

Studiengang	Elektro- und Informationstechnik (Master)
Modulname	EITM110.A Advanced Control
Zugeordnete Lehrveranstaltungen	EITM110.A 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 Signalprocessing
Voraussetzungen nach Prüfungsordnung	none
Lernziele/ Kompetenzen	<p><i>Allgemein:</i> 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.</p> <p><i>Zusammenhänge/Abgrenzung zu anderen Modulen:</i> 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.</p> <p><i>Kenntnisse, Fertigkeiten, Kompetenzen:</i> Upon successful completion of this course, the students</p> <ul style="list-style-type: none"> <li>• understand the limits in classical control and are able to combine classical control concepts with modern control theory</li> <li>• are able to analyze and design digital control systems</li> <li>• know the theory of modern state space methods and are able to apply them to real processes</li> <li>• are able to cope with complexity of distributed large systems</li> <li>• have expanded their abilities of abstraction and modeling real processes</li> </ul>
Inhalt	<ul style="list-style-type: none"> <li>• Fundamental limits of feedback systems: Sensitivity and complementary sensitivity, Bode's integral formula, waterbed-effect.</li> <li>• Robustness analysis of plants with bounded uncertainties</li> <li>• Extensions of standard PID control loops: Two-degree-of-freedom controllers, notch filter in the feedback loop, gain scheduling, auto-tuning of PID-Controllers.</li> <li>• Modeling for control: Principles of modeling continuous systems, state space representation of (linear) MIMO-systems, canonical normal forms, and equivalence transformations.</li> </ul>

	<ul style="list-style-type: none"> <li>• Digital control: Sampling and reconstruction of signals, continuous-to-discrete conversion methods, esp. BLT with prewarping, digital redesign of continuous controllers.</li> <li>• Modern control theory: Controllability, observability, Kalman decomposition, pole assignment, state-feedback with integral action, Luenberger observer, LQR/LQG.</li> <li>• Selected topics in nonlinear control: zero dynamics, exact feedback linearization, flatness-based process-inversion.</li> <li>• 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.</li> </ul>
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	<ul style="list-style-type: none"> <li>• slides (Powerpoint, PDF)</li> <li>• additional handouts (scientific articles, selected papers)</li> <li>• Matlab simulation programs</li> <li>• exercises, and detailed homework</li> <li>• demonstrations/applications in Process Control Lab</li> </ul>
Literatur	<p>A. Braun: Grundlagen der Regelungstechnik: Kontinuierliche und diskrete Systeme, Fachbuchverlag Leipzig, 2005.</p> <p>B.C. Kuo: Automatic Control Systems, Prentice Hall, New Jersey, ISBN 0-13-054842-1, 1987.</p> <p>H. Unbehauen: Regelungstechnik II, Vieweg, 6. Aufl., 1993.</p> <p>H. Unbehauen: Regelungstechnik III, Vieweg, 5. Aufl., 1995.</p> <p>W. Büttner: Digitale Regelungssysteme, Vieweg, 1994.</p> <p>J. Lunze: Automatisierungstechnik, Oldenbourg, 2003.</p> <p>Slotine and Li: Applied Nonlinear Control, Prentice Hall, New Jersey, ISBN 0-13-040890-5, 1991.</p> <p>Hoffmann und Brunner: MATLAB &amp; Tools für die Simulation dynamischer Systeme, Addison-Wesley, München, 2002.</p> <p>U. Brunner: Einführung in die Modellbildung und Simulation ereignis-getriebener Systeme mit Stateflow, Grin-Verlag, (v129403), 2010.</p>