# ME 755: Advanced Control on Internal Combustion Engines

**Lecture:** Monday 1:30pm - 4:30pm
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This course aims to introduce the advanced control system design for internal combustion engines. To meet the ever-growing demands on energy efficiency and emissions, engine control systems are evolving very fast with substantial growth in complexity. Internal combustion engine systems, as nonlinear multi-input-multi-output systems, often feature significant un-modeled dynamics and parametric uncertainties. Therefore, design of engine control systems requires systematic combinations of understanding of engine system characteristics and advanced control theory. This course is for the students at Mechanical Engineering Department who are interested in and willing to do the research on advanced control techniques for engines.

**Contents:**
• Overview of current automotive control systems (1)
• Control-oriented modeling for engines: air-path systems (2)
• Control-oriented modeling for engines: injection and combustion (2)
• Introduction to Lyapunov stability theory (5~6)
• Basic control design techniques in nonlinear control (7-8)
• Introduction to parameter estimation and system identification (3~4)
• Lyapunov-based adaptive control (3)
• Sliding Mode Control (3)

No textbook will be used. Lecture notes based on reference books and research papers will be available. Below are the reference books.
1. Hassan K. Khalil, “Nonlinear Systems”, Maxwell Macmillan, 1992.
2. Glad and Ljung, “Control Theory - Multivariable and nonlinear methods”, Taylor and Francis, 2000.
3. Franklin, Powell, Emami-Naeini, “Feedback control of dynamic systems”, Addison- Wesley, 2002.

**Evaluation:**

Assignments (20%): There will be 4 assignments in this course, covering diesel engine modeling, control, estimation aspects. Each of the assignments counts 5% of overall score. The assignment will be posted on http://avenue.mcmaster.ca and will need to be submitted in class on the due date.

Mid-term report (40%): Due Nov 1st. Critical literature reviews on current advanced control techniques and propose project. (A review with about 6 pages single column, double space, 12pt, or 2-3 pages in IEEE conference format).

Term project and final report (40%): Due Dec 20th. The term project is student self-proposed or instructor- assigned, related to the vehicle powertrain estimation and control, and needs to be approved by the instructor. A project team may consist 1~3 members. The innovation (10%), project quality (10%), completeness (10%), and report writing (10%) will be considered in the grading in this part. (A complete report with at least 12 pages, single column, double space, 12pt, or about 6 pages in IEEE conference format).