

ME441/541 Advanced Vehicle Systems
Spring 2024
Syllabus

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COURSE Monday: 8:40 am -10:30 am @ FENS G032
SCHEDULE Tuesday: 4:40 pm -5:30 pm @ FENS G029

COURSE OBJECTIVES This course aims to provide basic concepts towards understanding electrified vehicles. It aims to provide the students the technical fundamentals to build mathematical models of certain vehicle components, and perform simplified analyses on vehicle dynamics, battery behavior, energy consumption and power management.

After the course, the students should be able to :

- Identify different electrified powertrain alternatives.
- Understand the working principles and challenges of batteries, fuel cells and super/ultra capacitors.
- Understand the working principles of internal combustion engines and electric motors, their advantages and disadvantages.
- Create simplified vehicle component models in Matlab and Simulink.
- Explain the technical, economic, environmental and social advantages and disadvantages of alternative vehicle technologies.

COURSE CONTENT The intended content of the class is listed below. There might be small changes throughout the semester depending on how the class proceeds.

- Week 1 : Introduction to electrified vehicles, comparison to conventional vehicles, advantages, current situation of technology and market, challenges, environmental and policy issues.
- Week 2-3 : Vehicle dynamics and performance fundamentals, longitudinal dynamics, propulsion and braking, modeling vehicle performance and dynamics.
- Weeks 4-5 : Internal combustion engines: fundamentals, types, efficiency maps, fuel economy, emission control.
- Weeks 5-6 : Battery Electric Vehicles: power and torque generation, electric motor types, efficiency, BEV powertrain basics, energy consumption calculations
- Week 7 : Introduction to batteries: electrochemical fundamentals, battery types. (Midterm, tentative, exact date TBA)
- Week 8-9 : Batteries cont'd: Li-ion batteries, battery modeling, battery management systems, cell-to-pack design, thermal management.
- Weeks 10-11 : Hybrid Electric Vehicles: hybrid powertrain configurations (series, parallel, split), powertrain simulation, energy management.
- Week 12 : Plug-in Hybrid Electric Vehicles, powertrain simulation
- Week 13 : Fuel cell electric vehicles, fundamentals of fuel cells, types, basic modeling and powertrain simulation.
- Week 14 : Semester review. ME541 Project Presentations/Potential guest speaker.

COURSE REQUIREMENTS There is not an officially assigned prerequisite for this course. However students are expected to have background on dynamics, systems modeling and control, and basic electric circuits .

Matlab and Matlab/Simulink will be used extensively. The course will require you to build models in Matlab and Simulink from scratch (with no prior template given). Therefore experience is strongly recommended.

There will be no recitations. Limited number of problems will be solved in the class. This class assumes that you are interested in the material, that you will spare the time and effort yourselves to practice the concepts that are taught in the class and that you will reflect this to the assignments, exams and (if applicable) term project.

REFERENCES There is no official textbook for this course but the following references will be used occasionally:

- Iqbal Husain, *Electric and Hybrid Vehicles-Design Fundamentals, 2nd Edition*, CRC Press, 2011.
- Amir Khajepour, Saber Fallah, Avesta Goodarzi, *Electric and Hybrid Vehicles - Technologies, Modeling and Control: A Mechatronic Approach*, Wiley, 2014.
- James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2004.
- Gianfranco Pistoia, *Electric and Hybrid Vehicles-Power Sources, Models, Sustainability, Infrastructure and the Market*, Elsevier, 2010.

Additional materials will be shared at SUCourse when necessary.

ASSESSMENT & GRADING ME 441 Grading :

Take-home assignments (20%), Midterm (35%), Final (35%), Quizzes(10%)

ME 541 Grading :

Take-home assignments (15%), Midterm (25%), Final (30%), Term Project/Paper (25%), Quizzes(5%)

- More details on the take-home assignments and ME541 Term Project will be shared after the add-drop period.
- Throughout the semester, random oral exams might be given. You may be called upon to explain your homework/project solution and answer course related questions in a one-to-one meeting with the TA/instructor. Students who fail to explain their work or answer related questions will get zero (0) credit from the related homework/project.
- Pop-quizzes with short answer questions will be given randomly during classes either on paper or through SUCourse+. You must be present in the lecture for at least 40 minutes otherwise your quiz will be void. Best 80% of the quizzes will be counted towards your final grade, therefore if you miss a quiz you can consider it to be among your worst 20%. No make-up for quizzes.
- Attendance will be taken. Less than 50% in-class attendance will result in NA grade. Your attendance and participation in the lectures may also affect your final grade, especially for borderline cases. Attendance consists of joining lectures (you must be present in the lecture for at least 40 minutes) and participation in quizzes.
- One make-up examination, covering the whole course material, will be given after the final exam date for the students who missed midterm or final examination **due to a valid excuse approved by the Health Services or University.**
- Homework will be distributed via SUCourse+. Zero credit for late homework unless

arrangements are made in advance (only with valid excuses). You can discuss the problems/questions with your classmates but copying work is against University regulations and might result in a grade zero (0).

- All solutions (homework, exam and quizzes) must be written in a professional manner. You may lose points for poorly written answers.

SUCOURSE+ All announcements will be made through SUCourse+, students are responsible from following the announcements.

DISCLAIMER

- Time conflict requests can be accepted for one hour only. Students who are registered to the course with time-conflict override accept the responsibility of any inconvenience that might occur due to missed content and/or (if any) quizzes. No make-up will be available for missed quizzes/content. To get approval for time conflict, you need to send an e-mail stating you are aware of these facts and you accept the responsibility.

ACADEMIC INTEGRITY

- Students are expected to be familiar with and comply with Sabanci University Academic Integrity Statement available [on this link](#). Any form of academic dishonesty (plagiarism, copying/using other people's work, attending classes/exams on behalf of other people, etc) will be penalized with a failing grade (i.e., zero points) for the related assignment, quiz, or exam and **disciplinary actions will be taken**.