

ENGG*4480 Advanced Mechatronic Systems Design

Winter 2018



(Revision 1: January 3, 2018)

1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: S. Andrew Gadsden, Ph.D., P.Eng., P.M.P.
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Office hours: By appointment

1.2 Lab Technician

Instructor: Kevin Dong, M.A.Sc., P.Eng.
Office: RICH 2506 or THRN 2308
Email: kdong at uoguelph dot ca
Office hours: By appointment

1.3 Teaching Assistants

Instructor: Richard Bustos, B.Eng. and Felix Plappert, B.Eng.
Office: TBA
Email: rbustos and fplapper at uoguelph dot ca
Office hours: By appointment

2 LEARNING RESOURCES

2.1 Course Website

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

2.2 Required Resources

Students are expected to attend all of the lectures. Students are **responsible** for whatever material is taught in the class. Note that the textbook may not have all of the material taught in the class. The textbook for the course is available at the bookstore (or online) and is as follows:

- “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering”, by W. Bolton, Pearson, 6th Edition, 2015.

2.3 Recommended Resources

Other recommended resources (optional) are as follows:

- “Kalman Filtering: Theory and Practice using Matlab”, by M. S. Grewal and A. P. Andrews, Wiley, 4th Edition, 2014.
- Information on Arduino systems: www.arduino.cc
- Information on Raspberry Pi systems: www.raspberrypi.org
- Online electronics shop: www.sparkfun.com

2.4 Additional Resources

Lecture Information: **Some parts** of the lectures notes are posted on the web page. The reason that only some parts are posted is to ensure that students attend the classes to learn the material. Note that the posted lectures on the webpage **may NOT** have all of the material taught in the class. Students should attend the classes and make their own notes.

Assignments: Assignments will cover lecture material and theory taught in the class. They will be completed individually. No late assignments will be accepted.

Miscellaneous Information: Other information related to estimation theory will also be posted on the course web page.

2.5 Communication & Email Policy

Please use lectures and 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.

3 ASSESSMENT

3.1 Dates and Distribution

Laboratories (Group): 25%

Lab 1: Sensor Integration (7.5%)

Lab 2: Electronic Filters (7.5%)

Lab 3: i) Self-Balancing Robot, or ii) Stewart Platform, or iii) Inverted Pendulum (10%)

Skills Inventory and Resume (Individual): 5%

Midterm Exam (Individual): 30%

Project (Group): 40%

Proposal (5%)

Presentation and Demonstration (5%)

Final Report (30%)

Dates: See section 5 below for dates.

Important Note: While you are encouraged to discuss with other classmates on problems in the class, there is zero tolerance for plagiarism or copying. A grade of 0% will be assigned to an exam if it is copied or plagiarized by any means.

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 at 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: You must pass both the laboratories and midterm section, as well as the project portion, in order to pass the course. For example, obtaining 40/40 on the project but 20/60 on the laboratories and midterm exam portion will result in a failure of the course.

Late Submissions: Late submissions without a pre-approved reason 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 modeling linear systems, state-space and transfer functions, control theory in mechatronic systems, estimation theory, Kalman filtering, artificial intelligence, and MATLAB programming.

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 a variety of mechatronic systems. For this course, the laboratories and project will be completed in groups of three to five people. Groups will be tasked with designing, building, and running their own experimental setup based on Arduino-system and control or estimation theory. Successful setups may be used in future course offerings.

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. Address safety concerns of mechatronic systems as well as during the fabrication process.
3. Sensor and actuator implementation on Arduino board and/or Raspberry PI board.
4. Use of a variety of sensors and how to use them as input devices for a mechatronics system.
5. How to achieve higher accuracies by combining more than two different sensors.
6. Understand the basics of estimation theory.
7. Understand the basics of machine or artificial intelligence.
8. Manipulate mechatronic systems and obtain relevant measurement data for engineering purposes.
9. Understand what an employer looks for in an employee, and how to create a resume.

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 – 7	Exam, Project
2. Problem Analysis	1 – 7	Exam, Project

3. Investigation	-	-
4. Design	3, 4, 8	Labs, Project
5. Use of Engineering Tools	-	-
6. Individual and Teamwork	-	-
7. Communication	1, 8	Labs, Project
8. Professionalism	9	Resume
9. Impact of Engineering on Society and the Environment	-	-
10. Ethics and Equity	-	-
11. Environment, Society, Business, & Project Management	-	-
12. Life-Long Learning	-	-

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 quizzes and examination(s).

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*3490: Introduction to Mechatronic Systems Design (basic concepts)

ENGG*3640: Microcomputer Interfacing (data acquisition)

ENGG*4460: Robotic Systems (modeling and design of complex mechatronic systems)

5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

The course registration details on Webadvisor determines the lecture times. The course code for Advanced Mechatronic Systems Design is ENGG*4480*0101. The lecture times and location are Tuesday and Thursday at 2:30 pm until 3:50 pm in THRN 2313 (Computer Lab). Labs run Wednesday at 8:30 am in THRN 2307 (Mechatronics Lab). Note the TAs may assign your group different lab start times (e.g., 8:30 am or 10:00 am).

5.2 Class Schedule

Week	Day	Topic/Event	References	Deliverables
1 (01/08)	Tuesday Thursday <i>Labs</i>	L01: Course Introduction L02: System Modeling I <i>Lab #0: Safety, Group Formation, and Soldering</i>	Slides, Chps. 1, 17-20	N/A
2 (01/15)	Tuesday Thursday <i>Labs</i>	L03: System Modeling II L04: System Modeling and MATLAB I <i>Lab #1: Sensor Integration</i>	Slides, Chps. 17-20	N/A
3 (01/22)	Tuesday Thursday <i>Labs</i>	L05: System Modeling and MATLAB II L06: System Modeling and MATLAB III <i>Lab #1 or Lab #2: Electronic Filters</i>	Slides, Chps. 17-20	N/A
4 (01/29)	Tuesday Thursday <i>Labs</i>	L07: Signal Conditioning L08: Estimation Theory <i>Lab #2: Electronic Filters</i>	Slides, Chp. 3, Grewal Text	Lab #1
5 (02/05)	Tuesday Thursday <i>Labs</i>	L09: Kalman Filter I L10: Kalman Filter II <i>Lab #2 or Lab #3: Robot, Platform, or Pendulum</i>	Slides, Grewal Text	Preliminary Report
6 (02/12)	Tuesday Thursday <i>Labs</i>	L11: Kalman Filter and MATLAB I L12: Kalman Filter and MATLAB II <i>Lab #3: Robot, Platform, or Pendulum</i>	Slides, Grewal Text	Lab #2
7 (02/19)	Tuesday Thursday <i>Labs</i>	No Class or Labs (Winter Break)	N/A	N/A
8 (02/26)	Tuesday Thursday <i>Labs</i>	L13: Skills Inventory and Resume L14: Microcontroller (Raspberry Pi) Tutorial <i>Skills Inventory and Resume</i>	Slides	Lab #3
9 (03/05)	Tuesday Thursday <i>Labs</i>	L15: Controllers I L16: Controllers II <i>Group Work and Prototyping Time</i>	Slides, Chp. 22	Skills Inv. and Resume
10 (03/12)	Tuesday Thursday <i>Labs</i>	L17: Controllers and MATLAB I L18: Controllers and MATLAB II <i>Group Work and Prototyping Time</i>	Slides, Chp. 22	N/A
11 (03/19)	Tuesday Thursday <i>Labs</i>	L19: Artificial Intelligence L20: Midterm Review and Course Evaluation <i>Group Work and Prototyping Time</i>	Slides, Chp. 23	N/A

12 (03/26)	Tuesday Thursday <i>Labs</i>	Midterm Exam No Class or Labs <i>Group Work and Prototyping Time</i>	All	MT Exam
13 (04/02)	Tuesday Thursday <i>Labs</i>	No Class or Labs Group Presentations and Demos <i>Group Work and Prototyping Time</i>	N/A	Presentations
14 (04/09)	Tuesday Thursday <i>Labs</i>	No Class or Labs	N/A	Final Report

Important Note: The class schedule may be subject to change. Please refer to the most recent syllabus or outline available online.

5.3 Other Important Dates

Drop date is typically the 40th class day of the academic year (Friday, March 9, 2018). Refer to the University of Guelph's online calendar for the schedule of dates.

6 LAB SAFETY

Safety is critically important to the School and it 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](tel: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>