Signals and dynamic systems - course description

General information

Course name	Signals and dynamic systems
Course ID	06.0-WE-AutP-SygDynamSyst-Er
Faculty	Faculty of Computer Science, Electrical Engineering and Automatics
Field of study	Automatic Control and Robotics
Education profile	academic
Level of studies	First-cycle Erasmus programme
Beginning semester	winter term 2022/2023

Course information

Semester	3
ECTS credits to win	5
Course type	obligatory
Teaching language	english
Author of syllabus	• prof. dr hab. inż. Krzysztof Patan

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Exam
Laboratory	30	2	-	-	Credit with grade

Aim of the course

- Skills and competences in signal analysis, convolution of signals, Fourier transform, Laplace transform and Z transform.
- Skills in system analysis and mathematical representation of systems.
- Using stability criteria.

Prerequisites

Mathematical analysis, Linear algebra, modeling and simulation.

Scope

1. *Signals*. Signal representation. Signal types: step function, binary pseudo-random sequence, auto-regressive sequence, moving average, sum of sinusoids. Persistently exciting signals. Practical aspects of selecting input signal.
2. *Fourier transform.* Fourier series and Fourier transform. Spectroanalysis. Fast Fourier Transform (FFT). Fourier analysis of systems.
3. *Laplace transform.* Linear differential equations. Laplace transform and its properties. Solving linear differential equations using Laplace transform. Inverse Laplace transform. Transfer function.. Basic operations on transfer functions.
4. *Z transform*. Linear difference equations. Properties of the Z transform. Z transform of the step function and exponential functions. Application of the Z transform to solving linear difference equations. Determining the original of a given Z transform.
5. *System representation* Dynamic system. System input, system output, system state, control signal. Representation of discrete-time and continuous-time dynamic systems. Differential equations, difference equations. Transfer functions. State-space representations.
6. *Fundamental properties of systems.* Causality. Stationarity. Linearity. Stability of dynamic systems. Definitions of stability. Controllability and observability of linear dynamic systems, both continuous and discrete.
7. *Stability of dynamic systems.* Linear continuous systems stability criteria: Hurwitz criterion, Routh criterion, Nyquist criterion. The first and second Lyapunov methods. Discrete systems stability criteria. Transformation of the left half complex plane into unit circle.
8. *Spectral transfer function.* Frequency characteristics: Bode diagram, attenuation diagram, phase diagram. Transient response: step response and impulse response. Relationship between transient responses and spectral transfer function.
9. *Characteristic of selected dynamic elements.* Proportional element, inertial element of the first and second order, integrating element, differential element, oscillating element and delay element

Teaching methods

lecture: classical lecture

labs: laboratory exercises

Learning outcomes and methods of theirs verification

Outcome description	Outcomesymbols	Methods of verification	The class form
Is familiar with Laplace transform, Z transform and Fourier transform. Is able to solve linear differential equations and linear difference equations.		• a quiz • carrying out laboratory reports	• Laboratory
Is able to characterize and classify dynamic systems		• an exam - oral, descriptive, test and other	• Lecture
Is able to analyze signals in frequency domain.		• an exam - oral, descriptive, test and other	• Lecture
Can himself analyze characteristics of the dynamic systems.		• an exam - oral, descriptive, test and other	• Lecture
Student has competences in the field of stability of linear systems both continuous- and discrete-time.		• a quiz • carrying out laboratory reports • bieżąca kontrola na zajęciach	• Laboratory

Assignment conditions

Lecture - the passing condition is to obtain a positive mark from the final test.

Laboratory – the passing condition is to obtain positive marks from all laboratory exercises to be planned during the semester. as well as give back all reports from laboratory exercices.

Final grade = lecture: 50% + laboratory: 50%

Recommended reading

1. Won Y. Yang et al., Signals and systems with MATLAB, Springer, Berlin, 2009.

2. Steven T. Karris, Signals and systems with Matlab computing and Simulink modeling, Orchard Publications, 2007.

Further reading

Notes

Modified by dr hab. inż. Wojciech Paszke, prof. UZ (last modification: 11-04-2022 09:05)