

## **MME 4459b – Advanced CAE: Manufacturing Technologies**

### **COURSE OUTLINE - 2023-2024**

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<b>CALENDAR DESCRIPTION:</b>	This course is an introduction to modern computer aided manufacturing technologies. Topics include subtractive technologies, such as computer-numerically controlled (CNC) machining, as well as additive technologies used for rapid prototyping purposes.
<b>COURSE INFORMATION:</b>	Instructor: Remus Tutunea-Fatan, PhD, PEng Office: SEB 3002; Phone 519-661-2111, ext. 88289 E-mail: <a href="mailto:rtutunea@eng.uwo.ca">rtutunea@eng.uwo.ca</a>  Timetable information is available at <a href="https://draftmyschedule.uwo.ca/">https://draftmyschedule.uwo.ca/</a>
<b>PREREQUISITES:</b>	MME 3379A/B or MSE 3301A/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.
<b>CONSULTATION HOURS:</b>	By advance notice via email (preferred) or drop in. V-meetings via Zoom are also possible.
<b>ACCREDITATION UNITS:</b>	Engineering Science = 100%
<b>TOPICS:</b>	<ol style="list-style-type: none"><li>1. Introduction to computer-assisted manufacturing technologies<ul style="list-style-type: none"><li>• Generalities on computer-assisted manufacturing</li><li>• Subtractive and additive manufacturing processes*</li></ul></li><li>2. Subtractive manufacturing: computer numerically-controlled (CNC) machining<ul style="list-style-type: none"><li>• Historical notes on CNC machining</li><li>• Conventional vs. NC vs. CNC machining</li><li>• Word address programming (G-code)</li><li>• Milling operations</li><li>• CNC position and motion control systems</li><li>• Shop activities</li><li>• CNC machining centers</li><li>• Computer-aided part programming (CAM)</li></ul></li><li>3. Additive manufacturing (AM)*<ul style="list-style-type: none"><li>• Historical notes on AM</li><li>• Generic AM process</li><li>• Types of AM processes</li><li>• Software issues for AM</li><li>• Practical applications of AM</li></ul></li></ol>

- CNC machining vs. AM
- \* AM topics make up approximately 10-15% of course content.

### **LEARNING OUTCOMES**

Upon the successful completion of the course, students will:

- Understand, assess and apply the advantages and limitations of the subtractive and additive manufacturing processes
- Know how to use and operate CNC machines and FDM 3D printers in order to fabricate geometries of a certain/limited complexity
- Evaluate and implement setups and workholding methods that allow a fast, accurate and safe generation of the intended geometry
- Select cutting tools and process parameters that are in agreement with machine tool available and surfaces/material being cut
- Use computer-aided manufacturing (CAM) software to generate tool paths to be followed by the CNC machine and/or 3D printer
- Read and troubleshoot NC programs written in standard G-code format
- Evaluate and decide among different 3D building options available when fabricating a part through FDM 3D printing
- Generate FDM 3D printer-specific command programs/codes
- Apply “design for manufacturability” (DFM) principles in routine design tasks
- Observe the principles of a safe working environment

**CONTACT HOURS:** 2 lecture hours/week, 2 laboratory hours/week, 0.5 course

### **RECOMMENDED TEXTBOOKS:**

Valentino J.V., Goldenberg J., *Introduction to Computer Numerical Control (CNC)*, 5<sup>th</sup> Edition, Prentice Hall, 2013

Gibson I., Rosen D.W., Stucker B., *3D Printing: Technology, Applications, and Selection*, CRC Press, 2018

### **EVALUATION:**

The final course grade will be determined according to the following weighting scheme:

Assignments	15%
Projects	35%
Final examination (closed book)	50%

Course assignments and projects will be handed out and collected according to the following *tentative* schedule:

<b>Evaluation Format</b>	<b>Weight</b>	<b>Effort Type</b>	<b>Assigned</b>	<b>Due</b>
Assignment 1	5%	Individual	Week of Jan. 29	Week of Feb. 26
Assignment 2	5%	Individual	Week of Mar. 4	Week of Mar. 11
Assignment 3	5%	Individual	Week of Mar. 26	Week of Apr. 1
Project 1	10%	Team	Week of Jan. 22	Week of Feb. 5
Project 2	15%	Team	Week of Feb. 12	Week of Mar. 11
Project 3	10%	Team	Week of Mar. 18	Week of Apr. 1

**Term coursework topics:**

- Assignment 1: Manual part programming
- Assignment 2: Machining process parameters
- Assignment 3: Motion control systems
- Project 1: Manual part programming
- Project 2: CAM software-assisted part programming
- Project 3: CNC machining vs. AM of complex surfaces

**COURSE POLICIES** The following course-specific policies will be enforced throughout the course:

**Course projects/laboratory sessions**

- All three course projects are hands-on machining and/or 3D printing projects to be completed during the timetabled laboratory sessions.
- Due to the nature of the hands-on projects, *lab session changes (in any of the weeks of the term) are not permitted*. The structure of each team (to be determined in the first lab session) will remain the same for the entire duration of the course. Each team will complete the assigned project at its own speed and its own approach, such that ‘jumping’ between teams and lab sessions does not make any (educational) sense.
- The hands-on component of the project will be carried out during laboratory sessions as follows: three lab sessions for Project 1 (including the first safety/demo week), five lab sessions for Project 2 and three lab sessions for Project 3.
- Due to the high load of the CNC laboratory as well as limited amount of TA hours available for the course, non-timetabled laboratory sessions cannot be provided. Because of this, each group will have to complete the hands-on component of the project (*i.e.*, machine the required part) during the allotted timetabled lab sessions. If the project will not be completed in the allotted number of laboratory sessions, appropriate project mark penalties will have to be applied.
- Conversely, if a group will complete the hands-on component of the project in a number of sessions that is smaller than the allotted number, then group members are allowed to be absent from the rest of sessions that are allotted to that particular project (however, the supervising TA should be notified about group intention to be absent from the remainder of project-specific laboratory sessions). However, please note that – due to the inherent pacing of the course material – subsequent roll forward of the course project timelines are not possible. In other words, while each project will be assigned/announced/distributed on the same day for the entire class, its earlier completion is possible/allowed.
- Laboratory session attendance is mandatory, the only allowed exceptions being sessions that are missed with academic consideration (*i.e.*, approved by [Engineering Undergraduate Services](#)).
- No make-up lab sessions can be offered since each lab session will be virtually different from the previous one (the project will continuously progress during the allotted weekly lab sessions).
- If a certain lab session is missed with academic consideration, the student is advised to agree with his/her group members ways to compensate for

missed project work. If no consensus is reached, the instructor might decide to penalize the student who has missed a lab session.

- If more than *one* lab session allotted to a certain project is missed *with academic consideration*, individual penalties will likely be applied on the corresponding project mark. The amount of mark penalty will be determined by the course instructor.
- If a certain lab session is missed *without academic consideration*, individual penalties will be applied on the corresponding project mark. The penalties to be applied are increasing in severity as follows: at the first unjustified lab absence, the penalty on the project mark will be proportional with the percentage of one lab session out of the total number of lab sessions allotted to the project (*i.e.*, 33% for Project 1 and 3 and 25% for Project 2). After two unjustified lab absences a penalty of 50% of the entire project mark (worth of 35% of the final course grade) will be applied. Three unjustified lab absences are equivalent with course failure.

### **Final examination**

- Final examination will be closed book (all required formulas will be provided).
- Only non-programmable calculators will be allowed during the final examination.
- If a minimum of 50% is not obtained on the final examination, the student cannot receive a final mark greater than 48%.

**UNITS:** Metric and US customary.

**CLASSROOM DEMEANOR:** The instructor is committed to providing a respectful learning environment for all students involved in this course. This is a collective responsibility of the instructor and students, and therefore students partaking in this course agree to abide by this criterion. This includes arriving at lectures on time, and acting in a professional manner during class.

**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 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.

**CHEATING:** University policy states that cheating, including plagiarism, is a scholastic offense. 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 (see Scholastic Offence Policy in the Western Calendar).

**SSD:** 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 661-2111 x 82147 for any specific question regarding an accommodation.

**NOTE:** Students who have failed an Engineering course (*i.e.* < 50%) 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 for grading by the student in subsequent years.

**STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE**

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).

**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 relief will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services Office) that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations and late assignments. Please read the instructions carefully.

**A. GENERAL REGULATIONS & PROCEDURES**

1. All first-year students will report to the Undergraduate Services Office by submitting the [Academic Consideration Request Form](#), for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or examination you will report the absence by submitting [Academic Consideration Request Form](#). Absences worth LESS THAN 10% of your mark, will be processed by your department office. If your course work is worth 10% OR MORE of your final grade, your request will be processed by the Undergraduate Services Office.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. 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/MIDTERM TESTS**

1. If you are in first year and you are unable to write a midterm/term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a midterm/term test, inform your instructor PRIOR to the scheduled date of the test and request relief through the [Academic Consideration Request Form](#). If the instructor is not available, leave a message for him/her at the department office. If the test is worth LESS THAN 10% of your mark, your request for relief will be processed by your department office. If the test is worth MORE THAN 10% of your final grade your request for relief will be processed by the Undergraduate Services Office.
3. Be prepared to attach supporting documentation to the Department Chair and/or the Undergraduate Services Office through the online form (see next page for information on documentation).
4. Discuss with the instructor if and when the test can be rescheduled. The approval of the Chair or the Undergraduate Services Office is required when rescheduling midterm/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 report your absence using the [Academic Consideration Request Form](#) and 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.
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, 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 "[Application for a Special Exam](#)" form. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

**PLEASE NOTE: 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 submit the [Academic Consideration Request Form](#) and 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 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.
  - i) 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.
  - 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, Undergraduate Studies.

### E. SHORT ABSENCES

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

### F. 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 are strongly encouraged to seek advice from your Academic Counsellor in the Undergraduate Services Office.

### G. 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). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

**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).**

## H. ACADEMIC CONCERNS

1. 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).
2. **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.**
3. 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 2023 Western Academic Calendar available at [www.westerncalendar.uwo.ca](http://www.westerncalendar.uwo.ca).

### **Absences Due to Illness:**

[https://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page\\_13\\_5](https://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_13_5)

### **Academic Accommodations for Students with Disabilities:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page\\_10](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_10)

### **Academic Accommodations for Religious or Holy Days:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page\\_16](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_16)

### **Course Withdrawals:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=6&SelectedCalendar=Live&ArchiveID=#Page\\_75](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=6&SelectedCalendar=Live&ArchiveID=#Page_75)

### **Examinations:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=5&command=showCategory&SelectedCalendar=Live&ArchiveID=#Page\\_78](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=5&command=showCategory&SelectedCalendar=Live&ArchiveID=#Page_78)

### **Scheduling of Term Assignments:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=5&SelectedCalendar=Live&ArchiveID=#SubHeading\\_78](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=5&SelectedCalendar=Live&ArchiveID=#SubHeading_78)

### **Scholastic Offences:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page\\_20](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_20)

### **Student Medical Certificate:**

<https://www.eng.uwo.ca/files/undergraduate/student-medical-certificate.pdf>

### **Engineering Academic Regulations:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=4&SelectedCalendar=Live&ArchiveID=#Page\\_86](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=4&SelectedCalendar=Live&ArchiveID=#Page_86)

**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 15, 2023
Full courses and full-year half course (i.e. “E”, “Y” or no suffix)	September 15, 2023
Second term half course (i.e. “B” or “G”)	January 16, 2023

### **Drop Deadlines:**

First term half course without penalty (i.e. “A” or “F”)	November 13, 2023
Full courses and full-year half courses without penalty (i.e. “E”, “Y” or no suffix)	November 30, 2023
Second term half or second term full course without penalty (i.e. “B” or “G”)	March 7, 2023

### **Contact Information:**

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