ECE4803/8803: Electric Vehicles (Fall 2024)

MW, 11:00 am-12:15 pm, Clough UG Learning Commons

General Information

Instructor:
Primary: Maryam Saeedifard, Professor in School of ECE
- Email: maryam@ece.gatech.edu
- Office hours: Tuesday 11:30 am – 12:30 pm in Van Leer building room E168 (From Week 2)
- TA: TBD

Course Summary
ECE 4803/8803 constitutes a comprehensive learning experience on Electric Vehicles (EVs), encompassing various aspects such as vehicle architectures, electrical components, their fundamental operations, their integration into the vehicle transmission system, the overarching management of vehicle power in diverse EVs, and their grid integration issues. The course provides insights into the architectures and technologies underpinning EVs, including their constituent components. Key topics include EV drivetrains, energy storage, electromechanical energy conversion, power electronics, vehicle-level modeling and control, safety optimization, and also insights into future of transportation electrification.

Future of transportation electrification, H2, Vehicle to Grid (V2G), grid interface, grid limitation on charging

Upon successful completion of this course, students should be able to:

- Demonstrate a deep understanding of the principal architectures employed in electric vehicles.
- Analyze performance characteristics and grasp the limitations inherent to each vehicle architecture.
- Acquire insight into the principal components that constitute an EV, encompassing power/energy storage, conversion systems, transmission elements, chargers, and control subsystems.
- Integrate diverse subsystem models to construct comprehensive end-to-end vehicle models.

Prerequisites/Corequisites
Undergraduate students must have taken or be concurrently taking ECE 4330. Graduate students do not need any prerequisite. Basic familiarity with the MATLAB/Simulink software will be leveraged.

Course Materials

Class Webpage
Canvas (https://canvas.gatech.edu/) is the primary means of distributing new information. **Homework assignments will be posted on Canvas and will not be handed out in class.** The following information

will also be found on Canvas as it becomes available: (1) homework solutions, (2) tutorial materials, (3) class grades, (4) this syllabus, and (5) any supplementary materials relevant to this course.

On-Line Discussions
We will use **Piazza** (integrated in Canvas) to facilitate class discussions. We will try to check Piazza at least once a day. Please post questions about anything related to the course material, and also answer other students' questions, as long as you don't "give away the answer".

Textbooks

There is no textbook available on this topic. The instructor will also rely on openly available reading-materials/papers that will be put together and made available on canvas.

Workload and Grading

Grading
Students in this course will be graded based on 3 components:

- Homework assignments (50%)
- Midterm exam (20%), **October 9, 2024 in the class during the lecture**
- Final Exam (30% for undergraduate students and 20% for graduate students))
- Final Project (10% for graduate students)

Note 1: This course includes both graduate and undergraduate students, so the grading scheme will differ slightly. Graduate students are required to submit a final project, with further details to be discussed later in the course.

Note 2: This course accommodates both on-campus and online students. For online students, all assignment due dates and exam dates will be shifted by one week.

Homework Assignments
There will be 5 assignments throughout the course which will be used to reinforce the theory and concepts taught during lectures, as is typical of most courses. Each of these assignments will have an additional question for graduate students to test their capability in applying concepts in a more advanced fashion.

Each of you is expected to turn in homework that is completely your own work, but you are encouraged to discuss problems and solution approaches with others. You will be graded primarily on the method of your solution. The actual numerical answer accounts for only a small portion of the problem score. Organize your problem solutions in a logical step-by-step fashion to get the maximum number of points. I expect you to do your best professional looking work on your homework. POINTS WILL BE REDUCED FOR SLOPPY WORK. The easier it is to understand and follow the logic of your solution the more points you will receive. Be sure to put your name, date, section, and the assignment number on the front page or on a cover sheet.

As students in this course will hopefully eventually appreciate that assignments constitute key checkpoints/milestones for each subject covered in the course. Late assignments will be penalized (2% per day) and there will be a maximum of 3 days of overdue submission.

Course Expectations & Guidelines

Getting Help
The material in this course builds on earlier material, so it is very important to not get behind. Be sure to take advantage of office hours and other resources that are available. If you can't make office hours, email questions or arrange for an appointment.

Major Emergencies
If you have some sort of major life emergency – serious illness or injury, death in the family, house burns down or is flooded, etc. – that seriously impedes your progress in the class, please let us know as soon as possible so we can work something out. You will find professors can be quite reasonable if you keep us in the loop. Absence reporting procedures can be found in http://www.catalog.gatech.edu/rules/4/

On Things That Distract
Please silence all cell phones, tablets, pagers, etc. before entering class. If you forget to do so and receive a call, please shut the noisemaking device down as quickly as possible, and return the person's call *after* class. (Of course, there are reasonable exceptions for emergencies; in such cases leave your phone on vibrate, and answer it as quickly as possible and immediately step out of the room to handle the call.)

In general, please do not text, instant message, web surf, Facebook, tweet, e-mail, play games, etc. during class. It can be quite distracting. **Unless needed for class, the preferred position for laptops and tablets during class is in your backpack.**

Honor Code (http://www.policylibrary.gatech.edu/student-affairs/academic-honor-code)
Adherence to the Georgia Tech Honor Code is expected and all suspected instances of academic misconduct will be reported to the Dean of Students. It is your responsibility to ask for clarification if collaboration guidelines, test-taking policies, etc. are not clear.

Office of Disability Services (https://disabilityservices.gatech.edu/)
If you are a student registered with the Office of Disability Services (ODS), please make sure the appropriate forms and paperwork are completed by Prof. Li. We will abide by all accommodations required by ODS. It is the responsibility of the student to properly arrange test accommodations for each exam with ODS in sufficient time to guarantee space for exam administration. ALL exam accommodations must be handled through ODS. If the student does not register accommodations with ODS for the taking of an exam, then they will have to take the exam at the normally scheduled times without any additional accommodation unless the instructor is given specific directive from ODS on the student's behalf due to a mitigating circumstance.

Student-Faculty Expectations Agreement
It is important to strive for an atmosphere of mutual respect and responsibility between faculty members and students. In the end, a respect for knowledge and understanding, an appreciation for hard work, and respectful interactions all contribute to an environment conducive to learning and excellence. I encourage you to remain committed to the ideals of Georgia Tech while in this class. See www.catalog.gatech.edu/rules/22 for a description of some basic expectations that we can have of each other.

EV Course Schedule (Sp2024)			
Class Date	**Lecture**	**Topic**	**Homework Roadmap**
8/19	1	Introduction to the course (ICE cars, e-mobility, hybrid EVs, driving range, efficiency, limitations, and the need for EVs) Part 1	
8/21	2	Introduction to the course (ICE, e-mobility, hybrid EVs, driving range, limitations, and the need for and EVs) Part 2	
8/26	3	Drivetrain fundamentals (single-speed and two-speed transmissions, single-motor and double-motor configurations, configurations including forward, rear, all and four-wheel drives, gears, advantages and disadvantages, regenerative braking) Part 1	
8/28	4	Drivetrain fundamentals (single-speed and two-EV drivetrain fundamentals (single-speed and two-speed transmissions, configurations including forward, rear, all and four-wheel drives, gears, advantages and disadvantages, regenerative braking) Part 2	
9/2	-	Labor Day	
9/4	5	Battery (different types and electro-chemistries, characteristics, modules and packs, state-of-charge estimation, C-rates, lifetime, cost, efficiency, cell balancing, limitations, 400 V vs. 800 V battery systems, and thermal and power management) Part 1	Assignment 1
9/9	6	Batteries (different types and electro-chemistries, characteristics, modules and packs, state-of-charge estimation, C-rates, lifetime, cost, efficiency, cell balancing, limitations, 400 V vs. 800 V battery systems, and thermal and power management) Part 2	
9/11	7	Batteries (different types and electro-chemistries, characteristics, modules and packs, state-of-charge estimation, C-rates, lifetime, cost, efficiency, cell balancing, limitations, 400 V vs. 800 V battery systems, and thermal and power management) Part 3	

9/16	8	Traction power electronics (inverters, DC-DC converters, pulse-width modulation, control, semiconductor devices, impact of Si vs. WBG-based power conversion on power density, thermal management and efficiency) Part 1	Assignment 2
9/18	9	Traction power electronics (inverters, DC-DC converters, pulse-width modulation, control, semiconductor devices, impact of Si vs. WBG-based power conversion on power density, thermal management, and efficiency) Part 2	
9/23	10	Traction power electronics (inverters, DC-DC converters, pulse-width modulation, control, semiconductor devices, impact of Si vs. WBG-based power conversion on power density, thermal management and efficiency) Part 3	
9/25	11	Motor drives (different motor types, number of motors, gearbox options, performance, etc) Part 1	
9/30	12	Motor drives (different motor types, number of motors, gearbox options, performance, etc) Part 2	
10/2	13	Motor drives ((different motor types, number of motors, gearbox options, performance, etc) Part 3	Assignment 3
10/7	14	Motor drives ((different motor types, number of motors, gearbox options, performance, etc) Part 4	
10/9	(Midterm)	Midterm Exam	
10/14	No class	Fall break	
10/16	15	Vehicular control, overall energy management, sizing and optimization	
10/21	16	EV charges (onboard and offboard, Level 1, Level 2, and Level 3, static and dynamic wireless charging, charging protocols, and connectors) Part 1	
10/23	17	EV charges (onboard and offboard, Level 1, Level 2, and Level 3, static and dynamic wireless charging, charging protocols, and connectors) Part 2	
10/28	18	EV charges (onboard and offboard, Level 1, Level 2, and Level 3, static and dynamic wireless charging, charging protocols, and connectors) Part 3	Assignment 4
10/30	19	EV charges (onboard and offboard, Level 1, Level 2, and Level 3, static and dynamic wireless	

		charging, charging protocols, and connectors) Part 4	
11/04 11/06	20 21	Grid interface (Vehicle to Grid, i.e., V2G, impact on the grid, limitations) Electrical, EMI, mechanical and thermal issues	
11/11 11/13	22 23	System level issues, safety, accidents, recycling at end of life Part 1 System level issues, safety, accidents, recycling at end of life Part 2	
11/18 11/20	24 25	Guest Lecturer 1 Guest Lecturer 2	Assignment 5
11/25 11/27	26 -	Future of transportation electrification (Hydrogen-powered vehicles, trucks, planes, ships) Thanksgiving holidays-No class	
12/2	27	Standards and regulations, impacts on economy and environment, concluding remarks	