

**Western University**  
**Faculty of Engineering**  
**Mechatronic Systems Engineering Program**

**MSE 2202—Introduction to Mechatronic Design**  
**Course Outline 2017–2018**

**Description:** In this course, students will learn about the design process employed for the development of mechatronic devices and systems. Key components such as microcontrollers, sensors and actuators are introduced and students will apply this knowledge to the completion of several hands-on labs during the first half of the term. Afterwards, students will use the second half of the term to expand upon this knowledge, apply the mechatronic design process and use analysis tools, while tackling a mechatronic design project. Throughout the project, students will be expected to complete milestones related to the design process, participate in design reviews, construct a functional prototype that will be presented at an open showcase at the end of the term, and produce comprehensive design documentation.

**Instructor:** Dr. Michael Naish, P.Eng.  
SEB 2055  
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Consultation hours: Tuesdays 12:30–1:30 pm or by appointment

**Academic Calendar Copy:** Introduces engineering design and structured design methods from the perspective of mechatronic systems that integrate mechanical, electrical and control technologies. Topics include the mechatronic design process, simple sensors and actuators, heat management, electronic communications and microcontroller-based software design.

**Contact Hours:** 3 lecture hours, 3 laboratory hours, 0.5 course.

**Prerequisites:** ES 1021A/B, ES 1022A/B/Y, ES 1050. Restricted to students enrolled in the Mechatronic Systems Engineering Program.

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

**CEAB Academic Units:** Engineering Science 50%, Engineering Design 50%

**Textbook:** J. Edward Carrer, R. Matthew Ohline and Thomas W. Kenny, *Introduction to Mechatronic Design*, Upper Saddle River, NJ: Prentice Hall, 2011. This text is recommended but not required.

**Required Software:** Arduino IDE, SolidWorks, EAGLE

**Recommended References:** The following list outlines a number of references that may prove useful over the duration of the course:

Clive L. Dym and Patrick Little, *Engineering Design: A Project-Based Introduction*, 3<sup>rd</sup> edition, New York: John Wiley & Sons, 2009.

Kevin Otto and Kristin Wood, *Product Design: Techniques in Reverse Engineering and New Product Development*, Upper Saddle River, NJ: Prentice Hall: 2000.

David G. Ullman. *The Mechanical Design Process*, 4<sup>th</sup> edition, Boston, MA: McGraw-Hill, 2009.

George E. Dieter and Linda C. Schmidt, *Engineering Design*, 5<sup>th</sup> edition, New York, NY: McGraw-Hill, 2013.

David G. Alciatore and Michael B. Hstand, *Introduction to Mechatronics and Measurement Systems*, 4<sup>th</sup> edition, New York: McGraw-Hill, 2012.

William Bolton, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, 5<sup>th</sup> edition, Essex, England: Pearson, 2011.

Klaus Pohl, *Requirements Engineering: Fundamentals, Principles and Techniques*, London: Springer-Verlag, 2010.

Pankaj Jalote, *A Concise Introduction to Software Engineering*, London: Springer-Verlag, 2008.

Michael Margolis, *Arduino Cookbook*, Sebastopol, CA: O'Reilly, 2011.

Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera and David P. DeWitt, *Fundamentals of Heat and Mass Transfer*, 7<sup>th</sup> edition, New York: John Wiley & Sons, 2011.

**General Learning Objectives (CEAB Graduate Attributes):**

Knowledge Base	I	Use of Engineering Tools	D	Impact on Society and the Environment	I
Problem Analysis	D	Individual and Team Work	D	Ethics and Equity	
Investigation	I	Communication Skills	D	Economics and Project Management	I
Design	D	Professionalism		Life-Long Learning	D

Notation: x represents the content level code as defined by the CEAB. blank = not applicable; I = introduced (introductory); D = developed (intermediate) and A = applied (advanced).

**Topics and Specific Learning Objectives:** Mechatronics, as an engineering discipline, strives to optimally integrate mechanical, electronic and computer systems to create high quality products and processes. This course will cover a variety of design considerations relevant to the development of integrated mechatronic systems. Students will develop knowledge and skills that allow them to adopt an interdisciplinary and integrated approach to engineering design.

**1. Microcontroller programming**

At the end of this section, students will be able to:

- a. Understand the architecture and organization of microcontrollers
- b. Program an Arduino-compatible microcontroller
- c. Understand how to interface with analog and digital peripheral devices
- d. Develop a microcontroller-based control system
- e. Use an industry-standard version control system as part of the software development process

## **2. Introduction to mechatronic systems**

At the end of this section, students will be able to:

- a. Recognize and explain the components and characteristics of a mechatronic system
- b. Understand the role of sensors, actuators, control, and machine intelligence in product design
- c. Explain how intelligent products and systems are developed

## **3. Transducers**

At the end of this section, students will be able to:

- a. Explain the operating characteristics of sensors and actuators
- b. Understand the operation and use of basic sensors
- c. Select and integrate suitable sensors and actuators into a mechatronic design

## **4. Engineering design principles**

At the end of this section, students will be able to:

- a. Understand and apply the product design process
- b. Clearly define the design problem with customer requirements and engineering specifications
- c. Generate and evaluate multiple possible solutions using knowledge from different engineering disciplines
- d. Plan and schedule the complete design process

## **5. Detailed design**

At the end of this section, students will be able to:

- a. Use an electronics CAD package (EagleCAD) to produce schematics and printed circuit board layouts for electronic circuits
- b. Understand how specify geometric dimensions and tolerances
- c. Produce detailed design documentation (detailed drawings, assembly drawings, etc.) to acceptable engineering standards
- d. Perform simple simulation studies to analyze component strength and mechanism motion
- e. Apply best-practices to the design and documentation of software and mechatronic systems

## **6. Design constraints**

At the end of this section, students will be able to:

- a. Understand and address a variety of factors that influence design decisions
- b. Apply techniques to improve the design of a product considering manufacturability, assembly, reliability, impact on the environment, disassembly, human factors, etc.

## **7. Heat Transfer**

At the end of this section, students will be able to:

- a. Understand the modes of heat transfer
- b. Analyze simple heat transfer problems

**Course Materials:** Guides for the laboratories will be available on the course OWL site. The material for this course will be taught in both lectures and labs; therefore, it is imperative that you attend each lecture and lab.

**Units:** SI

**Evaluation:** Grades for the course will be determined approximately on the following basis:

Course Component	Weight
Labs	16%
Team Project: Individual design notebook	10%
Product development file	16%
Final report	16%
Prototype	12%
Final Examination	30%

In order to pass the course, the following requirements must be met:

- A minimum mark of 50% in each laboratory exercise, with a minimum average of 60% across all laboratory exercises. This means that attendance in each laboratory period is mandatory. Your teaching assistant will sign your lab report as testimony to your attendance. You will only be allowed to make up for a missed laboratory if you have a valid excuse (e.g., approved academic accommodation).
- A minimum of 60% on the project and on the final exam.

If these conditions are not met, your final grade cannot be greater than 48%. Students who have failed this course (i.e., final average <50%) must repeat all components of the course.

Note that, the efforts of the team on the major project constitute nearly half of the grade for this course. Each student will be asked to specify the contribution made by each member of the team, including his/herself. Team grades may be adjusted by up to 30% for each student based on self and peer evaluation.

**Laboratories:** Labs will run every week. There will be 4 introductory labs covering circuit construction and soldering, microcontroller programming, basic sensors and actuators, drive systems and mechanical construction. Students will be required to purchase a microcontroller kit that includes an Arduino-compatible board, components for building and testing prototype circuits and a cable to interface with a computer. All other components required for the lab will be provided. The second half of the term will focus on a team-based mechatronic design project. A hardbound book (such as a standard quad-lined Physics notebook) must be used to record all pre-lab exercises, laboratory observations and project work.

**Final Examination:** The final exam will take place during the regular examination period. The final exam will be three hours long, closed book. Only simple, nonprogrammable calculators are allowed.

**Late Submission Policy:** All assigned work is due at the start of class or laboratory period, as appropriate. Late submissions will be penalized by  $2^{n+1}\%$ , where  $n$  is the number of days past the set due date. Weekends count as a single day. Any deliverables submitted more than 5 days late will not be accepted. Work submitted after the last day of classes (April 11) will not be accepted and will receive a grade of 0 automatically.

**Use of English:** In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work, with the exception of the final examination, may be returned

without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

In the professional life of an engineer, the manner in which oral and written communications are presented is extremely important. An engineering student must develop these skills as an integral part of the undergraduate program. To encourage the student to do so, the grades assigned to all written and oral work will take into account all aspects of presentation including conciseness, organization, neatness, use of headings and the preparation and use of tables and figures.

*All work will be marked first for content* after which a penalty not to exceed the maximum indicated may be applied for lack of proficiency in English and/or presentation.

**Attendance:** Attendance is mandatory for scheduled activities, including labs, the design reviews, and final showcase. Any student who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

**Absence Due to Illness or Other Circumstances:** Students should immediately consult with the instructor or program Director if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached “Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled”). The student should seek advice from the instructor or program Director regarding how best to deal with the problem. Failure to notify the instructor or program Director immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_medical.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf)

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_religious.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf)

**Cheating and Plagiarism:** Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf)

**Policy on Repeating All Components of a Course:** Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

**Use of Electronic Devices:** Students may use laptops *only* to access the course OWL site and perform course-related activities during lectures and laboratories. Calculator use is permitted during the final examination; students using programmable calculators must clear the device's memory at the beginning of exams. No other electronic devices (e.g., cell phones, MP3 players) may be used during lectures, laboratories or examinations.

**Internet and Electronic Mail:** Students are responsible for regularly checking their Western e-mail and the course web site (<https://owl.uwo.ca/portal/>) and making themselves aware of any information that is posted about the course.

**Accessibility:** Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

**Support Services:** Office of the Registrar, <http://www.registrar.uwo.ca/>

Student Development Centre, <http://www.sdc.uwo.ca/>

Engineering Undergraduate Services, <http://www.eng.uwo.ca/undergraduate/>

USC Student Support Services, <http://westernusc.ca/services/>

Students who are in emotional/mental distress should refer to Mental Health @ Western, [http://www.health.uwo.ca/mental\\_health/](http://www.health.uwo.ca/mental_health/), for a complete list of options about how to obtain help.

**Note: The above topics and outline are subject to adjustments and changes as needed.**

**INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED**

IF, ON MEDICAL OR COMPASSIONATE GROUNDS, YOU ARE UNABLE TO WRITE TERM TESTS OR FINAL EXAMINATIONS OR COMPLETE COURSE WORK BY THE DUE DATE, YOU SHOULD FOLLOW THE INSTRUCTIONS LISTED BELOW. YOU SHOULD UNDERSTAND THAT ACADEMIC RELIEF WILL NOT BE GRANTED AUTOMATICALLY ON REQUEST. YOU MUST DEMONSTRATE TO YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE) THAT THERE ARE COMPELLING MEDICAL OR COMPASSIONATE GROUNDS THAT CAN BE DOCUMENTED BEFORE ACADEMIC RELIEF WILL BE CONSIDERED. DIFFERENT REGULATIONS APPLY TO TERM TESTS, FINAL EXAMINATIONS AND LATE ASSIGNMENTS. PLEASE READ THE INSTRUCTIONS CAREFULLY. (SEE THE 2017 UWO ACADEMIC CALENDAR).

**A. GENERAL REGULATIONS & PROCEDURES**

1. All first year students will report to the Undergraduate Services Office, SEB 2097, for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or exam that is worth MORE THAN 10% of your final grade, you will report to the Undergraduate Services Office, SEB 2097. Otherwise, you will report to your department office to request relief.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your Department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

**B. TERM TESTS**

1. If you are in first year and you are unable to write a term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a term test, inform your instructor PRIOR to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office. If the test is worth MORE THAN 10% of your final grade you will report to the Undergraduate Services Office, SEB 2097 to request relief. Otherwise, you will report to your department office to request relief.
3. Be prepared to provide supporting documentation to the Department Chair and/or the Undergraduate Services Office (see next page for information on documentation).
4. Discuss with the instructor if and when the test can be rescheduled. **N.B.** The approval of the Chair or the Undergraduate Services Office is required when rescheduling term tests.

**C. FINAL EXAMINATIONS**

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

**N.B. It is the student's responsibility to check the date, time and location of the Special Examination.**

**D. LATE ASSIGNMENTS**

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4.
  - i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.
  - ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.

## E. SHORT ABSENCES

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

## F. EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or Ms. Karen Murray in the Undergraduate Services Office, if you are in first year.

## G. DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

**In Case of Serious Illness of a Family Member:** Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**In Case of a Death:** Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**For Other Extenuating Circumstances:** If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

**Note:** Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

## H. ACADEMIC CONCERNS

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).
2. **You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.**
3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

**Calendar References:** Check these regulations in your 2017 Western Academic Calendar available at [www.westerncalendar.uwo.ca](http://www.westerncalendar.uwo.ca).

Absences Due to Illness: <http://westerncalendar.uwo.ca/2017/pg117.html>  
Academic Accommodations for Students with Disabilities: <http://westerncalendar.uwo.ca/2017/pg118.html>  
Academic Accommodations for Religious or Holy Days: <http://westerncalendar.uwo.ca/2017/pg119.html>  
Course Withdrawals: <http://westerncalendar.uwo.ca/2017/pg157.html>  
Examinations: <http://westerncalendar.uwo.ca/2017/pg129.html>  
Scheduling of Term Assignments: <http://westerncalendar.uwo.ca/2017/pg135.html>  
Scholastic Offences: <http://www.westerncalendar.uwo.ca/2017/pg111.html>  
Student Medical Certificate: [http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/medicalform.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf)  
Engineering Academic Regulations: <http://www.westerncalendar.uwo.ca/2017/pg1442.html>

**Note:** These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

### **Drop Deadlines:**

First term half course (i.e. "A" or "F"):	November 5, 2017
Full courses and full-year half courses (i.e. "E", "Y" or no suffix):	November 30, 2017
Second term half or second term full course (i.e. "B" or "G"):	March 7, 2017

### **Contact Information:**

Undergraduate Services Office:	SEB 2097	Telephone: (519) 661-2130	E-mail: <a href="mailto:engugrad@uwo.ca">engugrad@uwo.ca</a>
Dept. of Chemical and Biochemical Engineering & Green Process Engineering:	TEB 477	Telephone: (519) 661-2131	E-mail: <a href="mailto:cbeugrad@uwo.ca">cbeugrad@uwo.ca</a>
Dept. of Civil and Environmental Engineering:	SEB 3005	Telephone: (519) 661-2139	E-mail: <a href="mailto:civil@uwo.ca">civil@uwo.ca</a>
Dept. of Electrical and Computer Engineering, Software Engineering & Mechatronics Engineering:	TEB 279	Telephone: (519) 661-3758	E-mail: <a href="mailto:eceugrad@uwo.ca">eceugrad@uwo.ca</a>
Dept. of Mechanical and Materials Engineering:	SEB 3002	Telephone: (519) 661-4122	E-mail: <a href="mailto:mmeundergraduate@uwo.ca">mmeundergraduate@uwo.ca</a>