

Course Outline




Instructors:	Dr. Ross Wagner (primary) and several invited guest lecturers  Ross.Wagner@McGill.ca  (514) 398-6740  Duff 315C Office Hours (see below)
Class Location:	Duff 321 Some components may be offered remotely.
Class Time:	TR 13h05-14h25
Objective:	To examine the principles and practice of making biological measurements, including theory of linear systems, data sampling, computer interfaces and electronic circuit design. Topics covered: <ul style="list-style-type: none">i) Electronicsii) The body/instrument interface (e.g. transducers, electrodes, ...)iii) Signal conditioningiv) Computer interfacingv) Electrical safety issuesvi) Noise management See the course timetable at the end for a more detailed list of topics.
Instructional Method:	Lectures and laboratory sessions in place of lectures
Evaluation:	The course will be graded based on: <ul style="list-style-type: none">i) Ten best "Assignments" out of twelve (60%)ii) Final Exam – Open book, online (40%)iii) A bonus will be awarded for completing the End-of-Course Evaluations in a timely manner: final course grades will be increased by one point if a minimum of 80% of the class completes the evaluation by midnight Dec. 12, 2023.iv) A bonus will be awarded for attending the guest-lecture presentations: your final course grades will be increased by a maximum of one point, prorated based on the number of lectures you attend.

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What the Course is Not About

Biomedical instrumentation is a vast field, and the course title lends to differing interpretations. This course is not an exposition of various instruments used in healthcare.

Learning Outcomes

By the end of this course students will be able to solve electronic circuits, have an appreciation of some of the issues involved in making electrical measurements on living organisms and generally understand the signal processing chain of a typical data acquisition system. Electronics plays a central role in the course.

Pre-Requisites

A basic understanding of linear algebra, calculus, differential equations (primarily Laplace Transform techniques) and basic complex numbers is required. Also, beginner-level experience writing computer programs is an asset.

Attendance

Attendance is not mandatory for lectures given by the primary instructor. Students are required to attend guest-lecturer presentations.

Course Delivery

Manner of Delivery

The course is primarily given in person. Some lectures may be offered remotely using the Zoom web conferencing tool integrated in [myCourses](#).

Session Recordings

Zoom lectures will not be recorded, nor should they be recorded without unanimous consent from attending students and the lecturer.

Learning resources

The [Learning resources](#) page contains links to resources to help you stay on track and support your learning.

Instructional Method

The course builds upon itself. As such,

- Subject matter covered in previous lectures is often referred to in subsequent ones
- Assignment questions may (i) draw upon the material presented in several lectures and (ii) build upon previous assignment questions
- Keep up with the lectures
- Review assignment solutions when released – regardless of your assignment grade. Solutions may show a more efficient means of solving a problem.
- Discuss issues with the instructor as soon as possible (**this point cannot be overemphasized**)

Students will need access to a personal computer with enough space to install the [application](#) used during the course.

Assignments

Types

Assignments consist of either:

- i) A traditional assignment consisting of a combination of analytical and [computer-based](#) problems
- ii) A [full lab experiment](#) conducted in the department's electronics workshop followed by an informal write up. (A full lab session replaces a lecture.)

Schedule

Twelve assignments will be released, typically one per week, via [myCourses](#).

Length

A "traditional assignment" should take six hours to complete. Please manage your time. If you get stuck on a question discuss it with the course instructor.

Submissions

An assignment is to be submitted in [myCourses](#) as a single legible PDF document by the due date indicated on the assignment. (See [Grading](#) below for grace period policy.)

The following [FAQ for students using myCourses: Assignments](#) may be of value.

Grading

1. Assignments will be graded and returned to the student typically one week after being handed in.
2. Late submissions will be subject to a penalty of 10% of the assignment worth which will grow cumulatively each 24-hour period post deadline.
3. Grace period: you are automatically granted a 24-hour extension on every assignment.

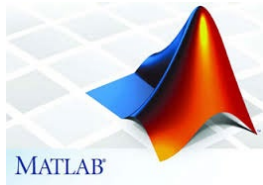
Example: An assignment due on Tuesday at 4:00 PM may be handed in on Wednesday at 4:00 PM without penalty. Should you miss the 4:00 PM grace deadline the assignment will be considered 24-hours late.
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4. Assignments will be graded primarily on their content but must be presented in a clear, concise, and neat manner.
 - A penalty of 10% of the total assignment worth will be incurred for inadequate presentation.
 - It is **NOT** necessary to type your solutions, nor is it necessary to draw diagrams using a computer program – provided that your handwriting is legible, and sketches are neat.
5. Students are encouraged to collaborate on assignments but must hand in solutions independently. Any obvious copying between people will be considered plagiarism and implicated parties will receive a grade of 0 on the relevant question. Moreover, the University will be notified of this act and a note will be entered into the student's record. (See [Academic Integrity](#) below.)

Software Restrictions

Use of symbolic math tools is prohibited unless otherwise indicated.

Computer-Based Problems

Computer-based problems will be done with Mathworks' MATLAB application (free for students).



MATLAB is a numeric computation and visualization software package used in many fields. Only a modest level of proficiency in MATLAB will be required, as this is not a course in computer science or programming. Example programs will be provided to help you get started.

Please refer to [IT Services](#) article KB0011460, [Create a Mathworks account and install MATLAB](#), for information on how to obtain MATLAB for your personal computer. You will need to install the following toolboxes:

- Signal Processing
- Control System

To confirm that the proper toolboxes are installed, type “ver” as the MATLAB command prompt and confirm that the above two toolboxes are listed.

Alternatively, MathWorks offers [an online version of MATLAB](#) that uses their MATLAB Drive cloud storage. Refer to the above-mentioned KB article on how to create a MathWorks account.

Lab Work

For lecture timeslots designated as laboratory sessions the class* will adjourn in the electronics workshop (room 315D, via room 316.) Typically, labs cannot be completed during the lecture timeslot. As such, the remainder of the lab time and lab questions will constitute the week's assignment. Moreover, lab write ups will be informal.

- There are four experimental stations available for use.
- (*) Due to limited resources work required to be done in the electronics lab will be done in groups of two, unless circumstances dictate otherwise. Each individual is to submit their own lab write up.
- (*) Should there be more than 8 students registered in the course the class will be divided into sections. One section will work on their lab during normal class time. The other section(s) will have to find common time(s) so that we may meet in the workshop and make-up the session.
- When you will require time at a workstation outside of the class timeslot you will be able to reserve time in *myCourses*.

The electronics lab is open 24/7. After the first lab session your McGill ID card will be programmed into the card reader system so that, during the semester, you will have access the department anytime.

myCourses (Learning Technology)

myCourses is a web-based instructional management system used at McGill and will be used as a resource in this course to provide:

- Lecture notes
- Reference material
- Assignment releases
- Assignment hints, corrections, and clarifications

- Public announcements of course events
- Public discussion forum (option to post anonymously)
- Private summary of marks and comments

You may access *myCourses* via the following link: <https://www.mcgill.ca/mycourses/>.

[IT Services](#) article KB0011163 [FAQs for students using myCourses](#) may also be useful.

Required Course Materials

Course materials will be distributed by any of the following means:

- Primarily through *myCourses* (material intended to be downloaded prior to class will appear in *myCourses* no later than 5:00 PM the eve of the lecture day)
- During lectures by way of illustrations

Final Exam (Final Assessment)

Modality

The final exam will be an online, 3-hour, open-book examination.

Scheduling

The scheduling of the final exam is conducted by the Faculty of Engineering. Any conflicts should be reported to the scheduling office as instructors have no influence on the date chosen.

End-of-Course Evaluation (Mercury Evaluations)

[Mercury \(end-of-course\) evaluations](#) are one of the ways that McGill works towards maintaining and improving the quality of courses and the student's learning experience. Instructors have no idea how well a course is received by students. The evaluations are usually an instructor's only feedback and are crucial for improving a course. You will be notified by e-mail when the evaluations are available. Please fill out the course evaluation. Written comments indicating what worked well in the course and what can be improved are much more helpful than just numerical evaluations. A bonus will be awarded if enough students complete the evaluation by a specified deadline. (See the [evaluation overview](#) for more detail.)

Please note that a minimum number of responses must be received for results to be available to students.

Office Hours

I am usually free after class. For other times please make an appointment.

McGill Policy Statements

As the primary instructor of this course, I endeavor to provide an inclusive learning environment. However, if you experience barriers to learning in this course, do not hesitate to discuss them with me and the [Office for Students with Disabilities](#), 514-398-6009.

Copyright

© Instructor-generated course materials (e.g., handouts, notes, summaries, assessment questions) are protected by law and may not be copied or distributed in any form or in any medium without explicit permission of the instructor. Note that infringements of copyright can be subject to follow up by the University under the [Code of Student Conduct and Disciplinary Procedures](#).

Academic Integrity

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the [Code of Student Conduct and Disciplinary Procedures](#).

See [McGill's guide to academic honesty](#) for more information.

Language Submission

In accord with McGill University's [Charter of Students' Rights](#), students in this course have the right to submit in English or in French any written work that is to be graded.

Student Assessment

The [University Student Assessment Policy](#) exists to ensure fair and equitable academic assessment for all students and to protect students from excessive workloads.

Basic Needs

If you have difficulty affording food or if you lack a safe and stable place to live, and believe that these circumstances may affect your performance in this course, I encourage you to contact the [Dean of Students](#), who can connect you with support services. If you feel comfortable doing so, please let me know as well so we can discuss how I can best support your learning.

Wellness

Many students may face mental health challenges that can impact not only their academic success but also their ability to thrive in our campus community. Please reach out for support when you need it; [wellness resources](#) are available on campus, off campus, and online.

Extraordinary Circumstances

In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.

Preparations for Next Lecture

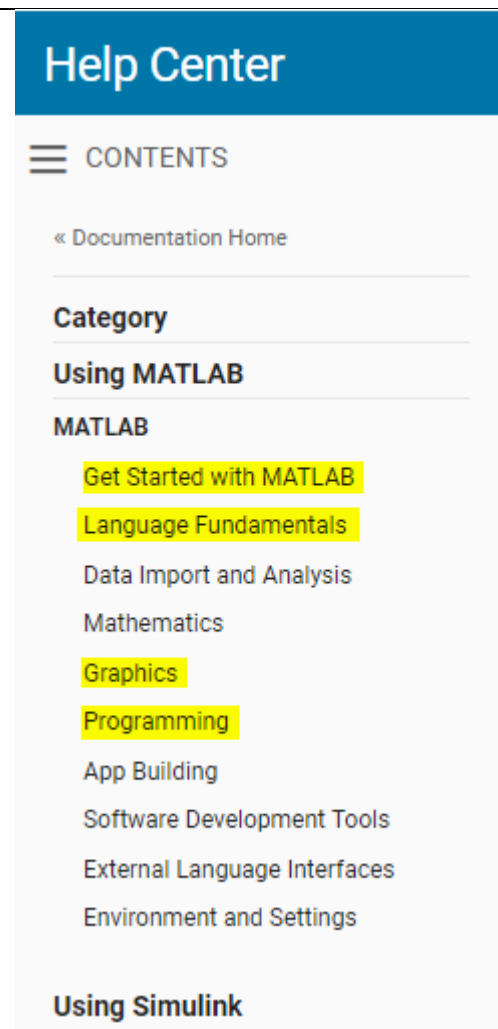
- Acquaint yourself with [myCourses](#)
- Download the class notes for lecture No. 2 and have them ready

Preparations for First Assignment

- Get access to MATLAB
- Confirm that the necessary [toolboxes](#) are installed
- Read the introduction to MATLAB available from The Mathworks web site at:
<https://www.mathworks.com/help/matlab/index.html>

In the left CONTENTS menu options, under the MATLAB section, consider working through the following topics:

- Get Started with MATLAB
- Language Fundamentals
 - Matrices and Arrays (*focus on arrays*)
- Graphics (focus on 2-D line plotting)
- Programming (focus on scripts and functions)



The screenshot shows the MATLAB Help Center interface. At the top is a blue header with the text "Help Center". Below this is a white area with a hamburger menu icon and the word "CONTENTS". Underneath, there is a link "« Documentation Home". A horizontal line separates this from the "Category" section. The "Using MATLAB" section is highlighted in bold. Below it, the "MATLAB" section is listed with several sub-items: "Get Started with MATLAB", "Language Fundamentals", "Data Import and Analysis", "Mathematics", "Graphics", "Programming", "App Building", "Software Development Tools", "External Language Interfaces", and "Environment and Settings". The "Using Simulink" section is also visible at the bottom of the list.

Course Timetable

<i>Date</i>	<i>Lecture No.</i>	<i>Topic(s)</i>	<i>Lecturer</i>
Aug 31	1	Orientation Session (+ Medical Instrumentation System)	Dr. Wagner
Sep 05	2	Frequency-Domain Representations and Linear Time-Invariant Systems	Dr. Wagner
Sep 07	3	Electronic Circuits (Kirchoff's laws, Superposition theorem, 1 st -order ODE, Laplace methods and Thevenin/Norton theorems, modulation, etc.)	Dr. Wagner
Sep 12	4	Electronic Circuits (continued)	Dr. Wagner
Sep 14	5	Electronic Circuits (conclusion)	Dr. Wagner
Sep 19	6	Transfer functions, higher-order ordinary differential equations, and frequency responses	Dr. Wagner
Sep 21	7	Bode Plots	Dr. Wagner
Sep 26	8	<i>Electronics lab 1 (Introduction to equipment)</i>	Dr. Wagner
Sep 28	9	Operational Amplifiers	Dr. Wagner
Oct 03	10	Operational Amplifiers (conclusion)	Dr. Wagner
Oct 05	11	Basic Sensors and Principles	Dr. Wagner
Oct 12	12	<i>Electronics lab 2 (Op Amps)</i>	Dr. Wagner
Oct 17	13	Sensor Interfacing	Dr. Wagner
Oct 19	14	(Analog Filtering) / Tutorial	Dr. Wagner
Oct 24	15	Signal Digitization	Dr. Wagner
Oct 26	16	Electrical Safety and Isolation	Dr. Wagner
Oct 31	17(*)	Electrodes and Electromyography (EMG)	Prof. Kearney
Nov 02	18	Electroencephalography (EEG)	Dr. Gotman
Nov 07	19	Electrocardiography (ECG)	Dr. Guevara
Nov 09	20	Measuring Eye Movements and Biopotential Amplifiers	Dr. Wagner
Nov 14	21	Digital Electronics	Dr. Wagner
Nov 16	22	Data Conversion (A/D, D/A and acquisition)	Dr. Wagner
Nov 21	23	Noise Management	Dr. Wagner
Nov 23	24	<i>Electronics lab 3 (Sampling and measuring the ECG)</i>	Dr. Wagner
Nov 28	25	<i>Electronics lab 3 (Measuring the ECG, continued)</i>	Dr. Wagner
Dec 05	26	<i>Electronics lab 3 (Measuring the ECG, conclusion)</i>	Dr. Wagner

Fall Reading Break: Oct 06 – 11, inclusive.

*: Lecture delivered remotely

Last day of lectures Dec 05 – **No assignment submissions allowed beyond this date**