3.2.5 Advanced Control

Module title: Advanced Control

Module summary
Module code: EITM 220A
Module coordinator: Prof. Dr. Dirk Feßler
Credits (ECTS): 5 CP workload: in lecture 60 h, independent study time 90 h
Semester: 1st or 2nd semester
Pre-requisites with regard to content: Classical Control Theory, Digital Signal Processing
Pre-requisites according to the examination regulations: none
Competencies: 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
Assessment: Assessment is done by either a written exam (90 minutes) or an oral examination (30 minutes). The form of examination will be announced at the beginning of the semester
Usability: *General:* 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. *Connection with other modules:* 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.

Course: Advanced Control
Module code: EITM 220A
Lecturer: Prof. Dr. Dirk Feßler
Contact hours: by arrangement
Semester of delivery: yearly, summer semester
Type/mode: lecture 4h/week; mandatory in the study field Information technology, optional in the other study fields of the program
Language of instruction: English or German; the course language will be announced at the beginning of the semester
Content: • 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, auto-tuning 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

Recommended reading:

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 ereignis-getriebener Systeme mit Stateflow*, Grin-Verlag, (v129403), 2010

Comments: -