COURSE DESCRIPTION CARD - SYLLABUS

Course name
Signals and dynamic systems [S1AiR1E>SiSD1]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/2

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
english

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other (e.g. online)
0

Tutorials
15

Projects/seminars
0

Number of credit points

4,00

Coordinators

dr inż. Andrzej Florek
andrzej.florek@put.poznan.pl

Lecturers

dr inż. Andrzej Florek
andrzej.florek@put.poznan.pl

Prerequisites

The student starting this subject should have a basic knowledge of mathematics, especially algebra and analysis as well as statistics. Should be able to use a computer and show willingness to learn to use various computer programs, such as Matlab. The student should be able to obtain information from the indicated sources. He should also understand the need to expand his competences. In addition, in the field of social competences, the student must present attitudes and qualities such as: honesty, responsibility, perseverance, cognitive curiosity, creative thinking, diligence, personal culture, good education and respect for other people.

Course objective

To acquaint students with the basic principles of signal classification and methods of their analysis in the time domain and especially in the frequency domain.Overview and discussion of the estimation of the basic statistical values of signals. Introduction to discrete signal analysis, learning the principles of signal sampling and DFT or FFT transformation and their applications. Presentation of the basic description of linear models of dynamic systems and phenomena accompanying the passage of signals through these systems.

Course-related learning outcomes

Knowledge:
The graduates has an advanced knowledge and understanding of selected facts, objects and phenomena and the methods and theories relating to them that explain the complex relationships between them; he has a basic general knowledge of mathematics including algebra, geometry, analysis, probabilistic and elements of discrete mathematics and logic, including mathematical methods and numerical methods necessary to:
▪ describe and analyse the properties of linear and basic non-linear dynamic and static systems,
▪ the description and analysis of complex numbers,
▪ the description of random processes and uncertain quantities,
▪ the description and analysis of combinatorial and sequential logic systems,
▪ description of control algorithms and stability analysis of dynamic systems,
▪ the description, analysis and methods of signal processing in the time and frequency domain,
▪ numerical simulation of dynamic systems in the continuous and discrete time domain [K1_W1 (P6S_WG)].
Knows and understands to an advanced degree signal processing methods in the time and frequency domain; has a structured knowledge of signal and information theory [K1_W5 (P6S_WG)].
Has a basic knowledge of the handling and use of IT tools for the design, rapid prototyping, simulation and visualisation of automation and robotics systems and for recording the design of mechanical constructions [K1_W10 (P6S_WG)].
Skills:
Be able to use basic methods of signal processing and analysis in the time and frequency domain and extract information from analysed signals [K1_U9 (P6S_UW)].
Social competences:
Is ready to critically assess his/her knowledge; understands the need for and knows the possibilities of continuous training - improving professional, personal and social competence, is able to inspire and organize the learning process of others [K1_K1 (P6S_KK)].
The graduate is aware of the need for a professional approach to technical issues, meticulous familiarization with the documentation and environmental conditions in which the equipment and its components can operate. The graduate is ready to observe the rules of professional ethics and to demand it from others, to respect the diversity of opinions and cultures [K1_K5 (P6S_KR)].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The final grade for the tutorial exercises is determined mainly on the basis of a written test, consisting in solving three tasks in the field of a specific analysis of deterministic and random signals and continuous Fourier transform. In order to determine the final grade for the tutorials, the grade for the test is modified depending on the student's activity in the tutorials and the grades for answers to the questions asked.
The final written exam is in the form of a single-choice test, consisting of 60 questions regarding the lecture material. The time to answer one question is 60 seconds, and only 45 seconds for the resit exam.

Programme content

The main topics presented and discussed during the lectures are:
- Signal classification and their basic parameters, signal energy and power.
- Basic deterministic signals in automation, periodic signals and complex signals.
- Stochastic process, random signals and basic statistical quantities of signals and their estimators.
- Spectral representation of signals: from the trigonometric series to the Fourier transform and analogies to the Laplace transform; discussion of the basic and useful properties of these transforms.
- Discrete signal analysis: sampling theorem, discrete Fourier transform and its application in signal analysis and processing.
- Linear models of dynamic systems: linear differential equation, time responses, transfer function and frequency response (spectral transfer function), frequency characteristics (Bode plots).
- Passage of signals through a linear system: linear convolution and its geometric interpretation, spectral domain analysis, steady state under harmonic excitation.
- Correlation functions and power spectrum after the signal passes through the linear system.
As part of the auditorium tutorials, tasks related to such issues as: determination of parameters of deterministic signals, their power and energy, determination of statistics describing random signals (probability density function, cumulative distribution function, expected value, variance and power), determination of Fourier series coefficients and calculation of Fourier transforms for simple analog signals. The solution to the remaining problems presented in the lectures takes place during the later laboratory

classes in semester 3.

Teaching methods

The lecture is conducted as a multimedia presentation, illustrated with examples solved on the blackboard and applications for demonstrating the results of analysis and signal synthesis. During the lectures, questions about the discussed phenomenon and the presented methods are often put to the audience. As part of the auditorium exercises, sample tasks are solved on the blackboard and a deep analysis of possible ways of solving them with various methods is carried out, using previously obtained solutions, proven lemmas, specific properties of the signal modeling functions, etc.

Bibliography

Basic:
1. Oppenheim A.V., Willsky A.S., Nawab S.H, Signals end System, Pearson 2016, 944 pp.
2. Courses 6.003 and 6.011 on https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/.
Additional:
1. Florek A., Mazurkiewicz P., Sygnały i systemy Dynamiczne. Interpretacje - przykłady - zadania, wyd. 2, WPP, Poznań, 2015, 158 pp.
2. Szabatin J., Podstawy teorii sygnałów, WKŁ, Warszawa, 2008, 499 pp.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	55	2,00