

RESEARCH AND ENGINEERING OF PACKAGING EQUIPMENT. COURSE PROJECT

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>G9 «Applied Mechanics»</i>
Educational program	<i>Educational and Professional Program Engineering of packaging products, processes and equipment</i>
Status of the educational component	<i>Mandatory</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>2(60)</i>
Semester control/control measures	<i>Test</i>
Class schedule	
Language of instruction	<i>Ukrainian</i>
Information about the course leader/teachers	Course project: https://cpsm.kpi.ua/karvatskij-anton-yanovich.html
Course placement	Link to a remote resource Google classroom, https://cpsm.kpi.ua/navchannya/sylabusy/sylabusy-2025-roku.html

Educational component program

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

The term "Engineering" comes from the English word "engineering", which means "to build, design, arrange, undertake, invent, invent". Engineering is defined as a set of intellectual activities that have as their ultimate goal the best (optimal) results from capital investments or other expenses associated with the implementation of projects for various purposes through the most rational selection and effective use of material, labor, technological and financial resources in their unity and interconnection, as well as methods of organization and management, based on advanced scientific and technical achievements and taking into account specific conditions and projects.

The modern level of development of science and technology requires the training of future specialists with in-depth knowledge in the field of engineering, which in the broad sense of this term includes: drawing up technical tasks; conducting research; drawing up project proposals and feasibility studies for the construction of industrial and other facilities; conducting engineering and search works; developing technical projects and working drawings for the construction of new and reconstruction of existing industrial and other facilities; developing proposals in internal factory and internal shop planning, inter-operational connections and transitions; designing and engineering development of machines, equipment, installations, devices, products; developing compositions of materials, alloys, other substances and conducting their tests; developing technological processes, techniques and methods; consulting and

author's supervision during installation supervision, commissioning and operation of equipment and facilities in general; consulting of an economic, financial or other order.

Educational component "Research and engineering of packaging equipment. Course project" provides students with the development of the basics of applying science-intensive computer engineering methods in the practice of designing packaging equipment.

Science-intensive computer engineering is aimed at determining the performance and competitiveness of a development object at the design stage using modern CAD systems and computer software products for numerical analysis of its physical fields.

Studying the educational component enables students to conduct theoretical research into packaging processes and packaging equipment using modern CAD-CAE design systems.

The purpose of the educational component "Research and Engineering of Packaging Equipment. Course Project"

The purpose of the educational component is to form and develop the following competencies (abilities) of students: general, professional and program learning outcomes.

Subject of the educational component "Research and Engineering of Packaging Equipment. Course Project" – methods and tools of science-intensive computer engineering in terms of calculations and design during the development and design of packaging equipment.

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

Integral competence:

- The ability to solve complex tasks and problems in applied mechanics or in the learning process, which involves conducting research and/or implementing innovations and is characterized by uncertainty of conditions and requirements.

General competencies:

- Ability to identify, pose and solve engineering, technical and scientific and applied problems (ZK 01);
- Ability to use information and communication technologies (ZK 02);
- Ability to generate new ideas (creativity) (ZK 03);
- Ability to develop and manage projects (ZK 04);
- Ability to communicate with representatives of other professional groups of different levels (with experts from other fields of knowledge/types of economic activity) (ZK 05);
- Ability to learn and master modern knowledge (ZK 06);
- Ability to abstract thinking, analysis and synthesis (ZK 08);
- Based on knowledge of sustainable development problems, solve engineering tasks of technological equipment (ZK 11).

Professional competencies:

- The ability to apply appropriate methods and resources of modern engineering to find optimal solutions to a wide range of engineering problems using modern approaches, forecasting methods, information technologies and taking into account existing limitations under conditions of incomplete information and conflicting requirements (FC 01);
- The ability to describe, classify and model a wide range of technical objects and processes, based on deep knowledge and understanding of the theories and practices of mechanical engineering, as well as knowledge of related sciences (FC 02);
- The ability to work independently and effectively as a team leader (FC 03);
- The ability to clearly and unambiguously convey one's own conclusions, knowledge and explanations to specialists and non-specialists, including in the process of teaching (FC 04);
- The ability to engineer packaging equipment to ensure its operability under the influence of operational loads and environmental influences (FC 05);

- Ability to search and analyze scientific and technical information on engineering of technological equipment (FC 06);
- Ability to master new types of equipment and technology in the field of packaging and related industries (FC 09);
- Ability to carry out design activities in the field of packaging equipment (FC 10).

According to the requirements of the educational component program "Research and Engineering of Packaging Equipment. Course Project", after mastering it, students must demonstrate the following program **learning outcomes**:

- Apply specialized conceptual knowledge of the latest methods and techniques of design, analysis and research of structures, machines and/or processes in the field of mechanical engineering and related fields of knowledge (PRN 01);
- Develop and put into production new types of products, in particular, perform research and development work and/or develop technological support for the process of their manufacture (PRN 02);
- Apply automation systems to perform research, design work, technological preparation and engineering analysis in mechanical engineering (PRN 03);
- Use modern methods of optimizing the parameters of technical systems by means of system analysis, mathematical and computer modeling, in particular under conditions of incomplete and contradictory information (PRN 04);
- Independently set and solve problems of an innovative nature, argue and defend the results obtained and decisions made (PRN 05);
- Develop, implement and evaluate innovative projects taking into account engineering, legal, environmental and social aspects (PRN 06);
- Clearly and unambiguously present the results of research and projects, convey one's own conclusions, arguments and explanations in the state and foreign languages orally and in writing to colleagues, education seekers and representatives of other professional groups of various levels (PRN 07);
- Master modern knowledge, technologies, tools and methods, in particular through independent study of professional literature, participation in scientific and technical and educational events (PRN 08);
- Search for the necessary information in scientific and technical literature, electronic databases and other sources, assimilate, evaluate and analyze this information (PRN 10);
- Be able to choose, determine processes and equipment for packaging products in consumer packaging, for group packaging, fastening, transportation, dismantling (PRN 15);
- Knowledge of packaging methods for various types of products and packaging equipment (PRN 21);
- Knowledge of the principles and methods of designing basic packaging and auxiliary equipment (PRN 23);
- Develop management and/or technological solutions under uncertain conditions and requirements, evaluate and compare alternatives, analyze risks, predict possible consequences (PRN 25);
- Organize safe operation of packaging equipment based on technological regulations and using safety rules (PRN 27).

Also, the educational component "Research and Engineering of Packaging Equipment. Course Project" will allow students to learn to solve complex tasks and problems of applied mechanics, which involves conducting research on processes, equipment and/or implementing innovations in this field and is characterized by uncertainty of conditions and requirements.

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 "Research and Engineering of Packaging Equipment. Course Project" is based on the study of the following credit modules: "Higher Mathematics", "Physics", "Chemistry", "Engineering and Computer Graphics", "Theoretical Mechanics", "Informatics", "Materials Science", "Technology of Structural Materials", "Mechanics of Materials and Structures", "Theory of Mechanisms and Machines", "Theoretical Fundamentals of Heat Engineering", "Machine Parts and Fundamentals of Design", "Fluid and Gas Mechanics", "Engineering Calculations on a PC", "Technologies and Equipment for the Production of Packaging Materials", "Packaging Technologies and Equipment", "Automated Engineering Systems", "Processes, Apparatus and Machines of the Industry", "Packaging Equipment".

Postrequisites: "Research and Engineering of Packaging Equipment. Course Project" provides the following educational components: "Packaging Equipment", "CAD of Technological Equipment", "Product Packaging and Storage Technologies", "Scientific Work on the Topic of the Master's Thesis" and "Design of Production Lines", execution of master's theses.

3. Content of the educational component

Schedule of course project implementation

Semester Week	Name of the stage of work	School time
		IWS
2	Get a theme and a task.	1
3-5	Selection and study of literature.	8
6-7	Execution of sections 1,2,3.	6
8-11	Execution of sections 4.5.	16
11	Implementation of section 6.	5
12-13	Sections 7.8.	7
14	Registration of an explanatory note.	7
15	Design of the graphic part.	8
16	Submission of a course project for verification.	1
17	Protection of the course project.	1
Total		60

4. Educational materials and resources

Basic literature

1. Research and engineering of packaging equipment. [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; 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 : <https://ela.kpi.ua/handle/123456789/74820>
2. Gavva O. M., Bepalko A. P., Volochko A. I. Packaging equipment in 3 volumes – 1 volume. Equipment for packaging products in consumer packaging: a manual: edited by O. M. Gavva. Kyiv: IAC "Packaging", 2008. 436 p.
3. Dassault Systems SolidWorks Corporation, a Dassault Systems S.A. company, 300 Baker Avenue, Concord, Massachusetts 01742 USA, 1995–2009, 534 p.
4. Research and engineering of packaging equipment. [Electronic resource] : course project : teaching. manual. for master's degree applicants in the educational program "Engineering of packaging and packaging equipment" spec. 131 "Applied mechanics" / A. Ya. Karvatsky, V. M. Vytvytsky; Igor Sikorsky Kyiv Polytechnic Institute. – 2nd ed. revised. – Electronic. text. data (1 file: 1.44 MB). – Kyiv : Igor Sikorsky Kyiv Polytechnic Institute, 2024. 48 p. URL : <http://ela.kpi.ua/handle/123456789/23914>

5. Methodological instructions for the implementation of computer workshops for practical classes of students in the discipline "Design of production lines", for students specializing in "Machinery and packaging technology" / A.Ya. Karvatsky, T.V. Lazarev. Kyiv: NTUU "KPI", 2013. 35 p. URL : https://cpsm.kpi.ua/Doc/Metod_Pract_PPL.pdf

Additional literature

1. SOLIDWORKS: Drawings Online Class. URL : <https://www.linkedin.com/learning/solidworks-drawings>
2. Hanlon J.F., Kelsey R. J. Handbook of Package Engineering: 3rd Edition. London : CRC Press, 1998. 698 p. URL : <https://www.amazon.com/Handbook-Package-Engineering-Joseph-Hanlon/dp/1566763061>
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. Zienkiewicz, O., Taylor, R., Fox, D.: The Finite Element Method for Solid and Structural Mechanics. 7th edn. Elsevier Ltd., Oxford (2014).
9. Website: PTC Mathcad – a software environment for performing various mathematical and technical calculations on a computer. URL : <http://www.ptc.com/product/mathcad/>
10. Finite element method in problems of mechanics of continuums. Laboratory practical course on the academic discipline [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 polymer and building materials and products" / A. Ya. Karvatsky. Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2018. 391 p. URL : <https://ela.kpi.ua/handle/123456789/11636>
11. Mechanics of continuums. [Electronic resource]: lecture notes: teaching aids for master's degree applicants in educational programs "Packaging and packaging equipment engineering" speciality 131 "Applied mechanics" and "Engineering and computer-integrated technologies for designing innovative industry equipment" speciality 133 "Industrial mechanical engineering" / A. Ya. Karvatsky, A. O. Chemerys; Igor Sikorsky Kyiv Polytechnic Institute. – 2nd ed. revised and supplemented – Electronic text data (1 file: 3.56 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2024. 214 p. URL : <https://ela.kpi.ua/handle/123456789/72094>

Information resources on the Internet

1. DSpace STL Igor Sikorsky Kyiv Polytechnic Institute, <http://ela.kpi.ua/handle/123456789/23915>, <http://ela.kpi.ua/handle/123456789/23914>, <https://ela.kpi.ua/handle/123456789/11636>, <https://ela.kpi.ua/handle/123456789/19011>
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/>

5. Methodology for mastering the educational component

Lecture classes

The working curriculum does not include lectures.

Practical classes

According to the working curriculum, practical classes are not provided.

Seminar classes

The working curriculum does not include seminar classes.

Laboratory classes

The working curriculum does not include laboratory classes.

Methodical recommendations

The methodology of the course project is based on CAD-CAE technologies, that is, the methods and tools of science-intensive computer engineering consists of the following main stages:

- 1) creating a sketch of the design object in the CAD-system (for this, a prototype can be used). Here, the object of design is understood as a detail or node. Further, on the basis of the sketch, a solid-state model is created according to the schemes: for the part there is a sketch-solid-state three-dimensional model; for the node – a general sketch – sketches of all parts of the node – corresponding solid-state models – assembly of parts into a node. When creating a solid-state model of the unit, you can use standard parts, for example, bolts, screws, nuts, washers, etc. That is, for standard parts, separate sketches and solid-state models are not created;*
- 2) analysis, on the basis of the created solid-state model of the design object, the action of physical fields in the middle of the design object during its operation and their interaction with each other and external physical fields of different physical nature – gravitational, thermal, electromagnetic, radiation, etc. This point is decisive for the choice of a mathematical model for a numerical analysis of the physical condition of the object of study in order to establish its operational suitability;*
- 3) the choice of a mathematical model describing the physical fields in the design object and their interaction with each other and the outer fields of different physical nature during its operation (see paragraph 2), which includes a system of differential equations in the partial derivatives of the mechanics of a solid deformed body, or hydrodynamics, or together the mechanics of the continuum (mechanics of solid media) and the corresponding initial and boundary conditions;*
- 4) development on the basis of a solid state model and mathematical formulation of the problem of studying the physical state of the design object in any environment of the CAE-system of the numerical model, which includes: export of the developed solid state (geometric) model from CAD to the CAE-system; selection of the solver according to the chosen mathematical model (see paragraph 3); performing sampling of the geometric model; setting initial and limiting conditions on a discretized model according to the selected mathematical model; execution of calculations and review of their results in the form of physical fields and epuras;*
- 5) a detailed analysis of the results of numerical modeling for their compliance with the requirements of operating conditions, for example, for the tasks of the mechanics of the NDS, the criterion of operational suitability of the structure may be its safety margin, which is defined as the ratio of the material fluidity limit to the equivalent stresses according to Mises. In case of failure to comply with these requirements, we go to p 1. and change the input geometrical parameters of the model, or in clause 4 and replace the structural material, etc.;*
- 6) creation of drawings on the basis of the final version of the solid-state model of the design object.*

7) Course project on the discipline "Research and engineering of packaging equipment. Course project" is provided with methodological instructions in electronic form [1, 2, 4-6],

6. Student independent work

No s/p	Name of the topic submitted for self-study	Number of hours of IWS
1	Getting the topic of the course project and the task.	1
2	Selection and study of literary sources on the topic of the course project. Preparation of Title Letters, Introduction.	8
3	Execution of sections: 1) Purpose of the packaging machine, 2) Technical characteristics of the packaging machine, 3) Description of the design of the packaging machine, its main components and the principle of operation.	6
4	Implementation of sections 4) Description of the main stages of designing the assemblies of the packaging machine in the environment of the CAD-system, 5) analysis of the action of external loads on the unit of the packaging machine, causing its physical condition during operation.	16
5	Implementation of section 6) Selection and justification of mathematical formulation of the problem of physical condition of the unit of the packing machine (automatic).	5
6	Execution of sections 7) Description of the stages of constructing a numerical model of the physical condition of the packing machine node in the CAE-system environment, 8) the results of a numerical analysis confirming the operational suitability of the packaging machine node.	7
7	Registration of an explanatory note of the course project.	7
8	Design of the graphic part, including the following drawings and poster: assembly drawing of the machine node, detalization of the machine node, mathematical model and calculation results.	8
9	Submission of a course project for verification.	1
10	Protection of the course project.	1
Total		60

Individual tasks

The working curriculum does not provide for individual assignments.

Control works

The purpose of the modular test:

- summary of the study of the topics of the credit module;
- application of the acquired knowledge to perform engineering calculations;
- ability to independently apply the acquired knowledge to perform tasks in this credit module and in other educational components: "Packaging equipment", "Design of production lines", "CAD of technological equipment", "Course work on packaging equipment engineering", "Scientific work on the topic of the master's thesis".

The working 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 in the additional information of the syllabus of the educational component. 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.

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>.

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

Current control: schedule of the course project.

Calendar control: conducted twice a semester as monitoring of the current state of compliance with the requirements of the syllabus.

Semester control: protection of the course project.

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

The rating assessment from the course project has two components. The first (starter) characterizes the student's work on the course project and its result – the quality of the explanatory note and graphic material. The second component characterizes the quality of the student's defense of the course project.

The size of the scale of the first component is 40 points, and the second component is 60 points.

System of rating (weight) points and evaluation criteria

1. Starting component (r_1):

- timeliness of the course project schedule – 5-3 points;
- modernity and justification of decisions – 12-7 points;
- correctness of application of methods of analysis and calculation – 10-6 points;
- quality of registration, fulfillment of requirements of normative documents – 6-4 points;
- quality of graphic material and compliance with the requirements of DSTU – 7-4 points.

2. Component of course project protection (r_2):

- degree of ownership of the material – 10-6 points;
- completeness of analysis of possible options – 15-9 points;
- the degree of justification of the decisions made is 20-12 points;
- ability to defend your opinion – 15-9 points.

The rating of the credit module is:

$$R = r_1 + r_2 = 40 + 60 = 100 \text{ points.}$$

Terms of admission to semester control: semester rating of more than 40 points.

The sum of the points of the two components is transferred to the scoring assessment according to the table:

Table of conformity of rating points 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 topics of course projects

- 1) Viscous product bottling machine with the development of a pneumatic cylinder unit with guides and a base plate.
- 2) Viscous bottling machine with the development of a dose adjustment unit with a base plate.
- 3) Automatic bottling of viscous products with the development of a locking valve unit with a drive.
- 4) Automatic bottling of viscous products with the development of a piston node with a cylinder.
- 5) Automatic bottling of viscous products with the development of a nozzle node.
- 6) Automatic bottling of viscous products with the development of a node of movable pneumatic cylinder on guides.
- 7) Automatic bottling of viscous products with the development of a stopper node with fastening.
- 8) Automatic bottling of viscous products with the development of a unit for collecting drops on the stove.
- 9) Automatic bottling of viscous products with the development of a node of a movable bar with attachment of nozzles.
- 10) Viscous bottling machine with the development of a gear pump unit in the body.
- 11) Vex bottling machine with the development of a filling unit.

- 12) *Dosing and packing machine of bulk products with the development of a transverse welding unit (front).*
- 13) *Dosing and packing machine of bulk products with the development of a cross-welding unit (rear part with guides and base cooker).*
- 14) *Dosing and packing machine of bulk products with the development of a film broaching unit.*
- 15) *Dosing and packing machine of bulk products with the development of a funnel node with a pipe on brackets.*
- 16) *Dosing and packing machine of bulk products with the development of a node of longitudinal welding on supports.*
- 17) *Dosing and packing machine of bulk products with the development of a unit of a clamping device with a pneumatic cylinder.*
- 18) *Dosing and packing machine of bulk products with the development of a tray node on elastic supports.*
- 19) *Dosing and packing machine of bulk products in bags "Big-Bag" with the development of a dosage unit.*
- 20) *Dosing and packing machine of bulk products in bags "Big-Bag" with the development of a bearing frame unit.*

Work program of the discipline (syllabus):

Compiled by Professor, Doctor of Technical Sciences, Professor, Anton KARVATSKYI, PhD, assistant, Viktor VYTVYTSKYI

Approved by the Department of Chemical, Polymeric and Silicate Engineering (Protocol No. 17 of 04.06.2025)

Agreed by the Faculty Methodical Commission (Protocol No. 11 of 27.06.2025)