Module description ETB_603 Simulation and System Control

Last update: November 25, 2016

Degree: Bachelor of Engineering

1	**module no.** ETB 603	**degree programme** ETB	**semester** 6	**starts in** ☒WS ☒SS	**duration** 1 Semester	**module type** mandatory	**workload (h)** 150	**ECTS Credits** 5

2	**courses**	**type of instruction**	**language**	**contact hours (SWS)**	**(h)**	**self-study (h)**	**ECTS Credits**
	a) Digital Systems Control	lecture including practice	English	2	**30**	**30**	**2**
	b) Simulation Technology	lecture including practice	English	1	**15**	**15**	**1**
	c) Systems Control Laboratory	laboratory	English	1	**15**	**15**	**1**
	d) Simulation Technology	laboratory	English	1	**15**	**15**	**1**
	e)						
	f)						

3	**table of qualifications**	expertise	methodological skills	personal & social skills
	knowledge & understanding	☒	☒	☒
	applying knowledge & understanding	☒	☒	☒
	analysing & evaluating	☐	☒	☐
	acquiring and broadening knowledge	☐	☐	☐

4 **learning outcome and competences**

On completion of the module the students are expected to be able to :

knowledge and understanding

Digital System Control: The students

- know and understand how digital control systems works (e.g. sample and hold operation) and how it is structured as well as they know and understand its advantages and disadvantages compared to analogue control systems.
- know and understand different mathematical methods of describing, analyzing and synthesizing digital control systems.
- know and understand different methods to describe control systems (e.g. real-time status, block diagrams, transfer function).
- know and understand key words like stability, controllability and observability of linear systems and the relevant mathematical methods (eigenvalues, matrix operations).
- are capable of determining the steady-state position of a system based on differential equations and can derive the linearized state-space description.

Simulation technology: The students

- know motives and reasons why using simulation methods in production design, their advantages and disadvantages as well as their possible risks and chances.
- know the main linear and non-linear control oriented transfer elements (e.g. P-element, Look-up tables) and modelling elements and their implementation into a software tool (e.g. Matlab/Simulink).
- know the difference between a real time simulation and a non-real time simulation.

acquring skills

Digital System Control: The students

- are capable of describing nonlinear or linear mechatronic systems in state-space using systems of first order ordinary differential equations
- are capable of deriving the linearized equations and determining the time constants of the system
- are capable of calculating a transfer function based on a linear state-space description
- are capable of testing the system stability, controllability and observability in the state space representation

Module description ETB_603 Simulation and System Control Last update: November 25, 2016

Degree: Bachelor of Engineering

	• are capable of setting up state feedback controller using the state space representation. • are capable of actively influencing the dynamic behavior of the closed control circuit by pole placement. • are capable of designing state observers for the realization of state feedback controllers Simulation technology: The students • are capable of converting and implementing linear and non-linear general differential equations and systems to a signal-flow-oriented diagramme (block diagramme). • are capable of creating database modules for components (e.g. actuators, sensors, mechanical structures) and of linking them with the correct preceding sign. With these models they are capable of creating system models and of systematically testing them (e.g. parameter studies). • are capable of choosing integration methods and of setting up integration stepsize. • are capable of understanding numerical integration methods (Euler Integration) as far as the figures are concerned by means of simple examples. **analysing and evaluating skills** Digital System Control: The students • are capable of characterizing the behavior of system controls as well as their components (e.g. stability, steady-state accuracy, transient time) based on the transfer function, the poles and the system response. • Are capable of setting up digital controllers of linear systems (e.g. compensation method) as well as state controllers (e.g. pole setting) by the use of different methods. Simulation technology: The students • are capable of evaluating the time response of simulations as far as the quality and the quantity are concerned (e.g. of differentiating codes) and of assigning it to a technical application. • are capable of analysing and correcting possible causes for a faulty and unstable simulation. **acquiring and broadening (skills)** • none
5	**content** **a)** Digital System Control - Stability of linear systems, time constants, sampling time, transfer function, state feedback control, design of control algorithms, state observers, observer design, realisation, eigenvalue assignment - b) Simulation technology • model-based development process, chances and risks, accuracy, tools. Model design: signal-flow-oriented model design of mechatronic systems, mechanical drives and direct current drives. System diagrammes: general differential equations and block diagrammes. System analysis: numerical integration methods, Euler method, numerical stepsize, rounding errors/ discretisation errors, real time simulation. c) Digital System Control Laboratory • test 1: simulation of a vehicle suspension with MATLAB/Simulink • test 2: control of a DC motor • test 3: control of rotor arms with MATLAB/dSPACE d) Simulation Technology Laboratory • test 1: repetition of Matlab/Simulink, Euler integration of a simple system with Matlab • test 2: mathematical system diagrams in Simulink • test 3: modelling and identification of an electrical driving system with Matlab/Simulink • test 4: analysis of an electrical driving system with cascade control with Matlab/Simulink

Module description ETB_603 Simulation and System Control Last update: November 25, 2016

Degree: Bachelor of Engineering

6	**prerequisites** **according to the study and examination regulations:** mathematics 1, signals and systems, system control **recommended**: none
7	**type of assessment and requirements for credits** a) common written exam (exam, 90 minutes, for both lectures) b) Every trial is to be successfully passed including report (for both laboratories)
8	**use of the module** Mandatory module in the bachelor degree programme of ETB
9	**person responsible for the module and other lecturers involved** Prof. Dr.-Ing. Gerd Wittler Prof. Dr.-Ing. Ralf Rothfuß
10	**literature** • Lutz/Wendt: Taschenbuch der Regelungstechnik, Verlag Harri Deutsch • Zirn: Modellbildung und Simulation mechatronischer Systeme, Expert Verlag
11	**contribution to the educational aims of the degree programme** The students gain interdisciplinary skills in the field of mechatronics with the aim "Electronical Engineering". Graduates are capable of gaining skills in latest engineering problems regarding mechatronics/ electrical engineering. They are in a position to understand scientific and technical developments and to follow them permanently.
12	**last update:** November 16