SYLLABUS

Nonlinear and Optimal Systems 7.5 credits R7004E

Olinjära och optimala system

Course syllabus admitted: Autumn 2011 Sp 1 - Spring 2016 Sp 4

DECISION DATE
2011-02-04

Luleå University of Technology 971 87 Luleå, Sweden
Phone: +46 (0)920 49 10 00 • Corporate Identity: 202100-2841

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Nonlinear and Optimal Systems 7.5 credits R7004E

Olinjära och optimala system

Second cycle, R7004E

Education level	Grade scale	Subject	Subject group (SCB)
Second cycle	G U 3 4 5	Reglerteknik	Automation Technology

Entry requirements

Courses of at least 90 credits at first cycle including the following knowledge/courses. Intermediate level knowledge in the subject of Automatic control, specifically regarding frequency response, state-space form, and state feedback. Experience with using Matlab for analysis of control systems is also presumed. These prerequisites correspond to the course R7003E.

Selection

The selection is based on 30-285 credits

Examiner

Andreas Johansson

Course Aim

The student shall be able to:

- Analyze nonlinear dynamical systems regarding qualitative behavior and stability
- Analyze nonlinear feedback systems with respect to stability and oscillations
- Describe control errors and disturbances regarding frequency properties and different size measures
- Design optimal estimation algorithms and feedback controllers for linear systems
- Design estimation algorithms and feedback controllers for nonlinear systems
- Find open loop control strategies for minimizing consumption of resources
- Implement and commission a control system

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Contents

Many technical systems, such as industrial processes, robots, vehicles, motors etc. are best described in the form of nonlinear dynamical systems. Methods to analyze these system descriptions are important to be able to e.g. perform measurement and control in these systems. In this course, we will address a number of methods that are available for analyzing nonlinear systems, specifically for the purpose of estimating and controlling quantities. Phase portrait is a tool for graphical illustration of the behavior of a nonlinear system. Elementary methods for drawing phase portraits are introduced. Stability for nonlinear systems is defined and analyzed with Lyapunov functions. For feedback systems, the circle criterion and describing functions are tools for analyzing stability and oscillations. In order to optimize e.g. a control system, one must be able to describe signals quantitatively. Frequency descriptions and size measures, in the form of signal norms, are covered. For linear systems with white, gaussian disturbances, optimal estimation algorithms and controllers can be derived. These are known as Kalman filters and LQG controllers, respectively, and are described thoroughly in the course. For nonlinear systems, the situation is much more complicated but some methods are treated in this course, e.g. the Extended Kalman filter and Model predictive control.

Control strategies without feedback for minimizing consumption of resourses are also treated in the course. A typical example is Goddard's rocket problem wich concerns the question how to vary the engine thrust to reach a given altitude with minimal fuel. Such problem are solved using Pontryagin's maximum principle.

Realization

Each course occasion´s language and form is stated and appear on the course page on Luleå University of Technology's website.
The teaching consists of lectures and problem seminars. Lab work and a project assignment is performed in groups of no more than two students and accounted for with written reports and a demonstration.

Examination

If there is a decision on special educational support, in accordance with the Guideline Student's rights and obligations at Luleå University of Technology, an adapted or alternative form of examination can be provided.
Written exam with differentiated grades and approved lab work.

Remarks

The course will not be given every year.

Transition terms

Sustainable development has been implemented in this course from Autumn semester 2011.

Literature. Valid from Autumn 2007 Sp 1

Glad, T. and L. Ljung: Control Theory. Multivariable and Nonlinear Methods. Taylor & Francis.

Course offered by

Department of Computer Science, Electrical and Space Engineering

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Items/credits

Number	Type	Credits	Grade
0001	Written exam	4.5	G U 3 4 5
0002	Laboratory work	3	U G#

Study guidance

Study guidance for the course is to be found in our learning platform Canvas before the course starts. Students applying for single subject courses get more information in the Welcome letter. You will find the learning platform via My LTU.

Last revised

by huvudansvarig utb.ledare vid SRT, Jonny Johansson 2011-02-04

Syllabus established

The syllabus was established by the Department of Computer Science and Electrical Engineering February 28, 2007 and is valid from Autumn semester 2007.

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