COURSE DESCRIPTION CARD - SYLLABUS

Course name
Real-time systems [S1AiR1E>SCR1]

Course

Field of study
Automatic Control and Robotics

Year/Semester
2/3

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
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

1 Knowledge Student has knowledge in mathematical fields of logic and discrete mathematics necessary to description and analysis of sequential and discrete systems, description of control algorithms and stability analysis of dynamical systems. [K1_W01 (P6S_WG)] Has also systematized knowledge of methods and technics of procedural and object programming. [K1_W10 (P6S_WG)] 2 Skills Is able to obtain information from bibliography, databases and other sources; has the ability to self-educate in order to improve and update professional competences. [K_U01 (P6S_UU)] Is able to document and present the results of an engineering task. Is able to communicate using specialized terminology. Can take part in a debate - present, assess and discuss various opinions and positions. [K_U03 (P6S_UK)] 3 Social competencies The graduate is ready to critically evaluate his or her knowledge. The graduate understands the need for and knows the possibilities of continuous learning - improving professional, personal and social competences, the graduate is able to inspire and organize the learning process of others. [K_K01 (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. [K_K04 (P6S_KR)]

Course objective

Acquaintance of the basic knowledge about real-time applications and supporting them real-time operating systems

Course-related learning outcomes

Knowledge:
Has a structured knowledge of computer architectures, computer systems and networks and operating systems including real-time operating systems [K1_W9 (P6S_WG)].
Knows and understands to an advanced degree the theory and methods in the architecture and programming of microprocessor systems, knows and understands selected high- and low-level microprocessor programming languages; knows and understands the principle of operation of basic peripheral modules and communication interfaces used in microprocessor systems [K1_W13 (P6S_WG)].
Knows and understands to an advanced degree the structure and principles of operation of programmable industrial controllers, as well as their analog and digital peripheral systems; knows and understands the principle of operation of basic communication interfaces used in industrial control systems [K1_W19 (P6S_WG)].
Skills:
Is able to develop a solution to a simple engineering task and implement, test and run it in a selected programming environment on a PC for selected operating systems [K1_U26 (P6S_UW)].
Is able to construct an algorithm to solve a simple measurement and control task and implement, test and run it in a selected programming environment on a microprocessor platform [K1_U27 (P6S_UW)].
Be able to design and implement a local ICT network (including an industrial network) by selecting and configuring communication elements and devices (wired and wireless) [K1_U28 (P6S_UW)].
Social competences:
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:

Learning outcomes presented above are verified as follows:
Formative assessment:
based on answers to questions about the material discussed in previous lectures.
Main rating:
verification of assumed learning outcomes is carried out by:
i. assessment of knowledge and skills demonstrated during the written lecture exam
ii. assessment of knowledge and skills based on individual discussion of the results of the written exam (additional control questions),

Programme content

Lectures:
Specificity of real-time and critical applications: Basic criteria that systems dedicated to real-time applications must meet.
Real-time system architectures and real-time hardware platforms and operating systems.
Creating tasks and methods of scheduling them.
Communication between tasks and time services and task synchronization.
Principles of designing applications for real-time systems.
Basic administrative functions in real-time systems.
Examples of real-time operating systems.
Labs:
Creating tasks. Study of real-time task scheduling algorithms: RMS, EDF, LLF, MLLF, MUF, MMUF. Multiprocessor scheduling. Principles of creating real-time applications: Real-time systems on the PLC platform.

Course topics

Lectures:
1. Specificity of real-time and critical applications: Characteristics of applications requiring immediate response and their applications.
2. Requirements for real-time operating systems: Basic criteria that must be met by operating systems dedicated to real-time applications.
3. Hardware platforms: Process computers, PLCs, microcontrollers Real-time system architectures: Various system structures designed to work in real time.
4. Examples of real-time operating systems: QNX, ECOS, VxWorks systems.
5. Real-time operating systems: Creating tasks and methods of scheduling them.
6. Administrative functions: Basic administrative functions in real-time systems
7. Processes and threads
8. Task scheduling algorithms: RMS, EDF, LLF, MLLF, MUF, MMUF.
9. Scheduling tasks in multiprocessor systems
10. Communication between tasks: Messages, interrupt and signal handling.
11. Time services and process synchronization: Methods of time management and synchronization in operating systems.
12. Task synchronization mechanisms: global variables, semaphores, monitors
13. Creating real-time applications: Principles of designing applications for real-time systems.
14. Access to real time in programming languages.
Labs:
Creating tasks. Study of real-time task scheduling algorithms: RMS, EDF, LLF, MLLF, MUF, MMUF. Multiprocessor scheduling. Principles of creating real-time applications: Real-time systems on the PLC platform.

Teaching methods

Lectures - a lecture with a multimedia presentation (including drawings, photos, animations, films) supplemented by examples given on the board, taking into account various aspects of the issues presented. Presenting a new topic preceded by a reminder of related content known to students in other subjects,

Bibliography

Basic
Burns, A., Wellings, A. : Analysable Real-Time Systems: Programmed in ADA. Createspace Independent Pub. 2016.
Gupta, A., Chandra, A.K. Luksch, P.: Real-Time and Distributed Real-Time Systems: Theory and Applications. CRC Press, 2016.
Chetto, M. (Editor): Real-time Systems Scheduling 1. Fundamentals. J. Wiley & Sons, 2014.
Silberschatz, A., Galvin, P.B., Gagne, G.: Operating System Concepts Essentials, 2nd Edition. J. Wiley & Sons, 2010
Ben-Ari, M.: Principles of Concurrent and Distributed Programming 2nd Edition, Addison Wesley, 2005.
Additional
Cottet, F., Delacroix, J., Mammeri, Z., Kaiser, C.: Scheduling in real-time systems J.Wiley &Sons, 2002.
Luca Aceto, Anna Ingolfsdottir, Kim G. Larsen, Jiri Srba. Reactive Systems: Modeling, Specification, and Verification. Cambridge Press, 2007.
Buttazzo, G. "Hard Real-time Computing Systems: Predictable Scheduling Algorithms and Applications", Second Edition, Springer, 2005.
Jane W. S. Liu: Real-time systems. Pearson, 2000.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	30	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	45	1,50