EITM110A Advanced Control

Studiengang	Elektro- und Informationstechnik (Master)
Modulname	EITM110A Advanced Control
Zugeordnete Lehrveranstaltungen	EITM110A Advanced Control
Studiensemester	1st Semester
Modulverantwortlicher	Prof. Dr. Urban Brunner
Dozenten	Prof. Dr. Urban Brunner
Sprache	English or German; the course language will be announced at the beginning of the semester
Lehrform, SWS und Gruppengröße	Course, 4h/week
Modus	Mandatory in the study field Automation, elective in the other study fields of the program
Turnus	Winter semester
Arbeitsaufwand	On-campus program 60 h, self study 90 h
Kreditpunkte	5 CP
Empfohlene Vorkenntnisse	Classical Control Theory, Digital Signal Processing
Voraussetzungen nach Prüfungsordnung	none
Lernziele / Kompetenzen	*Allgemein:* The module provides an advanced education in control systems engineering, emphasising modern theoretical developments and their practical application. The course gives a sound fundamental understanding of feedback systems and enables students to apply modern control principles in various areas of industry. *Zusammenhänge / Abgrenzung zu anderen Modulen:* Most of the design methods in classical control theory rely heavily on trial-and-error. In contrast, modern control design methods lead to a unique solution to a given design problem. The course introduces modern control design methods ranging from linear optimal control to non-linear and supervisory control emphasizing a general view and sound understanding rather than algorithmic details. These skills will benefit the students throughout their career. *Kenntnisse, Fertigkeiten, Kompetenzen:* Upon successful completion of this course, the students • understand the limits in classical control and are able to combine classical control concepts with modern control theory • are able to analyze and design digital control systems • know the theory of modern state space methods and are able to apply them to real processes • are able to cope with complexity of distributed large systems • have expanded their abilities of abstraction and modeling real processes
Inhalt	• Fundamental limits of feedback systems: Sensitivity and complementary sensitivity, Bode's integral formula, waterbed-effect • Robustness analysis of plants with bounded uncertainties • Extensions of standard PID control loops: Two-degree-of-freedom controllers, notch filter in the feedback loop, gain scheduling, autotuning of PID-Controllers

	• Modeling for control: Principles of modeling continuous systems, state space representation of (linear) MIMO-systems, canonical normal forms, and equivalence transformations • Digital control: Sampling and reconstruction of signals, continuous-to-discrete conversion methods, esp. BLT with prewarping, digital redesign of continuous controllers • Modern control theory: Controllability, observability, Kalman decomposition, pole assignment, state-feedback with integral action, Luenberger observer, LQR/LQG • Selected topics in nonlinear control: zero dynamics, exact feedback linearization, flatness-based process-inversion • Control of large distributed systems: Balanced realization, Model reduction, design of reduced order controllers, decentralized control, modeling of event-driven systems and supervisory control, modeling and simulation of hybrid systems
Studien- und Prüfungsleistungen	Assessment is done by either a written exam (90 minutes) or an oral examination (20 minutes). The form of examination will be announced at the beginning of the semester.
Medienformen	• slides (Powerpoint, PDF) • additional handouts (scientific articles, selected papers) • Matlab simulation programs • exercises, and detailed homework • demonstrations / applications in Process Control Lab
Literatur	A. Braun: *Grundlagen der Regelungstechnik: Kontinuierliche und diskrete Systeme*, Fachbuchverlag Leipzig, 2005 B.C. Kuo: *Automatic Control Systems*, Prentice Hall, New Jersey, ISBN 0-13-054842-1, 1987 H. Unbehauen: *Regelungstechnik II*, Vieweg, 6. Aufl., 1993 H. Unbehauen: *Regelungstechnik III*, Vieweg, 5. Aufl., 1995 W. Büttner: *Digitale Regelungssysteme*, Vieweg, 1994 J. Lunze: *Automatisierungstechnik*, Oldenbourg, 2003 Slotine and Li: *Applied Nonlinear Control*, Prentice Hall, New Jersey, ISBN 0-13-040890-5, 1991 Hoffmann und Brunner: *MATLAB & Tools für die Simulation dynamischer Systeme*, Addison-Wesley, München, 2002 U. Brunner: *Einführung in die Modellbildung und Simulation ereignisgetriebener Systeme mit Stateflow*, Grin-Verlag, (v129403), 2010