

**Energy Efficiency of Hybrid and Electric Vehicles, Labs**  
 Community College Course  
Syllabus

Course Description

The goal of this course is to provide analytical and hands-on skills on defining and testing power losses in powertrain systems of electric vehicles (EV) and hybrid-electric vehicles (HEV).

The course contains introductory lectures to present power losses and energy efficiency in EV and HEV. Laboratory experiments and computer workshops, the main portion of the course, follow the lectures. The laboratory test modules are built with the use of hardware and tests including ordinary and planetary gear sets, gear power loss test rig, electric motors, two unmanned ground vehicles with individual wheel drives (3-wheeler and 4-wheeler), etc. National Instruments LabVIEW and myRIO are in use for practical laboratory work. Computer workshops facilitate the understanding of HE concepts and operational modes and develop skills in simulating vehicle characteristics.

Course Topic Outline

Week	Topics
Week 1.	Introduction to Electrical and Hybrid-Electrical Vehicles: <ul style="list-style-type: none"> <li>• Vehicle concepts</li> <li>• Power losses in vehicle systems</li> </ul> Safety instructions in HE and E vehicle operation. Safety instructions in the Vehicle and Robotics Engineering Laboratory.
Week 2.	Different HEV concepts and operational modes – a practical study (Computer Workshops)
Week 3.	Vehicle gear transmission and gear drives(Two Lectures)
Week 4.	Vehicle gear drives – a practical study on gear ratio and power transmission principles (Laboratory Works)
Week 5.	Power losses in gear drives: an experimental study and evaluation (Laboratory Works)
Week 6.	Electrical motors/generators – principles and construction (Two Lectures)
Week 7 and 8.	Electrical motors – open loop control (Laboratory Works)
Week 9.	Batteries and ultracapacitors (Two Lectures)
Week 10.	Tires and tire-terrain interaction/power losses (Two Lectures)
Week 11.	Mechanical and electrical power in electrical 3-wheeler robot (Laboratory Works) Part I. Robot design and operation
Week 12.	Mechanical and electrical power in electrical 3-wheeler robot (Laboratory Works) Part II. Mechanical and electrical power estimation

Week 13.	Mechanical power losses in tires of an unmanned ground vehicle with 4-independently/electrically driven wheels (Computer Workshop).
Week 14.	Electrical unmanned ground vehicle: tires/terrain Interaction and power losses (Laboratory Works). Part I. Robot design and electrical drives of the wheels.
Week 15.	Electrical unmanned ground vehicle: tires/terrain Interaction and power losses (Laboratory Works). Part II. Tire slippage power loss and its electric equivalent.
Week 15a.	EXTRA Lecture Advanced Material: Power convertors (Two Lectures)