Western University
Department of Mechanical & Materials Engineering

MME 4480A – Advanced CAE: Reverse Engineering

COURSE OUTLINE – 2026-2027

CALENDAR DESCRIPTION: This course is an introduction to the use of modern computer-aided design (CAD) techniques in generation of 3D digital models from physical objects. Topics include contact and non-contact data acquisition techniques, data type and exchange formats, and advanced visualization and surfacing techniques.

COURSE INFORMATION:

Instructor: Ben Hamilton, PhD

Email: ben.hamilton@uwo.ca

Lectures/tutorials/labs: See Draft My Schedule

CONSULTATION HOURS: By appointment

PREREQUISITES: MME2259A/B, or MSE2202A/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.

ANTIREQUISITES: None

ACCREDITATION UNITS: Engineering Science = 70%, Engineering Design = 30%

TOPICS:

1. Introduction to reverse engineering of physical objects
   - historical notes on reverse engineering (RE)
   - overview of RE process
2. Data acquisition techniques
   - classification of RE techniques
   - noncontact techniques: laser scanning, CT/MRI
   - contact techniques: coordinate measurement machine (CMM)
   - destructive techniques
   - case studies involving RE
3. Data types and data exchange formats
   - nonparametric data formats: cloud of points, polygonal mesh
   - parametric data format (B-Rep/NURBS)
   - polygonal vs. parametric data
   - data exchange operations
   - mitigation of data exchange errors

4. Parametric data reconstruction
   - nonparametric to parametric data conversion
   - computer graphics and graphical output of CAD
   - modeling strategies: history-based and direct
   - manifold and non-manifold models
   - surfacing operations and functionality
   - surface quality analysis; class A surfaces
   - industrial applications of class A surfaces
   - accuracy of parametric data reconstruction
5. Additive manufacturing
   - review of additive manufacturing technologies
   - materials
   - model preparation
   - printing scanned models

LEARNIG OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Understand the principles underlying data acquisition in the context of reverse engineering of physical objects. (**KB3**, ET2, ET3)
2. Compare and exploit the capabilities of different data acquisition techniques to generate digital models of physical objects. (D3, D4, **LL2**)
3. Understand the structural differences between the different types of CAD data formats. (**KB4**, ET1, ET2)
4. Select and use the appropriate format for a CAD data exchange operation. (ET1, ET2, **LL2**)
5. Understand the theoretical basis of internal CAD representations. (KB1, **KB4**)
6. Develop strategies and skills for manipulation and modeling for freeform/complex/sculptured surfaces. (ET1, **ET2**)
7. Select and implement additive manufacturing processes to 3D scanned models. (ET2, D3, D4)

The terms in parentheses following each learning outcome refer to Graduate Attributes (GAs) established by the Canadian Engineering Accreditation Board (CEAB) of Engineers Canada. These attributes are used in the accreditation process to ensure that accredited engineering programs are providing the academic requirements for licensure as a professional engineer in Canada. Information on Graduate Attributes and Indicators can be found at GA Indicators. The table below indicates which specific attributes are measured in this course and the level at which it is measured, wherein I=*Introduced*, D=*Developed* and A=*Advanced*/*Applied*

CEAB Graduate Attribute Learning Levels for this course:

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

CONTACT HOURS: 3 lecture hours, 2 hours of supervised lab time per week for assignment/project help, half course

TEXTBOOK: References will be provided during lectures.

UNITS: SI will be used; however, English units may be introduced through examples as required

EVALUATION:

Assessment Type	Due Date	Weight	CEAB GAs Assessed
Assignment 1	Sept. 28	4%	ET4, KB4
Assignment 2	Oct. 19	4%	ET2
Assignment 3	Nov. 16	4%	ET2
CSWP-SU Exam (closed book)	Nov. 20	5%	LL2
Project	Nov. 30	23%	
Midterm Exam (closed book)	Oct. 30	15%	
Final Exam (closed book)	During the examination period	45%	KB3

COURSE POLICIES: If deadlines for assignments are not met, a three-day grace period will be allowed without penalty. A delay of more than three days will result in a mark of zero. Please note that because the submission deadline for these assignments already includes flexibility in the form of a 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.

Attendance: Attendance at lectures is not mandatory; however, regular attendance is strongly encouraged, as lectures frequently include demonstrations, modeling strategies, and guidance that extend beyond the posted notes. All material presented or discussed during lectures may be assessed. **Mandatory attendance**: students are required to attend the first scheduled laboratory session for each assignment (September 18, October 2, and October 23). During these sessions, assignment problems will be discussed, and demonstrations will be provided illustrating the methods and workflows used to solve each problem.

Students who do not attend the first scheduled laboratory session for an assignment, without an approved absence or academic consideration, will receive a **maximum grade of 75% on that assignment**. Students remain responsible for all material covered during laboratory sessions they do not attend.

CSW Exams: If technical issues prevent a student from successfully completing or submitting a CSW exam, the instructor will decide whether a second attempt is permitted. If approved, a makeup exam will be scheduled at a later date.

Midterm Examination: If a student misses the midterm exam with consideration, the weight of the midterm exam will be applied to the final exam. If a student misses the midterm exam without consideration, the midterm exam's mark will be zero. Please note that the midterm exam is the **designated assessment** for this course. Accordingly, students seeking academic consideration for this assessment will be required to provide formal supporting documentation.

If technical issues prevent a student from successfully completing and submitting the midterm examination, at the instructor's discretion, the weight of the examination may be shifted to the final exam. No make-up midterm examination will be offered in this case.

Final Examination: If technical issues prevent a student from successfully completing and submitting the final examination, the official guidelines from the Associate Dean's Office, Undergraduate Affairs will be followed. Options to be considered will include, but are not limited to, an oral examination or a make-up examination in the special examination period.

Generative AI: The use of generative artificial intelligence (AI) tools (i.e., ChatGPT, Google Gemini, Microsoft Copilot, image or code generation tools, etc.) is not permitted for any assessed work in this course, including exams, assignments, and projects. All submitted work must be produced by the student without the aid of generative AI technologies.

If you are unsure whether a particular tool or approach is permitted, please consult the instructor before using it.

If a student is suspected of cheating on a course assessment, the student will be notified, and an investigation will be completed by the Associate Chair – Undergraduate (MME). If it is determined that a scholastic offence has taken place, the Associate Chair – Undergraduate may apply a grade penalty, up to and including course failure. Further disciplinary actions may be imposed by the Associate Dean for Undergraduate Studies (Engineering).

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.

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 policies 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.

The policy covers:

- Absence/Late Accommodation Policy
- Religious Accommodation
- Academic Integrity
- Academic Offences
- Faculty of Engineering AI Policy
- Accessibility
- Inclusivity, Diversity, and Respect
- Health and Well-being
- Gender-Based and Sexual Violence

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