National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department
of Manufacturing Engineering

ROBOTIC MANUFACTURING PROCESSES

Working program of educational discipline (Syllabus)

Details of educational discipline

Level of higher education	***First (bachelor's)***
Branch of knowledge	*13 Mechanical Engineering*
Specialty	*131 Applied mechanics*
Educational program	*Manufacturing Engineering*
Discipline status	*Normative / Selective*
Form of study	*full-time (day)/full-time (evening)/part-time/remote/mixed*
Year of preparation, semester	*4th year, spring semester*
The scope of discipline	*45 hours*
Semester monitoring/ control measures	*Exam*
Class schedule	*Lectures - 1 time a week, practical - 1 time in 2 weeks*
Language of instruction	*English*
Information about the course leader / teachers	Lecturer: *Candidate Degree in Technical Sciences, Docent, Lapkovsky S., phone: 0677851784* Practical / Seminar: *Candidate Degree in Technical Sciences, Docent, Lapkovsky S., phone: 0677851784* Laboratory:
Course placement	G-Suite, Telegram, EK, Google classroom etc.

Curriculum

1. Description of the discipline, its purpose, subject of study and learning outcomes

Robotization of manufacturing processes is a discipline that studies the methodological foundations of creating and ensuring the further effective operation of robotic systems in various fields of mechanical engineering. n the process of studying this discipline the student masters the universal mathematical apparatus and a systematic approach to the specifics of robotic technological processes in machine-building production, existing standard solutions in the field of robotization of technological processes in mechanical engineering; characteristics of industrial robots and structures and technical characteristics of working bodies of industrial robots. It allows to define possibilities of robotization of technological process of manufacturing of a product, to carry out working off on DFM of a product on condition of manufacturing of the last in the conditions of robotic production, to make a reasonable choice of a specific model of an industrial robot to ensure the manufacture of the product in terms of robotic production, determine and select the layout of the equipment of the robotic complex to ensure the manufacture of the product in robotic production. The most important concepts such as programming and teaching of industrial robot are considered, DFM, speed, accuracy and error of working off the robot of the set trajectory, methods of increasing the efficiency of robotics complexes and industrial robots in mechanical engineering are studied.

The discipline is taught in such a way that it is fully adapted to the future specialty of the student in the field of engineering, namely, manufacturing engineering. Based on this concept, we consider not only the specifics of existing robotic industries, but also the methodology for creating new robotic industries.

The discipline refers to the cycle of professional and practical training.

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of education according to the relevant educational program)

The course consists of lectures, practical classes and tests. The discipline is based on the courses "Mathematics", "Physics", "Computer Science", "Theoretical Mechanics", "Machine Parts and Fundamentals of Design", "Theory of Mechanisms and Machines" and prepares students for better mastering materials of courses "Fundamentals of automation of mechanical engineering", "Automated systems of technological preparation of production and flexible automated productions", "Equipment of machining shops", "Design of equipment of machining shops".

3. The content of the discipline

Topic 1 *History of development and current state of industrial robotics.*

Topic 2 *Basic concepts and definitions.*

Topic 3 *Technological preparation of robotic production.*

Topic 4 *DFMA of objects of robotization.*

Topic 5 *Manipulators of industrial robots.*

Topic 6 *Classification of industrial robots.*

Topic 7 *Control systems of industrial robots.*

Topic 8 *Working bodies of industrial robots.*

4. Educational materials and resources

References:

1) M.P. Groover: Automation, Production Systems, and Computer-Integrated Manufacturing, 2nd edn. (Prentice Hall, Upper Saddle River, 2000).

2) S.Y. Nof: Handbook of Industrial Robotics (Wiley, New York, 1985).

3) L. Westerlund: The Extended Arm of Man. A History of the Industrial Robot (Informations Förlaget, Stockholm, 2000).

4) Y.R. Siegwart, I.R. Nourbakhsh: Introduction to Autonomous Mobile Robots (MIT Press, Cambridge, 2004).

5) K. Ikeuchi, B.K.P. Horn, S. Nagata: Picking up an object from a pile of objects, A.I. Memo 726, Artificial Intelligence Laboratory, Massachusetts Institute of Technology (1983).

6) K. Modrich: 3D machine vision solution for bin picking applications, Proc. Int. Robot. Vision Show (Rosemont, 2007).

7) B. Siciliano, L. Villani: Robot Force Control, Ser. Eng. Comput. Sci. (Springer, Berlin, Heidelberg, 2000).

8) J.J. Craig: Introduction to Robotics: Mechanics and Control (Prentice Hall, Upper Saddle River, 2003).

9) Wolf, R. Steinmann, H. Schunk: Grippers in Motion (Springer, New York, 2005).

10) J.N. Pires: Industrial Robot Programming, Building Applications for the Factories of the Future (Springer, New York 2007).

11) R. Zurawski: Integration Technologies for Industrial Automated Systems (CRC, Boca Raton, 2006).

12) Wesley L. Stone: Robotics and Automation Handbook (Western Carolina University, 2005).

Educational content

5. Methods of mastering the discipline (educational component)

Topic	Content	Lectures	Practical / Seminars
Topic 1 *Introduction. History of development and current state of industrial robotics.*	*Introduction. Historical background on the development of industrial robotics and its significance. The first robots. Three laws of robotics. The first industrial robots. Three main periods of development of industrial robots. Chronology of industrial robotics development in the USA, Japan and Europe. The current state of industrial robotics.*	6	
Topic 2 *Basic concepts and definitions.*	*The concept and definition of manipulator, industrial robot, robotic complex. The concept of manipulation, information and control system of industrial robot.. Block diagram of industrial robot. The concept of automated and supervisory control of industrial robots. The concept of working and gripping devices of industrial robot. The concept of programming and teaching of industrial robot.*	6	2
Topic 3 *Technological preparation of robotic production.*	*Stages of production preparation. Scientific preparation of production. Organizational preparation of production. Design preparation of production. Technological preparation of production. The main tasks to be solved at the stages of scientific, organizational, design and technological preparation of production. Tasks of technological preparation of robotic production. Stages of technological preparation of robotic production.*	6	2
Topic 4 *DFMA of objects of robotization.*	*The concept of DFMA. Examples of working out of a design of parts on DFMA. Automation of the process of working out the design of parts for DFMA. Requirements for the DFMA of the design of parts that are produced in robotic production. Requirements for the DFMA of the design of assembly units that are produced in robotic production.*	6	4
Topic 5 *Manipulators of industrial robots.*	*History of manipulators. The conditioned need for the emergence of manipulators. Classification of manipulators of industrial robots. Classification of manipulators of industrial robots by control method. Classification of industrial robot manipulators by type of coordinate system. Cartesian coordinate system of the manipulator. Spherical (polar) coordinate system of the manipulator. Cylindrical coordinate system of the manipulator. Articulated coordinate system of the manipulator. SCARA system manipulators. Manipulator of pendulum type. Parallel manipulators. Parallel manipulators Delta . Classification of manipulators of industrial robots according to the method of placing drive devices in the design of the manipulator relative to its circuits and the working body. Classification of manipulators of industrial robots depending on the type of drive.*	4	2

Topic 6 *Classification of industrial robots.*	*The main classification features of industrial robots. Classification of industrial robots by the number of manipulators. Classification of industrial robots by the type of the operations performed. Classification of industrial robots by degree of specialization. Classification of industrial robots by industry. Classification of industrial robots by type of manipulator coordinate system. Classification of industrial robots by the number of degrees of mobility. Classification of industrial robots by load capacity. Classification of industrial robots by method of installation in the workplace. Classification of industrial robots by mobility. Stationary and mobile robots. Classification of industrial robots by type of power drive. Classification of industrial robots by accuracy class. Classification of industrial robots by type of control. Classification of industrial robots by type of movement by individual degrees of mobility. Use of collaborative robots in production.*	4	2
Topic 7 *Control systems of industrial robots.*	*Classification of control systems for industrial robots according to the method of motion control. Classification of control systems for industrial robots depending on the degree of adaptation to changes in the environment. Classification of control systems for industrial robots by type of signals in the control device. Classification of control systems for industrial robots by the number of robots that are jointly controlled. Classification of control systems for industrial robots by the type of participation in the management of the human-operator. Classification of control systems for industrial robots by type of software.*	2	2
Topic 8 *Working bodies of industrial robots.*	*General requirements for the design of working bodies of industrial robots. Classification of working bodies of industrial robots. Classification of the main types of human hand grips according to Schlesinger. Classification of basic manipulations by the human hand according to Crosley. Designs of gripping devices of industrial robots. Mechanical gripping devices for industrial robots. Pneumatic gripping devices of industrial robots. Magnetic gripping devices for industrial robots.*	2	4
Exam			

6. Independent work of a student/graduate student

Independent work is provided by topics:

Topic 1 *History of development and current state of industrial robotics.*

Topic 2 *Basic concepts and definitions.*

Topic 3 *Technological preparation of robotic production.*

Topic 4 *DFMA of objects of robotization.*

Topic 5 *Manipulators of industrial robots.*

Topic 6 *Classification of industrial robots.*

Topic 7 *Control systems of industrial robots.*

Topic 8 *Working bodies of industrial robots.*

Policy and control

7. Course policy (educational component)

Deadline and recompilation policy. *Works that are submitted in violation of deadlines without good reason are evaluated at a lower score (-10 points). Re-examination takes place with the permission of the dean's office if there are good reasons (for example, hospital).*
Academic Integrity Policy. *All written works are checked for plagiarism and are allowed to be defended with correct text borrowings not more than 20%.*
Attendance policy. *Attendance is a mandatory component of the assessment, for which points are accrued. For objective reasons (eg illness, international internship) training can take place on-line in agreement with the course leader.*

8. Types of control and rating system of assessing learning outcomes (RSA)

Current monitoring: express survey, survey on the topic of the lesson, test, etc.
Semester monitoring: exam.
Conditions of admission to semester control: semester rating is more than 63 points.

Table of correspondence of rating points to grades on a university scale:

The number of points	Rating
100-95	*Perfectly*
94-85	*Very good*
84-75	*Good*
74-65	*Satisfactorily*
64-60	*Enough*
Less than 60	*Unsatisfactorily*
Admission conditions are not met	*Not allowed*

9. Additional information on the discipline (educational component)

- the possibility of enrollment in certificates of distance or online courses on relevant topics;
- the possibility of crediting articles published abroad.

Curriculum (Syllabus):

Folded: Candidate Degree in Technical Sciences, Docent Lapkovsky S.

Approved: Department of Manufacturing Engineering (minutes № 1 of 30 August 2021)

Agreed Methodical commission of the faculty [1] (minutes № ___ of _____)

[1] Methodical council of the University - for general university disciplines