COURSE DESCRIPTION CARD - SYLLABUS

Course name
Control theory of the continuous and discrete events processes [S1AiR1E>TSPCiD1]

Course

Field of study	Year/Semester
Automatic Control and Robotics	3/5
Area of study (specialization)	**Profile of study**
–	general academic
Level of study	**Course offered in**
first-cycle	English
Form of study	**Requirements**
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other
15	0	0
Tutorials	**Projects/seminars**	
0	0	

Number of credit points

1,00

Coordinators

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Lecturers

Prerequisites

Knowledge: A student starting this subject should have basic knowledge of subjects such as Mathematical Analysis, Linear Algebra, and Physics with special attention to General Mechanics, as well as fundamental knowledge of the subjects Fundamentals of Automation and Signal Theory and Processing. Skills: Should be able to solve basic problems covered by the required expertise and obtain information from the indicated sources. He should also understand the need to expand his competences. Social competences: In addition, in terms of social competences, the student must present attitudes such as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1 To provide students with knowledge of the mathematical description and control theory of continuous and discrete linear and selected nonlinear control systems. 2. To develop students' skills related to modelling of dynamic systems, transformation of linear systems to equivalent forms, interpretation and study of controllability and observability of linear systems, study of state input and input-output stability, basic stability analysis according to the Lyapunov methodology. In addition, students will be skilled in the design of various observers and in solving selected optimisation problems of control systems.

Course-related learning outcomes

In terms of knowledge:
Has a structured knowledge of the theory of linear dynamic systems, including selected modeling methods and stability theories; knows and understands the basic properties of linear dynamic elements in the time and frequency domain, as well as the properties of selected nonlinear elements; knows and understands techniques for designing linear control systems using state space description [K1_W14 (P6S_WG)].
Has a structured knowledge of the structures and operating principles of analog and discrete control systems (open- and closed-loop) as well as linear and simple nonlinear analog and digital controllers [K1_W16 (P6S_WG)].
Knows and understands to an advanced degree the basic criteria for synthesis and tuning of the controllers, tools, and techniques for automatic selection of controller settings and identification of control elements [K1_W17 (P6S_WG)].
In terms of skills:
Can plan, prepare and simulate the operation of simple automation and robotics systems [K1_U10 (P6S_UW)].
Can derive and use models of simple electromechanical systems and selected industrial processes, as well as use them for the analysis and design of automation and robotics systems [K1_U11 (P6S_UW)].
Can check the stability of linear and selected nonlinear elements and dynamic systems [K1_U12 (P6S_UW)].
Can evaluate the applicability of routine methods and tools for the design of automation and robotics systems as well as select and apply the appropriate methods and tools [K1_U24 (P6S_UW)].
Can design simple control systems for industrial processes; can consciously use standard functional blocks of automation systems and shape the dynamic properties of measurement circuits [K1_U29 (P6S_UW)].
In terms of social competence:
He is ready to determine priorities for the realization of a task defined by himself or others [K1_K4 (P6S_KO)].
Is aware of the need to approach technical issues in a professional manner, to be meticulously familiar with the documentation and the environmental conditions in which the equipment and its components may operate; Is ready to follow the principles of professional ethics and require this from others, respecting the diversity of views and cultures [K1_K5 (P6S_KR)].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:
a) in the field of lectures: on the basis of answers to questions about the material discussed in previous lectures,

Final assessment:
a) in the field of lectures:
i. after first semester: verification of the established learning outcomes is realized by assessing the knowledge and skills demonstrated in the written test on the subject.
ii. after second semester: verification of the established learning outcomes is realized by assessing the knowledge and skills demonstrated in the written exam on the subject.

Programme content

The lecture program covers the following topics:
1. Dynamical systems and description of systems in the state space.
a) definition of a dynamical system
b) typical forms of dynamic systems in the continuous time domain
c) relation between state space and transfer function representation
d) linear approximation
e) exemplary models

2. State and input transformations. Equivalent systems.
a) basic concepts
b) linear transformations and normal forms

c) transformation into controllable and observable normal forms (the LTI case)
d) transformation to modal form (diagonal and Jordan form, real Jordan form)

3. Selected properties of linear systems
a) time domain solution of
state equations and properties of the state-transition matrix
b) the concepts of controllability and observability
c) derivation of Kalman conditions

4. Selected stability issues
a) BIBO stability (of finite input finite output type), BIBS stability (of finite input finite state type)
b) Lyapunov stability
c) definition of positive, negative, semi-positive, semi-negative Lyapunov functions with examples for linear and non-linear systems
d) stability criteria for LTI systems
e) classes of trajectories for the solution of an autonomous LTI system
f) phase plane method

5. Observers for linear systems
a) derivation of the Luenberger observer and condition of applicability
b) Kalman filter as a case of stochastic observer
c) interpretation of the Kalman filter equations

6. Dynamic correction and design of linear control systems
a) state feedback and output feedback
b) stabilizability condition
c) definition of input-output decoupling
d) design of a decoupling algorithm for a linear system
e) control algorithm using dynamic extention
f) design of decoupling control algorithm
g) application of an observer application and separation rule

7. Elements of optimal control

Course topics

none

Teaching methods

Teaching methods
1. Lecture: traditional presentation on the board illustrated with examples, using multimedia tools.

Bibliography

Basic
1. R. C. Dorf, R. H. Bishop, Modern Control Systems, tenth edition, Pearson Educational International, Prentice Hall, 2005
2. NISE, Norman S. Control systems engineering. John Wiley & Sons, 2020.
3. OGATA, Katsuhiko, et al. Modern control engineering. Upper Saddle River, NJ: Prentice hall, 2010.

Additional
1. A. Isidori, Nonlinear Control Systems, Springer Verlag, 1995

Breakdown of average student's workload

	Hours	ECTS
Total workload	30	1,00
Classes requiring direct contact with the teacher	15	0,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	15	0,50