ENGG*4390 Bio-Instrumentation Design
Fall 2013

UNIVERSITY of GUELPH

School of Engineering

(Revision 0, August 2013)

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1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Dr. Suresh Neethirajan, PhD., P.Eng
Office: THRN 2505, ext. 53922
Email: sneethir@uoguelph.ca
Office hours: TBA on Courselink or by appointment

1.2 Lab Technician

Technician: Hong Ma
Office: RICH 1506, ext. 53873
Email: hongma@uoguelph.ca

1.3 Teaching Assistants

GTA	Email	Office Hours
Bruce Guest	guestb@uoguelph.ca	TBA on Courselink

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2 LEARNING RESOURCES

2.1 Course Website

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

2.2 Required Resources

1. John G. Webster, Editor. Medical Instrumentation – Application and Design, 4th Edition

2.3 Recommended Resources

1. Measurement Systems – Application and Design by Ernest O. Doebelin, 5th Edition
2. Introduction to Biomedical Equipment Technology – 4th Edition

2.4 Additional Resources

Lecture Information: All the lecture notes are posted on the web page (week #1-#12).

Lab Information: The handouts for all the lab sessions are within the lab section. All types of resources regarding tutorials, links to web pages can be found in this section.

Assignments: Download the assignments according to the schedule given in this handout. All the solutions will be posted as indicated.

Miscellaneous Information: Other information related to the laboratory experiments are also posted on the courselink web page.

2.5 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 <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its student.

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3 ASSESSMENT

3.1 Dates and Distribution

Distribution	Grades	Due Date
Lab Report 1 (Thermocouple Sensor)	5%	October 4, 2013
Lab Report 2 (Sensor Integration / Group Project)	10%	October 25, 2013
Mid Term Exam	20%	November 1, 2013
Presentation	5%	November 18 – 27, 2013
Design Project (Team Project)	30%	November 29, 2013

Assignments / Home Work (A total of 7)	0%	None
Final Exam	30%	December 6, 2013, 8:30 Am to 10:30 AM

3.2 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: In order to pass the course, you must pass both the laboratory and exam course portions. Students must obtain a grade of 50% or higher on the exam portion of the course in order for the laboratory write-up portion of the course to count towards the final grade.

Missed midterm tests: If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of the missed test will be added to the final exam. There will be no makeup midterm tests.

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 assistant to complete a makeup lab.

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

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 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.

Prerequisite(s): ENGG*3450

4.2 Course Aims

The objective of this course is to introduce students to the fundamental aspects of instrumentation, and basic principles of design issues of sensors, and transducers using specific applications. The major goal is to provide the students with hands-on experience in biomedical instrumentation through digital and analog circuits designed for practical applications in the biological and biomedical industries.

4.3 Learning Objectives (LO)

At the successful completion of this course, the student will have demonstrated the ability to:

1) To develop the ability to apply knowledge of science and mathematics to solve problems at the interface of biology and engineering
2) To appreciate the issues and considerations involved in the design and development of biological and biomedical instrumentation
3) To understand the principles of instrumentation used to measure factors that characterize biological, physical or chemical factors that have a profound effect of biosystems
4) To quantify the performance of bio-instrumentation systems through calibration, testing and error analysis

4.4 Graduate Attributes:

Graduate Attribute	Learning Objectives	Assessment
1. Knowledge Base for Engineering	1, 2, 4,	Labs, Exams
2. Problem Analysis	1,2,3,4	Exams, Project
3. Investigation	3, 4,	Labs
4. Design	2, 3, 4,	Project
5. Use of Engineering Tools	2, 3, 4	Labs, Project
6. Communication	3, 4,	Labs, Project
7. Individual and Teamwork	1,2,34	Labs
8. Professionalism	2,3,4	Labs, Exams
9. Impact of Engineering on Society and the Environment	3, 4,	Project
10. Ethics and Equity	-	-
11. Environment, Society, Business, & Project Management	3, 4,	Project
12. Life-Long Learning	4	-

Learning Outcomes:

- Demonstrate and apply knowledge on the use of sensors and electronic instruments to measure physical, chemical and biological signals

- Interpret and present results of experimental measurements of physiological signals and assess potential sources of error that affects the quality

4.5 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/D2L but these are not intended to be stand-alone course notes. 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 project.

4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. 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.

4.7 Relationships with other Courses & Labs

Previous Courses:

ENGG*2450 Electric Circuits

ENGG*3450 Electrical Devices

The students need to have equivalent skills or prior experience in electrical circuit analysis and knowledge of working principle of electrical devices to be able to complete the laboratory component and the instrumentation design for ENGG*4390.

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5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:

Monday	12:30 PM – 13:20 PM	MACK 116
Wednesday	12:30 PM – 13:20 PM	MACK 116
Friday	12:30 PM – 13:20 PM	MACK 116

Laboratory:

Monday	Sec 01	15:30PM - 17:20 PM	RICH 1504B
Friday	Sec 02	15:30 PM - 17:20 PM	RICH 1504B

5.2 Lecture Schedule

Week 1:
Review of basic electronics - Bioinstrumentation - Definition, Bioelectronics, bio optics, biomaterials, biosystems, medical imaging - Precision vs Accuracy; Resolution vs sensitivity – LO 1,2,3,4

Week 2:
Linear circuit Analysis; Kirchoff's Laws KCL; KVL; Series and parallel combination; First and second order instruments; Thevenin and Norton equivalents - LO 1,2,3,4

Week 2 and 3:
Basic Sensors: Displacement, strain and pressure - Wheatstone bridge - LO 1,2,3,4

Week 4:
Sensors and control elements: Inductive, Capacitive, Piezoelectric, Temperature (Thermistor vs Thermocouple) Sensors - Amplifiers and Active Linear Circuits for Signal Processing - Amplifiers and signal processing - Analysis of linear active circuits with IDEAL opamps - LO 1,2,3,4

Week 5:
Comparators, timers and digital circuits; Overview of variety of sensors - LO 1,2,3,4
Week 6:
Biopotentials- ECG, EMG, EEG - Nernst potential - Action potential - Volume conduction - Alpha, beta, gamma, delta, theta brain waves; Biopotential electrodes - polarization - polarizable, non-polarizable electrodes - LO 1,2,3,4

Week 7:
Biopotential sources and signals - Biosignal recording - Deep brain simulation electrodes - Blood pressure measurement - Bandwidth requirements - Blood volume and flow measurement - LO 1,2,3,4

Week 8 and 9:
Measurement of flow and volume of blood; respiratory system - LO 1,2,3,4

Week 10:
Electrochemical Biosensors - pH P02, and PCO2 - Chemical biosensors - Severinghaus electrode - LO 1,2,3,4

Week 11 and 12:
Ion selective and Optical Biosensors - Optical transduction - Ion Sensitive FET - Electrical safety and physiological effects - parameters of susceptibility - point of entry - Design for protection, grounded vs ungrounded examples, protection of power distribution - LO 1,2,3,4

5.3 Lab Schedule

Disclaimer

Week	Topic
1, 2	Lab Safety Orientation
3	Introduction to Lab Equipment and Safety Training
3 and 4	Lab view Demo and Design of Thermocouple Sensors
3 and 4	Thermocouple Experiments
5, 6, 7	Laboratory 2 / Sensor Integration
8, 9, 10	Final Design Project / Instrumentation System Development
11, 12	Final Design Project Review and Presentations

5.4 Other Important Dates

Thursday, 5 September 2013: First class

Monday, 14 October 2013: Thanks giving holiday

Thursday, 31 October 2013: drop date – 40th class

Thursday, 28 November 2013: last class (Monday Schedule in effect)

Please refer the undergraduate calendar for semester scheduled dates.

Disclaimer

The instructor reserves the right to change any or all of the above in the event of appropriate circumstances, subject to the University of Guelph Academic Regulations.

6 LAB SAFETY

Safety in the laboratory is a prime concern. Lab proposals must include a safety section. Depending upon the experiment conducted, appropriate safety protection such as gloves and goggles must be worn. University policy forbids working alone in a lab; this will be strictly enforced.

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.

7 ACADEMIC MISCONDUCT

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 discourages misconduct. 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.

7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at: http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in your Engineering Program Guide.

The School of Engineering has adopted a Code of Ethics that can be found at: http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

8 Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible.

For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.csd.uoguelph.ca/csd/