Model Based Systems Engineering (MOD-E12)

Code Number	Workload	Credits	Semester	Frequency	Duration
10415	180 h	6		annually	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Model Based Systems Engineering	4 SWS / 60 h	120 h	25 students

2 Course Description

The demands on automotive computing platforms are continuously rising due to the increasing amount of software that is driven by new automotive functionalities. Deploying these applications to computing platforms will introduce several challenges, such as maintaining freedom from interference in safety-critical applications -as required by the ISO~26262 standard,- or meeting constraints such as timing requirements. As the complexity of those systems results in intricate and unforeseen impacts of product and project decisions on the system level, even in late development phases, an early assessment of design decisions will be a key factor for success. This course gives an overview about the recent state of the art in model based systems engineering with focus on the emerging trends in automotive systems and transfers recent findings into teaching. The student will learn how to explore and structure models of automotive systems – especially in the context of hardware/software co-design – and how to map the acquired skills and knowledge to that particular domain. Furthermore, the students will learn about developing and integrating own rudimentary tooling into the APP4MC platform.

3 Course Structure

1. Trends and challenges for future automotive E/E architectures
2. Automotive Standards: e.g. AUTOSAR, EastADL, Amalthea, …
3. Eclipse APP4MC
4. Modelling embedded systems
5. Developing rudimentary tooling for analyzing resp. modifying existing models of applications
6. Open Source and proprietary tools in Model based Automotive Engineering (e.g. Vector / TA Tool Suite, Inchron, Eclipse APP4MC Task Visualizer, …)
7. Deploying software to embedded multi- and many-core hardware
8. Code generation
9. Testing and Verification
10. Application Examples

4 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
- Contact hours: 60
- Self-Study hours: 120
- Course characteristics: elective
- Course frequency: every year - winter semester
- Maximal capacity: 25 students
- Course admittance prerequisites: programming skills (pref. Java), basics of embedded systems

	• Skills trained in this course: theoretical, practical and methodological skills • Assessment of the course: Oral Exam at the end of the course (50%) and group work as homework (50%): set up of a MBSE development project in the context of an automotive application, modeling and deploying software to embedded multi-/many core hardware using APP4MC, demonstration and presentation • Teaching staff: Prof. Dr. Carsten Wolff, M.Sc. Lukas Krawczyk
5	**Learning outcomes** 5.1 Knowledge • Knows typical challenges in developing future e.g. automotive embedded systems and how to address these using model based approaches • Knows how to apply 3rd party tools in MBSE • Has acquired an overview on the various views on automotive applications 5.2 Skills • Can model a system from e.g. the automotive context (software, hardware, global functionality) according to a real-world example • Can assess an application using tools based on their model description • Can select and develop own (rudimentary) tools as well as integrate these into design flows 5.3 Competence - attitude • Can structure a real model based systems engineering development project • Can communicate and find solutions with domain experts • Understands challenges in using heterogeneous hardware platforms
6	**Teaching and training methods** • Lectures, Labs (with APP4MC and 3rd party tools), homework • Access to tools and tool tutorials from industrial partners (e.g. Bosch, Inchron, Vector) • Access to recent research papers • Company visit from at least one of the partner companies
7	**Course mapping** Requires: • MOD1-02 – Distributed and Parallel Systems • MOD1-03 - Embedded Software Engineering Connects to: • MOD-E01 – Applied Embedded Systems
8	**References** APP4MC Documentation: https://www.eclipse.org/app4mc/documentation/ Amalthea Model: https://wiki.eclipse.org/images/5/5c/2013-06-04_AMALTHEA_Project.pdf Research papers in the context of model based systems engineering in the context of automotive development: https://scholar.google.de/citations?hl=en&user=iBKd0uAAAAAJ Peter Marwedel: Embedded System Design, 2nd Edition, Springer, 2011