Western University
Department of Mechanical & Materials Engineering

MME 4480A – Advanced CAE: Reverse Engineering

COURSE OUTLINE – 2025-2026

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 surface
   - accuracy of parametric data reconstruction
5. Additive manufacturing
   - review of additive manufacturing technologies
   - materials
   - model preparation
   - printing scanned models

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 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)

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	Material Covered	Assigned	Due Date	Weight
Assignment 1	Topic 1, 2	Sept. 8	Oct. 3	5%
Assignment 2	Topic 2, 3, 4	Oct. 9	Nov. 21	5%
CSWP-SU Exam (closed book)		N/A	Nov. 20	5%
Project		Sept. 4	Dec. 1	20%
Midterm Exam (closed book)	Topics 1-3	N/A	Oct. 23	15%
Final Exam (closed book)	Topics 1-5	During the examination period		50%

COURSE POLICIES: If deadlines for assignments and projects 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.

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 without being 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 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.