1 Description

One of the key elements in the implementation of mechatronic systems is the integration of computational intelligence with sensing (measurement of environmental conditions) and actuation (affecting the surrounding environment through a controlled response). In this course, students are introduced to advanced concepts in sensing and actuation for mechatronic systems, including both traditional sensors and actuators, an introduction to advanced topics in micro electromechanical system (MEMS) sensing, and smart materials.

2 Contact Information

Course Instructor:
Instructor: Duane Jacques, Ph.D.
Email: djacque4@uwo.ca
Office: N/A

Consultation Hours:
TEB 216 Monday 2-3:30pm

Course Website:
[OWL]

Contact Hours: 3 lecture hours and 1.5 lab hours per week, 0.5 credit course.

CEAB Units: Engineering Science 60%, Engineering Design 40%

Pre-requisites: MSE 3301a/b, ECE 3332a/b

Co-requisites: ECE 3375a/b

Unless you have either the pre- and co-requisites for this course or written special permission from
your Dean to enrol 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 the course for failing to have the necessary prerequisites.

3 Course Materials


A course laboratory manual will be available on the course OWL site. All of the material for this course will be taught in the lectures and labs; therefore, it is imperative that you attend each lecture and lab.

4 General Learning Objectives

<table>
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<tr>
<th>Knowledge Base</th>
<th>3/2</th>
<th>Individual Work</th>
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<th>Ethics and Equity</th>
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<tbody>
<tr>
<td>Problem Analysis</td>
<td>3/3</td>
<td>Team Work</td>
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<td>Investigation</td>
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<td>Communication</td>
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<td>Life-Long Learning</td>
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<td>Design</td>
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<tr>
<td>Engineering Tools</td>
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<td>Impact on Society</td>
<td></td>
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</tbody>
</table>

Notation: x/y, where x is the cognitive level (1: Remember, 2: Understand, 3: Apply) at which the attribute is assessed and y is the academic level (1: Beginner, 2: Intermediate, 3: Advanced) at which the attribute is assessed.

5 Specific Learning Objectives

- Be able to determine the required sensor and actuator criteria for a mechatronic system.
- Understand the operation of commonly employed sensors and actuators.
- Be able to analyze and select the most appropriate sensors or actuator for an application.
- Be able to design and construct the appropriate interface circuits for the sensors and actuators.

6 Topics

1. Mechatronic systems and performance criteria
2. Mechanical transmission components in mechatronics systems
3. Sensor performance criteria and selection
   (a) Thermocouples
   (b) Resistive sensors
   (c) Inductive sensors
   (d) Capacitive sensors
   (e) Piezoelectric sensors
   (f) Encoders and tachometers

4. Actuator performance criteria and selection
   (a) Fluidic actuators
   (b) Solenoids and voice coil motors
   (c) Stepper motors
   (d) DC motors
   (e) Piezoelectric actuators
   (f) Shape memory alloy actuators
   (g) MEMS sensors and actuators

7 Evaluation

<table>
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<tr>
<th>Course Component</th>
<th>Weighting</th>
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<tbody>
<tr>
<td>Quizzes and Assignments</td>
<td>10%</td>
</tr>
<tr>
<td>Lab (including pre-lab)</td>
<td>20%</td>
</tr>
<tr>
<td>Project</td>
<td>20%</td>
</tr>
<tr>
<td>Final Examination</td>
<td>50%</td>
</tr>
</tbody>
</table>

To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination as well as on the laboratory. A final examination or laboratory mark less than 50% will result in a final course grade of 48% or less.

7.1 Quizzes and Assignments

A maximum of five Quizzes and/or Assignments will given throughout the term. The format may vary between online within OWL or requiring hard copy submission.

7.2 Laboratories

The MSE Arduino prototyping kit is required for the laboratory exercises. Please ensure that yours is in proper working order before the labs commence.
Six laboratory exercises are scheduled for the term. Students are only permitted to work on lab exercises during their registered lab section unless special permission to attend an alternate lab section is given by the instructor. Labs will be performed in small groups (usually 2 students per group) which will be assigned by instructor after the add/drop period ends.

1. Closed loop temperature control.
2. LVDT, encoder and tachometer interface and performance.
3. Pneumatic components and closed loop system.
5. Brushless DC motor drive construction and closed loop linear positioning.
6. Shape memory alloy actuator closed loop linear positioning.

7.3 Project

Groups of students will complete an analysis of the requirements and selection of actuators and sensors for a three axis of motion desktop fabrication machine. The details of the project will be distributed and discussed in class. The assignment of project groups will be announced at the same time as lab groups.

7.4 Final Examination

The final exam will be three hours long, closed book, programmable calculators allowed.

7.5 Use of English Policy

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.

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

All classes, laboratories and tutorials are mandatory, unless otherwise stated. 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.

9 Absence Due to Illness or Other Circumstances

Students should immediately consult with the instructor or department Chair 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 department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair 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

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

10 Cheating and Plagiarism Policy

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

11 Use of Electronic Devices Policy

Students may use laptops only to access the course OWL site 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.

12 Missed Midterm Policy

If a student misses a midterm examination, the exam will not be rescheduled. The student must follow the Instructions for Students Unable to Write Tests and provide documentation to their Department within 24 hours of the missed test. The Department will decide whether to allow the reweighting of the test, where reweighting means the marks normally allotted for the midterm will be added to the final exam (i.e., the weighing of the final exam will be increased to 70%). If no reasonable justification for missing the test can be found, then the student will receive a mark of zero for the test.

If a student is going to miss the midterm examination for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam.

13 Internet/Bulletin Board Policy

It is the student's responsibility to read the course website and/or bulletin board and be aware of any information that is posted about the course. If the student fails to act on information that has been posted on these sites and does so without a legitimate explanation (i.e., those covered under the illness/compassionate form), then there are NO grounds for an appeal.

14 Use of Electronic Devices

Students may use laptops, tablet computers, or smart phones only to access the course OWL site during lectures and tutorials. Use of nonprogrammable calculators only is permitted during quizzes and examinations. No other electronic devices may be used at any time during lectures, tutorials, or examinations.
15 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.

16 Internet and Electronic Mail

Students are responsible for regularly checking their Western email and the course web site (https://owl.uwo.ca/) and making themselves aware of any information that is posted about the course.

17 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:
- 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/, for a complete list of options about how to obtain help.
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 ACCOMMODATION WILL NOT BE GRANTED AUTOMATICALLY ON REQUEST. YOU MUST DEMONSTRATE TO YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE IF YOU ARE IN FIRST YEAR) THAT THERE ARE COMPELLING MEDICAL OR COMPASSIONATE GROUNDS THAT CAN BE DOCUMENTED BEFORE ACADEMIC ACCOMMODATION WILL BE CONSIDERED. DIFFERENT REGULATIONS APPLY TO TERM TESTS, FINAL EXAMINATIONS AND LATE ASSIGNMENTS. READ THE INSTRUCTIONS CAREFULLY. (SEE THE 2013 UWO ACADEMIC CALENDAR).

A. GENERAL REGULATIONS & PROCEDURES

1. CHECK THE COURSE OUTLINE TO SEE IF THE INSTRUCTOR HAS A POLICY FOR MISSED TESTS, EXAMINATIONS, LATE ASSIGNMENTS OR ATTENDANCE.

2. BRING YOUR REQUEST FOR ACADEMIC ACCOMMODATION TO THE ATTENTION OF THE CHAIR OF YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE IF YOU ARE IN FIRST YEAR) PRIOR TO THE SCHEDULED TIME OF THE TEST OR FINAL EXAMINATION OR DUE DATE OF THE ASSIGNMENT. IF YOU ARE UNABLE TO CONTACT THE RELEVANT PERSON, LEAVE A MESSAGE WITH THE APPROPRIATE DEPARTMENT (OR WITH THE UNDERGRADUATE SERVICES OFFICE, IF YOU ARE IN FIRST YEAR). THE ADDRESSES, TELEPHONE AND FAX NUMBERS ARE GIVEN AT THE END OF THESE INSTRUCTIONS. DOCUMENTATION MUST BE PROVIDED AS SOON AS POSSIBLE.

3. 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 unable to write a term test, inform your instructor and the Chair of your Department (or the Undergraduate Services Office if you are in first year) prior to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office and inform the Chair of the Department (or the Undergraduate Services Office if you are in first year).

2. Be prepared to provide supporting documentation to the Chair and the Undergraduate Services Office (see next page for information on documentation).

3. Discuss with the instructor if and when the test can be rescheduled. N.B. The approval of the Chair (or the Undergraduate Services Office if you are in first year) 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 (please spell your full name).

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.

**SHORT ABSENCES**

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

**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 the counsellors in the Undergraduate Services Office if you are in first year.

**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 if you are in first year). **This note must contain the following information:** severity of illness, effect on academic studies and duration of absence.

**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).

**ACADEMIC CONCERNS**

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).

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.

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 2013 Western Academic Calendar available at [www.westerncalendar.uwo.ca](http://www.westerncalendar.uwo.ca).

Absences Due to Illness: [http://www.westerncalendar.uwo.ca/2013/pg117.html](http://www.westerncalendar.uwo.ca/2013/pg117.html)

Academic Accommodations for Students with Disabilities: [http://www.westerncalendar.uwo.ca/2013/pg118.html](http://www.westerncalendar.uwo.ca/2013/pg118.html)

Academic Accommodations for Religious or Holy Days: [http://www.westerncalendar.uwo.ca/2013/pg119.html](http://www.westerncalendar.uwo.ca/2013/pg119.html)


Examinations: [http://www.westerncalendar.uwo.ca/2013/pg129.html](http://www.westerncalendar.uwo.ca/2013/pg129.html)

Scheduling of Term Assignments: [http://www.westerncalendar.uwo.ca/2013/pg97.html](http://www.westerncalendar.uwo.ca/2013/pg97.html)

Scholastic Offences: [http://www.westerncalendar.uwo.ca/2013/pg113.html](http://www.westerncalendar.uwo.ca/2013/pg113.html)

Engineering Academic Regulations: [http://www.westerncalendar.uwo.ca/2013/pg1442.html](http://www.westerncalendar.uwo.ca/2013/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:**

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<thead>
<tr>
<th>Course Type</th>
<th>First Term Half Course (i.e. “A” or “F”):</th>
<th>November 5, 2013</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Full Courses and Full-Year Half Courses (i.e. “E”, “Y” or no suffix):</td>
<td>November 30, 2013</td>
</tr>
<tr>
<td></td>
<td>Second Term Half or Second Term Full Course (i.e. “B” or “G”):</td>
<td>March 7, 2014</td>
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Undergraduate Services Office: SEB 2097 telephone: (519) 661-2130 fax: (519) 661-3757

Dept. of Chemical and Biochemical Engineering & Green Process Engineering: TEB 477 telephone: (519) 661-2131 fax: (519) 661-3498

Dept. of Civil and Environmental Engineering: SEB 3005 telephone: (519) 661-2139 fax: (519) 661-3779

Dept. of Electrical and Computer Engineering, Software Engineering: TEB 279 telephone: (519) 661-3758 fax: (519) 850-2436

Mechatronics Engineering: TEB 279 telephone: (519) 661-3758 fax: (519) 850-2436

Dept. of Mechanical and Materials Engineering: SEB 3002 telephone: (519) 661-4412 fax: (519) 661-3020

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