WM984-15 Systems Engineering and Functional Safety

26/27

Department
WMG
Level
Taught Postgraduate Level
Module leader
Borislav Dimitrov
Credit value
15
Module duration
4 weeks
Assessment
Multiple
Study locations
University of Warwick main campus, Coventry Primary
Distance or Online Delivery

Description

Introductory description

The module outlines the fundamental principles relevant to Systems Engineering, Systems Thinking, and Functional Safety. It begins with Document-Based Systems Engineering, covering the principles and concepts of complexity and systems thinking, system architecture, the functional analysis of automotive sub-systems, and the definition of customer needs and requirements. Moving to Model-Based Systems Engineering, the module introduces students to the application of specialised software products in developing systems engineering projects. Finally, it presents functional safety while incorporating systems engineering principles, where students cover the safety lifecycle, hazard and risk analysis, system/hardware/software development, and associated processes, including safety and change management, confidence levels and verification. Learning is reinforced through case studies and practical design exercises.

Module aims

The module aims to ensure students understand and follow the essential processes of developing complex automotive systems. This includes grasping user cases, requirements, and specifications, as well as the validation and verification of functional and safe systems. Systems

Engineering serves as the industrial framework for developing complex systems, and functional safety guarantees their safe use. Students learn to apply Model-Based principles in Systems Engineering by using relevant software tools as part of their problem-solving and project development activities.

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.

An Introduction to System Engineering.
System Engineering methods and Model-Based SE.
Customer needs and requirements.
Functional analysis and engineering design.
Assembly and test procedures.
Risk assessment.
Functional safety.

Learning outcomes

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

- Critically evaluate the Systems Engineering methods and approaches for the entire System Engineering life-cycle, showing their application in the Electric Propulsion System [AHEP:4; 7, M5]
- Evaluate customer needs, interpret the global requirements and cascade requirements to the sub-systems in advanced complex Electric Propulsion System, supporting the requirements development with relevant software [AHEP:4; 7, M5]
- Systematically define the concept of operation, functional analysis, and high-level and detailed engineering design procedures for Electric Propulsion System as a part of the Model-Based System engineering applied with relevant software [AHEP:4; 7, M5]
- Systematically define Electric Propulsion sub-systems assembling, testing and validation procedures, along with the risk assessment and risk mitigation techniques [AHEP:4; 7, M5]
- Comprehensively apply functional safety principles, HARA and ASIL evaluation in the design of complex Electric Propulsion Systems [AHEP:4; 7, M5]
- Demonstrate the V-method application with a specific case study [AHEP:4; 7, M5]

Indicative reading list

Reading lists can be found in Talis

Specific reading list for the module

Subject specific skills

The students will be able to apply systems thinking to complex engineering problems, following a structured, methodical process applied in Electric Propulsion System development. The students

will gain the ability to understand interactions and integration across multiple disciplines and domains – mechanical, electrical/electronics, thermal, software, etc. – applicable in the primary Electric Propulsion sub-systems development process. The student will understand the System Engineering needs analysis, requirements elicitation, the concept of operation and functional analysis, hazard and risk analysis, functional safety and management processes, engineering design, assembling and verification procedures in order to develop Electric Propulsion System industrial projects meeting the customer needs and requirements.

Core Skills:

| To understand the System Engineering methods and approaches and their applications in Electric Propulsion System |

| To understand the main Electric Propulsion sub-systems concept of operation and to define the conceptional architecture as a part of a complex industrial project |

| To understand the main Electric Propulsion System requirements and practically apply requirements cascading techniques, functional analysis and functional architecture definition |

| To understand and practically apply the high-level and detailed engineering design methodologies, assembling and testing procedures necessary for the Electric Propulsion System development process |

| To understand the functional safety basic principles and application in Electric Propulsion System development, based on ISO26262 standard |

| Gain a deep understanding of technical responsibility for complex engineering systems |

| Ability to validate that the design will satisfy the requirements of the product or service |

| Ability to ensure that engineering integrity is achieved and engineering procedures are complied with |

| Ability to ensure the rigorous application of risk management and lessons learnt to ensure project risk is understood and minimised through the project life cycle |

| Knowledge to ensure all internal process, regulatory and customer requirements are met |

| To understand the Modul-Based System engineering and to apply relevant software for its application |

Transferable skills

The module develops problem solving and troubleshooting capabilities, in addition to team working and lateral thinking. The ability to get into the "customer mindset" and work through issues in a thorough and methodical manner whilst working with different teams is essential in todays work force.

Core Behaviours
| Professional commitment
Demonstrating a personal, ethical and professional commitment to society, their profession and the environment, adopting a set of values and behaviours that will maintain and enhance the

reputation of the profession as well as their organisation and fulfilling requirements with respect to maintenance of personal records for Professional Registration.|

Study

Study time

Type	Required
Lectures	18 sessions of 1 hour (12%)
Seminars	12 sessions of 1 hour (8%)
Online learning (independent)	18 sessions of 1 hour (12%)
Private study	42 hours (28%)
Assessment	60 hours (40%)
Total	150 hours

Private study description

During the module delivery, the students are expected to learn the theory independently, following the materials presented in the lectures and seminars. This includes the central topics of System Engineering and Model-Based System Engineering – customer needs estimation, requirements, functional analysis, pre- and engineering design, assembly and test procedures. Their step-by-step development during the 4-week delivery will help the students to apply the fundamental theory in their assignments independently.
Functional Safety is covered by the industrial standard ISO26262, studied in the seminars and design activities. The students are expected to independently conduct HARA and ASIL procedures as part of their coursework.

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group A2

	Weighting	Study time	Eligible for self-certification
Coursework: Electric Drivetrain System	80%	48 hours	Yes (extension)

	Weighting	Study time	Eligible for self-certification
Engineering Project The coursework focuses on developing the Electric Drivetrain (ED) SEFS project, following the main SE methods and life cycle. The project includes the main ED sub-systems – energy storage, DC-DC converter, DC-AC inverter, electric motor and the battery charger. The main points are the application of the SE V-model, customer needs estimation, global and cascaded requirements, engineering design, assembly and test procedures. The functional safety is developed and analysed according to the industrial ISO 26262 standard.			
In module online assessement (Video Presentation) The video presentation focuses on developing an electric vehicle charging system based on renewable energy sources, utilising system engineering methods. The project includes a compatibility analysis of the main subsystems, including the source, inverter, charger, and backup battery pack. Following the SE V-method, the students estimate customer needs, which determine the global and cascaded requirements. The engineering design includes the quantification of the central interface parameters and final verification of the system's functionality. The students are asked to submit a recorded video presentation or a PowerPoint with a voice-over.	20%	12 hours	Yes (extension)

Assessment group R

	Weighting	Study time	Eligible for self-certification
Coursework: Electric Drivetrain System Engineering Project	80%	48 hours	No
In module online assessement (Video Presentation)	20%	12 hours	No

Feedback on assessment

Written feedback for both assessments will be provided.
The feedback will provide details on the current work assessment and suggestions for future improvements applicable to students’ future industrial projects.

Availability

Pre-requisites

To take this module, you must have passed:

- All of
  - WM985-15 Automotive Hybridisation and Electrification

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