SYLLABUS

Measurement and feedback control 7.5 credits R0005E

Mät- och reglerteknik

Course syllabus admitted: Autumn 2023 Sp 1 - Present

DECISION DATE
2021-02-16

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LULEÅ TEKNISKA UNIVERSITET

Measurement and feedback control 7.5 credits R0005E

Mät- och reglerteknik

First cycle, R0005E

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

Main field of study

Civil Engineering, Engineering Physics and Electrical Engineering

Entry requirements

In order to meet the general entry requirements for first cycle studies you must have successfully completed upper secondary education and documented skills in English language and Basic knowledge of the Laplace transform, e.g. from the course M0018M Linear Analysis, M0046M Mathematics Space, or M0053M Linear Systems and Transforms. Alternative to completed courses can be corresponding knowledge acquired through work within the process industry or electronics sector.

Selection

The selection is based on 1-165 credits.

Course Aim

The course aim is for students to acquire basic knowledge of feedback systems, their design and their use in control engineering applications.

The students should have the skills and knowledge to:

- demonstrate knowledge of basic methods and terminology of measurement and instrumentation system.
- demonstrate basic knowledge of proven methods for the design of measurement systems.
- demonstrate knowledge of basic methods and terminology of automatic control.
- demonstrate a basic knowledge of proven methods for designing controllers.
- demonstrate the ability to model and simulate dynamic systems.
- using mathematical methods to analyze the static, dynamic and frequency characteristics of dynamic systems.
- use standard methods for designing and analyzing controllers.
- demonstrate an ability to, in a team, design and implement controllers, as well as evaluate their performance for a real process.
- demonstrate the ability to, both orally and in writing, report on the practical work of modeling, design and implementation of closed loop control for a real process.
- identify the usefulness of basic control methods and their limitations, and identify the need for more advanced methods.

Contents

Automatic Control is the science of controlling processes. A typical example is the cruise control in a car (In this case the car is the "process") that by varying the throttle ("input" to the process) will keep the speed ("output" of the process) constant despite hills and wind (so-called "disturbances"). Other common examples include companies in the process industry, where the aim is to control pressures and temperatures, and in communication where you want to control data rates and transmission powers.

Automatic Control is not limited to technical processes but can also be applied in areas such as economics and medicine. One example is the human body's, highly sophisticated control system that is able to keep the body temperature constant at 37 degrees Celsius despite variations in ambient temperature or to keep the body weight constant despite assiduous efforts to better nutrition and exercise.

This course is our first course in control theory and covers the classical methods of analysis and synthesis of feedback control for a wide range of technical processes. This course provides in-depth knowledge of the subject, sufficient for non-specialists in control theory to develop simple control systems. The is a necessary basis for continued studies in the subject.

During the course, the following methods and concepts will be discussed:

Introduction: Introduction to general control engineering concepts, such as static systems, dynamic systems, process, reference signal (setpoint), control signal, output signal, noise, open systems, measurement signal, the feedback, controller.

Dynamic models: Mathematical modeling of physical systems. Differential equations. Differential equations in state space. Linearization.

Simulation: Introduction to simulation of dynamic systems using Matlab/Simulink.

Mathematical tools: Laplace transform and its properties. Transfer function. Static gain. Super-position principle. Block Diagrams. Specifications. Rise time. Settling time. Overshoot. Poles and Zeroes. Modeling based on emperical data.

Feedback systems: PID controller. Process disturbances. Steady state control error. Ziegler-Nichols methods. Lambda tuning. Stability Concepts.

Frequency domain: The frequency function. Frequency analysis. Bode plots. Asymptotic Bode plot. Stability. Stability Margins. Compensation. Sensitivity. Time delays.

Digital control: Approximation of continuous controllers. Sampling.

Realization

Each course occasion´s language and form is stated and appear on the course page on Luleå University of Technology's website.
Course activities are lectures, laboratory sessions and problem solving sessions.
Problem solving exercises are intended to provide practice in solving theoretical problems with a practical connection where the students solve the exercises on their own. The results are submitted and selected students present the solution to the exercises during a problem solving sessions.

The laboratory sessions are designed to provide insight into how the theory can be applied in practical control engineering work, which also results in increased familiarity with analytical and simulation tools. The laboratory work makes use of a water tank process where students, in groups, will produce a level control system.

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, graded laboratory work, and graded problem solving

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.

Overlap

The course R0005E is equal to R0001E

Course offered by

Department of Computer Science, Electrical and Space Engineering

Modules

Code	Description	Grade scale	Cr	Status	From period	Title
0003	Laboratory work	U G#	2	Mandatory	A19	
0004	Problem solving	U G#	2	Mandatory	A19	
0005	Written exam	G U 3 4 5	3.5	Mandatory	A19	

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 2021-02-16

Syllabus established

by Jonny Johansson, HUL SRT 2018-02-15