Western University
Department of Mechanical & Materials Engineering

MME 4487a — Mechatronic System Design

COURSE OUTLINE 2025–2026

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

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**
1. Mechatronic System Design 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:	
a. Identify and explain the components and characteristics of a mechatronic system	KB4
b. Explain how intelligent products and systems are developed	KB4
c. Expand engineering design knowledge to encompass mechatronic design principles	KB4
d. Explain the role of sensors, actuators, control, and machine intelligence in product performance	KB4
e. Apply product design and systems engineering concepts to the development of a mechatronic system	D1, D2, D3, D4
f. Adapt mechanical designs into mechatronic designs	D1, D2, D3, D4

2. Microcontrollers 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:	
a. Understand the architecture and organization of microcontrollers	KB4
b. Discuss how to integrate a programmable device into a smart product	PA2
c. Demonstrate the programming skills needed to write, modify, and implement code for an ESP32 microcontroller	PA2, ET2, ET3
d. Understand and demonstrate how to interface with analog and digital peripheral devices	KB4, PA2, ET2, ET3
e. Design, construct, and evaluate functional mechatronic systems	D2, **D3**, **D4**
3. Sensors and Actuators 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:	
a. Explain the operating characteristics and use of electrical and optical sensors	KB4
b. Explain the operating characteristics and use of DC electromechanical actuators	KB4
c. Select and integrate suitable sensors and actuators into a mechatronic design	PA1, PA2, PA3
d. Construct and evaluate simple electronic circuits to interface with sensors and actuators	ET2, ET3
4. Communication Systems Several methods of wireless communications will be introduced. At the end of this section, students will be able to:	
a. Explain the operating principles of wireless communication	KB4
b. Assess simple wireless electronic (optical and radio-frequency) communication systems	KB4
c. Implement wireless communication methods with a microcontroller	ET2, ET3
5. Machine Control and Intelligence 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:	
a. Explain how human knowledge can be represented by a digital computer	KB4
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	KB4

CONTACT HOURS: 2 lecture hours, 3 laboratory hours, 0.5 course. Lectures and labs occur every week throughout the term. Timetable information is available at https://draftmyschedule.uwo.ca/

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

Note: Students must purchase an *MME 4487 Lab Kit* through Western Engineering Stores: https://estore.eng.uwo.ca. The cost of a kit is $80.

REFERENCES: Assigned Readings

UNITS: SI

EVALUATION: The course grade will be determined as follows:

Evaluation Format	Weight	Effort Type	Assigned	Due	CEAB GAs ASSESSED
Labs (5 total)	25%	Individual	Week of Sep. 8, Sep. 15, Sep. 22, Oct. 6, Oct. 13	Week of Sep. 8, Sep. 22, Oct. 6, Oct. 20, Oct. 27	
Milestones (4 total)	20%	Team	Sep. 11	Oct. 27, Nov. 10, Nov. 21, Nov. 28	D3, D4
In-class Test	10%	Individual	Nov. 13	Nov. 13	
Showcase	5%	Team	Sep. 11	Dec. 4	
Prototype	10%	Team	Sep. 11	Dec. 9	
Design Report	30%	Team	Sep. 11	Dec. 9	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 for 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. ***Furthermore, to verify effective use of AI in a submitted lab, students may be selected randomly for an interview pertaining to their code and other aspects of their lab***. If irresponsible use of GenAI tools is determined by the instructor, the deliverable will receive a grade of zero. Repeated offences may result in further academic offence penalties.
- Lab submissions may be submitted up to 48 hours after the due date without incurring academic penalty. **No further extension will be granted and submissions later than 48 hours past the deadline 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., the test is a designated assessment and 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 academic penalty.
- 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 themself. 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.
- Generative AI may be used as a tool to help generate ideas and edit portions of the project milestones and project report submissions; however, it is expected that students are the primary authors of these deliverables and are responsible for the content. **All use of Generative AI in any project deliverable must be fully and clearly disclosed**. In particular, it should be clear how students assessed the validity and accuracy of all generated content, along with any corrections that were necessary. ***Furthermore, to verify effective use of AI in a submitted course deliverable, students may be selected randomly for an interview pertaining to the deliverable submitted by the design team***. If irresponsible use of GenAI tools is determined by the instructor, the deliverable will receive a grade of zero. Repeated offences may result in further academic offence penalties.
- 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.

LATE SUBMISSION POLICY:

This course employs flexible deadlines for labs and project milestone submissions. The deadlines can be found above in the course outline. For each deliverable, students are expected to submit the assignment by the deadline listed. Should illness or extenuating circumstances arise, students are permitted to submit their deliverable up to 48 hours past the deadline without academic penalty. **As flexible deadlines are used in this course, requests for academic consideration will not be granted.** If you have a long-term academic consideration or an accommodation for disability that allows greater flexibility than provided here, please reach out to Prof. Naish at least one week prior to the posted deadline.

CONSULTATION HOURS:

By appointment

USE OF GENERATIVE ARTIFICIAL INTELLIGENCE:	As stated above in the Course Policies section, the use of generative artificial intelligence (AI) tools/software/apps is permitted in specific situations. It is expected that students will 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

The Faculty of Engineering and Western University have overarching policies that prescribe how undergraduate courses should run. The course-specific policies described above should be considered *in addition to* those overarching policies, or as course-specific interpretations of them. In the event of contradictions or confusion between course-specific policies above and general Faculty / University policies, please contact your course instructor for clarification.

Western Engineering's undergraduate polices can be found by navigating to:
https://www.eng.uwo.ca/undergraduate/academic-support-and-accommodations/policies.html

and then clicking the "*Engineering Undergraduate Policies framework*" link.