SYLLABUS

Advanced Control Design 7.5 credits R7014E

Avancerade reglersystem

Course syllabus admitted: Autumn 2023 Sp 1 - Present

DECISION DATE
2021-11-03

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LULEÅ TEKNISKA UNIVERSITET

Advanced Control Design 7.5 credits R7014E

Avancerade reglersystem

Second cycle, R7014E

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

Main field of study

Engineering Physics and Electrical Engineering

Entry requirements

Knowledge in the subject of Automatic control, specifically regarding frequency response, state-space form, and state feedback. Experience with using Matlab/Simulink or similar for analysis of control systems is also presumed. These prerequisites correspond to the course R7003E Automatic control.
Good knowledge in English equivalent to English 6.

Selection

The selection is based on 30-285 credits

Course Aim

After completion of the course the student shall be able to

- show a deep knowledge of control engineering methods and terminology for robust and optimal control;

- show deep understanding of mathematical methods to design advanced control schemes for dynamic system which can be non-linear, uncertain and multivariable;

- demonstrate the ability to model non-linear and multivariable dynamic systems based on empirical data and formulate descriptions of uncertainties and disturbances in
  dynamical systems;

- demonstrate an ability to formulate performance requirements for control systems and determine what performance is achievable;

- use standard methods for designing and analyzing robust, optimal and predictive controllers, even in the multivariable case;

- demonstrate an ability to, in a group, simulate, analyze, evaluate and implement robust, optimal and predictive controllers for a real process and to report on this work,
  both orally and in writing;

- show the ability to identify constraints of simple controllers and the need for more advanced methods;

- demonstrate an ability to analyze observability of a dynamic system, to design and implement estimators for states and non-measurable variables

Contents

The course deals with design of advanced control systems for real-life engineering systems and the analysis of their performance characteristics. Emphasis is on techniques which render robust and optimal control systems.

When attempting to apply control to a complex real-world process, a number of problems appear that this course provides theoretical methods to handle. 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.

The first problem treated in the course is the derivation of process models which are non-linear and are never an exact description of the process in question. How to analyze the non-linear system description and also describe model uncertainty is treated, as well as methods for designing robust and optimizing controllers that achieve various criteria, like e.g. stability or optimality, and performance despite variations in the process.

The second problem is that many processes that are interesting to be able to control are in practice multivariable, i.e. that several inputs affect several outputs. Basic notions, such as poles and zeros, controllability and observability are treated for multivariable systems, as well as methods to determine when single input and single output controllers can be used on a multivariable process with acceptable performance. Controllers, based on optimization of a cost function, are treated for the situation where multivariable control must be used.

The third problem is estimation of either not directly measurable quantities or that a quantity can not be measured with sufficient quality. For this end, the Kalman filter and the extended Kalman filter are introduced enabling estimation and sensor fusion based on measurements.

The theoretical parts of the course are supplemented with practical lab work in the form of project assignments on an experimental or simulated setup in the laboratory of the Department of Computer Science and Electrical Engineering.

Realization

Each course occasion´s language and form is stated and appear on the course page on Luleå University of Technology's website.

The course activities are lectures, laboratory sessions, and problem seminars. Laboratory sessions are performed in groups of no more than three students and accounted for with written reports and a demonstration. During the problem seminars, the students present in groups solutions to exercises that are handed out in advance.

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 graded laboratory work.

Unauthorized aids during exams and assessments

If a student, by using unauthorized aids, tries to mislead during an exam or when a study performance is to be assessed, disciplinary measures may be taken. The term “unauthorized aids” refers to aids that the teacher has not previously specified as permissible aids and that may assist in solving the examination task. This means that all aids not specified as permissible are prohibited. The Swedish version has interpretative precedence in the event of a conflict.

Transition terms

The course can be combined with no more than one of the two courses R7004E och R7005E

Course offered by

Department of Computer Science, Electrical and Space Engineering

Modules

Code	Description	Grade scale	Cr	Status	From period	Title
0002	Laboratory work	U G#	3	Mandatory	A17	
0004	Written exam	G U 3 4 5	4.5	Mandatory	S22	

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 Jonny Johansson, HUL SRT 2021-11-03

Syllabus established

by Jonny Johansson, HUL SRT 2017-02-15