COURSE DESCRIPTION CARD - SYLLABUS

Course name

Advanced diagnostics and monitoring systems

Course

Field of study	Year/Semester
automatic control and robotics	1/2
Area of study (specialization)	Profile of study
intelligent control systems	general academic
Level of study	Course offered in
Second-cycle studies	polish
Form of study	Requirements
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	30	
Tutorials	Projects/seminars	

Number of credit points

4

Lecturers

Responsible for the course/lecturer:

PhD eng. Dominik Łuczak

email: Dominik.Luczak@put.poznan.pl

tel. 48 61 665 2557

Faculty of Control, Robotics and Electrical Engineering

ul. Piotrowo 3A 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

Knowledge: The student starting this course should have knowledge of automation and robotics corresponding to the 6th level of the Polish Qualifications Framework, in particular knowledge of the analysis of automation models, data structures, complex numbers, basics of signal processing.

Skills: The student should have the ability to analyze and implement control and measurement systems in the field of automation and robotics and the ability to obtain information from the indicated sources. They should also understand the need to expand their competences and be ready to cooperate in a team.

Social competences: In addition, in terms of social competences, the student must show such qualities as honesty, responsibility, persistence, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1. Provide students with knowledge about the methods used in monitoring and diagnostic systems.

2. Developing students' skills to develop automatic monitoring and diagnosis systems with the use of available signal processing techniques.

3. Shaping in students the importance of knowledge of technology and recommendations related to automatic monitoring and diagnostics of devices.

Course-related learning outcomes

Knowledge

1. The student has an ordered and detailed knowledge of artificial intelligence methods and their application in automation and robotics systems; [K2_W2]

2. has specialist knowledge of remote and distributed systems, real-time systems and network techniques; [K2_W3]

3. has detailed knowledge of the construction and use of advanced sensory systems; [K2_W6]

4. has a basic knowledge of the life cycle of automation and robotics systems as well as control and measurement systems; [K2_W13]

Skills

1. The student is able to assess the usefulness and the possibility of using new achievements (including techniques and technologies) in the field of automation and robotics; [K2_U16]

2. can construct an algorithm for solving a complex and unusual engineering task and a simple research problem and implement, test and run it in a selected programming environment for selected operating systems; [K2_U25]

3. is able to construct an algorithm for solving a complex and untypical measurement and computational-control task and implement, test and run it in a selected programming environment on a microprocessor platform; [K2_U26]

Social competences

1. The student is aware of the need for a professional approach to technical issues, meticulous familiarization with the documentation and environmental conditions in which devices and their components can function; [K2_K4]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:

a) in the field of lectures:

based on homework assignments and answers to questions about the material discussed in previous lectures,

b) in the field of the laboratory:

on the basis of the assessment of knowledge and understanding of the current issues presented in the course.

Summative assessment:

a) in the field of lectures, verification of the assumed learning outcomes is carried out by:

i. assessment of the knowledge and skills shown on the written test in the form of a test

ii. discussion of the credit results.

b) in the scope of the laboratory, verification of the assumed learning outcomes is carried out by:

i. assessment of the student's preparation for individual classes,

ii. continuous assessment during each class (oral answers) - rewarding the increase in the ability to use the learned rules and methods,

iii. evaluation of tasks partially prepared during the classes, and also after their completion.

Obtaining additional points for activity during classes, in particular for:

i. independent construction of a distributed system of testing and diagnostics consisting of several electronic modules with microprocessors communicating in real time and development of documentation,

ii. the effectiveness of applying the acquired knowledge while solving a given problem

iii. remarks related to the improvement of teaching materials.

Programme content

The lecture program covers the following topics:

1. Introduction to diagnostics and monitoring of devices, in particular electromechanical devices. Types of damage. Types of measurement signals. The theory of digital measurements.

Section I. Diagnostics and monitoring of devices with the use of data sets (nonparametric models).

2. Frequency analysis.

3. Time-frequency analysis.

4. Time-scale analysis.

5. Sliding frequency analysis.

6. Technique of demodulation and decomposition of signals.

7. Modification and improvement of the frequency spectrum.

Section II. Diagnostics and monitoring of devices using parametric models.

8. Data collection methods for building models. Selected signals forcing e.g. chirp, PRBS, Kronecker pulse.

9. Simplified parametric models. Types of parametric models. Ways of model transformation.

10. Obtaining and evaluating a discrete parametric model based on the frequency response.

11. Obtaining and evaluating a continuous parametric model based on the frequency response. Nonlinear least squares method.

Division III. Isolation and fault location

12. Binary classifier.

13. A multi-class classifier built on the basis of supervised and partially supervised machine learning algorithms.

14. R&D works including device diagnostics and monitoring systems.

15. Summary.

The laboratory program includes:

1. Organizational classes - familiarization with equipment and OHS footnotes, introduction to the design environment.

2. Getting acquainted with data representing the monitored electromechanical system. Preparation of data visualization and presentation of fragments from the data set.

3. Frequency analysis of system data (simulation or real data).

4. Time-frequency analysis.

5. Time-scale analysis.

6. Sliding frequency analysis.

7. Techniques of demodulation and decomposition of signals.

8. Modification and improvement of the frequency spectrum.

9. Analysis of forcing signals and obtained responses. Frequency response data analysis.

10. Determination and evaluation of discrete models.

11. Determination and evaluation of continuous models.

12. Construction and evaluation of a binary classifier.

13. Application and evaluation of a group of binary classifiers. Building a multi-class classifier.

14. Application and evaluation of the multi-class classifier.

15. Presentation of the final task: the monitoring and diagnosis system for selected system elements.

Teaching methods

1. Lecture: presentation of the use of frequency analysis for an electromechanical system, a multimedia presentation illustrated with literature data and sample projects

2. Laboratory classes: using data from a simulated / real electromechanical system as input data, simulation environment for designing and implementing a monitoring and diagnostic system

Bibliography

Basic

1. Fault Detection and Diagnosis of Industrial Robot Based on Power Consumption Modeling, Ahmad H. Sabry i inni, 2020, https://doi.org/10.1109/TIE.2019.2931511

2. Gudovskiy, Denis A., and Lichung Chu. "An Accurate and Stable Sliding DFT Computed by a Modified CIC Filter [Tips & Tricks]." IEEE Signal Processing Magazine 34.1 (2017): 89-93., https://doi.org/10.1109/MSP.2016.2620198

3. Jacobsen, Eric, and Richard Lyons. "The sliding DFT." IEEE Signal Processing Magazine 20.2 (2003): 74-80., https://doi.org/10.1109/MSP.2003.1184347

4. Diagnostyka drganiowa stanu maszyn i urządzeń / Józef Dwojak, Marek Rzepiela ; konsultacje techniczne Grzegorz Jezierski, 2005.

Additional

1. Comparison of fault tolerant control algorithm using space vector modulation of PMSM drive, Łuczak i Siembab, 2014, https://doi.org/10.1109/MECHATRONIKA.2014.7018231

2. Mathematical model of multi-mass electric drive system with flexible connection, Łuczak 2014, https://doi.org/10.1109/MMAR.2014.6957420

3. Identification of multi-mass mechanical systems in electrical drives, Łuczak, 2014, https://doi.org/10.1109/MECHATRONIKA.2014.7018271

Breakdown of average student's workload

	Hours	ECTS
Total workload	120	4,0
Classes requiring direct contact with the teacher	60	2,0
Student's own work (literature studies, preparation for laboratory classes, preparation for exam, tasks preparation) [1]	60	2,0

[1] delete or add other activities as appropriate