Mechanical & Industrial Engineering
UNIVERSITY OF TORONTO

MIE498H1: Research Thesis 2025-2026

Supervisor	Pierre Sullivan
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Number of Positions	1
Open to	Mechanical Engineering Students
Term Offered	Full-year
Research Area	Thermofluids
Research Topic	Multiphysics Modeling of a Fabry-Perot Optical Pressure Transducer for Enhanced Performance and Reliability in High-Temperature, High-Pressure Liquid Environments

Project Description

This thesis will focus on developing a comprehensive multiphysics model of a Fabry-Perot optical pressure transducer operating within extreme high-temperature and high-pressure liquid environments, utilizing COMSOL Multiphysics. The project will integrate the Structural Mechanics Module to analyze the deformation and stress distribution of the transducer's diaphragm under pressure, which directly influences the Fabry-Pérot cavity length. The Heat Transfer Module will account for thermal expansion and temperature-dependent material properties, which are crucial for understanding thermal drift in the Fabry-Pérot cavity. Crucially, the Wave Optics Module will be employed to simulate the light propagation and interference within the Fabry-Perot cavity, analyzing how pressure-induced deformations and temperature variations affect the optical signal (e.g., changes in fringe patterns, wavelength shifts). The Fluid Flow Module will also be used to simulate the high-pressure liquid environment, potentially integrating with the Structural Mechanics Module via Fluid-Structure Interaction (FSI) to capture dynamic coupling. The primary objective is to simulate the transducer's optical response, sensitivity, and long-term stability under varying thermal and pressure loads, identifying potential failure modes or performance deviations in harsh conditions. The COMSOL model will enable detailed parametric studies and optimization routines, utilizing its built-in material libraries and solver capabilities, to serve as a powerful tool for optimizing Fabry-Perot transducer design, predicting its behavior in challenging operational scenarios, and contributing to the development of more robust optical sensing technologies for demanding industrial or scientific applications.

Application Instructions	Please submit CV and unofficial transcript to pierre.sullivan@utoronto.ca