

ME 4013: Hybrid Vehicle Powertrains

Instructor: Dr. Michael Leamy, Associate Professor, 132 Erskine Love Building,
michael.leafy@me.gatech.edu

Meeting Times: MWF 12:05 – 12:55, MRDC 3403

Textbook: None Required

Optional (available online through GT library): M. Ehsani, Y. Gao, S.E. Gay and A. Emadi,
Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, 2nd Edition, CRC Press, 2009
<http://www.crcnetbase.com/isbn/978-1-4200-5398-2>

Prerequisites: ECE-3710

Office Hours: Tuesday 11:00 – 12:00 and Wednesdays 3:00 – 4:00

Course Topics:

Introduction

Course Description, Components and Architectures

HEV Mechanics and Modeling

Vehicle Longitudinal Dynamics

Powertrain Tractive Effort

Hybrid & Regenerative Braking

Electric Machine Fundamentals

Energy Storage Fundamentals

HEV Controls Fundamentals

High-Level Series/Parallel Hybrid Design

Architectures

Operation

Performance Goals

Sizing of Components

Supervisory Control Strategies

Backward-Looking and Forward-Looking Simulation of HEVs

Modeling Fundamentals

Block Diagrams and Equivalent Circuits

Modeling of Electromechanical Systems

Controllability and Observability

Dynamic Programming

HEV Exam (in class)

Case Study 1: Toyota THS-II Powersplit

Case Study 2: GM 2-Mode Powersplit

Conclusion
Recap and Future Trends

Group Project Presentations (during final exam period)

* * denotes time permitting

Grade Determination:

HEV Exam (30%), Final Project (40%), Problem Sets (30%)

Final Project:

The final project requires groups of 2-3 students to complete a simulation-based design of a parallel architecture HEV. The expectation is that the Simulink/SimScape tools introduced during the semester will be employed (forward-looking simulation), or backward-looking simulation models will be written in an appropriate language, such as Matlab. The parallel architecture, component parameters (gear ratios, fuel consumption curves, etc.), and other design considerations are open-ended choices for each team. However, all choices must be researched and justified. The project will be assigned in the final 1/3rd of the semester, and a mid-project review will occur at the half-way mark. In lieu of a final exam, each team will present their final project in poster form during the time allotted for the final exam. A written report will also be required.

Rules Regarding Homework:

It is permissible to discuss homework assignments with your peers, but the written work that you turn in must be your own. Copying computer code and/or other parts of problem solutions is a serious violation of the Georgia Tech Honor Code and will be referred to the Dean of Students for investigation and penalties.

Timing of Gradable Events:

Exams are to be taken at the time announced by the instructor. Exceptions require prior approval from the instructor and will be granted only under unusual circumstances and with appropriate documentation.

Homework must be submitted on time to receive full credit. At the discretion of the instructor, homework submitted shortly after the due date may be accepted for partial credit, but no credit will be given once solutions are posted.

Academic Misconduct: All students are expected to comply with the Georgia Tech Honor Code. Any evidence of cheating or other violations will be referred to the Dean of Students with a recommendation that the penalty be an award of zero points for the graded requirement, and a one letter grade reduction in the course. Cheating includes, but is not limited to: using unauthorized references or notes; copying directly from any source, including friends, classmates, tutors, or a solutions manual; allowing another person to copy your work; taking an exam or handing in a graded requirement in someone else's name, or having someone else take an exam or hand in a graded requirement in your name; or asking for a re-grade of a paper that has been altered from its original form.

Students with Special Needs: Please see the instructor as soon as possible to discuss arrangements to fit your needs. The Office of Disability Services can identify any learning issues and assist you with course management through testing accommodations and other measures. Please see <http://www.adapts.gatech.edu/> for more information.

Course Outcomes:

Outcome 1: To teach students the basic principles underlying the operation, control, and design of hybrid vehicles.

Outcome 1.1: Students will demonstrate a basic technical understanding of the function, operation, and control of each component of a hybrid vehicle.

Outcome 1.2: Students will demonstrate an understanding of the functions a hybrid vehicle employs to increase efficiency and performance, such as regenerative braking and engine load-point shifting.

Outcome 1.3: Students will recognize series, parallel, and power-split architectures and demonstrate knowledge of their relative advantages and disadvantages.

Outcome 1.4: Students will demonstrate the ability to perform calculations necessary to support the design of series and parallel hybrid vehicles.

Outcome 2: To educate students to model, formulate, and simulate the operation of hybrid vehicles.

Outcome 2.1: Students will demonstrate the ability to model and write basic equations governing hybrid vehicle components, such as electric machines, energy storage systems, internal combustion engines, and basic transmissions.

Outcome 2.2: Students will demonstrate the ability to size components based on design equations and results from simulation.

Outcome 2.3: Students will demonstrate the ability to select supervisory control strategies and apply them towards the design of a hybrid vehicle.

Outcome 2.4: Students will demonstrate the ability to employ modern simulation tools towards the analysis and design of hybrid vehicles.

Outcome 3: To introduce students to open-ended design of hybrid vehicles.

Outcome 3.1: Students will demonstrate an ability to specify performance objectives based on vehicle class (e.g., efficient transportation, performance vehicle, large transport, etc.) and intended consumer.

Outcome 3.2: Students will demonstrate an ability to integrate component sizing and selection while simultaneously evolving a supervisory control strategy, in an iterative manner, using simulation tools.

Outcome 3.3: Students will demonstrate an ability to obtain basic cost estimates for their hybrid vehicle design and weigh their choices versus gains in performance.

Outcome 3.4: Students will demonstrate an ability to work effectively as a team to design a hybrid vehicle requiring multidisciplinary domain expertise.

Outcome 3.5: Students will demonstrate an ability to effectively communicate their hybrid vehicle design in both written and oral form.

Correlation between Course Outcomes and Program Educational Outcomes:

ME 4813											
	Mechanical Engineering Program Educational Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1	x									x	x
Course Outcome 1.2	x				x			x		x	X
Course Outcome 1.3	x				x						X
Course Outcome 1.4	x				x						X
Course Outcome 2.1	x				x						x

Course Outcome 2.2	x				x						x
Course Outcome 2.3	x				x						x
Course Outcome 2.4	x				x				x		x
Course Outcome 3.1	x		x		x			x		x	x
Course Outcome 3.2	x				x						x
Course Outcome 3.3	x		x		x		x			x	x
Course Outcome 3.4	x		x	x	x		x				x
Course Outcome 3.5	x		x		x		x	x		x	x