Nonlinear control theory

Credits: 4 Semester 2 Compulsory: No

Format	Lectures 20 h	Examples 12 h	Private study 68 h

Lecturers: C.Moog (ECN)

Course objectives: The goal is to give the basis of modern nonlinear control theory. Analysis and control of nonlinear systems are considered using a so-called algebraic approach. Examples taken from robotics or electric drives demonstrate the feasibility of the methodology.

Contents:

- Introduction to the algebraic approach for nonlinear systems and its mathematical tools.
- Structural analysis, concepts of relative degree, of controllability and observability.
- Control methods: feedback linearization, decoupling, reference trajectory tracking.
- Lyapunov functions and their properties.
- Recursive global stabilization by state feedback of nonlinear systems.
- Design of a nonlinear observer. Special observability forms for input-affine systems.
- Observer-based stabilization. Methods to avoid finite-escape time.
- Dynamic output feedback semi-global stabilization.

Practical Work: Exercises, use of computer algebra, case study on an inverted pendulum.

Objectives: After completing this course, the students will be able to:

Understand the theoretical fondamentals on the control of nonlinear systems,
Apply advanced nonlinear control on a variety of robotics systems,
Implement control strategy, and calculate the corresponding observer.

Assessment: 30% continuous assessment, 70% from end-semester examination

Recommended texts:

- G. Conte, C.H. Moog and A.M. Perdon, *Algebraic Methods for Nonlinear Control Systems. Theory and Applications*, Springer-Verlag, 2006.
- A. Isidori, *Nonlinear Control Systems. 2nd edition*, Springer-Verlag, 1989.
- R. Marino and P. Tomei, *Nonlinear Control Design: Geometric, Adaptive and Robust,* Prentice Hall, 1995.

Further readings:

- M. Vidyasagar, *Nonlinear Systems Analysis,* Prentice Hall, 1993.