Studiengang: *Program:*	**Master of Science Maschinenbau** *Master of Science in Mechanical Engineering*			FACH HOCHSCHULE LÜBECK University of Applied Sciences
1 **Modul:** *Module:*	**Selected Topics in Mechatronics** *Ausgewählte Themenfelder der Mechatronik*			**English** *Englisch*
	Semester *Semester*	**Dauer** *Duration*	**Status** *Status*	**Turnus** *Regular cycle*
	2. Semester	1 Semester	elective	annual
Kreditpunkte *Credits*	**Aufwand** *Workload*	**Kontaktzeit** *Contact-hours*	**Selbststudium** *Student's efforts*	
5 ECTS	150h	2hrs/week = 30hrs Lecture 2h/week = 30hrs Laboratory	30hrs Preparation and post processing 60hrs Self-study	

2 **Beschreibung**

Description

Complexity in system design is rising and the engineer needs more productivity boosting design methods and software-tools, especially in the field of mechatronic systems design. An integrated system design approach from the first sketches up to the prototype phase is necessary to design the structure and the parameters of mechatronic systems. A major role plays the building of physical models for mechatronic systems because this avoids the time-consuming derivation of mathematical models by hand, which can be often only derived, if the physical model is simplified and major influences of the nonlinearities of the systems are neglected. To develope mechatronic systems successfully, the use of nonlinear physical models is a must and using such models for simulation, hardware-in-the-loop tests and in the prototype is necessary for the development of intelligent functions for the machines. But the comfort using physical models must not hide the fact, that for a correct interpretation of the measurement and analysis results an excellent understanding of the underlying theory is necessary especially in multibody system dynamics and hardware-in-the-loop techniques - This is contents of the course.

3 **Lernziele**

Learning Outcomes

The students should learn the special requirements necessary for the design of mechatronic systems and especially of the mechanical subsystem. In the first step the students learn to understand the design methods for mechatronic systems and what vital role the dynamics of the mechanical subsystem plays herein. In the second step the physical modelling of multibody system models is teached and trained and in the third step the students getting a deep insight into the mathematical methods behind physical modelling techniques. In the Laboratory exercises the students train the use of multibody system tools for modelling, analysis, parameter studies and optimization tasks of multibody systems. The training comprises the offline-simulation of multibody-system models as well as the simulation on ECU systems for the development of intelligent functions with the help of test-bed applications (HiL-tests).

4 **Schlüsselqualifikationen**

Key qualifications

Sozialkompetenz	Methodenkompetenz	Selbstkompetenz / Personenkompetenz	Interkulturelle Kompetenz	Medienkompetenz
	X	X		

5 **Lehrveranstaltung/ -methoden**

Course type and methods

Lecture
- Seminar-like teaching
- Exercises and examples (case studies)

Laboratory exercises

6 **Vorbedingungen / Vorkenntnisse**

Prerequisites

- Control Systems, Base Courses in Mechanics esp. dynamics

7 **Arbeitsmittel / Literatur**

Required material / Literature

Chapters of suitable selected textbooks, list provided in the beginning of the class

Detailinformationen

8 **Inhalte**

Course topics

Overview - Mechatronic systems
Design principles of mechatronic systems, success factors in the development of mechatronic systems, micro and macro systems, state of the art in mechatronic products in production technology, automotive engineering and consumer products, influence of microelectronics, implication for system design, system concept in mechatronics, flow of information, energy and material, function-oriented design, the role of hierarchical structuring in systems design, X-by-wire technologies as best practice example in developing mechatronic systems, intelligent vehicles, integration into local and global ecosystems, S-curve of technologies, technology trends.

Model based design of mechatronic systems
Introduction to mechatronic systems, Components of mechatronic systems, tasks of the components, the role of feedback in mechatronic systems, system complexity, design process, base design process: requirements-model stage-testbed stage-prototype stage-series product, development process according to the standard VDI 2206 - Design methodology for mechatronic systems, the role of simulation and hardware-in-the-loop simulations in the design of mechatronic systems, hard and soft real-time conditions, basic building blocks for the modelling of mechatronic systems

Modelling of mechatronic systems
Basic building blocks of control engineering systems (linear and nonlinear state space description, transfer functions, characteristic curves) and using the hierarchy concept for structuring the mechatronic system, analysis techniques (e.g. simulation, eigenvalues, transfer functions), code generation for simulation and embedded systems, example development of an active suspension system, model-based testing, structure and properties of driving simulators,

Multibody system dynamics
Mechanical subsystems of mechatronic systems, modelling depth, types of mechanical base structures in mechatronic systems, role of FEM models, simple mechanical models and multibody system models for the design, examples from automotive and robotics how to derive multibody system models for the analysis of the dynamical systems behavior, design tasks for the mechanical subsystem, function-oriented design of the mechanical subsystem (kinematic function, dynamic function, mechatronic function), the parts of multibody systems modeling, connection and joint types, degrees of freedom, system graph of topology, introduction to multibody systems formalisms

Multibody system dynamics mathematics
Coordinate systems, main views, center of gravity, moment of inertia and deviation, translational and rotational displacement of coordinate systems, coordinate transformations (euler, cardan, quaternion, cosinus), kinematic matrices, connections in multibody systems models and their mathematical description, mbs-formalisms and their mathematics (lagrange and newton-euler based formalisms suitable for real-time simulations of mechatronic systems)

Engineering tools for the analysis of multibody system dynamics
Modelling and simulation tools used in industry – overview, basic building blocks for multibody systems modelling used in a selected modelling tool suitable for the development of mechatronic systems, tool requirements from a mechatronics perspective, introduction into the tool structure, demonstration and discussion of typical multibody system models from automotive and robotics.

Hardware-in-the-loop simulation
Basic building blocks of hardware-in-the-loop simulation (AD-converters, DA-converters, PWM-in and outputs, CAN, SPI), signal capture, analogue and digital signals, algorithms, filters, sensors, actuators, real-time multibody system models, monitoring and reporting of system variables, connection to non real-time systems, embedded systems used in industry.

Laboratory Exercises: Training of modelling and simulation of multibody systems as part of mechatronic systems
Introduction into the design environment CAMeL-View for the modelling of multibody systems, deriving the mathematical equations of motion and code them into the simulation environment, learn the use of rigid body, joint, actuator and hierarchical system parts, parameterization of systems, build a model of the NASA multi-axis trainer in the lab in a given time-frame.

9 **Prüfungsform**

Assessment

Written examination at the end of the term: 2 hours.

10 **Voraussetzung für die Vergabe von Kreditpunkten**

Requirements for granting of credits

- Successful passing of exam

11 **Weiterführende Veranstaltungen**

Related courses

- none

12 **Zuordnung**

Classification

Mathematik & Naturwissenschaft	Ingenieur-wissenschaften	Ingenieur-anwendungen	Entwicklung & Konstruktion	Werkstoffe	Wirschaft, Management, Sprachen	Anderes
	X	X				

13 **Modulbeauftragter / Lehrpersonen**

Responsible person / Lecturers

Prof. Dr.-Ing. M. Hahn/ Prof. Dr.-Ing. M. Hahn