WM993-15 Modelling and Simulation of Systems

24/25

Department
WMG
Level
Taught Postgraduate Level
Module leader
Dhammika Widanalage
Credit value
15
Module duration
1 week
Assessment
100% coursework
Study location
University of Warwick main campus, Coventry

Description

Introductory description

Modelling and simulation is a key engineering stage. It allows us to evaluate various system configurations and how they will behave in various operating environments. In this module we will focus on systems known as dynamical systems derived from various physical domains and their modeling and control. You will understand how to model them and evaluate their validity for various applications. This module will also enable you to use a model-based approach to design controllers and observers at various levels of automotive abstraction. You will learn how to use MATLAB/Simulink to model such systems and develop controllers and see how other similar software tools allow engineers to develop such models.

Module aims

In this module the student will gain a comprehensive understanding and practical experience of the modelling, simulation and control of physical systems within an automotive context with a concentration of electrified powertrain systems. Developing a thorough understanding of deriving ordinary differential equations, constructing empirical models, applying relevant numerical methods and development of controller desing methods to solve problems in both the time and frequency domains, both theoretically and practically. 30 hours consisting of interactive

presentations, question and answer sessions, talks from industrial practitioners and researchers and discussion, videos, and hands-on computer simulation sessions.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

- 1-D Multi Physics System Simulation within the electrical, mechanical and hydraulic domains.
- Physical Modelling using ordinary differential equations (ODE's) and state variable block diagram modelling methods for both linear and non-linear systems.
- Eigen-value calculation & transfer-function analysis of physical automotive systems within the frequency domain and time domain.
- Understanding and application of data-driven and empirical modelling.
- Development of controllers and observers for dynamical systems.
- Application of modelling and simulation to determine the primary performance and energy consumption of electrified powertrains.
- Application of model-based controller design techniques for a variety of automotive applications.

Learning outcomes

By the end of the module, students should be able to:

- Demonstrate a comprehensive understanding of the practical application of the different approaches to mathematical modelling and analysis of one-dimensional physical systems [AHEP:4-M1]
- Derive, translate, solve & analyse 1D functional models of physical systems in sequential block diagram, transfer functions & state variable forms [AHEP:4-M1,M3]
- Demonstrate understanding in model linearization and validation of the linearized models with application in automotive systems. [AHEP:4-M1]
- Develop and apply controller and observer systems for dynamical systems in automotive applications, utilizing both classical and modern model based techniques. [AHEP:4-M1,M3]
- Develop integrated models of automotive systems to gain a practical understanding of multi-physics simulation techniques. [AHEP:4-M3]

Subject specific skills

- Understand dynamical systems.
- How to model electrical, mechanical, thermal, fluid systems as analogous systems.
- Numerical/block diagram methods to solve ordinary differential dynamical systems.
- Implement data-driven and empirical modelling in automotive applications.
- Validating and verification of linearised dynamical models.
- Development of controllers for various sub-systems and components within electrified powertrains.
- How the automotive industry use such models and model based design methods.

- MATLAB programming/Simulink Modelling.

Transferable skills

- Technology literacy
- Dependability
- Communication
- Adaptability

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (79%)
Online learning (independent)	8 sessions of 1 hour (21%)
Total	38 hours

Private study description

Self-study time for preparation for assessed tasks, including independent research activity.

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group A1

	Weighting	Study time	Eligible for self-certification
Modelling and Simulation of Electric Vehicles	60%	36 hours	Yes (extension)

Employing a variety of modelling approaches, including ODEs and empirical methods, to develop a model that accurately represents the performance and energy consumption characteristics of electric powertrain systems. (ILOs 1, 2, and 5)

	Weighting	Study time	Eligible for self-certification
The students will need to solve the problems through mathematical derivation and computer simulation and show the written solution and simulation results.			
Development of Controllers/Observers	40%	24 hours	Yes (extension)
Development of a controller or observer at the system/component level for an electrified vehicle using a model-based approach to satisfy the system/component requirements. (ILOs 3 and 4) The students will need to solve the problems through control desing toolboxes and show the written solution and simulation results.			

Feedback on assessment

Scaled ratings for Comprehension, effort and presentation, individual written feedback and overall mark following on from WMG feedback sheet templates.

As this is a Model A reassessment only any failed components will be individually reassessed at the same weighting.

Availability

There is currently no information about the courses for which this module is core or optional.