Western University
Department of Mechanical & Materials Engineering

MME 4452b — Robotics and Manufacturing Automation

COURSE OUTLINE 2024–2025

CALENDAR DESCRIPTION:

An overview of robotics and manufacturing automation technology and principles. Topics include: automatic production and assembly, sensors, actuators and drives, mechanization of part handling, industrial robots, and vision systems. Emphasis will be on the planning, design and implementation of automation systems. PLCs will be used in the lab sessions.

COURSE INFORMATION:

Instructor: HaoTian Harvey Shi, Ph.D., P.Eng.
Office: SEB 3089
Email: Harvey.shi@uwo.ca

Lectures: See Draft My Schedule

Labs: See Draft My Schedule

PREREQUISITES:

ECE 3374a/b and MME 3380a/b or ECE 3330a/b and ECE 3375a/b or registration in year four of the Integrated Engineering Program.

ACCREDITATION UNITS:

Engineering Science = 75%, Engineering Design = 25%

TOPICS:

- Introduction to industrial automation
- Components of manufacturing automation
- Assembly process and part handling
- Actuators for automated systems
- Industrial control
- Industrial robotics and robot motion analysis
- Industrial sensors and quality control
- Machine vision systems

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.

Upon successful completion of the course, each student should be able to:

- Demonstrate understanding of manufacturing automation technologies and principles **(KB4)**
- Categorize different types of automated production processes **(KB4)**
- Apply electrical, mechanical and pneumatic actuators in the context of an automated system **(ET1)**
- Understand the operation and use of common industrial controllers (PLCs) **(ET2)**
- Understand the performance and dynamic characteristics of industrial robots **(PA2)**
- Perform motion analysis of serial link industrial robots **(PA2)**
- Design elementary mechanisms for automated machinery **(D2 & D3)**
- Apply the principles of Design for Assembly (DFA) **(D3)**
- Understand the principles and use of industrial sensors **(ET2)**
- Describe the basic operation of industrial machine vision systems **(ET2)**
- Integrate these manufacturing technologies into the design of an automated workcell **(D4)**
- During the term each student will design an automated production system as part of a team-based project. **(ITW2, EPM2)**

CONTACT HOURS:

2 lecture hours and 3 laboratory hours per week, half course.

TEXT:

James A. Rehg, Introduction to Robotics in CIM Systems, 5th edition, Upper Saddle River, NJ: Prentice Hall, 2003. ISBN 0130602434 (Optional)

REFERENCES: Beno Benhabib, *Manufacturing: Design, Production, Automation and Integration*, New York: Marcel-Dekker, 2003. (Optional)

Mikell P. Groover, *Automation, Production Systems, and Computer-Integrated Manufacturing*, 2nd Edition, Upper Saddle River, NJ: Prentice Hall, 2001. (optional)

UNITS: SI

EVALUATION: The final course grade will be determined as follows:

Lab Work	Weekly lab sessions starting **Jan. 13th**	10%
Individual Assignments (4)	Approx. biweekly, starting **Jan. 27th**	10%
Individual Design Notebook	Week of **Mar. 31st** in lab	10%
Group Project	Week of **Mar. 31st** (Demo)	30%
Final Examination	April Exam Period TBD	40%

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. 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 scheduled lab sessions is mandatory.
- Students who arrive 20 min after the scheduled lab time without academic consideration or leave the lab early without permission from the TA or miss the lab without academic consideration will receive a 0 in the lab.

Assignments:

- There will be a total of 4 assignments over the term.
- Each assignment is worth 2.5% of the final grade.
- Assignments will be on OWL as specified. There is a 3-day grace period: no penalty will be applied if submitted within 3 days of the deadline.
- Homework assignments are expected to be completed individually. Plagiarism checks will be in place to ensure that each student submits original material. Work that is found to be unoriginal will result in a grade of 0 for the assignment, in the first instance. Subsequent submissions of unoriginal material will result in more severe academic penalties.
- Assignments will be penalized by 20% of the available marks per day for late submission.
- Assignments submitted more than 5 days late will not be accepted.
- Since there is flexibility incorporated into the submission deadlines for assignments, requests for academic consideration will be denied.

Term 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.
- The ideal team size will be 4 students.
- Students who do not choose a team will be assigned to one.
- 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.
- If necessary, 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 30% for each student based on self and peer evaluation.
- If academic consideration was requested by one or more of the team members, then only the parts that they are responsible for can be submitted later.
- Term project is considered the designated assignment and a minimum of 60% must be obtained on the project in order to pass the course.

Design Notebook:

- Each student must maintain a hardbound design notebook throughout the term.
- Design notebook entries should be checked by a TA weekly during lab sessions.
- Failure to submit a notebook will result in a grade of zero.

Final examination:

- The exam will take place during the April examination period, with the timing of the exam to be announced in advance.
- Standard calculators will be allowed.
- The exam will be closed book.
- The length of the final exam will be three hours.
- To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination. A final examination mark < 50% will lead to final course grade < 48%.
- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

Tips for success:

- Paying close attention to the material presented each week will ensure your understanding of the topics and will allow you to gain the most from the course. In particular, the biweekly assignments are intended to provide preparation for the final exam.
- 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 communicating with the instructor will all contribute to your successful completion of the assignments, exams, and the project. Such behavior is highly encouraged.
- It is your responsibility to determine what is required of you. Read through the online materials to determine the instructions regarding assignments, unit tests, project deliverables, and exams.

OFFICE HOURS: By appointment

UNITS: Metric and US customary

USE OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI) The use of generative artificial intelligence (AI) tools/software/apps is NOT allowed in this course. Students are encouraged to consult AI tools for revision and proof-reading purposes, but not to generate the ideas/solutions in their assignments and lab report. Students who used AI tools for proof-reading must also indicate this in their lab report clearly.

January 7, 2025