



ENGG*4390 Bio-instrumentation Design

01

Fall 2023

Section(s): C01

School of Engineering

Credit Weight: 0.75

Version 1.00 - September 06, 2023

1 Course Details

1.1 Calendar Description

Theory and selection criteria of devices used in measurements in biological systems; design of complete measurement systems including transducers, signal conditioning and recording components; error analysis. Differences between measurements in biological and physical systems.

Pre-Requisites:

ENGG*3450

Restrictions:

This is a Priority Access Course. Enrolment may be restricted to the BIOE and BME specializations in the BENG and BENG:C programs. See department for more information. Non-BENG students may take a maximum of 4.00 ENGG credits.

1.2 Timetable

Lectures:

Tues, Thur 2:30 PM – 3:50 PM CRSC, 116

Laboratory:

Mon Sec 01 11:30 AM - 1:20 PM RICH, Room 1504A

Mon Sec 02 3:30 PM - 5:20 PM RICH, Room 1504A

1.3 Final Exam

There is no final exam in this course.

2 Instructional Support

2.1 Instructional Support Team

Instructor:	Huiyan Li
Email:	huiyanli@uoguelph.ca
Telephone:	+1-519-824-4120 x54699
Office:	THRN 1333
Office Hours:	By appointment

2.2 Teaching Assistants

Teaching Assistant (GTA):	Debarshi Nath
Email:	debarshi@uoguelph.ca
Teaching Assistant (GTA):	Katelyn Roe
Email:	kroe01@uoguelph.ca

3 Learning Resources

3.1 Required Resources

Course Website (Website)

<http://courselink.uoguelph.ca>

Course material, news, announcements, and grades will be regularly posted to the ENGG*4390 CourseLink site. You are responsible for checking the site regularly.

Medical Instrumentation – Application and Design, 4th Edition, John G. Webster (Textbook)

3.2 Recommended Resources

Measurement Systems: Application and Design, 5th Edition, Ernest O. Doebelin (Textbook)

Introduction to Biomedical Equipment Technology, 4th Edition, J.J. Carr and J.M. Brown (Textbook)

3.3 Additional Resources

Lecture Information (Notes)

All the lecture notes are posted on the web page.

Lab Information (Lab Manual)

The handouts for all the lab sessions reside within the lab section of the course website. All types of resources regarding tutorials, links to web pages can be found in this section.

Miscellaneous Information (Other)

Other information related to the laboratory experiments, interesting articles, and project ideas will be posted on the courselink web page.

3.4 Communication & Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course.

Major announcements will be posted to the course website. **It is your responsibility to check the course website regularly.** As per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Apply knowledge of interdisciplinary sciences and mathematics to develop solutions to problems at the interface of biology and engineering
2. Demonstrate and apply knowledge on the use of sensors and electronic instruments to measure physical, chemical and biological signals
3. Interpret and contrast principles of instrumentation used to measure factors that characterize biological, physical or chemical factors that have a profound effect of biosystems
4. Design and development of biological, and biomedical instrumentation through application of electrical device theory, sensor theory, and signal conditioning.
5. Design and evaluate the performance of bio-instrumentation systems through calibration, signal conditioning, testing and error analysis
6. Interpret and present results of experimental measurements of physiological signals and assess potential sources of error that affects the quality of results

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1, 2, 4, 5
1.1	Recall, describe and apply fundamental mathematical principles and concepts	1, 2, 4, 5
1.2	Recall, describe and apply fundamental principles and concepts in natural science	1, 2, 4, 5
1.3	Recall, describe and apply fundamental engineering principles and concepts	1, 2, 4, 5
1.4	Recall, describe and apply program-specific engineering principles and concepts	1, 2, 4, 5
2	Problem Analysis	1, 2, 4, 5
2.1	Formulate a problem statement in engineering and non-engineering terminology	1, 2, 4, 5
2.2	Identify, organize and justify appropriate information, including assumptions	1, 2, 4, 5
2.3	Construct a conceptual framework and select an appropriate solution approach	1, 2, 4, 5
2.4	Execute an engineering solution	1, 2, 4, 5
2.5	Critique and appraise solution approach and results	1, 2, 4, 5
3	Investigation	2, 4, 5, 6
3.1	Propose a working hypothesis	2, 4, 5
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	2, 4, 5, 6
3.3	Analyze and interpret experimental data	2, 4, 5, 6
3.4	Assess validity of conclusions within limitations of data and methodologies	2, 4, 5, 6
4	Design	1, 2, 4, 5, 6
4.1	Describe design process used to develop design solution	1, 2, 4, 5, 6
4.2	Construct design-specific problem statements including the definition of	1, 2, 4, 5, 6

#	Outcome	Learning Outcome
	criteria and constraints	
4.3	Create a variety of engineering design solutions	1, 2, 4, 5, 6
4.4	Evaluate alternative design solutions based on problem definition	1, 2, 4, 5, 6
4.5	Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping	1, 2, 4, 5, 6
5	Use of Engineering Tools	2, 3, 4, 5, 6
5.1	Select appropriate engineering tools from various alternatives	2, 3, 4, 5, 6
5.2	Demonstrate proficiency in the application of selected engineering tools	2, 3, 4, 5, 6
5.3	Recognize limitations of selected engineering tools	2, 3, 4, 5, 6
6	Individual & Teamwork	2, 3, 4
6.1	Describe principles of team dynamics and leadership	2, 3
6.2	Understand all members' roles and responsibilities within a team	2, 3, 4
6.3	Execute and adapt individual role to promote team success through, for example, timeliness, respect, positive attitude	2, 3, 4
6.4	Apply strategies to mitigate and/or resolve conflicts	2, 3, 4
6.5	Demonstrate leadership through, for example, influencing team vision and process, promoting a positive team culture, and inspiring team members to excel	2, 3, 4
7	Communication Skills	4, 5, 6
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	4
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	4, 5, 6
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	4, 5
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	4, 5, 6
7.5	Demonstrate ability to process oral and written communication by following	4, 5

#	Outcome	Learning Outcome
	instructions, actively listening, incorporating feedback, and formulating meaningful questions	
8	Professionalism	4
8.3	Demonstrate professional behaviour	4
9	Impact of Engineering on Society and the Environment	4
9.1	Analyze the safety, social, environmental, and legal aspects of engineering activity	4
9.2	Evaluate the uncertainties and risks associated with engineering activities	4
9.3	Anticipate the positive and negative impacts of introducing innovative technologies to solve engineering problems	4
11	Economics and Project Management	1, 2, 3, 4, 5, 6
11.1	Apply project management techniques and manage resources within identified constraints	1, 2, 3, 4, 5, 6
11.2	Identify risk and change management techniques, in the context of effective project management	1, 2, 3, 5, 6
11.3	Estimate economic impact and feasibility of an engineering project or design using techniques such as cost benefit analysis over the life of the project or design	1, 2, 3, 4, 5, 6

5 Teaching and Learning Activities

5.1 Lecture Components

Basic concepts in bioinstrumentation design

Review of circuit analysis and electronic devices

Basic sensors and control elements

Biopotentials: ECG, EMG, EEG

Biosignal recording

Measurement of flow and volume of blood

Respiratory system

Chemical biosensors

Optical sensors

Electrical safety

5.2 Lab Schedule

Week	Topic
1 (Sept 11th)	No Lab
2 (Sept 18th)	Lab Intro, Form Design Groups
3 (Sept 25th)	Lab 1
4, 5 (Oct 2nd)	No lab
6 (Oct 16th)	Lab 2
7-10 (Oct 23rd)	Final Design Project
11 (Nov 20th)	Final Design Project Presentations and Reviews

5.3 Other Important Dates

First day of class: Thursday September 7, 2023

Fall Study Break Day: Tuesday, October 10, 2023 - no classes

Thursday, November 30, 2023: Make up for Oct 10, Tuesday Schedule

Last day of class: Thursday, November 30, 2023

Please refer to the undergraduate calendar for semester scheduled dates.

6 Assessments

6.1 Assessment Details

Lab Report 1 (15%)

Date: Mon, Oct 16

Learning Outcome: 1, 2, 3, 4, 5, 6

Lab Report 2 (15%)

Due: Mon, Oct 30

Learning Outcome: 1, 2, 3, 4, 5, 6

Design Component 1 (10%)

Date: Mon, Oct 16

Learning Outcome: 1, 3, 4, 5

Design Component 2 (10%)

Date: Mon, Nov 6

Learning Outcome: 1, 3, 4, 5

Design Component 3 (10%)

Date: Fri, Dec 1

Learning Outcome: 1, 3, 4, 5

Final Design Presentation (15%)

Date: Mon, Nov 20

Learning Outcome: 1, 2, 3, 4, 5, 6

In-class quizzes (25%)

Learning Outcome: 1, 1, 2, 2, 3, 3, 4, 4, 5, 5, 6, 6

There will be 7 in-class quizzes throughout the semester. The best 5 out of the 7 marks will be counted towards final grades, 5 marks for each quiz.

7 Course Statements

7.1 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start

of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

Passing grade: Students must obtain a grade of 50% or higher overall to pass this course.

Lab Work: You must attend and complete all laboratories. If you miss a laboratory due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistants to complete a makeup lab.

Late Lab Reports: Late submissions of lab reports will not be accepted.

8 School of Engineering Statements

8.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is

required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

For Guelph students, information can be found on the SAS website
<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>

9.9 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).
