MECH 4006: VEHICLE ENGINEERING I

Tentative Course Outline – Fall 2021

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Class Times and Modality

This course will be delivered using an on-line synchronous format. To fully participate in the course, students will require reliable high-speed internet access, a computer, speakers/headphones, and a microphone. Synchronous lectures may be supplemented by or occasionally substituted with asynchronous learning activities. Live lectures will be recorded and made available to students. Please contact the instructor if you cannot attend synchronous sessions.

The scheduled class times are:

Monday	11:35-12:55	Virtual meeting on BBB
Wednesday	11:35-12:55	Virtual meeting on BBB

This course does not have labs or problem analysis sessions.

The instructor will be available for virtual office hours by appointment. When emailing the instructor, please include "MECH 4006" in the subject line of the email to facilitate a prompt response. If you have not received a response within two business days, please do not hesitate to email again.

Session Recording

Lectures will be recorded for the benefit of students with internet connectivity issues, who are based in a different time zone, and/or who have conflicting commitments. If students wish not to be recorded, they should ensure that their camera and microphone are turned off. If you have concerns about being recorded, please email me directly so we can discuss these, since it may affect your ability to participate fully in class discussion.

Please note that recordings are protected by copyright. The recordings are for your own educational use. You are not permitted to publish them to third party sites, such as social media sites and course materials sites.

Calendar Description

The course emphasizes the engineering and design principles of road transport vehicles. Topics to be covered include: performance characteristics, handling behaviour, and ride quality of road vehicles.
Prerequisite(s): MAAE 3004 and fourth-year status in Engineering.
Lectures three hours a week.

Overview

The high-level ***learning outcomes*** for the course are to provide: (1) an introduction to vehicle dynamics nomenclature and conventions; (2) understanding of the basic approach used for evaluating road vehicle performance, handling, and ride quality; (3) an appreciation of the effects of design and operational

factors affecting road vehicle behaviour; and (4) an overview of some relatively-recent advances in automotive technologies.

Recommended Text Wong, J. Y., Theory of Ground Vehicles, Fourth Edition, John Wiley, 2008. (Available from the campus bookstore and other retailers**)**

Evaluation

Project 1 (Qualitative)	15%
Project 2 (Quantitative)	15%
Midterm Exam	20%
Final Exam	50%

Final course grades are determined by the course instructor subject to the approval of the Faculty Dean. This means that grades submitted by the instructor may be subject to revision. No grades are final until they have been approved by the Dean.

Outline

Week	Topics
1,2	Performance characteristics of ground vehicles. Motion of a vehicle as a rigid body. Properties of pneumatic tires: rolling resistance, tractive (braking) effort and longitudinal slip (skid), performance on wet surfaces.
3	Aerodynamic drag estimation. Dynamic load transfer, maximum transferable tractive force.
4	Acceleration limits, gradeability, deceleration and braking, maximum deceleration rates, stopping distance. Antilock braking systems.
5,6	Power plant performance and selection. Transmission characteristics, selection of gear ratios. Electric and hybrid vehicles. Vehicle performance analysis, estimation of acceleration time and distance.
7	Handling characteristics of road vehicles. Lateral behaviour of pneumatic tires, lateral force and side slip angle, cornering stiffness.
8,9	Steady state cornering. Neutral steer, understeer, and oversteer. Directional stability of road vehicles. Characteristic speed and critical speed. Steady state response characteristics. Active stability control. Four-wheel steering.
10	Transient handling characteristics. Testing of handling performance.
11	Ride characteristics of ground vehicles. General vehicle ride models, linear model of sprung and unsprung mass. Two-degrees-of-freedom ride model for sprung mass, pitch and bounce, oscillation centres.
12	Criteria for good ride, dynamic index, flat riding tuning. Suspension mechanics. Suspension dynamic properties. Active and semi-active suspensions.
13	Review

Assignments

Problem sets will be assigned periodically. Assigned problems will include theoretical, practical, and computational components. Assignments will not be marked but final answers will be provided, and solutions will be discussed in class. Completing assigned problems is *essential* to succeeding in the course.

Projects

Two individual projects will be assigned. The first (qualitative) project will be completed during the first half of the term. The second (quantitative) project will be completed during the second half of the term. Deliverables will comprise short reports prepared using the LaTeX document typesetting software for which appropriate templates will be provided. If practical, individual contributions will be compiled into a composite document that will be shared with the class.

Exams

Midterm and final exams will cover material contained in course notes, supplemental materials, and assigned homework problems. Formula sheets will be provided with the exams. The midterm exam will be held during the class period on November 3, 2021. The midterm exam will be returned to students; the final exam is for evaluation purposes only and will not be returned to students.

Academic Integrity

Students are expected to conduct themselves with academic integrity and be familiar with Carleton University's Academic Integrity Policy that is available at:
https://carleton.ca/registrar/wp-content/uploads/Academic-Integrity-policy-June-2021.pdf

Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. Please refer to https://students.carleton.ca/course-outline/ for information on academic accommodations that may be available to you.

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