

DESIGN OF CURRENT LINES

Educational component work program (Syllabus)

Educational component details

Level of higher education	<i>Second (Master's)</i>
Branch of knowledge	<i>G - Engineering, manufacturing and construction</i>
Specialty	<i>G11 "Mechanical Engineering"</i>
Educational program	<i>Educational and Professional Program Engineering of innovative industry equipment</i>
Status of the educational component	<i>selective</i>
Form of study	<i>full-time / day</i>
Year of preparation, semester	<i>1 course, spring semester</i>
The scope of the educational component	<i>5(150)</i>
Semester control/control measures	<i>Exam</i>
Class schedule	
Language of instruction	<i>Ukrainian</i>
Information about the course leader/teachers	Lecturer: https://cpsm.kpi.ua/karvatskij-anton-yanovich.html Practical: https://cpsm.kpi.ua/karvatskij-anton-yanovich.html Laboratory: –
Course placement	<i>Link to a remote resource Google classroom, https://cpsm.kpi.ua/navchannya/sylabusy/sylabusy-2025-roku.html</i>

Educational component program

1. Description of the educational component, its purpose, subject matter and learning outcomes

The educational component "Design of current lines" is the most important link in the educational process, which combines CAD technologies, fundamental and general engineering educational components into a logically unified system, and has a practical focus in the training of specialists specializing in the field of engineering mechanics.

The purpose of the educational component "Design of current lines"

The purpose of the educational component is to strengthen the process of forming a complex of knowledge among students regarding methods and means of designing current lines for the production of materials for the manufacture of packaging, packaging of finished products and its packaging.

Subject of the educational component "Design of current lines" – methods and means of designing production lines for the production of packaging materials, packaging of finished products and its packaging.

Studying the educational component enables students to design and perform theoretical research of production lines using modern CAD-CAE systems.

In accordance with the purpose, the training of masters in this specialty requires the strengthening of the formation of the following competencies:

Integral competence:

- The ability to solve complex tasks and problems in industrial mechanical engineering, which involves conducting research on processes, equipment and/or implementing innovations in a given industry and is characterized by uncertainty of conditions and requirements.

General competencies:

- Ability to use information and communication technologies (ZK 01);
- Ability to learn and master modern knowledge (ZK 02);
- Ability to generate new ideas (creativity) (ZK 06);
- Ability to identify, pose and solve problems (ZK 07);
- Ability to make informed decisions (ZK 08).

Professional competencies:

- Ability to create, improve and apply quantitative mathematical, scientific and technical methods and computer software, to apply a systematic approach to solving engineering problems in the field of mechanical engineering, in particular, in conditions of technical uncertainty (SK 01);
- Critical understanding of advanced scientific facts, concepts, theories, principles for the field of mechanical engineering and the ability to apply them to solve complex problems in the field of mechanical engineering and sustainable development (SK 02);
- Ability to perform mathematical modeling to solve problems in scientific research, design, maintenance and modernization of equipment using computer technologies, CAD systems and other applied programs (SK 07).

According to the requirements of the educational component program "Design of current lines", after mastering it, students must demonstrate the following enhanced program **learning outcomes**:

- Knowledge and understanding of the principles of technological, fundamental and engineering sciences that underlie the branch of mechanical engineering of the relevant industry (PRN 01);
- Knowledge and understanding of mechanics and mechanical engineering and the prospects for their development (PRN 02);
- Know and understand the processes of mechanical engineering, have the skills to use them practically (PRN 03);
- Perform engineering calculations to solve complex tasks and practical problems in mechanical engineering (PRN 04);
- Analyze engineering objects, processes and methods (PRN 05);
- Using the fundamental laws of conservation and transfer, select/develop/analyze/implement in the environments of CAD systems and other application programs mathematical models and regulations of processes occurring in the workspace and/or in the structures of technological equipment to solve the problems of scientific research, design, operation, modernization of mechanical engineering equipment (PRN 12).

Studying the educational component "Design of current lines" will also allow students to strengthen their ability to conduct research on production lines and their components using modern CAD-CAE technologies - design and numerical analysis systems, and to process and analyze the results obtained.

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

Prerequisites: The educational component "Design of current lines" is based on the study of the following credit modules: "Higher Mathematics", "Physics", "Chemistry", "Engineering and Computer Graphics", "Theoretical Mechanics", "Engineering Calculation Software", "Materials Science", "Heat Transfer",

"Applied Mechanics of a Deformed Solid", "Rheology", "Mechanics of Materials and Structures", "Polymer Processing Technology", "Theoretical Fundamentals of Heat Engineering", "Machine Parts", "Fluid and Gas Mechanics", "Mechanical Engineering Technology", "Lifting and Transporting Machines", "Press Equipment", "Hydraulic and Pneumatic Drives", "Fundamentals of Automation", "Processes, Apparatus and Machines of the Industry", "Modernization of Technological Equipment", "Applied Numerical Methods", "Modern Methods of Calculation of Processes and Equipment", "Information Support for Design".

Postrequisites: The educational component "Design of current lines" provides the following educational components: "Design of equipment", "Engineering of innovative technologies and equipment", "Computer-integrated technologies for the design of technological equipment" and "Scientific work on the topic of a master's thesis", completion of master's theses.

3. Content of the educational component

Section 1. The current form of production organization. The main stages of designing different types of assembly lines

Topic 1.1. The purpose and objectives of the educational component. Basic definitions.

Topic 1.2. Design of current lines (CL) and determining their efficiency.

Topic 1.3. The procedure for calculating the main performance indicators of an intermittent current line.

Topic 1.4. Construction of a schedule for an intermittent current line.

Topic 1.5. Planning equipment on a current line.

Topic 1.6. Advantages of the current form of production organization.

Section 2. Theoretical foundations of current line design

Topic 2.1. Technological machines and flow lines.

Topic 2.2. Productivity of working machines of CL.

Topic 2.3. Cyclic and synchronous diagrams of working machines of CL.

Topic 2.4. Principles of construction of multi-position automatic machines and automatic lines.

Topic 2.5. Typical mechanisms of CL and the basics of their calculation.

4. Educational materials and resources

Basic literature

1. Design of current lines. [Electronic resource]: lecture notes: teaching aids for master's degree applicants in the educational program "Packaging and packaging equipment engineering" speciality 131 "Applied mechanics" / A. Ya. Karvatsky, A. O. Chemerys; Igor Sikorsky Kyiv Polytechnic Institute. – 3rd ed. revised and supplemented Electronic text data (1 file: 3.95 MB). Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2024. 194 p. URL: <https://ela.kpi.ua/handle/123456789/72096>
2. Karvatsky A.Ya., Lazarev T.V. Methodological instructions for conducting computer workshops on practical classes of students in the discipline "Design of production lines", for students speciality "Machines and packaging technology". Kyiv: NTUU "KPI", 2013. 35 p. URL: https://cpsm.kpi.ua/Doc/Metod_Pract_PPL.pdf
3. Methodological instructions for the implementation of independent work of students in the discipline "Design of production lines", for students of the speciality "Machines and packaging technology" / Compiled by: A.Ya. Karvatsky. Kyiv: NTUU "KPI", 2013. 13 p. URL: https://cpsm.kpi.ua/Doc/Metod_CPC_PPL.pdf
4. Kodra Yu. V., Stotsko Z. A. Technological machines. Calculation and design: Textbook / Ed. Z. A. Stotsko. Lviv: Publishing house of the National University "Lviv Polytechnic", 2004. 468 p.
5. Finite element method in problems of mechanics of continua. Laboratory practical course on the subject [Electronic resource]: teaching aids for students of specialties 131 "Applied mechanics", 133 "Industrial mechanical engineering", specializations "Engineering, computer modeling and design of packaging equipment", "Engineering, computer modeling and design of equipment for

the production of polymeric and building materials and products" / A. Ya. Karvatsky. Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2018. 391 p. URL: <https://ela.kpi.ua/handle/123456789/23916>

Additional literature

1. SOLIDWORKS: Drawings Online Class. URL: <https://www.linkedin.com/learning/solidworks-drawings>
2. Dassault Systems SolidWorks Corporation, a Dassault Systems S.A. company, 300 Baker Avenue, Concord, Massachusetts 01742 USA, 1995–2009, 534 p.
3. Introduction to SolidWorks. 2014. · 207 p. · URL : <https://www.pdfdrive.com/introduction-to-solidworks-e13723438.html>
4. SolidWorks Simulation. 2010. 146 p. URL : <https://www.pdfdrive.com/solidworks-simulation-e17219094.html>
5. Tickoo Sham. Solidworks A Tutorial Approach. 2016, 593 p. URL : <https://www.pdfdrive.com/solidworks-a-tutorial-approach-e175343946.html>
6. Website: Autodesk Inventor. URL : <http://www.autodesk.ru/products/autodesk-inventor-family/overview> .
7. Segerlind Larry J. Applied Finite Element Analysis ; sec. edit. New York : John Wiley & Sons, Inc., 1984. 393 p. URL : <https://www.scribd.com/doc/241729488/Applied-Finite-Element-Analysis-Larry-J-Segerlind-pdf>
8. Website: PTC Mathcad is a software environment for performing various mathematical and technical calculations on a computer. URL : <http://www.ptc.com/product/mathcad/>
9. Website: OpenFOAM. Open Source Field Operation And Manipulation CFD ToolBox – an open integrated platform for numerical modeling of problems in the mechanics of continuums URL : <https://www.openfoam.com/>
10. Website: LIGGGHTS Open Source Discrete Element Method Particle Simulation Code. URL : <https://www.cfdem.com/>
11. Website: ParaView. An open-source, multi-platform data analysis and visualization application. URL : <https://www.paraview.org/>
12. Production organization: textbook / A. I. Yakovlev [et al.]; ed.: A. I. Yakovlev, S. P. Sudarkina, M. I. Larka; National Technical University "Kharkiv Polytechnic Institute". Kharkiv: NTU "KhPI", 2016. 436 p. URL : <http://repository.kpi.kharkov.ua/handle/KhPI-Press/28324>
13. Economics and production organization: textbook / ed. V.G. Gerasymchuk, A.E. Rosenplenter. Kyiv: Znannya, 2007. 678 p.
14. Production organization: a manual / V. V. Prokhorov, O. Yu. Davydova. Kharkiv: Ivanchenko I.S. Publishing House, 2018. 275 p. URL: <http://ktepe.kiev.ua/wp-content/uploads/2019/12/Organizacziya-virobnicztva-Prohorov-V.-V..pdf>
15. Professional management in modern market development conditions: Materials of the reports of the V scientific and practical conference with international participation (November 1, 2016): Collection of additional materials. Kharkiv: Monograph. 2016. 358 p.
16. Website: ANSYS Engineering Simulation & 3D Design Software ANSYS [Electronic resource]. URL : <https://www.ansys.com/>
17. SolidWorks. Training. Dassault Systems SolidWorks Corporation, a Dassault Systems S.A. company, 300 Baker Avenue, Concord, Massachusetts 01742 USA, 2010. 333 p.
18. Mikulyonok I. O. Equipment and processes of processing thermoplastic materials using secondary raw materials: monograph. Kyiv: NTUU "KPI", 2009. 264 p. URL : <https://ela.kpi.ua/handle/123456789/28259>
19. Research and engineering of packaging equipment. [Electronic resource] : lecture notes : teaching aids for master's degree applicants in the educational program "Engineering of packaging and packaging equipment" speciality 131 "Applied mechanics" / A. Ya. Karvatskyi ; Igor Sikorsky Kyiv Polytechnic Institute. – 2nd ed. revised. – Electronic text data (1 file: 2.73 MB). Kyiv : Igor Sikorsky Kyiv Polytechnic Institute, 2024. 143 p. URL : <http://ela.kpi.ua/handle/123456789/23915>

Information resources on the Internet

1. DSpace STL Igor Sikorsky Kyiv Polytechnic Institute
<https://ela.kpi.ua/bitstream/123456789/19012/3/PPL.pdf>,
<https://ela.kpi.ua/handle/123456789/23916>, <http://ela.kpi.ua/handle/123456789/23915>
2. Website: Department of Chemical, Polymeric and Silicate Engineering, <http://cpsm.kpi.ua/mr.html>
3. Campus Igor Sikorsky Kyiv Polytechnic Institute, <http://login.kpi.ua/>
4. Distance learning platform "Sikorsky", <https://sikorsky-distance.kpi.ua/>

Educational content

5. Methodology for mastering the educational component

Lecture classes

Lectures are aimed at:

- providing modern, holistic, interdependent knowledge on the educational component "Design of current lines", the level of which is determined by the target setting for each specific topic;
- ensuring creative work of students together with the teacher during the lecture;
- educating students in professional and business qualities and developing their independent creative thinking;
- forming the necessary interest in students and providing a direction for independent work;
- determining the current level of development of science in the field of modern methods of design of current lines;
- reflecting the methodological processing of the material (highlighting the main provisions, conclusions, recommendations, clear and adequate formulation of them);
- using visual materials for demonstration, combining them, if possible, with the demonstration of results and samples;
- teaching research materials in a clear and high-quality language with observance of structural and logical connections, explanation of all newly introduced terms and concepts;
- accessibility for perception by this audience.

No s/p	The name of the lecture topic and the list of main issues (links to literature and tasks on the IWS)	Number of hours
Section 1. The current form of production organization. The main stages of designing different types of current lines		
1	Topic 1.1. Purpose and objectives of the educational component. Basic definitions <i>Lecture 1. Introduction. Literature. Basic concepts and terms. Current production systems - lines. Characteristics of the current form of production organization.</i> <i>List of didactic aids:</i> The lecture uses a laptop with an electronic version of the lecture and a projector. Drawings, posters for the lecture. <i>Tasks for the IWS.</i> The current line, principles of direct current, specialization, rhythm, etc. Organizational forms of current lines. Classification of current lines. <i>Literature:</i> lecture notes [1], pp. 12–19; [A12] pp. 39–51. Topic 1.2. Design of flow lines and determining their efficiency. Main stages of design. Single-subject and multi-subject current lines. Design of the line operating mode. Variability coefficient. Variable loading of the current line. Design of the current line operating mode. Cycle (rhythm) of the current line. The size of the transport party. <i>Literature:</i> lecture notes [1], pp. 20–25; [A13] pp. 51–76.	2
2	Topic 1.3. The procedure for calculating the main indicators of the work of an intermittent-current line <i>Lecture 2. Monthly time fund; number of types of products; number of</i>	2

No s/p	The name of the lecture topic and the list of main issues (links to literature and tasks on the IWS)	Number of hours
	operations. Product processing time. Variable program. <u>List of didactic aids:</u> The lecture uses a laptop with an electronic version of the lecture and a projector. Drawings, posters for the lecture. <u>Tasks for the IWS.</u> The procedure for calculating the main indicators of the work of an intermittent-flow line. The cycle of the current line for each type of product. <u>Literature:</u> lecture notes [1], p. 26–30; [A13] p. 80–91. Topic 1.4. Construction of the regulations of an intermittent-current line. Variants of the regulations of the current line. Current line stocks: technological, transport, insurance or reserve, circulating, inter-operation circulating. Construction of the regulations of an intermittent-current line. Calculation of inter-operation circulating stocks. <u>Literature:</u> lecture notes [1], p. 31–38; [D14] pp. 67–77.	
3	Topic 1.5. Equipment planning on the current line Lecture 3. Options for planning current lines. Types of conveyors. Length of the working part of the conveyor. <u>List of didactic aids:</u> The lecture uses a laptop with an electronic version of the lecture and a projector. Drawings, posters for the lecture. <u>Tasks on the IWS.</u> Equipment planning on assembly lines. Options for planning multi-subject assembly lines. <u>Literature:</u> lecture notes [1], pp. 39–42; [A15] pp. 123–138. Topic 1.6. Advantages of the current form of production organization. Calculation of the economic effect of the implementation of the CL. Methodology for calculating the economic efficiency of the project based on the net present value of the project. Net present value of the project. Net cash flow. Project profitability index. Project payback period. Project internal rate of return. <u>Literature:</u> lecture notes [1], pp. 42–46.	2
Section 2. Theoretical foundations of current line design		
4	Topic 2.1. Technological machines and current lines <u>Lecture 4.</u> Technological process (TP) - the basis for the design of technological equipment. Hardware and machine TP, machine technology. Working and auxiliary parts of machines. Basic concepts and definitions of tools for the production of PL. The structure of an automatic working machine. Machine, working and non-working moves. Production, technological, working, kinematic, dynamic, energy cycles of CL machines. Degree of automation of the machine. Semi-automatic, automatic, automatic line. <u>List of didactic aids:</u> The lecture uses a laptop with an electronic version of the lecture and a projector. Drawings, posters for the lecture. <u>Tasks for the IWS.</u> Components of the working cycle of the machine. Classification of machines of the current line by the nature of the action of the processing tool on the object of processing of the technological process. <u>Literature:</u> [4] section 1, pp. 9–21; lecture notes [1], pp. 47–50. Production, technological, working, kinematic, dynamic, energy cycles of machines of production lines. Degree of automation of the machine. <u>Literature:</u> [4] section 1, pp. 22–28; lecture notes [1], pp. 51–54.	2
5	<u>Lecture 5.</u> Structure of an automatic line, workshop. Classification of machines by the nature of the movement of the processing object. General stages of the process of designing a CL machine. <u>List of didactic aids:</u> The lecture uses a laptop with an electronic version of the lecture and a projector. Drawings, posters for the lecture. <u>Tasks for the IWS.</u> Commonality of automatic machines and automatic lines of various technological purposes. Cycle diagram of the operation of an automatic machine. <u>Literature:</u> [4] section 1, pp. 30–41; lecture notes [1], pp. 55–65. Topic	2

No s/p	The name of the lecture topic and the list of main issues (links to literature and tasks on the IWS)	Number of hours
	2.2. Productivity of working machines of current lines. <i>Basic provisions of the theory of productivity of machines and labor. Technological and cyclical productivity. Actual productivity. Machine utilization factor. Types of off-cycle losses. Total off-cycle losses. Own and organizational and technical losses. Machine productivity balance. Coefficients of technical use and machine loading. Forms of machine productivity - necessary, expected and actual. Literature: [4] section 2, pp. 42–52; lecture notes [1], pp. 66–76.</i>	
6	<u>Lecture 6.</u> Methodology for calculating and analyzing the productivity of working machines in operating conditions. Costs of the planned fund of machine time. Examples of calculating the main characteristics of the workability of machines CL. Topic 2.3. Cyclic and synchronous diagrams of working machines of the current line. The concept of the cycle diagram of the machine. Circular, rectangular and linear cyclograms. The concept of the synchronous diagram of the machine. An example of developing a cycle diagram of the machine. <u>List of didactic aids:</u> The lecture uses a laptop with an electronic version of the lecture and a projector. Drawings, posters for the lecture. <u>Tasks for the IWS.</u> Calculation of the main characteristics of workability and construction of the balance of machine productivity. Calculation of machine productivity. <u>Literature:</u> [4] section 2, pp. 53–62 lecture notes [1], pp. 77–89. Cyclic and synchronous diagrams of working machines of the current line. Stages of constructing cyclograms. <u>Literature:</u> [4] chapter 3, pp. 63–75; lecture notes [1], pp. 89–104.	2
7	Topic 2.4. Principles of construction of multi-position automatic machines and automatic lines <u>Lecture 7.</u> Features of technological processes of automated production. Principle of differentiation of TP. Principle of concentration of operations. Selection of the optimal degree of differentiation and concentration of TP. Calculation of the number of positions of multi-position machines of sequential action. Examples of automata and lines of sequential-parallel action. <u>List of didactic aids:</u> The lecture uses a laptop with an electronic version of the lecture and a projector. Drawings, posters for the lecture. <u>Tasks on the IWS.</u> Principles of differentiation and concentration of operations of the technological process. Types of multi-position automatic machines. Automatic machines of parallel and sequential-parallel action. <u>Literature:</u> [4] section 4, pp. 76–87; lecture notes [1], pp. 104–115. Optimal degree of differentiation and concentration of the technological process. Universal and special automatic machines and semi-automatic machines. <u>Literature:</u> [4] chapter 4, pp. 88–99; lecture notes [1], pp. 115–128.	1
8	<u>Lecture 8.</u> Rotor and conveyor-rotor machines. Basic concepts and definitions. Rotary automaton (RA). Automatic rotary line (ARL). <u>List of didactic aids:</u> The lecture uses a laptop with an electronic version of the lecture and a projector. Drawings, posters for the lecture. Scheme of a typical rotary machine. Technological (working) rotor. Technological rotors for tool processing. Technological rotors for hardware processing. <u>Tasks on the IWS.</u> Rotor and conveyor-rotor machines. Automatic rotary-conveyor line (ARCL). <u>Literature:</u> [4] section 4, pp. 100–112; lecture notes [1], pp. 128–141. Technological rotors for hardware processing. Rotor for dosed liquid pouring. <u>Literature:</u> [4] section 4, pp. 114–125; lecture notes [1], pp. 141–149.	1
9	<u>Lecture 9.</u> Transport rotors. Typical schemes of rotary and rotary-conveyor machines. Drives of rotary machines. Instrument blocks. Determination of	2

No s/p	The name of the lecture topic and the list of main issues (links to literature and tasks on the IWS)	Number of hours
	<i>parameters of rotary and rotary-conveyor machines.</i> <u>List of didactic aids:</u> The lecture uses a laptop with an electronic version of the lecture and a projector. Drawings, posters for the lecture. <u>Tasks for the IWS.</u> Typical schemes of rotary and rotary-conveyor machines. Main indicators of rotary machines. Continuous conveyor machines. <u>Literature:</u> [4] section 4, pp. 130–145; lecture notes [1], pp. 149–172. Topic 2.5. Typical mechanisms of current lines and the basis of their calculation. Classification, functions and characteristics of mechanisms. Classification of cam mechanisms. Design of a kinematic scheme. Classification, functions and characteristics of mechanisms. Determination of the total gear ratio and its breakdown by stages. <u>Literature:</u> [4] chapter 5, pp. 146–167; lecture notes [1], pp. 173–175.	
Total		16

Practical classes

The main goals of the practical training cycle are for students to apply theoretical knowledge in the design of current lines, to acquire skills in using CAD systems (SolidWorks [7], [A1–A5], Autodesk Inventor [A6], Mathcad [A8]) and software products (free open source software OpenFOAM [A9], LIGGGHTS [A10]) when building complex solid-state and numerical models of processes, nodes and parts of current lines, and to analyze the obtained results of calculations of physical fields during the design or modernization of current lines in the packaging industry.

No s/p	The name of the topic of practical classes and the list of main issues (reference to literature and tasks on the IWS)	Number of hours
1	Topic 1. SolidWorks. Solid multi-body objects <i>Joining a multi-body part. Installing joints in multi-body parts. References: [7], pp. 67–76.</i> <u>List of didactic tools:</u> personal computer, SolidWorks CAD system, examples of building sketches and solid models of complex parts. <u>Tasks on the IWS.</u> Creating a multi-body object using a mirror array. Placing inserted parts. <u>Literature:</u> [7], pp. 71–76.	5
2	Topic 2. SolidWorks. Elements along the trajectory <i>Modeling a spring, a bottle. Literature: [7], p. 83–129.</i> <u>List of didactic tools:</u> personal computer, SolidWorks CAD system, examples of building sketches and solid-state models of complex parts. <u>Tasks on the IWS.</u> Examples of building complex elements along the trajectory. <u>Literature:</u> [7], p. 83–129.	5
3	Topic 3. SolidWorks. Elements along the trajectory <i>Zorelit. Suspension bracket. Literature: [7], p. 187–204.</i> <u>List of didactic tools:</u> personal computer, SolidWorks CAD system, examples of building sketches and solid-state models of complex parts. <u>Tasks on the IWS.</u> Complex connections. <u>Literature:</u> [7], 205–212.	5
4	Topic 4. SolidWorks. Elements by sections and splines <i>Basic operations for creating an element by sections. Literature: [7], p. 214–217.</i> <u>List of didactic tools:</u> personal computer, SolidWorks CAD system, examples of building sketches and solid models of complex parts. <u>Tasks on the IWS.</u> Creating elements by sections. <u>Literature:</u> [7], p. 214–217.	5
5	Topic 5. SolidWorks. Drawing design. Adding dimensions to drawings <i>Creating and using layers in SolidWorks. Literature: [7], [A1].</i> <u>List of didactic tools:</u> personal computer, CAD systems Autodesk Inventor,	3

No s/p	The name of the topic of practical classes and the list of main issues (reference to literature and tasks on the IWS)	Number of hours
	<i>SolidWorks.</i> <i>Tasks on the IWS.</i> Drawing – Rocking chair. Drawing – Gearbox housing. <i>Literature:</i> [A1], p. 3-1 (53), 4.1(92); p. 3-18 (70), 4-9 (100).	
6	Topic 6. Feasibility studies of the modernization of the production line <i>Literature:</i> lecture notes [1], pp. 42–46. <i>List of didactic aids:</i> personal computer, NPV methodology, Mathcad, Excel software. <i>Tasks for the IWS.</i> Feasibility studies on the topic of the master's thesis. <i>Literature:</i> lecture notes [1], pp. 42–46.	2
7	Topic 7. Hydrodynamic calculations in ANSYS Workbench <i>List of didactic tools:</i> personal computer, ANSYS Workbench software. <i>Tasks for the IWS.</i> Problems with a free gas-liquid surface. <i>Literature:</i> [A16].	3
8	Modular control work	2
Total		30

Seminar classes

The working curriculum does not include seminar classes.

Laboratory classes

The working curriculum does not include laboratory classes.

6. Student independent work

No s/p	Name of the topic submitted for self-study	Number of hours of IWS
1	Topic 1.1. The purpose and objectives of the educational component. Basic definitions <i>Construction of the schedule of the intermittent current line. Calculation of inter-operational working stock. Literature:</i> lecture notes [1], pp. 31–38; [A14] pp. 67–77. <i>SolidWorks.</i> Solid multi-body objects. Joining a multi-body part. Installing joints in multi-body parts. <i>Literature:</i> [7], pp. 67–76.	6
2	Topic 1.2. Design of production lines and determination of their efficiency <i>Design of the operating mode of the current line. The rhythm of the current line. The size of the transport batch. Literature:</i> lecture notes [1], pp. 20–25; [A13] pp. 51–76. <i>SolidWorks.</i> Solid multi-body objects. Creating a multi-body object using a mirror array. Placing inserted parts. <i>Literature:</i> [7], pp. 71–76.	6
3	Topic 1.3. The procedure for calculating the main indicators of the operation of an intermittent-current line <i>The procedure for calculating the main indicators of the operation of an intermittent current line. The cycle time of the current line for each type of product. Literature:</i> lecture notes [1], p. 26–30; [A13] p. 80–91. <i>SolidWorks.</i> Elements along the trajectory. Modeling a spring, a bottle. <i>Literature:</i> [7], p. 83–129.	6
4	Topic 1.4. Construction of a discontinuous current line schedule <i>Construction of a discontinuous current line schedule. Calculation of interoperational working inventory. Literature:</i> lecture notes [1], pp. 31–38; [A14] pp. 67–77.	6

No s/p	Name of the topic submitted for self-study	Number of hours of IWS
	<i>SolidWorks. Elements along a trajectory. Examples of constructing complex elements along a trajectory. Literature: [7], pp. 83–129.</i>	
5	Topic 1.5. Planning of equipment on the current line <i>Planning of equipment on current lines. Variants of planning of multi-subject current lines. Literature: lecture notes [1], p. 39–42; [A15] p. 123–138.</i> <i>SolidWorks. Elements along the trajectory. Spacecraft. Suspension bracket. Literature: [7], p. 187–204.</i>	6
6	Topic 1.6. Advantages of the current form of production organization <i>Net cash flow. Project profitability index. Project payback period. Project internal rate of return. Literature: lecture notes [1], pp. 42–46.</i> <i>SolidWorks. Elements along the trajectory. Complex connections. Literature: [7], 205–212.</i>	6
7	Topic 2.1. Technological machines and current lines <i>Components of the working cycle of the machine. Classification of machines of the current line by the nature of the action of the processing tool on the object of processing of the technological process. Literature: [4] section 1, p. 9–21; lecture notes [1], p. 47–50.</i> <i>Production, technological, working, kinematic, dynamic, energy cycles of machines of current lines. Degree of automation of the machine. Literature: [4] section 1, p. 22–28; lecture notes [1], p. 51–54.</i> <i>Commonality of automatic machines and automatic lines of various technological purposes. Cycle diagram of the automatic machine. Literature: [4] section 1, p. 30–41; lecture notes [1], p. 55–65.</i> <i>SolidWorks. Elements by sections and splines. Basic operations for creating an element by sections. Literature: [7], p. 214–217.</i>	6
8	Topic 2.2. Productivity of working machines of current lines <i>Coefficients of technical use and machine loading. Forms of machine productivity – necessary, expected and actual. Literature: [4] section 2, p. 42–52; lecture notes [1], p. 66–76.</i> <i>Calculation of the main characteristics of workability and construction of a machine productivity balance. Calculation of machine productivity. Literature: [4] section 2, p. 53–62, lecture notes [1], p. 77–89.</i> <i>SolidWorks. Elements by sections and splines. Creation of elements by sections. Literature: [7], p. 214–217.</i>	8
9	Topic 2.3. Cyclic and synchronous diagrams of working machines of the current line <i>Cyclic and synchronous diagrams of working machines of the current line. Stages of construction of cyclic diagrams. Literature: [4] section 3, p. 63–75; lecture notes [1], p. 89–104.</i> <i>SolidWorks. Drawing design. Adding dimensions to drawings.</i> <i>Creating and using layers in SolidWorks. Literature: [7], [A1].</i>	8
10	Topic 2.4. Principles of construction of multi-position automatic machines and automatic lines <i>Principles of differentiation and concentration of technological process operations. Types of multi-position automatic machines. Automatic machines of parallel and serial-parallel action. Literature: [4] section 4, pp. 76–87; lecture notes [1], pp. 104–115.</i>	8

No s/p	Name of the topic submitted for self-study	Number of hours of IWS
	<i>Optimal degree of differentiation and concentration of technological process. Universal and special automatic machines and semi-automatic machines. Literature: [4] section 4, pp. 88–99; lecture notes [1], pp. 115–128.</i> <i>Rotary and conveyor-rotary machines. Automatic rotary-conveyor line. Literature: [4] section 4, pp. 100–112; lecture notes [1], pp. 128–141.</i> <i>Technological rotors for hardware processing. Rotor for dosed liquid pouring. Literature: [4] section 4, pp. 114–125; lecture notes [1], pp. 141–149.</i> <i>Typical schemes of rotary and rotary-conveyor machines. Main indicators of rotary machines. Continuous conveyor machines. Literature: [4] section 4, pp. 130–145; lecture notes [1], pp. 149–172.</i> <i>Technical and economic calculations on the topic of the master's thesis. Literature: lecture notes [1], pp. 42–46.</i>	
11	Topic 2.5. Typical mechanisms of the current lines and the basics of their calculation <i>Classification, functions and characteristics of mechanisms. Determination of the total gear ratio and its breakdown by stages. Literature: [4] section 5, pp. 146–167; lecture notes [1], pp. 173–175.</i> <i>Hydrodynamic calculations in ANSYS Workbench. Problems with a free gas-liquid surface. Literature: [A16].</i>	4
12	Modular control work	4
13	Exam	30
Total		104

Individual tasks

The working curriculum does not provide for individual assignments.

Control works

The purpose of the modular test:

- a summary of the study of the topics of the credit module;
- application of the acquired knowledge to perform engineering calculations;
- the ability to independently apply the acquired knowledge to perform tasks in this credit module and in other educational components: “Packaging Equipment”, “CAD of Technological Equipment”, “Course Project on Research and Engineering of Packaging Equipment”, “Scientific Work on the Topic of the Master's Thesis”.

The curriculum of the educational component provides for one modular test, which covers sections 1 and 2. An approximate list of questions for the MCW is given at the end of the Syllabus. The formulation of questions for the MCW may be slightly changed in accordance with the features of teaching the lecture material and its perception by students. In order to prepare students in the IWS mode, the teacher familiarizes them with the questions for the MCW 1–2 weeks before performing the work. A package of tasks for the MCW has been developed.

Politics and control

7. Educational component policy

Rules for attending classes and behavior in classes

Attending classes is a mandatory component of assessment. Students are obliged to take an active part in the educational process, not to be late for classes and not to miss them without a good reason, not to interfere with the teacher to conduct classes, not to be distracted by actions that are not related to the educational process.

Rules for the implementation and protection of practical work (computer workshops):

- practical work (computer workshops) takes place during hours of practical classes and SRS and is sent to the teacher's e-mail or telegrams;
- practical work (computer workshops) takes place during hours of practical classes and SRS and is sent to the teacher's e-mail or telegrams;
- rules for the protection of practical works (computer workshops) are based on a rating system for assessing learning outcomes.

Rules for assigning incentive and penalty points:

- encouraging points can be credited by the teacher for active participation in lectures, preparation of scientific publications on topics of the discipline. At the same time, the amount of incentive points may not exceed 25% of the rating scale.
- penalty points within the discipline are not provided.

Deadline and overlay policy

In case of debts in the discipline or any force majeure circumstances, students should contact the teacher through accessible (provided by the teacher) communication channels to solve problematic issues and coordinate the algorithm of actions for working out.

Academic Integrity Policy

Violation of the Code of Academic Integrity of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" is a serious violation, even if it is unintentional. The Code is available at the link: <https://kpi.ua/code.3>.

In particular, compliance with the Code of Academic Integrity means that all work in exams and tests must be performed individually. When doing independent work, students can consult with teachers and other students, but must independently solve problems, guided by their own knowledge, skills and abilities. References to all resources and sources (e.g. in reports from computer workshops, independent work or presentations) should be clearly defined and properly executed. That is, it is unacceptable to have no references when using printed and electronic materials, quotes, opinions of other authors.

Policy of academic behavior and ethics

Students should be tolerant, respect the opinion of others, object to formulate in the correct form, constructively maintain feedback in the classroom.

The norms of ethical behavior of students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". More: <https://kpi.ua/code.2>.

1. Types of control and rating system for assessing learning outcomes (RS)

Distribution of educational time by types of classes and tasks from the credit module according to the working curriculum:

Semester	School time		Distribution of training hours				Control measures		
	credit	acad. h.	Lecture	Pract.	Ind.less.	IWS	MCW	HCW	Semester certification
1	5	150	16	30	–	104	1	–	Exam

Current control: express survey, reports from computer workshops, modular control work.

Calendar control: carried out twice a semester as a monitoring of the current status of implementation of the syllabus requirements.

Semester control: exam.

The student's rating in the discipline consists of points that he receives for:

- 1) express control;
- 2) completion of design and calculation tasks in practical classes (6 in total);

- 3) modular test;
- 4) answer to the exam (written).

System of rating (weight) points and evaluation criteria

1. Express control:

- “excellent”, complete answer (at least 90% of the required information) – 2 points;
- “satisfactory”, incomplete answer (at least 60% of the required information) and minor errors – 1 point;
- “unsatisfactory”, unsatisfactory answer (does not meet the requirements for 1 point) – 0 points.

2. Practical exercises:

- “excellent”, creative execution of the task, fluent mastery of the material – 4-5 points;
- “good”, execution of the task in full, but with minor errors – 3 points;
- “satisfactory”, execution of the task with individual errors – 2 points;
- “unsatisfactory”, failure to complete the task – 0 points.

3. Modular test:

- “excellent”, complete answer (at least 90% of the required information) – 10-12 points;
- “good”, sufficiently complete answer (at least 75% of the required information), or a complete answer with minor inaccuracies – 7-9 points;
- “satisfactory”, incomplete answer (at least 60% of the required information) and minor errors – 4-5 points;
- “unsatisfactory”, unsatisfactory answer – 0 points.

One or two best students in each practical session may be awarded 1–2 bonus points; +5 bonus points for a report on the results of studying the educational component at a student conference or publication in a journal.

The maximum sum of points for the starting component is 50. A prerequisite for admission to the exam is the completion of all practical session tasks and passing the module test and a starting rating of at least 25 points.

According to the results of the academic work in the first 7 weeks, the "ideal student" should score 25 points. At the certification (8th week), the student receives "passed" if his current rating is at least 12 points.

Based on the results of 15 weeks, the "ideal student" should score $r_c = 50$ points. At the second certification (week 14), the student receives "passed" if his current rating is at least 25 points.

The maximum amount of points for semester R is 50 (where $R = r_{e-kp} \cdot 4 + r_{pr} \cdot 6 + r_{mkr} = 2 \cdot 4 + 5 \cdot 6 + 12 = 8 + 30 + 12 = 50$).

At the exam, students complete a written test. Each task contains two theoretical questions and one practical one. The list of questions is given in the methodological recommendations for mastering the credit module. Each theoretical question is evaluated at 15 points, and the practical one is evaluated at 20 points.

Theoretical question grading system (r_{T1}, r_{T1}):

- “excellent”, complete answer (at least 90% of the required information) – 15-14 points;
- “good”, sufficiently complete answer (at least 75% of the required information or minor inaccuracies) – 13-11 points;

– “satisfactory”, incomplete answer (at least 60% of the required information and some errors) – 10-9 points;

– “unsatisfactory”, unsatisfactory answer – 0 points.

Practical assignment evaluation system (r_{pr}):

– “excellent”, complete error-free solution of the task (at least 90% of the required information) – 20-18 points;

– “good”, complete solution of the task with insignificant inaccuracies (at least 75% of the required information or minor inaccuracies) – 17-15 points;

– “satisfactory”, the task was completed with certain shortcomings (at least 60% of the required information and some errors) – 14-12 points;

– “unsatisfactory”, the task was not completed – 0 points.

The maximum rating for the examination test is

$$r_E = r_{T1} + r_{T2} + r_{pr} = 15 + 15 + 20 = 50 \text{ points.}$$

Admission requirements for semester examination: semester rating of at least 25 points.

The sum of the starting points and the points for the examination test is converted into the examination grade according to the table:

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

Number of points	Estimation
100-95	Perfectly
94-85	Very good
84-75	Good
74-65	Satisfactory
64-60	Enough
Less 60	Unsatisfactorily
Admission conditions not met	Not allowed

9. Additional information on the educational component

List of questions submitted for semester control

Theoretical questions

1. Describe technology machines and current lines. Analyze the basic concepts and definitions of production tools.
2. Describe the features of technological processes of automated production.
3. Analyze the main provisions of the theory of machine productivity and labor.
4. Analyze the classification of machines by the nature of the movement of the processing object.
5. Analyze the commonality of automatic machines and automatic lines for various technological purposes.
6. Describe the signs of the current line.
7. Describe the productivity of working machines. Analyze the main provisions of the theory of machine productivity and labor.
8. Analyze the types of extracycle losses.
9. Analyze and compare technological and cyclic performance, give formulas to determine them.
10. Analyze the main stages of designing current lines.
11. Describe the actual performance of the machine. Analyze the types of extracycle losses.
12. Analyze rotary and conveyor rotary machines. Describe the basic concepts and definitions.
13. Describe the methodology for calculating and analyzing the productivity of working machines in operating conditions.
14. Describe the technological process. Compare the hardware process with the machine technological process.

15. *Analyze the calculation of the main characteristics of robotic capability and building a balance of productivity.*
16. *Describe the purpose of the working and auxiliary organs of the machine, give examples.*
17. *Analyze examples of calculating the main characteristics of the robot ability of machines of current lines.*
18. *Describe four classes of machines by the nature of the action of the processing tool on the TP processing object.*
19. *Analyze the stages of calculating the performance of machines.*
20. *Describe their machines production, technological, working, kinematic, dynamic and energy cycles.*
21. *Describe their machines production, technological, working, kinematic, dynamic and energy cycles.*
22. *Describe semi-automatic and automatic lines, compare their work.*
23. *Describe the concept of a synchronous diagram of the machine.*
24. *Describe the classification of machines by the nature of moving the processing object.*
25. *Analyze the stages of development of the machine's cyclic chart. Formulate the stages of constructing cyclograms.*
26. *Analyze the advantages of the current form of production organization.*
27. *Describe the principles of building multi-position machines and automatic lines.*
28. *Analyze the commonality of automatic machines and automatic lines for various technological purposes.*
29. *Describe the productivity of working machines. Describe the main provisions of the theory of machine productivity and labor.*
30. *Analyze the features of the technological processes of automated production.*
31. *Describe vehicles on current lines. Analyze the features of their use.*
32. *Analyze the principle of differentiation of TP and concentration of operations, describe their growth in the design of the PL.*
33. *Describe the technological rotors for hardware processing. Analyze the principle of operation of the rotor for dosed liquid spilling.*
34. *Analyze universal and special machines and semiautomatic machines. Give examples of automata and lines of sequential-parallel action.*
35. *Analyze the classification of PL machines by the nature of the action of the processing tool on the TP processing object. Give examples.*
36. *Describe the degree of automation of the machine, semi-automatic, automatic, automatic line, current line.*
37. *Describe the definition of the coefficients of technical use and loading of the machine. Describe the forms of machine performance – necessary, expected and valid.*
38. *Describe the working and auxiliary organs of machines. Analyze the components of the machine workflow. Give examples.*
39. *Analyze the structure of the automatic line, current line, workshop.*
40. *Analyze the synchronous diagram of the machine. Give examples.*
41. *Describe the purpose, classification, functions and characteristics of rotary mechanisms.*
42. *Analyze the classification of machines by the nature of the movement of the processing object. Give examples of the corresponding current lines.*
43. *Analyze the general stages of the process of designing machines of current lines.*
44. *Describe the concept of the internal rate of profitability of the project.*
45. *Analyze and compare the parameters of rotary and rotary conveyor machines of current production.*
46. *Analyze examples of calculating the main characteristics of the performance of CL machines. Describe the stages of calculating the performance of machines.*
47. *Analyze the main signs of current production and the signs of the current line, compare them.*
48. *Analyze the choice of the optimal degree of differentiation and concentration of TP. Describe the calculation of the number of positions of multiposition machines of sequential action of current production.*

49. Describe the commonality of automatic machines and automatic lines for various technological purposes.
50. Analyze the main indicators of rotary machines. Describe the conveyor machines of continuous action.
51. Describe hardware and machine TP, machine technology.
52. Describe the actual performance and utilization rate of the machine. Write down the formulas for calculating them.
53. Analyze the method of calculating the stress-deformed state of the part in cad-systems Autodesk Inventor, SolidWorks.
54. Describe the net present value of the project and net cash flow.
55. Analyze the main provisions of the theory of machine productivity and labor. Describe technological and cyclical productivity.
56. Analyze the methodology for calculating the economic efficiency of the project on the basis of the net present cost of the project.
57. Describe the technological process as the basis for the design of technological equipment of current production.
58. Analyze the options for the regulations of the current line. Describe the stocks of the current line: technological, transport, insurance or reserve, reversible, interoperative reversible.
59. Analyze the stages of building a solid state model of the PL part and drawing in cad-systems Autodesk Inventor, SolidWorks.
60. Describe the methodology for calculating and analyzing the productivity of working machines in operating conditions.

Practical tasks

1. Develop a solid model according to the given part (Appendix 11) and make its drawing.
2. Develop a solid-state model according to the issued part (Appendix 30) and perform strength calculations (material Art. 45 (USA analogue – AISI 1045)). Test - excess pressure - 0.5 MPa. Plot displacement, stress and safety factor fields/plots. Analyze the obtained results and formulate conclusions.
3. Develop a solid-state model according to the issued part (Appendix 29) and perform strength calculations (material Art. 20 (USA analogue – AISI 1020)). Test - excess pressure - 0.6 MPa. Plot displacement, stress and safety factor fields/plots. Analyze the obtained results and formulate conclusions.
4. Develop a solid-state model according to the issued part (Appendix 28) and perform strength calculations (the material is an aluminum alloy (USA analogue – 1060-H12)). Test - excess pressure - 0.6 MPa. Plot displacement, stress and safety factor fields/plots. Analyze the obtained results and formulate conclusions.
5. Develop a solid-state model based on the issued part (Appendix 27) and perform strength calculations (part material - Art. 45 (USA analogue - AISI 1045)). Compression test - force 750 N. Plot displacement, stress and safety factor fields/plots. Analyze the obtained results and formulate conclusions.
6. Develop a solid model according to the given part (Appendix 1) and make its drawing.
7. Develop/select a solid model of the part (Appendix 15) and perform strength calculations. Material – cold-rolled steel (US – AISI 1045). Power load – bending force 125 N. Construct fields/plots of displacement, stress and safety factor. Analyze the obtained results and formulate conclusions.
8. Develop/select a solid model of the part (Appendix 16) and perform strength calculations. Material - cast alloy steel. The temperature load is 140 °C, fixing must be set on an arbitrary plane. Build displacement and stress graphs, determine the margin of safety. Analyze the obtained results and formulate conclusions.
9. Develop/select a solid model of the part (Appendix 17) and perform strength calculations. The material is brass. Force load – a force of 15 N, given at an arbitrary point/plane, fixing to be set on

a horizontal plane, which does not include the point/plane with the given force. Build displacement and stress graphs, determine the margin of safety. Analyze the obtained results and formulate conclusions.

- 10. Develop/select a solid model of the part (Appendix 18) and perform strength calculations. The material is aluminum bronze. Power load – a spreading force of 35 N on the internal planes. Build displacement and stress graphs, determine the margin of safety. Analyze the obtained results and formulate conclusions.*
- 11. Develop a solid-state model according to the issued part (Appendix 14) and perform strength calculations (material Art. 15 (USA analogue – AISI 1015)). Test - excess pressure - 0.25 MPa. Plot displacement, stress and safety factor fields/plots. Analyze the obtained results and formulate conclusions.*
- 12. Develop a solid model based on the issued part (Appendix 13) and perform strength calculations (material beryllium bronze (US equivalent - UNS C17000)). Test - excess pressure - 0.35 MPa. Plot displacement, stress and safety factor fields/plots. Analyze the obtained results and formulate conclusions.*
- 13. Develop a solid-state model based on the issued part (Appendix 12) and perform strength calculations (part material - Art. 45 (USA analogue - AISI 1045)). Load – moment 55 N×m. Plot displacement, stress and safety factor fields/plots. Analyze the obtained results and formulate conclusions.*
- 14. Develop a solid model according to the issued part (Appendix 10) and make its drawing.*
- 15. Develop a solid model according to the issued part (Appendix 9) and make its drawing.*

List of issues and tasks submitted for modular control work

- 1. Describe the signs of the current line.*
- 2. Describe the productivity of working machines. Analyze the main provisions of the theory of machine productivity and labor.*
- 3. Analyze the types of extracycle losses.*
- 4. Analyze and compare technological and cyclic performance, give formulas to determine them.*
- 5. Describe rotary and conveyor-rotary machines. Analyze the basic concepts and definitions.*
- 6. Describe the methodology for calculating and analyzing the productivity of working machines in operating conditions.*
- 7. Describe the technological process. Compare the hardware process with the machine technological process.*
- 8. Analyze the calculation of the main characteristics of robotic capability and building a balance of productivity.*
- 9. Describe the purpose of the working and auxiliary organs of the machine, give examples.*
- 10. Analyze examples of calculating the main characteristics of the robot ability of machines of current lines.*
- 11. Describe four classes of machines by the nature of the action of the processing tool on the TP processing object.*
- 12. Analyze the stages of calculating the performance of machines.*
- 13. Describe the loop and synchronous diagrams of work machines. Analyze the concept of a machine cycle chart.*
- 14. Describe semi-automatic and automatic lines, compare their work.*
- 15. Describe the concept of a synchronous diagram of the machine.*
- 16. Analyze the classification of machines by the nature of the movement of the processing object.*
- 17. Analyze the stages of development of the machine's cyclic chart. Formulate the stages of constructing cyclograms.*
- 18. Analyze the advantages of the current form of production organization.*
- 19. Describe the principles of building multi-position machines and automatic lines.*
- 20. Analyze the commonality of automatic machines and automatic lines for various technological purposes.*

21. Describe the features of technological processes of automated production.
22. Describe vehicles on current lines. Analyze the features of their use.
23. Describe the principle of differentiation of TP and concentration of operations, analyze their growth in the design of the PL.
24. Describe the technological rotors for hardware processing. Analyze the principle of operation of the rotor for dosed liquid spilling.
25. Describe universal and special machines and semiautomatic machines. Give examples of automata and lines of sequential-parallel action.
26. Analyze the classification of PL machines by the nature of the action of the processing tool on the TP processing object. Give examples.
27. Describe the degree of automation of the machine, semi-automatic, automatic, automatic line, current line.
28. Describe the working and auxiliary organs of machines. Analyze the components of the machine workflow. Give examples.
29. Analyze the structure of the automatic line, current line, workshop.
30. Analyze the synchronous diagram of the machine. Give examples.
31. Describe the purpose, classification, functions and characteristics of rotary mechanisms.
32. Analyze the classification of machines by the nature of the movement of the processing object. Give examples of the corresponding current lines.
33. Describe the general stages of the process of designing machines of current lines.
34. Analyze examples of calculating the main characteristics of the performance of CL machines. Describe the stages of calculating the performance of machines.
35. Analyze the main signs of current production and the signs of the current line, compare them.
36. Describe the choice of the optimal degree of differentiation and concentration of TP. Analyze the calculation of the number of positions of multi-position machines of sequential action of current production.
37. Describe the commonality of automatic machines and automatic lines for various technological purposes.
38. Describe the main indicators of rotary machines. Describe the conveyor machines of continuous action.
39. Describe hardware and machine TP, machine technology.
40. Describe the actual performance and utilization rate of the machine. Analyze the formulas for calculating them.

The working program of the educational component (syllabus):

Compiled by Professor, Doctor of Technical Sciences, Professor, Anton KARVATSKYI

Approved By the Department of Chemical, Polymer and Silicate Mechanical Engineering (Minutes No. 17 dated 04.06.2025)

Agreed By the Methodological Commission of the Faculty (Minutes No. 11 dated 06.27.2025)