ENGG*4480 Advanced Mechatronic Systems Design
Winter 2016

UNIVERSITY of GUELPH

School of Engineering

(Revision 0: January 5, 2014)

---

1 Instructional Support

1.1 Instructor

Instructor:	Omar Ahmed, Ph.D.
Office:	RICH 3523, ext. 58262
Email:	oahmed@uoguelph.ca
Office hours:	Tuesday and Thursdays: 3:00 - 4:00 PM

1.2 Lab Technician

Technician::	Nathaniel Groendyk
Office:	THRN 2308, ext. 53873
Email:	groendy@uoguelph.ca

1.3 Teaching Assistants

GTA	Email	Office Hours
Nitin Seth, Ph.D.	sethn@uoguelph.ca	TBA on Corselink

---

2 Learning Resources

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*4480 CourseLink site. You are responsible for checking the site regularly.

2.2 Required Resources

1. W. Bolton *Mechatronics: Electronic control systems in mechanical and electrical engineering*, 5th Edition, Pearson Publishers.

2.3 Recommended Resources

1. Arduino board website: http://arduino.cc/.
2. Raspberry PI website: https://www.raspberrypi.org/help/quick-start-guide/.
3. W. Bolton *Programmable Logic Controllers*, 5th Edition, Newnes Publishers.
4. M. Grewal and A. Andrews *Kalman Filtering: Theory and Practice Using MATLAB*, 2nd Edition, Wiley Publishers.
5. S. Cetinkunt *Mechatronics*, Wiley Publishers.

2.4 Additional Resources

1. Lecture Information: All the lecture notes are posted on the web page (week #1-#12).
2. 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.
3. Assignments: Download the assignments according to the schedule given in this handout. All the solutions will be posted as indicated.
4. Miscellaneous Information: Other information related to Mechatronic Systems are also posted on the 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 "mail.uoguelph.ca" e-mail account regularly: e-mail is the official route of communication between the University and its student.

---

3 ASSESSMENT

3.1 Dates and Distribution

1. Assignments: 10%
   See Section 5 for due dates
2. Labs: 15%
   See Section 5 for due dates
3. Project: 40%
   (a) Proposal: 5%
   Monday January 25th 2016 during the lab time (Week #3).
   (b) Biweekly meeting: 9%
   During lab time (Week #5 ,#7 ,#9).
   (c) Final Demonstration and Presentation: 16%
   Monday March 28th 2016 during lab time (Week #11).

(d) Final Report: 10%
Monday April 4th 2016 (Week #12).

4. Final Exam: 35%
Thursday April 21st 02:30 PM -04:30 PM, (Room TBA on Webadvisor).

3.2 Deliverables

3.2.1 Proposal: January 25th during the lab time

The proposal introduces the team members as well as brief description of the project. The proposal must also include:

1. Name, student ID, and email address of group members
2. Task descriptions of your mechatronic system
3. Constraints (duration, sensor, cost, etc.)
4. Material Selection: the number of required actuators and sensors as well as micro-controller.
5. A detail plan for the project with a time line and weekly progress.
6. Diagram, flow chart, electrical circuit layout, and mechanical design.
7. The proposal should be limited to 5 pages.

3.2.2 Biweekly meeting: During the lab time

Groups are required to attend a biweekly meeting with instructor. The meetings are expected to be regular group meetings but with the presence of the instructor who will silently observe the meeting and then provide feedback to the group on their progress. A one page summery of the project progress should submitted to course instructor day before the meeting.

3.2.3 Final Report: Monday April 4th 2016

The final report should show the details of your design (mechanical and electrical), calculations and analyses for your mechanical design, and how your completed system meets the design objectives and criteria. The final report should also include actual program with proper comments in appendix. Also, the test results and statistics (if required) should be discussed.

The main body of the report should include:

1. Introduction and motivation
2. Background (similar products and researches, require citation)
3. Design problem and challenges
4. Safety concerns
5. Goals and tasks
6. Design criteria and constraints
7. At least two alternative mechanical designs, which you have discussed during the preliminary design presentation. Description of why the current design is chosen.
8. List of tasks that your design should perform
9. Project plan (Gantt chart)

The final report should be a complete report (including cover page, list of figures, etc.). While the report should be comprehensive and include all the necessary information, the main body (from introduction to conclusion) should not exceed **15 pages**. Appendices which include program codes are not counted toward the 15 page limit.

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

This course is a project course which uses electronics to control real world mechanical systems. The course covers signal conditioning, system calibration, system models, dynamic models, large scale systems, networking, microprocessors, programmable logic controllers, communication systems and fault finding.
Prerequisite(s): ENGG*3490, ENGG*3640, ENGG*4460

4.2 Course Aims

The aim of this course is to design and implement a mechatronic system using the knowledge and experience you have gained from ENGG*3490, which demonstrated the basics of sensors and actuators as well as variety of mechatronic systems. For this course, the project will be completed in groups with three students to work on a mechatronics project using Raspberry PI board.

4.3 Learning Objectives

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

1. Design and implement mechanical parts on mechatronic systems
2. Addressing safety concerns of mechatronic systems as well as fabrication process
3. Sensor and actuator implementation on Arduino board and/or Raspberry PI board
4. Use of variety of sensors and how to use them as input devices of mechatronics system
5. How to achieve higher accuracies by combining more than two different sensors
6. How to use machine intelligence
7. Solve programming and implementation problems, by considering the engineering tradeoffs and constraints

4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

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

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 Course-link/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

ENGG*3490 Introduction to Mechatronic Systems Design: Basic concepts of Mechatronic Systems.

ENGG*3640 Microcomputer Interfacing: Interfacing computer to external equipment and data acquisition

ENGG*4460 Robotic Systems: Study the modeling and design of complex mechatronics systems (Robots)

---

5 Teaching and Learning Activities

5.1 Timetable

Lectures:				
Tuesday		10:00 AM - 11:20 AM	MACS 301	O. Ahmed
Thursday		10:00 AM - 11:20 AM	MACS 301	O. Ahmed
Laboratory:				
Monday	Sec 01	1:30 PM - 4:20 PM	RICH 1532	N. Seth

5.2 Lecture Schedule

Week	Lecture Topics	References	Learning Objectives
1	Sensors	Chapter 2	1
2	Signal conditioning	Chapter 3	2
3	Passive and Active Filter Design		2
4-5	Linear Optimal Filters and Predictors		1,2
6-7	Microprocessor Systems	Chapter 17	3
8	Communication Systems	Chapter 22	4
9-10	Programmable Logic Controllers	-	4
11	Fault finding	Chapter 23	2,5
12	Review	-	-

5.3 Assignments

There will be 4 assignments throughout the term. **Solve all problems** and hand in your assignment to the instructor in the lecture.

Item	Handed In	Due Date	Topic
Assign #1	(Week #1)	Week #3	Sensor and Signal conditioning
Assign #2	(Week #3)	Week #6	Kalman filter
Assign #3	(Week #6)	Week #9	Microprocessor and Communication Systems
Assign #4	(Week #9)	Week #12	Programmable Logic Controllers

5.4 Lab Schedule

There will be 4-5 labs throughout the term. **Hand in** your reports to the teaching assistant in the lab. Below are the due dates:

Week	Topic	Report	Due
2	L0: Intro to Lab Equipment and Safety Training	No	-
3	L1: Sensors integration	Yes	Week 4
4	L2: Basic filtering	Yes	Week 5
5-6	L3: Kalman filter implementation **(c-code)**	Yes	Week 7
7-8	L4: Complete Mechatronic system	Yes	Week 9
9	L5: Programmable logic controllers	Yes	Week 10
10	L6: Communication Systems	Yes	Week 11

5.5 Other Important Dates

1. **First Class**: Monday, January 11, 2016.
2. **Winter Break**: Monday, February 15 - February 19 2016
3. **Drop Date**: Friday March 11, 2016.
4. **Last Class**: Friday April 8, 2016.

---

6 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. If the laboratory rules are not followed, consequences will include removing access to the lab. If this results in lab work not being completed, the student will receive a grade of 0.

---

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 offenses 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 offense 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.uoguelph.ca/csd/

---

9 RECORDING OF MATERIALS

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

---

10 RESOURCES

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:
http://www.uoguelph.ca/registrar/calendars/index.cfm?index