

**MME 4487a — Mechatronic System Design**

**COURSE OUTLINE 2024–2025**

**CALENDAR DESCRIPTION:** An overview of electrical, mechanical, optical, and control technologies for system integration. Topics include: intelligent products and processes; design methodology; system modeling; sensors and actuators; microcontrollers; knowledge-based control.

**INSTRUCTOR INFORMATION:** Michael D. Naish, PhD, P.Eng.  
Room: ACEB 3470  
Email: [mnaish@uwo.ca](mailto:mnaish@uwo.ca)

**PREREQUISITES:** MME 2213A/B or MME 2234A/B, and MME 3374A/B (or the former ECE 3374A/B), or (ECE 2233A/B and ECE 2277A/B), or (ECE 2238A/B and ECE 2277A/B).

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.

**ACCREDITATION UNITS:** Engineering Science = 40%, Engineering Design = 60%

**TOPICS AND LEARNING OBJECTIVES:** Mechatronic system design strives to integrate mechanical, electronic, optical, and computer technologies in order to create “optimal” products and processes. Basic concepts and fundamental principles will be reviewed in this course. Students will develop the knowledge and skills necessary to adopt an interdisciplinary approach to mechatronic system design through the lectures, hands-on laboratory assignments, and a term design project. The table below summarizes the course learning outcomes.

The Mechanical and Materials Engineering Program has been accredited by Canadian Engineering Accreditation Board (CEAB) of Engineers Canada. Accredited programs provide the academic requirements for licensure as a professional engineer in Canada. Western Engineering has defined indicators of the 12 Graduate Attributes (GAs) that the CEAB expects graduating engineering students to demonstrate. The connections between course learning outcomes and [Western Engineering’s GA Indicators](#) are identified below, with those in bold indicating the ones to be measured and reported annually.

Course Topics and Specific Learning Outcomes	CEAB Graduate Attribute Indicators
<p><b>1. Mechatronic System Design</b> The concepts of mechatronic systems, their primary components, and how they are designed in a systematic manner will be introduced at the beginning and reinforced throughout the course. In the end, students will be able to:</p> <ul style="list-style-type: none"> <li>a Identify and explain the components and characteristics of a mechatronic system</li> <li>b Explain how intelligent products and systems are developed</li> <li>c Expand engineering design knowledge to encompass mechatronic design principles</li> <li>d Explain the role of sensors, actuators, control, and machine intelligence in product performance</li> <li>e Apply product design and systems engineering concepts to the development of a mechatronic system</li> <li>f Adapt mechanical designs into mechatronic designs</li> </ul>	<p>KB4</p> <p>KB4</p> <p>KB4</p> <p>KB4</p> <p>D1, D2, D3, D4</p> <p>D1, D2, D3, D4</p>

<p><b>2. Microcontrollers</b> Microcontrollers are a key component of mechatronic systems, providing control and intelligence functionality. The structure of microcontrollers, how they are programmed, and how they are interfaced with external devices will be introduced and expanded upon throughout the course. In the end, students will be able to:</p> <ul style="list-style-type: none"> <li>a Understand the architecture and organization of microcontrollers</li> <li>b Discuss how to integrate a programmable device into a smart product</li> <li>c Demonstrate the programming skills needed to write, modify, and implement code for an ESP32 microcontroller</li> <li>d Understand and demonstrate how to interface with analog and digital peripheral devices</li> <li>e Design, construct, and evaluate functional mechatronic systems</li> </ul>	<p>KB4 PA2 PA2, ET2, ET3 KB4, PA2, ET2, ET3 D2, <b>D3</b>, <b>D4</b></p>
<p><b>3. Sensors and Actuators</b> Sensors provide critical information to a mechatronic system and actuators allow a system to affect the environment. At the end of this section, students will be able to:</p> <ul style="list-style-type: none"> <li>a Explain the operating characteristics and use of electrical and optical sensors</li> <li>b Explain the operating characteristics and use of DC electromechanical actuators</li> <li>c Select and integrate suitable sensors and actuators into a mechatronic design</li> <li>d Construct and evaluate simple electronic circuits to interface with sensors and actuators</li> </ul>	<p>KB4 KB4 PA1, PA2, PA3 ET2, ET3</p>
<p><b>4. Communication Systems</b> Several methods of wireless communications will be introduced. At the end of this section, students will be able to:</p> <ul style="list-style-type: none"> <li>a Explain the operating principles of wireless communication</li> <li>b Assess simple wireless electronic (optical and radio-frequency) communication systems</li> <li>c Implement wireless communication methods with a microcontroller</li> </ul>	<p>KB4 KB4 ET2, ET3</p>
<p><b>5. Machine Control and Intelligence</b> Microcontrollers afford the opportunity to embed human knowledge into the operation of devices and enable them to behave in an intelligent manner. At the end of this section, students will be able to:</p> <ul style="list-style-type: none"> <li>a Explain how human knowledge can be represented by a digital computer</li> <li>b Illustrate how human-like control and intelligence can be integrated into a mechatronic system using knowledge based systems, fuzzy logic, and artificial neural networks</li> </ul>	<p>KB4 KB4</p>

**CONTACT HOURS:**

Timetable information is available at <https://draftmyschedule.uwo.ca/>

**TEXT:**

**Optional:** W. Bolton, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, 7<sup>th</sup> Edition, Pearson Education, 2018. ISBN # 978-1292250977

**Note:** Students must purchase an *MME 4487 Lab Kit* through Western Engineering.

**REFERENCES:**

Assigned Readings

**UNITS:**

SI

**EVALUATION:**

The course grade will be determined as follows:

<b>Evaluation Format</b>	<b>Weight</b>	<b>Effort Type</b>	<b>Assigned</b>	<b>Due</b>	<b>CEAB GAs ASSESSED</b>
Labs (5 total)	25%	Individual	Week of Sep. 9, Sep. 16, Sep. 23, Oct. 7, Oct. 21	Week of Sep. 9, Sep. 23, Oct. 7, Oct. 21, Oct. 28	
Milestones (4 total)	20%	Team	Sep. 12	Oct. 21, Nov. 4, Nov. 15, Nov. 22	D3, D4
In-class Test	10%	Individual	Nov. 7	Nov. 7	
Showcase	5%	Team	Sep. 12	Nov. 28	
Prototype	10%	Team	Sep. 12	Dec. 6	
Design Report	30%	Team	Sep. 12	Dec. 6	D3, D4

The dates listed above are **tentative** and may be adjusted if needed. Marks will be assigned on the basis of method of analysis and presentation, correctness of solution, clarity and neatness.

**COURSE POLICIES:**

All work submitted must be of professional quality. Material that is handed in dirty, illegible, or disorganized will be returned to the student for resubmission and the late submission penalty will take effect. An additional penalty of 10% may be deducted for poor grammar, incoherence, or lack of flow in the written reports.

Laboratory sessions:

- Attendance at all laboratory sessions is mandatory. Absence from any session, or a portion of a session, without permission will result in a zero assigned to the corresponding lab. The teaching assistants will maintain a record of your attendance. Students who arrive 20 minutes or more after the scheduled lab time without a legitimate reason, leave the lab early without permission from the TA, or miss the lab without a legitimate reason will receive a zero for the corresponding lab.
- Students who miss a lab with academic consideration are required to contact the course instructor for further instructions. Failure to do so will result in a zero for that lab.
- Except where indicated, the laboratory exercises are to be completed individually. The lab deliverables will be assessed as a combination of in-lab demonstrations and materials submitted online. In-lab demonstrations must take place by the end of the designated lab period. Related materials submitted online are due by midnight of the same day.
- The laboratory assignments all involve modifying and writing microcontroller code. While Generative AI may be used as a tool to help debug code, how and where it is used must be clearly indicated. It is expected that students are the authors of the majority of the code submitted.
- Assignments will be penalized by 10% of the available marks per day for late submission. Assignments submitted more than 5 days late will not be accepted.
- A minimum mark of 50% in each laboratory exercise, with a minimum average of 60% across all laboratory exercises is required to pass the course.

In-class test:

- If a student misses the test, the test will not be rescheduled regardless of the circumstances for which the test was missed.
- Since the test is the only proctored assessment of an individual student's understanding of the course material, students seeking academic consideration for the test will be required to provide formal supporting documentation (i.e., a self-reported absence cannot be used). Students who are granted academic consideration for this assessment will be provided with an opportunity to complete an oral examination on the test subject matter.
- Students should review the policy for [Accommodation for Religious Holidays](#). Where a student will be unable to write the in-class test due to a conflicting religious holiday, they should inform the instructors as soon as possible but not later than one week prior to the test.
- Missing the test without academic consideration will result in a grade of zero for the test.

## Project:

- Project teams will be formed by the third week of the term. Students must form a team with others in the same lab section.
- Since project deliverables are a team effort, it is expected that the team has sufficient capacity to accommodate the illness or absence of one or more team members. In other words, there will not be any academic consideration given for group submissions. If extenuating circumstances affect all team members, then the team may choose to submit milestone deliverables up to 48 hours after the due date without incurring late penalties.
- The default assumption is that everyone contributes equally to the team effort, and hence all students will receive the same grade for the project components. Each student will be asked to specify the contribution made by each member of the team, including themselves. Team grades may be adjusted by up to 50% for each student based on self and peer evaluation. Students who provide limited contributions to the team effort may receive a failing project grade, irrespective of the how well the rest of the team does.
- A minimum of 60% must be obtained on the project in order to pass the course.

## Tips for success:

- You are responsible for all material posted online and discussed in class. Class attendance is highly encouraged. Attention to the events happening in each lecture will ensure your understanding of the topics and will allow you to gain the most from the course.
- While every student works at a different level, it is the effort placed in each requirement that ultimately leads to success. Your interest in the course, participation in class by asking relevant questions, and talking to the instructor during office hours will all contribute to your successful completion of the assignments, labs, test, and project. Such behavior is highly encouraged.
- It is your responsibility to determine what is required of you. If you miss a lecture, it is your responsibility to find out what was discussed and what instructions were given regarding assignments, laboratory sessions, or exams.
- Plan to arrive to class and to the lab a few minutes early. Lectures will start promptly, and immediate attention will be required from the start.

**CONSULTATION  
HOURS:**

By appointment

**USE OF  
GENERATIVE  
ARTIFICIAL  
INTELLIGENCE:**

As stated above in the Course Policies section, the **limited use** of generative artificial intelligence (AI) tools/software/apps is permitted in specific situations. It is expected that students develop their understanding of microcontroller programming and can write functional software without assistance. Further, students are expected to be able to conduct design work on their own and write technical reports in their own words. In general, generative AI must not be treated as a substitute for a student's innate ability to write code, design, or write reports. Apart from isolated words, all use of generative AI must be clearly indicated. Further, any generated content must be carefully reviewed for correctness.

**General Faculty / University Policies**

In the event of contradictions between course-specific policies above and general Faculty / University policies described below, please contact your course instructor for clarification.

- Attendance** 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 Associate Dean Academic (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean Academic, the student will be debarred from taking the regular examination in the course.
- Missed/Late Accommodation Policy**
1. Students missing a test/assignment/lab or examination you will report the absence by submitting an Academic Consideration Request form through [STUDENT ABSENCE PORTAL](#).
  2. **Documentation must be provided as soon as possible.**
- Exam Accommodation**
1. If you are unable to write a final examination, report your absence using the Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#).
  2. Be prepared to provide the Undergraduate Services Office with supporting documentation (below 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, headache, 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 submit an Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#).
- PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.*
- 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 submit the Academic Consideration Request Form and provide documentation if requested by the instructor (see below 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 Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.
  4. Some courses may have built-in flexibility for assignment deadlines or the total number of assignments that will be graded. See course-specific policies for details.
  5. Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.
- Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).*
- Medical Accommodation**
1. The Academic Consideration Request Form is available through the [STUDENT ABSENCE PORTAL](#).
  2. Requests for academic consideration must include the following components:

- a. Indication of the course(s) and assessment(s) affected by the request
  - b. Medical note, and
  - c. Additional supporting documentation as relevant
3. Requests for academic consideration without a medical note or other supporting documentation may be accepted once per term, per course.
  4. Undocumented absences cannot be used for examinations scheduled by the Office of the Registrar during official examination periods (including take-home final exams and December mid-year exams for full courses) and practical laboratory and performance tests typically scheduled in the last week of the term. Undocumented absences also cannot be used for the “designated assessment” in each course. When flexibility in assessment exists and is clearly stated on the course outline, both undocumented absences and academic consideration requests with documentation may be denied.
  5. **Students must request academic consideration as soon as possible and no later than 48 hours after the missed assessment.**
  6. Once the request and supporting documents have been received and reviewed, appropriate academic consideration, if granted, shall be determined by the instructor in consultation with the academic advisor, in a manner consistent with the course outline.

Academic consideration may include extension of deadlines, waiver of attendance requirements for classes/labs/tutorials, or re-weighting of course requirements. Some forms of academic consideration, such as arranging Special Examinations, assigning a grade of Incomplete, or granting late withdrawals without academic penalty, may only be granted by the Academic Advising office of the Faculty of Registration.

7. An instructor may deny academic consideration for any assessment that is not required in the calculation of the final grade (e.g., “8 of 10 quizzes”). Assessment flexibility must be indicated on the course outline.
8. An instructor may deny academic consideration relating to the timeframe submission of work where there is already flexibility in the submission timeframe (e.g., 72-hour submission window). This assessment flexibility must be indicated on the course outline.

### **Religious Accommodation**

When scheduling unavoidably conflicts with religious holidays, which (a) require an absence from the University or (b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate Department Chair and, if necessary, the student's Dean.

It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

### **Academic Integrity**

In the Faculty of Engineering, we encourage students to create a culture of honesty, trust, fairness, respect, responsibility, and courage, befitting the professional degree you are pursuing.

Please visit [Academic Integrity Western Engineering](#) for more information

### **Academic Offences**

Plagiarism means using another's work without giving credit. The university has rules against plagiarism and other scholastic offences. Western Engineering has a zero-tolerance policy on plagiarism. The minimum penalty is zero on the course work and a repeat

offence will earn you zero on the course. A third offence may lead to expulsion from the university.

[Scholastic Discipline for Undergraduate Students & Cheating, Plagiarism and Unauthorized Collaboration: What Students Need to Know](#)

Students must write their reports, 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)

#### **Faculty of Engineering AI Policy**

The use of generative Artificial intelligence (GenAI) tools won't be discouraged in the Faculty of Engineering. As we pride ourselves on building the future we can't hide from the use of GenAI tools to contribute to the understanding of the course materials. However, the use of GenAI tools in any assignment or contribution during the course will have to be disclosed, as a resource.

**GenAI tools use won't be permitted in any type of examination or other assessments where the faculty have prohibited their use.** If use of GenAI tools is detected by the instructor in these instances, academic offences penalties might be imposed against the student.

#### **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 except for 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.

#### **Accessibility**

Western is committed to achieving barrier free accessibility for persons with disabilities studying, visiting and working at Western. As part of this commitment, there are a variety of services, groups and committees on campus devoted to promoting accessibility and to ensuring that individuals have equitable access to services and facilities. To help provide the best experience to all members of the campus community, please visit the [Accessibility Western University](#) for information on accessibility-related resources available at Western.

Students with disabilities may arrange for academic accommodation at Western. For a more detailed explanation, please visit [Academic Support & Engagement -Academic Accommodation](#).

#### **Inclusivity, Diversity, and Respect**

The Faculty of Engineering at Western University is committed to creating equitable and inclusive learning environments that value diverse perspectives and experiences. We recognize that university courses often marginalize students based on social identity characteristics such as, but not limited to, Indigeneity, race, ethnicity, nationality, ability, gender identity, gender expression, sexuality, age, language, religion, and socioeconomic status. Understanding this, we strive to facilitate equitable experiences and inclusion

within the classroom by respecting and integrating multiple ways of knowing, being, and doing. Please visit the [Office of Equity, Diversity and Inclusion](#).

- Health and Well-Being**
- [Health & Wellness Services – Students](#) - Offers appointment-based medical clinic for all registered part-time and full-time students.
  - [Mental Health Support](#) - Provides professional and confidential services, free of charge, to students needing assistance to meet their personal, social and academic goals. Services include consultation, referral, groups and workshops, as well as brief, change-oriented psychotherapy.
  - [Crisis Support](#) - For immediate assistance, please visit Thames Hall Room 2170 or call 519-661-3030. The crisis clinic operates between 11:00 am - 4:30 pm. For after-hours crisis support, click [here](#).
  - [Gender-Based Violence and Survivor Support](#) - Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, [here](#). To connect with a case manager or set up an appointment, please contact [support@uwo.ca](mailto:support@uwo.ca).

### Important Links

- [WESTERN ACADEMIC CALENDAR](#)
- [ACADEMIC RIGHTS AND RESPONSIBILITIES](#)
- [ENGINEERING PROGRESSION REQUIREMENTS AND ACADEMIC REGULATIONS](#)
- [UNIVERSITY STUDENTS' COUNCIL \(USC\) - SERVICES](#)
- [IMPORTANT DATES AND DEADLINES](#)
- [ACADEMIC CONSIDERATION FOR MEDICAL ILLNESS - UNDERGRADUATE STUDENTS](#)
- [ACCOMMODATIONS FOR RELIGIOUS HOLIDAYS](#)
- [SCHEDULING OF ASSIGNMENTS, TESTS, AND EXAMINATIONS](#)
- [STUDENT FORMS](#)
- [OFFICE OF THE REGISTRAR](#)
- [RETENTION OF ELECTRONIC VERSION OF COURSE OUTLINES \(SYLLABI\)](#)
- [ACADEMIC APPEALS](#)
- [STUDENT ABSENCE PORTAL](#)

**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.

### Add Deadlines:

First term half course (i.e. "A" or "F")	September 13, 2024
Full courses and full-year half course (i.e. "E", "Y" or no suffix)	September 13, 2024
Second term half course (i.e. "B" or "G")	January 14, 2025

### Drop Deadlines:

First term half course without penalty (i.e. "A" or "F")	November 12, 2024
Full courses and full-year half courses without penalty (i.e. "E", "Y" or no suffix)	December 2, 2024
Second term half or second term full course without penalty (i.e. "B" or "G")	March 7, 2025

**Contact Information:**

Undergraduate Services Office: Phone: 519-661-2130	SEB 2097 E-mail: <a href="mailto:engugrad@uwo.ca">engugrad@uwo.ca</a>
Mechanical Engineering: Phone: 519-661-4122	SEB 3002 E-mail: <a href="mailto:mmeundergraduate@uwo.ca">mmeundergraduate@uwo.ca</a>
Chemical & Green Process Engineering: Phone: 519-661-2131	TEB 477 E-mail: <a href="mailto:cbeugrad@uwo.ca">cbeugrad@uwo.ca</a>
Civil Engineering: Phone: 519-661-2139	SEB 3005 E-mail: <a href="mailto:civil@uwo.ca">civil@uwo.ca</a>
Computer, Electrical, Mechatronic Systems & Software Engineering Phone: 519-661-3758	TEB 279 E-mail: <a href="mailto:eceugrad@uwo.ca">eceugrad@uwo.ca</a>
Integrated Engineering Phone: 519-661-6725	ACEB 2410 E-mail: <a href="mailto:engceli@uwo.ca">engceli@uwo.ca</a>
Office of the Registrar/Student Central Phone: 519-661-2100	WSSB 1120