	Studiengang: *Program:*	**Bachelor of Science Maschinenbau** *Bachelor of Science in Mechanical Engineering*			FACH HOCHSCHULE LÜBECK University of Applied Sciences
1	**Modul:** *Module:*	**Modelling and Numerical Analysis**			**Englisch** *German*
		Semester *Semester*	**Dauer** *Duration*	**Status** *Status*	**Turnus** *Regular cycle*
		5. Semester	1 Semester	Pflichtfach	jährlich
	Kreditpunkte *Credits*	**Aufwand** *Workload*	**Kontaktzeit** *Contact-hours*	**Selbststudium** *Student's efforts*	**Gruppengröße** *Team size*
	5 ECTS	150h	4 SWS = 60h Vorlesung	30h Vor-/Nachbereitung 60h Übungen	10 – 20 Pers. Lehre

2 Beschreibung *Description*

The simulation of dynamical systems on a computer is of increasing importance for the conception, construction, performance analysis and maintenance of technical systems. It is possible to answer very detailed questions even in the case where the system consists only as a model on a computer. In the lecture, it will be shown how to derive a mathematical model from the physical laws. It will also be explained how this mathematical model can be implemented on a computer and how it can be applied.

3 Lernziele *Learning Outcomes*

The students are asked to learn

- how to derive the differential equations which describe the dynamics of the system by using the underlying physical laws
- how the mathematical model can be implemented on a computer and how hardware can be embedded
- about the most important properties of nonlinear and linear dynamic systems

4 Schlüsselqualifikationen *Key qualifications*

Sozialkompetenz	Methodenkompetenz	Selbstkompetenz / Personenkompetenz	Interkulturelle Kompetenz	Medienkompetenz
	X	X		

5 Lehrveranstaltung/ -methoden *Course type and methods*

Vorlesung mit Übungen, auch am PC und an Hardware

6 Vorbedingungen / Vorkenntnisse *Prerequisites*

Mathematik I, II, III und alle Grundvorlesungen mit mathematisch-technischem Inhalt

7 Arbeitsmittel / Literatur *Required material / Literature*

Auszüge aus verschiedenen einschlägigen Lehrbüchern

Detailinformationen

8 Inhalte
Course topics

- **Mathematical description of dynamic systems**
  Nonlinear and linear systems of differential equations, simple technical examples, behavior of the solution, controlled and observed systems, equilibrium points and linearization
- **Simulation of dynamic systems**
  One step methods, discretization error and convergence, implementation with MATLAB, simulation with SIMULINK block diagrams, hardware in the loop
- **Methods to derive a mathematical model**
  Mechanical systems: bilances of forces and torques, equations of Euler-Lagrange
  Examples: Spring-mass-damper system, pendulum, crane positioning system, anti blocking system
  Thermal systems: Heat flow bilances
  Examples: Heating of a dc motor, heat exchanger, heating of a thin rod
  Fluid systems: mass flow bilances
  Examples: Pressure container, three-tank-system
  Electrical systems: Voltage and current bilances
  Example: RLC circuit, RLC circuit with a nonlinear resistor
  Electromechanical systems: dc motor
  SIMULINK models for a selection of these examples
- **General properties of nonlinear systems**
  Stability of nonlinear systems, Lyapunov functions, stability of linear systems, Lyapunovs indirect method, phase portraits, periodic solutions, limit cycles
- **General properties of linear systems**
  Solution formula, step response, frequency response, transfer functions, MATLAB tools,
- **Case studie: Rotational pendelum (with laboratory experiment)**
  Equations of motion, linearization, transfer functions, SIMULINK block diagram, set-up of the experiment, comparision of simulated and measured results

9 Prüfungsform
Assessment

Klausur

10 Voraussetzung für die Vergabe von Kreditpunkten
Requirements for granting of credits

Erfolgreiches Bestehen der Klausur

11 Stellenwert der Note in der Endnote
Meaning of the mark concerning final exam

Anteilig 5/210

12 Weiterführende Veranstaltungen
Related courses

Automatic Control Systems I

13 Bezug zu Zielen des Studiengangs
Related objectives of the study program / Outcomes

14 Zuordnung
Classification

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

15 Modulbeauftragter / Lehrpersonen
Responsible person / Lecturers

Prof. Dr. Mackenroth