Model-Based Design Curriculum: Battery Systems

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Course Details

Description

The Model-Based Design Curriculum is a series of self-paced learning modules aimed at developing a basic understanding of Model-Based Design within the context of hybrid electric vehicles. In this course, Model-Based Design is defined as a method for developing mathematical models for physical systems and controllers in complex systems such as a vehicle powertrain. The intent of this course is to build understanding of complex systems through the development of basic models that can be modified to incorporate more complex behaviors. Battery Systems is the second course in the series. It provides an introduction to batteries, and discusses dynamic battery modeling, battery safety, state-of-charge and state-of-health estimations, and power management techniques.

The content of this course is designed for sophomore or higher college engineering students. The models developed in this module are built using MATLAB and Simulink release 2012b.

Prerequisites

- This course assumes a basic understanding of MATLAB and Simulink.

Original Course Documents

Source file URL (Includes lecture videos)

Course Contents

Lesson 1: Introduction to Batteries

- Lecture 1.1
- Lecture 1.2
- Lecture 1.3

Lesson 2: Dynamic Battery Modeling

- Lecture 2.1
- Lecture 2.2
- Lecture 2.3
- Lecture 2.4
- Demo: Current-Input Cell Model
  - Slides
  - CellModel.slx
  - SimulationScript.m
- Demo: Power-Input Cell Model
  - Slides
  - PowerInputModel.slx
  - PowerInputValidationTest.m
- Review Problems and Answers
  - Use the Current-Input Cell Model and the Power-Input Cell Model files to complete the review problems.

Lesson 3: Battery Balancing Methods

- Lecture 3.1
- Lecture 3.2
- Demo: Modeling Dissipative Shunting Resistor Balancing Using Simulink
  - Slides
  - Video
  - Shunting_Resistor_method.slx
- Lecture 3.3
- Demo: Modeling Single Switched Capacitor Balancing Using Simulink
  - Slides

Video
- Single_Switched_Capacitor_method_2cells.slx

Lesson 4: Battery Safety

- Lecture 4.1
- Lecture 4.2
- Lecture 4.3
- Model Files
  - ShortCircuitModel.slx
  - SCmodel.m
- Review Problems and Answers
  - Use the Short-Circuit Model files to complete the review problems.

Lesson 5: State of Charge and State of Health Estimations

- Lecture 5.1
- Demo: Simulink Model of SOC Feedback Observer
  - Slides
  - Video
  - SOC_estimator.slx
- Lecture 5.2
- Demo: Simulink Model of an Aged Battery Cell
  - Slides
  - Power_Capacity_Fade_Model.slx
- Lecture 5.3
- Demo: DFMEA for Power and Capacity Fade
  - Video

Lesson 6: Power Management and Supervisory Control

- Lecture 6.1
- Lecture 6.2
- Demo: PHEV Supervisory Control Model
  - Video
  - SeriesPHEV_New_Test.slx
  - int_series.m
  - ftp75.mat

Links

- EcoCAR2 Website
- EcoCAR3 Website
- EcoCAR2 Team at Pennsylvania State University