Winter 2022 - SYDE 544
Biomedical Measurement and Signal Processing
Course Objectives, Operation Format, Syllabus, and Schedule

Objectives:

SYDE 544 course introduces students to the biomedical systems and signal analysis area and provides them with an overall understanding of the tools used for analyzing biomedical systems and processing biomedical signals. The course develops an understanding of biomedical measurements through the examination of electromyogram (EMG), electrocardiogram (ECG), and encephalogram (EEG) Signals

The specific objectives of this course are to develop an understanding, formulate, and apply techniques related to the analysis of biomedical systems and signals. By the end of the course, the students should be able to:

1. Describe how and why the body generates electric signals;
2. Understand the electric safety issues when using bio-signal amplifiers;
3. Describe the mathematical models that represent the generation of biomedical signals;
4. Analyze the various types of artefacts that corrupt biomedical signals;
5. Understand the generation process of the electromyography (EMG) signals;
6. Describe and identify key parameters and features of electrocardiogram (ECG) signals;
7. Understand the electrical activity of the brain though electroencephalography (EEG) signals;
8. Apply biomedical signal processing methods and machine learning techniques in biomedical signal analysis.

Lectures, tutorials sessions, assignments, a research project, and homeworks are used to pursue these objectives. Students who master the above topics should be in a good position to pick up other related topics on their own.

Course Instructor:

Dr. Sarbast Rasheed
Email: sarbast.rasheed@uwaterloo.ca
Office hours: Contact the instructor by email to make an **appointment.**

SYDE-BME COVID-19 Mitigation Provision:

We are facing unusual and challenging times. The instructors reserves the right to modify course topics and/or assessments with due notice. In the event of further challenges, the instructor will work with the UW Department of Systems Design Engineering to find reasonable and fair solutions.

Operations Format:

The course consists of the following activities:

- Three hours of lectures per week provided by the course instructor. The lectures present pertinent theoretical concepts, solve examples, and provide exercises. The lecture will be recorded and published in UW LEARN.
- One hour tutorial session per week provided by the instructor. The first tutorial session will be on Monday January 10, 2022 from 11:30 a.m. to 12:20 p.m.

- Three graded assignments to assist students with the understanding of the theoretical concepts and the acquisition of design experience.
- One midterm test and a final exam to test students theoretical and problem solving knowledge.
- A research project about a topic related to biomedical systems and signal processing application area that emphasize how biomedical systems and signal processing have impacted the modern society.
- Writing a one-page summary and a review paper about the research project topic.
- A virtual presentation in the form of a video file to assess students understanding and matching with what has been written in the review paper.

1. Grading Categories and Relative Percentages:

The course mark is categorized as follows:

Three Assignments each worth 10% totalling	30%
Research Project	20%
Midterm Test	20%
Final Exam	30%

2. Assignments, Midterm Test, and Research Project Schedule

Week	First and Last Day of the Week	Assignments, Midterm Test, and Research Project Due
1	Jan 5 – 7	
2	Jan 10 – 14	
3	Jan 17 – 21	
4	Jan 24 – 28	Project Summary - Friday Jan 28, 2022
5	Jan 31 – Feb 4	Assignment #1 – Friday Feb 4, 2022
6	Feb 7 – 11	
7	Feb 14 – 18	
8	Feb 21 – 25	Reading Week
9	Feb 28 – Mar 4	Assignment #2 – Friday Mar 4, 2022
10	Mar 7– 11	Midterm Test – Thursday Mar 11, 2022
11	Mar 14 – 18	
12	Mar 21 – 25	Project Review Paper – Thursday Mar 24, 2022 Project Presentation – Friday Mar 25, 2022
13	Mar 28 - Apr 1	Assignment #3 – Friday Apr 1, 2022
14	Apr 4 – 5	Last day of Classes – Tuesday Apr 5, 2022 Final examinations begin Friday Apr 8, 2022

3. The Research Project, the Review Paper, and the Presentation

The research project, the review paper writing, and the presentation activities will be an individual work for each student. For these activities follow the following steps:

- Choose a topic that is related to biomedical systems and signal analysis and processing application area, for example: biomedical signals detection, acquisition, processing, classification, and applications; brain-computer interfaces; modeling and simulation of biomedical systems and signals; machine learning and deep learning techniques for biomedical engineering applications; electroencephalographic, electrocardiographic and electromyographic signals decomposition; or any topic that you are interested in.
- Once you chose your topic, write a one page **summary** about the topic: a short description about the topic, how it impacted the society, what you plan to research for, and how you will structure your submitted review paper. The deadline for the summary submission is the midnight (**11:59 p.m.**) of **Friday January 28, 2022**. Please submit your summary to a dropbox in UW LEARN created for this purpose and named **SYDE 544 – Research Project Summary**.
- You need to do the research systematically, i.e., using a step-by-step procedures and don't be chaotic when writing your review and findings.
- The instructor will only accept the review paper following totally the IEEE (Institute of Electrical and Electronics Engineers) format for writing conference papers. Students will be provided with an IEEE template for writing the review paper. The template is a guide for students to write the review paper so don't change the structure and all that is needed is to ignore the template text and remove it paragraph by paragraph or anyhow and include and embed your text instead of the available context material.
- In the review paper and the presentation, you need to cite the references carefully.
- Review paper should consist of minimum four pages and maximum six pages. The presentation duration time might be from 10 to 15 minutes.
- Do the research works responsibly, as the instructor might ask for a discussion of the research project and the paper and also he might use electronic means to detect plagiarism.
- Students are required to submit the review paper in an electronic form as a **.pdf file** submitted to a dropbox in UW LEARN created for this purpose and named **SYDE 544 – Research Project Review Paper**. The deadline for submitting the research project review paper is the midnight (**11:59 p.m.**) of **Thursday March 24, 2022.**
- The presentation part of the project will be a virtual presentation in the form of a video file to assess students understanding and matching with what has been written in the review paper. The due date for submitting the video file would be the midnight (**11:59 p.m.**) of **Friday March 25, 2022**. Please submit the presentation video file to the dropbox named **SYDE 544 – Presentation Video File**.
- The **20% mark** assigned for the research project will be distributed as follows: **2% for the summary**, **10% for the review paper**, and **8% for presentation**.

4. Authorized Aid:

Students may use the materials supplied (course notes, lab manuals, textbooks), and discuss course and lab concept with other students. However they are prohibited from sharing their work or using any work not done by themselves or using any other material.

5. Required Materials:

The required materials for SYDE 544 course are selected chapters and sections from the following books which are available from the UW book store:

a. Title: Biomedical Signal Analysis, 2nd Ed.
   Author: Rangaraj M. Rangayyan

Course Topics Schedule

Week	Dates	Topics
1	Jan 5 – 7	**Introduction to the Biomedical Measurement and Signal Processing Course**
2	Jan 10 - 14	**The Electromyogram (EMG), the Electrocardiogram (ECG), and the Encephalogram (EEG) Signals**
3	Jan 17 – 21	**Filtering for Removal of Artefacts that Corrupt Biomedical Signals**
4	Jan 24 – 28	**Time-Domain and Frequency-Domain Filters**
5	Jan 31 – Feb 4	**Detection of Events and Waves**
6	Feb 7 – 11	**Analysis of Waveshape and Waveform Complexity**
7	Feb 14 – 18	**Modeling Biomedical Signal Generating Processes and Systems**
8	Feb 21 – 25	**Reading Week**
9	Feb 28 – Mar 4	**Parametric Model-Based Methods**
10	Mar 7– 11	**Analysis of Nonstationary and Multicomponent Signals**
11	Mar 14 – 18	**Wavelets and Time-Frequency Analysis**
12	Mar 21 – 25	**Pattern Classification and Diagnostic Decision**
13	Mar 28 - Apr 1	**Probabilistic Models and Statistical Decision** **Neural Networks**
14	Apr 4 – 5	**Reliability of Features, Classifiers, and Decisions**

Academic Integrity:

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check www.uwaterloo.ca/academicintegrity/for more information.]

Plagiarism Software (Turnitin.com and alternatives):

Plagiarism detection software (Turnitin) will be used to screen assignments in this course. This is being done to verify that use of all material and sources in assignments is documented. Students will be given an option if they do not want to have their assignment screened by Turnitin. If requested, in the first week of the term, details will be provided about the arrangements for the use of Turnitin and alternatives in this course.

Grievance:

A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70 Petitions & Grievance, Student Petitions and Grievances, Section 4. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline:

A student is expected to know what constitutes academic integrity [check www.uwaterloo.ca/academicintegrity/] to avoid committing an academic offence, and to take responsibility for their actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71 Student Discipline. For typical penalties check Guidelines for the Assessment of Penalties.

Appeals:

A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 Student Appeals.

AccessAbility Services:

The AccessAbility Services (AAS)is the University's centralized office for the provision of academic accommodations for students with a known or unknown disability, illness, or condition. Even if students are unsure of whether they qualify for AAS support, an AAS consultant can talk them through next steps, and refer them elsewhere if appropriate.

Intellectual Property:

Students should be aware that this course contains the intellectual property of their instructor, TAs, and/or the University of Waterloo. Intellectual property includes items such as:

- Lecture content, spoken and written (and any audio/video recording thereof)
- Lecture handouts, presentations, lab manuals, and other materials prepared for the course (e.g., PowerPoint slides)
- Questions or solution sets from various types of assessments (e.g., assignments, quizzes, tests, final exams, labs); and work protected by copyright (e.g., any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner).Course materials and the intellectual property contained therein, are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owner's permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TA and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g., to an online repository).

Permission from an instructor, TA or the University is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. In many cases, instructors might be happy to allow distribution of certain materials. However, doing so without expressed permission is considered a violation of intellectual property rights.

Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online. The intellectual property rights owner deserves to know (and may have already given their consent).

Relevant University Policies:

Policy 71 – Student Discipline (https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-71)

Policy 73 – Intellectual Property Rights https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policies/policy-73-intellectual-property-rights)

Guiding Principles for our SYDE-BME Community:

1. Be compassionate. 2. Be accountable. 3. Be patient. 4. Be safe and healthy.

Compassionate and Respectful Communication:

Most online communication between the Department and students will be done through LEARN and/or email. Students are reminded that they should now use their email account name@uwaterloo.ca. Include an academic signature with your full name, program, student ID. We encourage you to include your preferred pronouns (he/him; she/her; they/them).

Scheduling of Synchronous (Live) Online Course Events:

Due to the COVID-19 pandemic, all University of Waterloo courses components will be delivered either in-person or online, until further notice. To accommodate different time zones, different working/studying conditions and limitations in Internet access, all critical course components, including lectures and student support, must be made available in asynchronous formats. Any timed component (e.g., test/quiz) must take time zone and Internet availability into account.

Academic Discipline Policy for Tests and Assignments:

All students are expected to work individually and submit their own original work. Under Policy 71, the instructor reserves the right to have follow-up conversations with individual students to ensure that the work submitted was completed on their own. Any follow-up conversations will be done in-person or through online voice or video communication (e.g., WebEx, Zoom, Hangouts).

SYDE-BME Comment on Accommodation:

The University of Waterloo's policy on accommodation for missed deliverables pertains to verifiable health matters, and highly unfortunate events (e.g., family tragedies). The Department of Systems Design Engineering follows UW's general policy: students who self-elect to forgo a deliverable receive a "0" for that deliverable. It is preferred practice so that fairness is maintained for members of the same class/course by avoiding preferential treatment. Please read the policy here: [Accommodation due to illness](#).

SYDE-BME Academic Priorities over Co-op Interviews:

Students should be able to arrange co-op interviews that do not conflict with major deliverables (i.e., labs, course midterms, final exams). For deliverables with longer time windows (e.g., 24-48 hours or more), students must manage their time for deliverables and co-op interviews accordingly. If a co-op interview conflicts with a short deliverable time window (e.g., 1-3 hours), then students MUST follow the CECA procedure for rescheduling the interview: [CECA rescheduling co-op interviews](#).

Compassionate Accommodation:

If you are facing challenges that are affecting more than one course, contact the Associate Chair Undergraduate (ACUG). They will review your case and coordinate a reasonable and fair plan in consultation with appropriate others (e.g., instructors, Department Undergraduate Studies Committee, Chair, AccessAbility Services, Engineering Counselling services, Registrar's Office).

Usage of Discussion Forums (e.g., Slack, Piazza, etc.):

Please note that posting partial or complete test or assignment solutions to a discussion forum in a public post before the assignment deadline is a violation of Policy 71 - Student Discipline. As stated in this policy: "Students are responsible for demonstrating behaviour that is honest and ethical in their academic work. Such behaviour includes: "Preventing their work from being used by others, e.g. not lending assignments to others, protecting access to computer files."

Each instance of violation of Policy 71 will be treated as academic misconduct and corresponding penalties as prescribed by the Faculty of Engineering will be applied. Also note that discussion forums are not complaint forums (e.g., complaints about assignment marking). If you have a concern about anything to do with the course, please address your concern directly with the instructor or TAs, as appropriate.