Western University
Faculty of Engineering
Artificial Intelligence Systems Engineering Program

AISE 3350A – Cyber-Physical Systems Theory

Course Outline Fall 2026

COURSE DESCRIPTION: Cyber-Physical systems (CPS) are physical and engineered systems whose operations are monitored, coordinated, controlled and integrated by a computing and communication core. CPSs are complex systems with the integration of computation, communication, and control (3C). In this course, the students are introduced to the fundamentals of CPSs, including the architecture of CPS, modelling in the continuous time domain, and the interface between physical (continuous) and cyber (discrete) worlds. Basis of control theory, sensors and actuators, will be introduced.

This course explores the foundational principles of cyber-physical systems with an emphasis on AI techniques for enhancing system intelligence, adaptability, and autonomy. Topics include the integration of machine learning algorithms into CPS, data-driven modeling, perception, and decision-making in real-time, as well as methods for ensuring safety, robustness, and efficiency in complex environments. Applications span areas like autonomous vehicles, smart cities, and robotics.

ACADEMIC CALENDAR:
https://www.westerncalendar.uwo.ca/Courses.cfm?CourseAcadCalendarID=MAIN_030974_1&SelectedCalendar=Live&ArchiveID=

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PREREQUISITES: Numerical and Mathematic Methods 2270A/B, Numerical and Mathematical Methods 2276A/B or Numerical and Mathematical Methods 2277A/B, Physics 1302A/B or Physics 1402A/B.

COREQUISITES: DS3000

ANTIREQUISITES: The former ECE 3350A/B.

CEAB ACADEMIC UNITS: Engineering Science 25%, Engineering Design 75%

INSTRUCTOR INFORMATION:

Instructor:
Office:
Phone:
Email:

CONTACT HOURS: Timetable information is available at https://draftmyschedule.uwo.ca/.

LECTURE:

LAB:

TUTORIAL:

RECOMMENDED/REQUIRED TEXT: None. Students are expected to have backgrounds in formal logic, circuits, programming, mathematical modelling, dynamic system, differential equations, linear algebra, and calculus.

RECOMMENDED/ REQUIRED SOFTWARE: Matlab/Simulink, Python/Jupyter Notebook/Google Colab

RECOMMENDED RESOURCES/REFERENCES:

N. Nise, "Control Systems Engineering", 8th (or 7th) edition, Wiley, ISBN: 978-1-119-47422-7

D.G. Manolakis and V.K. Ingle, "Applied Digital Signal Processing", Cambridge University Press, ISBN: 9780511835261

GENERAL LEARNING OBJECTIVES (CEAB GRADUATE ATTRIBUTES)

Knowledge Base	A	Engineering Tools	A	Impact on Society	**D**
Problem Analysis		Individual & Teamwork		Ethics and Equity	**D**
Investigation	I	Communication	A	Economics and Project Mgmt.	
Design	I	Professionalism	D	Life-Long Learning	**A**

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).

Rating: I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. A – It is expected that the student can apply the knowledge without prompting (e. g. no review).

COURSE MATERIALS: Weekly content and 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

COURSE TOPICS AND SPECIFIC LEARNING OUTCOMES: Cyber-Physical Systems refers to the integration of computation with physical processes. Often, communication is an integral part of the integration. This course will cover the mathematics needed to model them. Students will learn about the use of continuous systems, discrete systems, and hybrid systems for modelling CPSs, with modest use of communication, sensing and actuation.

The following table summarizes the course learning outcomes along with CEAB GAIs where the GAIs in bold indicate ones to be measured and reported annually.

Course Topics and Specific Learning Outcomes	**CEAB Graduate Attribute Indicators**
1. Introduction to Cyber-Physical Systems (CPS) • Architecture of Cyber-Physical world, including analog, digital, and cyber-systems. • Examples of CPS • Concept of software At the end of this section, students will be able to: • Understand the components of CPS, how they are interconnected, and the significance of CPS in modern society • Discuss intelligently about requirements for CPSs, such as real-time and fault tolerance • Discuss the significance of historical figures and their contributions to CPS	 KB4 IN3, CS3, IE1, LL2 EE4
2. Modelling of systems in continuous time • State-space models • Transfer functions • Frequency response • Stability • Feedback At the end of this section, students will be able to • Understand the basics of how to use mathematical principles to model physical systems and phenomena • Understand how to evaluate the performance of these systems • Capable of mathematical skills including modelling, differentiation and integration, and solving algebraic and differential equations	 KB1 KB2 KB1

3. Interface between Physical and Cyber Worlds • Sensors and actuators • Sampling, A/D and D/A conversion • Principles of data collection • Notion of information and control At the end of this section, students will be able to	
• Understand the basic types of sensors and actuators and how to model and evaluate them mathematically	IN3
• Understand how to convert a continuous (analog) signal and its discrete (digital) counterpart and vise versa, and the limitations of these techniques	CS1
• Assemble a given CPS	ET2
• Program a CPS to achieve a certain task	D3
• Evaluate and compare different CPS designs	

EVALUATION:

Name	% Worth	Assigned	Due Date	CEAB GAs ASSESSED
Assignments	10%		TBA	ET,IE,KB
Labs (Total = 4)	20%		TBA	KB,ITW,IN
Mid-term	10%		Oct. 20, 2026	KB,CS,EE
Project	30%		Dec. 3, 2026	ET,IN,DE,ITW,CS,LL,PR
Final Examination	30%		TBA	KB,CS,LL,EE

Note that 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 in the requested format. Material that is handed in dirty, illegible, disorganized, or in an unapproved format 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.

Homework Assignments: Assignments are posted on the course online portal. It should be noted that assignments are not only used as a means of student's assessment in the course, but also to provide information that complements the learning experience and enriches the study outcome. Student must use Assignments as a tool for evaluating their knowledge and understanding of each topic.

For each assignment, students are expected to submit the assignment by the deadline listed. Should illness or extenuating circumstances arise, students are permitted to submit up to 72 hours past the deadline without academic penalty. No late submission after 72 hours past the

deadline will be accepted unless proper documentation is submitted in advance requesting for consideration.

LABORATORIES: The schedule for laboratory exercises will be posted on the course online portal. Laboratory exercises may comprise a both the in-lab and take-home components. The In-lab components are to be completed in person during the allocated laboratory time. It is mandatory for the students to complete all lab exercises. Students will work in groups of 3. Equipment required for the labs will be provided.

The take-home components are to be submitted online on the course online portal. Students are expected to submit the take-home components by the deadline listed. Should illness or extenuating circumstances arise, students are permitted to submit up to 72 hours past the deadline without academic penalty. No late submission after 72 hours past the deadline will be accepted unless proper documentation is submitted in advance requesting for consideration.

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 laboratory report. The teaching assistants will sign your lab report as testimony to your attendance. Students who arrive 20 min after the scheduled lab time without a legitimate reason, leave the lab early without permission from the teaching assistant, or miss the lab without a legitimate reason will receive a zero for the corresponding laboratory assignment. Students who miss a lab with academic consideration are required to contact the course instructor within 2 days for further instructions. Failure to do so will result in a zero mark for that lab.

A minimum average of 60% across all laboratory exercises is required to pass the course.

PROJECT: A group project with flexible format will be completed in which students will perform critical analysis and design and implementation of a CPS. The details of the project, including requirements, grading specifications, and due date, will be distributed on the course online portal. Project reports are expected to be submitted in digital form to the course online portal. Please note that because the submission deadline for Project already includes flexibility in the form of 72 hour submission window, the instructor reserves the right to deny academic consideration for assignments which are submitted following the end of the period of flexibility.

FINAL EXAMINATION: The final exam will take place during the regular examination period. The final exam will be three 3 hours long, closed book, with 2-pages of notes allowed. Only simple, nonprogrammable calculators are allowed.

To obtain a passing grade in the course, a mark of 60% or more must be achieved on the final examination. Failure to achieve a mark of 60% or more in the final examination will results in a

final course grade of 49% or lower. Students who have failed this course (i.e., final average < 50%) must repeat all components of the course.

LATE SUBMISSION POLICY:
Advise the instructor if you are having problems completing the assignment on time prior to the due date of the assignment and be prepared to submit an Academic Consideration Request and provide documentation if requested by the instructor at:
https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

If you are granted an extension, establish a due date with the instructor. The approval of the Chair of your Department is not required if assignments are completed prior to the last day of classes. 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.

This course employs flexible deadlines for assignments. The assignment deadlines can be found above in the course outline. For each assignment, students are expected to submit the assignment by the deadline listed. Should illness or extenuating circumstances arise, students are permitted to submit their assignment up to 72 hours past the deadline without academic penalty. No submission beyond 72 hours past the deadline will be accepted unless proper documentation is submitted for academic accommodation. As flexible deadlines are used in this course, requests for academic consideration may 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 your instructor at least one week prior to the posted deadline.

ATTENDANCE: Attendance is mandatory for all lectures and labs.

FACULTY OF ENGINEERING POLICIES:
Students must familiarize themselves with the policies of the Faculty of Engineering
https://www.eng.uwo.ca/electrical//pdf/2025-UG-Policy-and-Procedures.pdf

FACULTY OF ENGINEERING POLICIES AND PROCEDURES - UNDERGRADUATE
Absence/Late Accommodation Policy
Students must familiarize themselves with the University Policy on Academic Consideration – Undergraduate Students in First Entry Programs posted on the Academic Calendar:
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/academic_consideration_Sep24.pdf
This policy does not apply to requests for Academic Consideration submitted for attempted or completed work, whether online or in person. The policy also does not apply to students

experiencing longer-term impacts on their academic responsibilities. These students should consult Accessible Education.

Students missing a test/assignment/lab or examination will report the absence by submitting Academic Consideration Request form through STUDENT ABSENCE PORTAL.

- All requests for Academic Consideration must be made within 48 hours after the assessment date or submission deadline. Academic consideration may include extension of deadlines, waiver of attendance requirements for classes/labs/tutorials, or re-weighting of course requirements.
- 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.
- 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.
- All Academic Consideration requests must include supporting documentation; however, recognizing that formal documentation may not be available in some extenuating circumstances, the policy allows students to make one Academic Consideration request without supporting documentation per course. Some assessments are excluded from this policy. Please refer to the course outline to determine if documentation isrequired.
- Requests without supporting documentation are limited to one per term per course.
- Please note that examinations scheduled during official examination periods always require official supporting documentation.
- If a student mistakenly submits their one allowed Academic Consideration request without supporting documentation for the assessments listed above that do not require academic consideration, the request cannot be recalled and reapplied. This privilege is forfeited.

An undocumented absence is only valid for a 24-hour period, from midnight on the day specified to midnight of the following day. An appropriate use of an undocumented absence would be for an in-class assessment that takes place that day. Where the time given to complete the assessment is longer than 24 hours, an undocumented absence will not cover a student for the full time given to complete the assessment, and flexibility considerations in submitting the assessment will override the undocumented absence.

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

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

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

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. Please refer to the course outline for the GenAI policy related to each course.

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.

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 assistant, 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 (GBSV) and providing compassionate support to anyone who is going through or has gone through these traumatic events. If you are experiencing or have experienced GBSV (either recently or in the past), you will find information about support services for survivors, including emergency contacts at the following website: https://www.uwo.ca/health/student_support/survivor_support/gethelp.html To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Important Contacts

Engineering Undergraduate Services

Department of Electrical and Computer Engineering

Office of the Registrar/Student Central

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