course, the student should be able to:

LO.01	To be able to design a mathematical model for a biomedical or biological problem. To understand how to test the model using computational approaches, mock systems and real life scenarios
LO.02	To be able to decide upon best mathematical models to investigate a real biological or biomedical problem. Be able to identify ways to simplify model by way of logical choices of assumptions. To know when to use model or data driven approaches.
LO.03	To be able to classify and characterize sources of error in biological models. Understand error propagation and sources of error in bio systems.
LO.04	Students will be required to complete a major data modeling and analysis project. These will be done in groups of up to 3 students.
LO.05	To understand complex systems (chaos theory, temporal and spatial fractals) and how they relate to biological modeling. To understand how complex systems relate to biomedical and environmental problems. Viral/bacterial spreading sustainability of herds/food sources-epidemiology.

Assessments

The course is assessed as follows.

GRADING MODULE	WEIGHT
Lecture Quizzes	4%
11, drop lowest one	(0.4%)
Assignments	21%
Assignment 1	(7%)
Assignment 2	(7%)
Assignment 3	(7%)
Analysis Project	25%
Major Assessments	50%
Midterm	(20%)
Final Exam	(30%)

Completion and Submission of Work

Assignments will be done in groups of up to 3 and will cover lecture and tutorial content. Assignments will require programming in Matlab or Python.

The exams will cover everything up to the end of the lecture 1 week prior. The final exam will cover all course materials after the midterm. Both the final and midterm exams will be open book.

Weekly quizzes will cover the previous weeks lecture content to ensure students are keeping up with and understanding content. The lowest marked quiz will be dropped, making each quiz worth 0.4%.

Students will be required to complete a major data modeling and analysis project. These will be done in *groups of up to 3 students*. Data will be anything physiological/biological in nature. There are numerous sites on the internet that are repositories of biological/medical data. It is suggested data from one of these sites be downloaded and used. The report will include an introduction about the data and why it might be important. Analysis will include modeling of some form of response and how this was determined as appropriate, proper statistical analysis from multiple subjects and error analysis where appropriate. The report should end with interpretations, conclusions, and possible future directions. The report should be 2000-3000 words and include figures, program code, etc. It should look like a journal paper.

Submission Penalties

Assignments are due digitally (i.e. upload to Avenue) at 11:59pm on the due date. Late assignments will be deducted 0.01389% per minute. No make-up assignments will be granted. The entire weight of missed material will be transferred to the final exam.

Important Dates

Fall Term	
Tuesday September 6	Fall Classes Begin!
Friday September 30th	Assignment 1 Due
Friday September 30	National Day for Truth and Reconciliation (no classes)
October 10 – 14	Fall Reading Week (no classes)
October 17th	Midterm examination (in class, location TBD)
November 4th	Assignment 2 Due
December 2nd	Assignment 3 Due
December 8th	Analysis Project Due
December 9 – 22	Fall Term Examinations (the date of the is TBD)

Communication Policy

Need help and have questions related to the course? We want to make sure your questions get answered. To ensure this, it's important that the correct communication method is used.

Got a question *during* scheduled class hours (e.g., lecture, tutorial)? The best way to get a prompt response is to message the person directly on **MS Teams** using the "@" tool.

Got a question *outside* scheduled class hours? In this case, email is the best method. Please direct tutorial questions to the tutorial TA. Assignment questions should be directed to the marking TA. Questions pertaining to content or grades should be directed to Taylor. This ensures your email gets directed to the most appropriate individual for the fastest response. Every attempt will be made to reply within 24 hours (excluding weekends). Please include a subject prefix of "IBEHS 4QZ3". Emails must be sent from your @mcmaster.ca account. Be sure to include your student number in your email.

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 of this preference early in the semester so that we may make appropriate changes to our records.

Accreditation

The Graduate Attributes 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. For more information on Accreditation, please visit: <https://www.engineerscanada.ca>. Mapping of the course **Learning Outcomes (LO)** to the Canadian Engineering Accreditation Board (CEAB) **Graduate Attributes (GA)** are outlined in the table below:

GRADUATE ATTRIBUTE	LEARNING OUTCOME(S)
GA01 - Knowledge Base for Engineering	LO.01 LO.02 LO.03 LO.04
1.1 – Competence in mathematics	LO.05
GA02 Problem Analysis	LO.01 LO.02 LO.03 LO.04
2.1 – Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem.	LO.05
GA03 Investigation	
3.1 – Selects appropriately from relevant knowledge base to plan appropriate data collection methods and analysis strategies	
3.2 – Synthesizes the results of an investigation to reach valid conclusions.	
GA05 Tools	LO.01 LO.02 LO.03 LO.04
5.1 – Evaluates engineering tools, identifies their limitations, and selects, adapts, or extends them appropriately. .	
GA07 Communication	LO.04
7.2 – Composes an effective written document for the intended audience.	

Commented [BBA1]: Please complete this table for your course by adding in the relevant GA's and respective LO's.

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.

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., submission of work not one's own or which other credit been obtained.
- Improper collaboration in group work.
- Copying or using unauthorized aids in tests and examinations.

Authenticity / Plagiarism Detection

In this course we will be using a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. Students will be expected to submit their work electronically either directly to Turnitin.com or via Avenue to Learn (A2L) plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish to submit their work through A2L and/or Turnitin.com must still submit an electronic and/or hardcopy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com or A2L. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). To see the Turnitin.com Policy, please go to the following website: www.mcmaster.ca/academicintegrity.

Academic Accommodations for 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 Observations (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 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 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](#)".

- All MSAFs are to be directed to prof1p10@mcmaster.ca. Sending to another email address will delay processing.
- It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in his/her course.
 - In the event an MSAF is applied to either the **Graphics Design Final Assessment** or **Computing Final Assessment**, they **will be rescheduled**.

Courses with an On-Line Element

In this course, we will be using **Avenue-to-Learn** and **Microsoft Teams**. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, usernames 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 this course 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.

Integrated Biomedical Engineering & Health Sciences (IBEHS) Labs/Design Studio Safety

Information for Laboratory Safety and Important Contacts

This document is for users of IBEHS instructional laboratories at the following locations:

- ABB C104 (Design Studio)
- ETB 533 (Medical Imaging/Biomaterials Lab)
- ETB 534 (Medical Instrumentation/Robotics Lab)
- HSC 4N72 (Genetic Engineering Lab)

This document provides essential information for the healthy and safe operation of IBEHS instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in IBEHS. It is expected that revisions and updates to this document will be done continually. A McMaster University [lab manual](#) is also available to read in every laboratory.

Details on Standard Operating Procedures (SOPs), Health and Safety videos and other resources can be found online at the [iBioMed Health and Safety webpage](#).

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following:

- Food and beverages are not permitted in the instructional laboratories.
- A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
- Laboratory equipment should only be used for its designed purpose.
- Proper and safe use of lab equipment should be known before using it.
- The lab tech or course TA leading the lab should be informed of any unsafe conditions.
- The location and correct use of all available safety equipment should be known.
- Potential hazards and appropriate safety precautions should be determined, and the sufficiency of existing safety equipment should be confirmed before beginning new operations.
- Proper waste disposal procedures should be followed.
- [Personal ergonomics](#) should be practiced when conducting lab work.
- [Current University health and safety](#) issues and protocols should be known.

Location of Safety Equipment

Fire Extinguisher: on walls in halls outside of labs or within labs

First Aid Kit: ABB C104, ETB 533, ETB 534, HSC 4N72 or dial "88" after 4:30 p.m.

Telephone: on the wall of every lab near the door

Fire Alarm Pulls: Near all building exit doors on all floors

Who to Contact?

Emergency Medical / Security:

On McMaster University campus, call Security at extension 88 or 905-522-4135 from a cell phone.

Hospital Emergency Medical / Security:

For McMaster HSC, call Security at extension 5555 or 905-521-2100 from a cell phone.

Non-Emergency Accident or Incident: Immediately inform the Lab Tech, TA on duty or Course Instructor.

University Security (Enquiries / Non-Emergency):

Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.

See Lab Tech, TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs.

Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.

IBEHS Specific Instructional Laboratory Concerns: For non-emergency questions specific to the IBEHS laboratories, please contact appropriate personnel below from a McMaster phone:

- Leela Pilli, Laboratory Technician – 26888
- Parmveer Bola, Instructional Assistant – 23521
- Andrej Rusin, Wet Laboratory Technician – 28347
- Alexa Behar-Bannelier, Program Manager – 24548

In Case of a Fire (Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people.

1. Douse with water from safety shower immediately or
2. Roll on the floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if a blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents. Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In Power Lab, press the wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol for Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you are not sure, ask!

Defined Roles

IBEHS Lab Technician	Leela Pilli, pillil@mcmaster.ca
IBEHS Instructional Assistant	Parmveer Bola, bolap1@mcmaster.ca
IBEHS Wet Lab Technician	Andrej Rusin, rusina@mcmaster.ca
IBEHS Co-Directors	Dr. Colin McDonald, cmcdona@mcmaster.ca Dr. Michelle MacDonald, macdonml@mcmaster.ca
IBEHS Program Manager	Alexa Behar-Bannelier, alexa.behar@mcmaster.ca
IBEHS Course Instructor	Please contact your specific course instructor directly