COURSE OVERVIEW 2023

BMDE: 519 ANALYSIS OF BIOMEDICAL SIGNALS AND SYSTEMS

TA and Instructor

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- Office hours
  - By arrangement

Outline

1) Basic Tools & Concepts

Signals & systems; deterministic and random variables; realizations; stationary & nonstationary processes; ergodicity; properties of random signals; estimators; amplitude statistics; correlation & covariance; linear function of random variables

2)Amplitude Structure Of Signals

Probability distributions, probability densities, joint probability distributions; statistical independence; Gaussian distribution and its properties; other distributions; amplitude histograms; identification of distributions

3) Frequency Content Of Signals

Periodic signals; Fourier series; discrete Fourier spectra; the Fourier transform; power spectra

4) Filtering

Types of noise; low-pass, band-pass, high-pass and band-reject filters; Bode plots; cut-off frequency and roll-off; analog filters; digital filters: frequency domain implementations, FIR filters, recursive filters

5) Sampling Considerations

Digitization, sampling, and quantization; Shannon-Nyquist sampling theorem; aliasing; Nyquist frequency; quantization; quantization theorem; analog-digital converters; digital-analog converters

6) Correlation Functions

Auto-correlation, auto-covariance, and auto-correlation coefficient functions; cross-correlation, cross-covariance, and cross-correlation coefficient functions; estimation of correlation functions; relation between correlation functions and spectral densities; practical applications

7) Introduction to Systems Analysis

Static and dynamic systems; time-varying and time invariant systems; mathematical modeling; linear systems, superposition and proportionality; importance of linearity; testing for linearity; linear range; Laplace transforms; transfer functions

8) The Method of Least Squares

Linear statistical models; the least squares problem; matrix formulation of least squares; properties of least squares estimates; comparing models; total least squares; non-linear minimization

9) Impulse Response Functions

Impulse response functions (IRF); convolution; parametric vs. nonparametric IRF; IRF determination

10) Frequency Response Analysis

Frequency response; sinusoidal frequency response determination; stochastic frequency response determination; practical applications

Teaching Methods – Zoom

- All lectures and tutorials will be delivered remotely using Zoom.
- You will find information about the Zoom meetings under the “Zoom” tab of MyCourses. This includes a link to the meeting.
- Access to the zoom meetings may require a pass code which you can obtain by examining the meeting details on MyCourses.

Teaching Methods – Zoom

- All lectures will be recorded and available asynchronously through myCourses.
- Students are encouraged to attend the lectures when they are live and to participate in the Q/A sessions which are an important part of the learning in this course.

Teaching Methods – Zoom

- When using Zoom please:
  - Keep you microphone muted except when asking questions. This will avoid unwanted noise and interruptions.
  - Keep your camera turned on whenever possible to encourage interactions.

- Resources:
  - https://www.mcgill.ca/tls/students/remote-learning-resources/learning-zoom

Teaching Methods – Modules

- Modules
  - Each module will cover a particular topic and will include
    - Important background material
    - References for further reading
    - Illustrative examples
    - Assignment
  - One module/week for 10 weeks

Assignments

- Assignments
  - Develop the points made in the background material,
  - Demonstrate how to apply methos
  - Illustrate a method's strengths and weaknesses
  - Test understanding of material.
- Assignments are due two weeks after release.

Communication – MyCourses

- Classes are tutorial in nature
  - The best time to ask questions is during class
  - The only *stupid* question is the one you do not ask
- myCourses discussion group
  - Preferred method for out-of-class communication
    - If you have questions regarding course material, it is most likely that others will too.
    - Using the discussion group will allow others to learn from your question.
  - E-mail
    - Use for personal issues only.

Assignment Evaluation

- Must be submitted via myCourses as single PDF files
- Assignments will be marked promptly by the TA
- Marks and comments on each assignment will be made available electronically on myCourses.
- Late submissions
  - will be penalized by 10% /day to a maximum of 50%.
  - assignments more than two weeks late will not be accepted

Assignment Evaluation

- Primarily based on content
- Reports must:
  - Describe what methods were used and why they were chosen
  - Describe the results obtained and interpretation
  - Must be presented neatly and concisely
  - Marks will be deducted for inadequate presentation
  - Respect page limits
- Figures must be legible and include:
  - Legends/Caption
  - Axis labels
  - Number
- The assignment text should refer to all figures, describe what each figure shows, and indicate how the figure relates to the assignment
- Guidelines for the presentation of the assignments are available in myCourses. These must be followed. Failure to do so will BE PENALIZED HEAVILY.

Assignment Grade

- Students who believe that an assignment has been graded incorrectly should e-mail the TA, with a copy to the instructor, and ask to have the assignment re-evaluated.
- Such requests must be submitted no latter than 2 weeks after the assignment was returned. Late requests will not be considered.
- Be aware that following a re-grade the assigned mark may go up, stay the same, or go down.

Workshops

- Workshops will be conducted by the course TA
  - Participation is voluntary.
  - Dates will be determined depending on the availability of those who plan to attend
  - Workshops may be held in person or by zoom depending on the conditions and student's wishes.
- Workshop #1: MATLAB/Assignment -
  - Introduce some Matlab tools that will be useful during the course. This is not an introduction to Matlab and some basic Matlab knowledge is required. Participants are encouraged to bring their own computers.
  - Discussion of what is expected in the assignments and reports.
- Workshop #2: Review and Preparation for Midterm Exam
  - Review modules 1 through 5
  - Preparation for Mid Term Exam
- Workshop #3: Review and Preparation for Final Exam
  - Review Modules 1-10
  - Preparation for final exam.
- Additional workshops
  - May be organized as and if necessary.

Mid Term Exam

- “Take-home” project requiring the independent analysis of a test data set
- Will cover material from modules 1-5.
- Will be graded by the course instructor.

Final Exam

- “Take-Home” project requiring the independent analysis of a test data set
- Will cover material from all ten modules.
- Will be graded by the course instructor.

Grades

- The final grade will be determined using the algorithm:

$$TG = .5 * AS + .15 * \max(ME, FE) + .35 * FE$$

where

TG = final grade %

AS = assignment grade %

ME = mid-term exam grade %

FE = final exam grade %

Supplementary Work

- Students with a failing grade
  - May be permitted to repeat the final exam provided they have submitted all assignments
  - If a student achieves a passing grade on the repeat examination, they will be given a pass for the course

MATLAB

- All demonstrations and analysis procedures will be done using MATLAB.
- Students are expected to be familiar with MATLAB and to be able to write simple scripts and functions.
- MathWorks, the producer of MATLAB, provides access to a variety of tutorials which are a convenient and useful way to become familiar with basic principles.

  Self-Paced Online Courses - MATLAB & Simulink (mathworks.com)
- There is also a link to this site on the main page of the course site.

MATLAB

- Exercises and assignments require MATLAB and the signal processing toolbox. If you do not have access to MATLAB at present you may:
  - use Matlab installed on computers in student laboratories or the research computers in your supervisor's laboratory.
  - purchase the student version of MATLAB and install it on your own computer. The student version is available through the McGill Computing Store.
- The preferred version of MATLAB is R2022a. This is the version used to develop and test the assignments.
- Using earlier versions of MATLAB may result in unexpected problems.

Copyright Issues

- Note that all Instructor-generated course materials (e.g., handouts, notes, summaries, exam questions, etc.) 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." (https://www.mcgill.ca/deanofstudents/students/student-rights-responsibilities/code)

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 http://www.mcgill.ca/integrity/ for more information.*

Academic Integrity: Assignments

- Students are encouraged to discuss the assignments in class, with the instructors, and with each other.
- Students are expected to carry out the analysis, interpretation and write-up of the assignments independently.
- Some sharing of material, such as a MATLAB function developed jointly, is acceptable provided that
  - It is a minor component of the assignment
  - All students involved consent to the sharing
  - The contributions of all students involved must be explicitly described

Academic Integrity: Examinations

- The mid-term and final examinations are take-home exams that are done asynchronously.
- Exams must be done completely independently
  - Students should not discuss the exam with other students until the end of the examination period.
  - No ‘sharing’ of code or algorithms is permitted.
- The TAs and Instructor will provide clarifications to the examination questions as necessary. They will not assist students with the examination.

Language of 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.*

- *"Conformément à la Charte des droits de l'étudiant de l'Université McGill, chaque étudiant a le droit de soumettre en français ou en anglais tout travail écrit devant être noté (sauf dans le cas des cours dont l'un des objets est la maîtrise d'une langue)."*

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*