Syllabus
Course Program

Industrial Robotics

Specialty
141 – Electric power engineering, electrical engineering and electromechanics

Institute
Institute of Computer Modeling, Applied Physics and Mathematics

Educational program
[Electric drive, Mechatronics and Robotics s

Department
Department of Automated Electromechanics Systems (129)

Level of education
Bachelor's level

Course type
Mandatory

Semester
8

Language of instruction
English

Lecturers and course developers

First name and surname

Yaroslav.Kyrylenko@ieee.khpi.edu.ua
Assistant at Department of Automated Electromechanics Systems of NTU "KhPI"

Author and co-author of more than 9 scientific publications.
Courses: "Embedded control systems in mechatronics", "Programming in the C language", "Вбудовані системи керування в мехатроніці"
More about the lecturer on the department's website

General information

Summary

Students learn the basic elements for modelling the kinematics, the statics and the dynamics of spatial articulated systems with both open (serial) and closed (parallel) architectures, which the current industrial robots is based on.
In addition, the students learn basic knowledge of criteria of use, motion planning, as well as economic and organizational aspects that are needed to integrate robots into production systems.

Course objectives and goals

The purpose of the course is to provide the required background to deeply understand the problems behind the design of an industrial robot. The course will provide analytical methods and guidelines to design and control most of the existing classes of industrial robots. Examples from the industrial field will be provided to make direct connection with the real applications on the market.

Format of classes

Lectures, Practical studies, consultations, self-study. Final control in the form of an exam.

Competencies

Ability to apply knowledge in practical situations. Ability to communicate in the state language both orally and in writing. Skills in the use of information and communication technologies. Ability to search, process and analyse information from various sources.

Learning outcomes

CO1: Explain robot anatomy, classification, and applications of robots
CO2: Model and industrial manipulator as a serial/parallel kinematic chain;
CO3: Analyze the workspace and distinguish the role of each joint within the robot motion capabilities;
CO4: Identify and model the robot interaction to the external forces in terms of the actuator torques;
CO5: Develop the robot dynamical model and simulate
CO6: Perform motion planning in joint and operative space
CO7: Develop basic and advanced strategies for trajectory and force control
CO8: Program an industrial robot to make simple tasks, through the manufacturer programming language

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures - 40 hours, Practical studies - 10 hours, self-study - 70 hours.

Course prerequisites

To successfully complete the course, a student must have some basic background in electronics, informatics, math, mechanical and programming.

Features of the course, teaching and learning methods, and technologies

Industrial robots typologies and applications, cartesian geometry and rotations representations, DH parameters, forward kinematics, differential kinematics, static and iterative methods for solving the inverse kinematics, redundant manipulators, analysis of the null space, statics, forces-torques duality, trajectory generation in the joints and 6D space, forward and inverse dynamics, Lagrangian vs Newton-Euler, simulation in 3D environment, dynamic parameters identification, centralized, and decentralized control, feedforward control with gravity compensation, inverse dynamics control, force control. Industrial robots programming languages, calibration methods..

Program of the course

Topics of the lectures

Topic 1. Introduction to Robotics
Topic 2. Rigid Motions
Topic 3. Forward Kinematics
Topic 4. Inverse Kinematics
Topic 5. Differential Kinematics
Topic 6. Manipulator Statics
Topic 7. Manipulator Dynamics
Topic 8. Path and Trajectory Planning
Topic 9. Computer Vision
Topic 10. Robot Motion Control
Topic 11. Interaction Contro

Topics of the workshops

No workshops in this course

Topics of the laboratory classes

No laboratory classes in this course

Self-study

Students complete an individual project following the materials given during the lectures.

Course materials and recommended reading

1. P.I. Corke, Robotics, Vision \& Control: Fundamental Algorithms in MATLAB. Second edition. Springer, 2017. ISBN 978-3-319-54413-7.
2. Damith Herath, David St-Onge . Foundations of Robotics A Multidisciplinary Approach with Python and ROS.
3. Nof S.Y., Handbook of Industrial Robotics, 2nd ed., John Wiley & Sons, 1999.
4. J.J. Craig, Introduction to Robotics: Mechanics and Controls, Second Ed., Addison Wesley, 1989.

Assessment and grading

Criteria for assessment of student performance, and the final score structure

The final grade consists of the results of the evaluation of practical reports (50%) and final exam (50%)

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by	Date, signature	Head of the department Bohdan VOROBYOV
	Date, signature	Guarantor of the educational program Mykola ANISHCHENKO