

The University Senate of Michigan Technological University
Proposal 03-26 Assessment Plan
Graduate Student Learning Outcomes Assessment Plan
Proposed Graduate Certificate in Internal Combustion Engine Systems
(2025)

I. Introduction

Student outcome assessment is part of Michigan Tech's commitment to continuous improvement of programs. Expected Student Outcomes are appropriate for the level of the degree or certificate awarded. For graduate certificates, the faculty set Graduate Learning Objectives (GLOs) and then annually assesses those Graduate Student Learning Outcomes against the Objectives.

Faculty submit an Annual Assessment Report to the Graduate School, indicating assessment results for the certificate and proposed actions for improvement.

This document describes the Graduate Student Outcomes Assessment Plan for the Graduate Certificate in Internal Combustion Engine Systems. This Certificate is available as part of a graduate degree or as a standalone certificate for non-degree-seeking students.

II. Graduate Certificate *in Internal Combustion Engine Systems*

This Graduate Certificate in Internal Combustion Engine Systems provides advanced knowledge of the operating principles, design, calibration, and simulation of internal combustion engines. This certificate formally recognizes curricular breadth in advanced principles of i) thermodynamic systems, ii) testing and analysis, and iii) simulation tools.

A. The Graduate Learning Objectives (GLOs) of the Certificate are:

Upon completion of the certificate, students will be able to:

- 1) Apply engineering principles of energy conversion, thermodynamics, and fluid mechanics to include thermochemistry and thermodynamics of reacting mixtures for the assessment of internal engine systems.
- 2) Analyze, evaluate, and specify engine subsystems to include turbocharged air-handling and fuel injection components by application of theory and established engineering correlations.
- 3) Demonstrate technical competencies in at least two of the following areas:
 - i. Design and plan testing in dynamometer-based engine testing and interpret performance and emissions data.
 - ii. Utilize cylinder pressure data and computed combustion metrics to quantify combustion characteristics, including heat release rates and mass fraction burned, for engine calibration and optimization.
 - iii. Calibrate engine controls for performance and emissions with constraints such as abnormal combustion and component limits.
 - iv. Create, simulate, and validate one-dimensional engine performance models

for system design and evaluation.

- v. Assess engine and aftertreatment requirements and designs in relation to current and future US emissions regulations.

B. Assessment Points for Measuring Certificate Graduate Student Learning Outcomes (GSLO)

The assessment of the GSLO for the Graduate Certificate in Internal Combustion Engine Systems is based on 9 credits and encompasses two required three-credit courses and the selection of additional elective courses for three additional credits. The elective courses listed on the student's Degree Schedule – Graduate Certificate in Internal Combustion Engine Systems, as listed at (*will need to be added*).

<https://www.mtu.edu/gradschool/policies-procedures/timelines/certificates/>

When a student applies for the Certificate, they will list on the degree/audit schedule the required core, focus, and elective courses taken. The schedule is then submitted to Professor Jeffrey D. Naber in the MAE Department as the Graduate Advisor for the Certificate and then to the Graduate School for approval. The Graduate School verifies with the student's transcript that the courses were passed with a grade of B or better.

Assessment Points for Graduate Student Learning Outcomes (GSLO)	Certificate Graduate Learning Objectives addressed	Notes on Assessment
Grades in the two required core courses (Internal Combustion Engines II & Thermodynamics of Internal Combustion Engines). Grades in Required courses embodied in GLOs 1 & 2. Elective courses covered in GLO3.	GLO1 GLO2	Data comes from required course grades; • Excellent: GPA; 3.75-4.0 • Satisfactory: GPA; 3.25-3.749 • Marginal: GPA; 3.0-3.249 • Deficient: GPA; <3.0 GPA: Grade of A: 4.0 Grade of AB: 3.5 Grade of B: 3.0
Passing Elective Course(s) with three credit hours	GLO3	The student must pass elective courses with GPA $\geq$ 3.0 to receive the certificate.
Final Engine Simulation Project in Internal Combustion Engines II course ME 5250	All	The final project requires students to assess, research, simulate, model, and calibrate the model for an internal combustion engine to match engine data and achieve the target performance. Teams will present their work to industry members and PhD students studying in the field. A rubric will be used to evaluate the presentations against the certificate's learning objectives.

Industry panel review of syllabus and other course material	All	An annual review will be conducted by a panel of industry representatives. Using a rubric, they will evaluate a subset of course syllabi and redacted final project reports from the ICE-II course to ensure alignment with the certificate's learning objectives.
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III. Data Compilation Plan

GLO1 and GLO2: The MAE Director of Graduate Studies will compile metrics from student transcripts at the time of submission of the degree schedule or certificate audit form. A determination of whether the core and focus classes were excellent, satisfactory, marginal, or deficient will be made according to the GPA ranges in the table above.

GLO3: The program will have achieved this (and been assessed) by virtue of the certificate being awarded with elective courses completed in at minimum two of these areas.

All: Assessments from the industry representatives will be compiled and shared with the graduate school and industry representatives. A continuous improvement plan will be developed and implemented in the respective courses from this information