



Applied Modeling

Work program of the educational component (Syllabus)

Details of the educational component

Higher education level	Second (Master's)
Field of Knowledge	13 Mechanical Engineering
Speciality	131 Applied Mechanics
Educational program	ONP Applied Mechanics
Status of the educational component	Selective
Form of study	full-time (full-time)
Year of preparation, semester	2nd year, autumn semester
Scope of the educational component	5(150)
Semester control / control measures	Exam
Class schedule	4 hours per week (2 hours of lectures, 2 hours of practical classes)
Language of instruction	Ukrainian
Information about the course leader / teachers	Lecturer: Prof., Doctor of Technical Sciences, Sokolsky Oleksandr Leonidovich, https://cpsm.kpi.ua/sokolskij-oleksandr-leonidovich.html?tmpl=component Practical/Seminar: Prof., Doctor of Technical Sciences, Sokolsky Oleksandr Leonidovich, https://cpsm.kpi.ua/sokolskij-oleksandr-leonidovich.html?tmpl=component
Course placement	Sikorsky Platform

Program of the educational component

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

The syllabus "Applied Modeling" is compiled in accordance with the educational and scientific program for the training of masters of the specialty 131 - Applied Mechanics according to the educational program "Applied Mechanics".

The educational component belongs to the cycle of selective educational components.

The subject of the educational component is the mathematical apparatus, methods and means of science-intensive computer modeling in terms of calculations and design during the development, modernization, design of industry equipment. The educational component is focused on the individual scientific interests of the student.

The purpose of the educational component "Applied Modeling"

The purpose of the educational component is to strengthen the process of forming a complex of knowledge by students on the features and methods of modeling technological processes. Modern technical calculations are provided, first of all, by numerical approaches to solving mathematical models. Therefore, these methods are the basis for engineering applied modeling.

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

Integral competence:

- Ability to solve complex problems and problems of applied mechanics or in the process of learning, which involves research and/or innovation and is characterized by uncertainty of conditions and requirements.

And:

- Ability to use information and communication technologies (GC 02);*
- Ability to generate new ideas (creativity) (GC 03);*
- Ability to critically analyze and predict performance parameters of new and existing mechanical structures, machines, materials and production processes of mechanical engineering based on knowledge and use of modern analytical and/or computerized methods and techniques (FC 09)*

According to the requirements of the program of the educational component "Applied Modeling", students after mastering it must demonstrate the following program learning outcomes:

- To use modern methods of optimization of parameters of technical systems by means of system analysis, mathematical and computer modeling, in particular under conditions of incomplete and contradictory information (PRN 04)

The use of additional provisions will also contribute to the formation of students' competencies, namely:

- Knowledge of the principles and methods of design of basic packaging and auxiliary equipment;*
- Knowledge of methods and techniques for performing design and verification calculations of packaging equipment and processes.*
- Design current lines using computer engineering methods (SolidWorks, ANSYS, etc.).*

2. Pre-requisites and post-requisites of the educational component (place in the structural and logical scheme of education according to the relevant educational program)

The educational component is an applied development of theoretical courses taught to students: "Materials Science", "Resistance of Materials", "Technology of Mechanical Engineering", "Packaging Equipment", "Fundamentals of Operation and Repair of Technological Equipment".

The knowledge, skills and abilities acquired during the study of the educational component provide the study of the educational component "Packaging Equipment Engineering" and the diploma design of the future master's degree.

3. Content of the educational component

Basic concepts and terms. The main theoretical provisions and methods on the basis of which modeling and numerical analysis are carried out in the Ansys Polyflow application. Familiarization with the interface, windows, structure and principle of operation of the Ansys Workbench package and the Polyflow application. Means of building geometric models. Means of building and optimizing the grid area. The choice of the material of the object and the task of its properties. Boundary conditions in Ansys Polyflow. Simulation of non-stationary flow. Initial conditions. Simulation of non-isothermal flow. Launch and control of the solution of the problem. Analysis of the calculation results. Consideration of viscoelastic effects during extrusion. Consideration of wall effects during extrusion. Modeling of thermoforming processes. Simulation of the process of blow molding of hollow products. Solving related problems. Verification and assessment of the reliability of the solutions obtained.

4. Training materials and resources

Basic literature

- 1. Karvatskyi A.Y. Mechanics of continuous environments – Kyiv: "Polytechnic", 2017. – 292 p. (in Russian).*
- 2. Modeling of equipment and processes of processing polymeric materials by the method of extrusion [Electronic resource] : monograph / O. L. Sokolsky, I. O. Mikulonok. – Kyiv: KPI. Igor Sikorsky, 2020. – 253 c.*
- 3. Konstantinov Yu.M., Gizha O.O. Technical mechanics of liquid and gas: Textbook. — Kyiv: Vyshcha shkola, 2002. — 277 p. (in Russian).*

4. *Processes and apparatus of chemical production. Technical hydraulics. Basics of heat transfer. Heat Exchange Equipment [Electronic resource] : textbook on the academic discipline for the performance of calculation work for students of the specialty 161 Chemical Technologies and Engineering, in the specializations "Chemical Technologies of Inorganic and Organic Binders", "Chemical Technologies of Processing of Polymeric and Composite Materials", "Chemical Technologies of Inorganic Ceramic Materials" / KPI. Igor Sikorsky; comp. T. B. Shilovich. – Kyiv: KPI. Igor Sikorsky, 2019. – 14 p. (in Russian).*
5. *The method of finite elements in problems of mechanics of continuous media. Laboratory Practicum on Academic Discipline [Electronic resource] : textbook for students of specialties 131 "Applied Mechanics", 133 "Industrial 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. Y. Karvatskyi; KPI. Igor Sikorsky. – Kyiv: KPI. Igor Sikorsky, 2018. – 392 p. (in Russian).*

Further reading

1. *ANSYS Polyflow User's Guide (2013), Canonsburg, ANSYS, Inc. South pointe, 762 p.*
2. *ANSYS Polyflow Tutorial Guide (2013), Canonsburg, ANSYS, Inc. South pointe, 408 p.*

Information resources on the Internet

1. *Electronic archive of KPI*
2. *Website of the Department of Chemical Engineering, <http://cpsm.kpi.ua/mr.html>*
3. *Campus of KPI. Igor Sikorsky, <http://login.kpi.ua/>*
4. *Internet resources: <https://www.ansys.com/academic>*

Educational content

5. Methods of mastering the educational component

Lectures

Lectures are aimed at:

- *providing modern, holistic, interdependent knowledge on the educational component "Applied Modeling", the level of which is determined by the target setting for each specific topic;*
- *ensuring the creative work of applicants together with the teacher during the lecture;*
- *education of professional and business qualities in applicants and the development of independent creative thinking in them;*
- *formation of the necessary interest in applicants and providing direction for independent work;*
- *determination at the current level of development of science in the field of modern methods and means of modeling, forecasting development for the coming years;*
- *reflection of methodological processing of the material (highlighting the main provisions, conclusions, recommendations, clear and adequate to their formulation);*
- *use of visual materials for demonstration, combining, if possible, them with the demonstration of results and samples;*
- *presentation of research materials in a clear and high-quality language in compliance with structural and logical connections, clarification of all newly introduced terms and concepts.*

No. s/p	Title of the topic of the lecture and a list of main questions (list of didactic tools, references to literature and tasks on the SRS)	Hours
1	Introduction. Purpose and objectives of the course. Basic concepts and terms. References: [bases 1, 2, 5, additions 1, 2]. Tasks on the SRS: Basic concepts and terminology. References: [bases 1, 2, 5, additions 1, 2].	2
2	The main theoretical provisions and methods on the basis of which modeling and numerical analysis are carried out in the Ansys Polyflow application. References: [bases 1, 5, additions 1, 2]. Tasks on the SRS: Basic relations of the mechanics of continuous media for describing the state of plastic and viscoelastic materials. References: [bases 1, 5, additions 1, 2].	2
3	Familiarization with the interface, windows, structure and principle of operation of the Ansys Workbench package and the Polyflow application. References: [bases 1, 5, additions 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [bases 1, 5, additions 1, 2].	2
4	Means of building geometric models. 2D and 3D projects. Tools for creating, editing a sketch and building three-dimensional solids (solids). Designation of geometric elements. References: [base 2, add. 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [base 2, add. 1, 2].	2
5	Means of building and optimizing the grid area. Generation of a finite element model. Types of cells. Specifying the types, sizes and number of cells on defined geometric elements. References: [base 2, add. 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [base 2, add. 1, 2].	2
6	The choice of the material of the object and the task of its properties. Setting properties from the keyboard, importing from the ANSYS material library. Types of material models. References: [base 2, add. 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [base 2, add. 1, 2].	2
7	Boundary conditions in Ansys Polyflow. Boundary conditions of the I, II and III kind. Mechanical and thermal boundary conditions. References: [bases 1–5, additions 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [bases 1–5, additions 1, 2].	2
8	Simulation of non-stationary flow. Initial conditions. Setting up the solver. References: [bases 1, 5, additions 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [bases 1, 5, additions 1, 2].	2

9	Simulation of non-isothermal flow. Consideration of dissipation and internal heat sources. Setting up the solver. References: [bases 1, 2, 5, additions 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [bases 1, 2, 5, additions 1, 2].	2
10	Launch and control of the solution of the problem. Setting up a solver. Types of solvers. Processing messages. Issues of accuracy and convergence of a numerical solution. References: [add. 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [add. 1, 2].	2
11	Analysis of the calculation results. Graphical and numerical representation of physical quantities in the form of pictures, tables, graphs, animations. References: [add. 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [add. 1, 2].	2
12	Consideration of viscoelastic effects during extrusion. References: [base 2, add. 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [base 2, add. 1, 2].	2
13	Consideration of wall effects during extrusion. References: [base 2, add. 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [base 2, add. 1, 2].	2
14	Modeling of thermoforming processes. References: [base 2, add. 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [base 2, add. 1, 2].	2
15	Simulation of the process of blow molding of hollow products. References: [base 2, add. 1, 2]. Task on the SRS: independent study of the material in the Ansys Polyflow environment. References: [base 2, add. 1, 2].	2
16	Solving related problems. Transfer data between Ansys applications and other applications. References: [add. 1, 2]. Tasks on the SRS: independent study of the material in the Ansys environment. References: [add. 1, 2].	2
17	Verification and assessment of the reliability of the solutions obtained. References: [bases 1, 5, additions 1, 2]. Tasks on the SRS: independent study of the material in the Ansys environment. References: [bases 1, 5, additions 1, 2].	2
18	MCR	2
	Just	36

Practical classes

In the system of training applicants for the educational component, practical classes occupy 50% of the classroom load. As a supplement to the lecture course, they lay and form the foundations of the master's qualification in modeling. The content of these classes and the methodology of their conduct should ensure the development of creative activity of the individual. They develop scientific thinking and the ability to use special terminology, allow you to test knowledge, therefore, this type of work acts as an important means of prompt feedback. Practical classes should perform not only cognitive and educational functions, but also contribute to the growth of applicants as creative workers in the field of machines and packaging technology.

The main tasks of the cycle of practical classes:

- to help applicants systematize, consolidate and deepen theoretical knowledge in the field of modern methods and means of modeling;
- to teach applicants techniques for solving practical problems, to promote the acquisition of skills and abilities in performing calculations, graphic and other tasks;
- to teach them to work with technical and reference literature.

No. s/p	Title of the topic of the practical lesson and a list of main questions (list of didactic support, references to literature and tasks on the SRS)	Hours
1	Building a geometric model of an object in the Ansys Polyflow environment References: [add. 1, 2]. Tasks on the SRS: performing geometry according to an individual task.	4
2	Building and optimizing a mesh area in an Ansys Polyflow environment References: [add. 1, 2]. Tasks on SRS: performance according to an individual task.	4
3	Simulation of the one-dimensional flow of a Newtonian fluid. References: [base 1, add. 1, 2]. Tasks on the SRS: performing calculations according to an individual task.	4
4	Simulation of the one-dimensional flow of a non-Newtonian fluid. References: [base 1, add. 1, 2]. Tasks on the SRS: performing calculations according to an individual task.	4
5	Simulation of a one-dimensional non-isothermal flow of a non-Newtonian fluid. References: [base 1, add. 1, 2]. Tasks on the SRS: performing calculations according to an individual task.	4
6	Simulation of non-stationary flow. References: [base 1, add. 1, 2]. Tasks on the SRS: performing calculations according to an individual task.	4
7	Simulation of the three-dimensional flow of a non-Newtonian fluid. References: [base 1, add. 1, 2]. Tasks on the SRS: performing calculations according to an individual task.	4
8	Simulation of the process of blow molding of hollow products. References: [base 1, add. 1, 2]. Tasks on the SRS: performing calculations according to an individual task.	4
9	Colloquium on the adoption and defense of practical tasks	2
	Just	36

Laboratory classes

In the system of professional training of applicants for this educational component, laboratory classes are not provided for by the curriculum.

6. Independent work of a student

Independent work takes 52% of the time spent studying the educational component, including preparation for the exam. The main task of independent work of applicants is to master scientific knowledge in areas that are not included in the list of lecture questions through personal search for information, the formation of an active interest in a creative approach in educational work. In the process of independent work within the framework of the educational component, the applicant must learn to deeply analyze modern approaches to the development and implementation of the latest packaging technologies, based on the characteristics of water and the requirements for the quality of packaged products. He must be able to create the most effective methods and means of packaging.

No. s/p	Name of the topic submitted for independent study	Number of CPC hours
1	<i>Purpose and objectives of the course. Basic concepts and terms. References: [bases 1, 2, 5, additions 1, 2].</i>	4
2	<i>Tasks on the SRS: Basic relations of the mechanics of continuous media for describing the state of plastic and viscoelastic materials. References: [bases 1, 5, additions 1, 2].</i>	4
3	<i>Familiarization with the interface, windows, structure and principle of operation of the Ansys Workbench package and the Polyflow application. References: [bases 1, 5, additions 1, 2].</i>	4
4	<i>Means of building geometric models. 2D and 3D projects. Tools for creating, editing a sketch and building three-dimensional bodies. References: [base 2, add. 1, 2].</i>	4
5	<i>Means of building and optimizing the grid area. Tasks of types, sizes and number of cells. References: [base 2, add. 1, 2].</i>	4
6	<i>The choice of the material of the object and the task of its properties. Types of material models. References: [base 2, add. 1, 2].</i>	4
7	<i>Boundary conditions in Ansys Polyflow. Mechanical and thermal boundary conditions. References: [bases 1–5, additions 1, 2].</i>	4
8	<i>Simulation of non-stationary flow. Initial conditions. Setting up the solver. References: [bases 1, 5, additions 1, 2].</i>	4
9	<i>Simulation of non-isothermal flow. Consideration of dissipation and internal heat sources. References: [bases 1, 2, 5, additions 1, 2].</i>	4
10	<i>Types of solvers. Message processing. Convergence of a numerical solution. References: [add. 1, 2].</i>	4
11	<i>Analysis of the calculation results. Graphical and numerical representation of physical quantities in the form of pictures, tables, graphs, animations. References: [add. 1, 2].</i>	6
12	<i>Preparation for the MCR</i>	4
14	<i>Exam preparation</i>	30
	Just	78

7. Individual lessons

Individual classes are not provided for by the working curriculum.

8. Educational Component Policy

Rules for attending classes and behavior in the classroom

Attendance at classes is a mandatory component of assessment. Applicants 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's conduct, not to be distracted by actions not related to the educational process.

Rules for assigning incentive and penalty points

Incentive points are not provided within the educational component

Penalty points (1 for each) are issued for untimely (later than before the nearest calendar control) delivery of a practical task.

Deadline and retake policy

In case of debts from the educational component or any force majeure circumstances, applicants should contact the teacher through the available (provided by the teacher) communication channels to solve problematic issues and agree on an algorithm of actions for working out.

Academic Integrity Policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the absence of references when using printed and electronic materials, quotes, opinions of other authors. Hints and cheating are unacceptable when writing tests, conducting classes; passing the test for another applicant; copying materials protected by the copyright system without the permission of the author of the work. The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: <https://kpi.ua/code>

Academic Conduct and Ethics Policy

Applicants should be tolerant, respect the opinion of others, formulate objections in the correct form, and constructively support 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". Read more: <https://kpi.ua/code>

9. Types of control and rating system for assessing learning outcomes (RSO)

Distribution of study time by types of classes and tasks from the educational component according to the curriculum:

Semester	Study time		Distribution of training hours				Control measures		
	Loans	Acad. H.	Lecture	Practical	Lab. Rob.	SRS	MCW	RR	Semester control
3	5	150	36	36		78	1	–	Exam

The student's rating in the educational component consists of the points that he receives for working on practical tests, completing the MCW and passing the exam.

Semester control is an exam.

System of rating (weight) points and evaluation criteria

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

- 1) *performance and defense of 8 practical works;*
- 2) *performance of tasks at the MCW;*
- 3) *passing the exam.*

System of rating (weight) points and evaluation criteria

Each practical work is evaluated at 5 points:

The correctness of the calculations made is 3 points.

Preparation of the report and defense of the work: weight score - 2.

The maximum points are given subject to the timely defense of the work, a full response to the defense and impeccable execution.

- "excellent" – 5 points;
- "good" – 4 points;
- "satisfactory" – 3 points;
- "unsatisfactory" – 0 points

The maximum number of points for all tasks is 5 points x 8 tasks = 40 points.

2. Tasks on the MCW

The work consists of two tasks.

Each task is evaluated at 5 points:

- "excellent" – 5 points;
- "good" – 4 points;
- "satisfactory" – 3 points;
- "unsatisfactory" – 0 points

The maximum number of points for all tasks is 10 points.

Incentive points are not provided within the educational component

Penalty points (1 for each) are issued for untimely (later than before the nearest calendar control) delivery of a practical task.

Calculation of the rating scale (R):

The sum of the weight points of control measures during the semester is:

$R_c = 40 + 10 = 50$ points.

The maximum amount of points is 100. The exam component is 50 points.

Thus, the rating scale for the discipline is:

$R = R_c + R_{\text{specimen}} = 50 + 50 = 100$ points

Two questions are submitted for the exam in each ticket, each is valued at 25 points.

- "excellent" – 25-24 points;
- "good" – 23-20 points;
- "satisfactory" – 19-15 points;
- "unsatisfactory" – 0 points

The list of exam questions is given in Section 10.

To obtain the final grade, the sum of all rating points R received during the semester is converted according to the table:

Score	Score
95...100	Perfectly
85...94	Very good
75...84	well
65...74	Satisfactory
60...64	enough
$RD < 60$	Disappointing
Not met the conditions of admission	not allowed

10. Additional information on the educational component

Approximate list of tasks for the MCR

1. *Describe the basic systems of equations that describe the processes of processing liquid media*
2. *Describe the basic equations that describe the state of liquid media*
3. *Describe the basic equations that describe heat transfer in the processes of processing liquid media*
4. *Describe the means of creating and editing sketches*
5. *Describe the means of constructing volumetric solids (solids) and the designation of geometric elements*
6. *Describe the means of generating a finite element model. Cell types*
7. *Describe the tasks of types, sizes and number of cells on defined geometric elements*
8. *Describe the selection of the object's material and the setting of its properties from the keyboard. Types of material models*
9. *Describe the selection of the object's material and the import from the ANSYS Material Library. Types of material models*
10. *Describe the boundary conditions of the I, II and III kind*
11. *Describe the types of mechanical boundary conditions in Ansys Polyflow*
12. *Describe thermal boundary conditions and their tasks in Ansys Polyflow*
13. *Describe the features of modeling a non-isothermal flow. Consideration of dissipation and internal heat sources*
14. *Describe the features of modeling a non-stationary flow. Initial conditions. Setting up the solver*
15. *Describe the possibilities of representing calculated physical quantities in the form of pictures and animations*
16. *Describe the possibilities of representing calculated physical quantities in the form of tables and graphs*
17. *Describe the estimation of the accuracy and convergence of a numerical solution*
18. *Describe the peculiarities of taking into account viscoelastic effects during extrusion*
19. *Describe the features of taking into account wall effects during extrusion*
20. *Describe the features of modeling the process of blow molding of hollow products*

List of exam tasks

1. *Describe the basic systems of equations that describe the processes of processing liquid media*
2. *Describe the basic equations that describe the state of liquid media*
3. *Describe the basic equations that describe heat transfer in the processes of processing liquid media*
4. *Describe the means of creating and editing sketches*
5. *Describe the means of constructing volumetric solids (solids) and the designation of geometric elements*
6. *Describe the means of generating a finite element model. Cell types*
7. *Describe the tasks of types, sizes and number of cells on defined geometric elements*
8. *Describe the selection of the object's material and the setting of its properties from the keyboard. Types of material models*
9. *Describe the selection of the object's material and the import from the ANSYS Material Library. Types of material models*
10. *Describe the boundary conditions of the I, II and III kind*
11. *Describe the types of mechanical boundary conditions in Ansys Polyflow*
12. *Describe thermal boundary conditions and their tasks in Ansys Polyflow*
13. *Describe the features of modeling a non-isothermal flow. Consideration of dissipation and internal heat sources*
14. *Describe the features of modeling a non-stationary flow. Initial conditions. Setting up the solver*
15. *Describe the possibilities of representing calculated physical quantities in the form of pictures and animations*
16. *Describe the possibilities of representing calculated physical quantities in the form of tables and graphs*
17. *Describe the estimation of the accuracy and convergence of a numerical solution*
18. *Describe the peculiarities of taking into account viscoelastic effects during extrusion*
19. *Describe the features of taking into account wall effects during extrusion*
20. *Describe the features of modeling the process of blow molding of hollow products*

Work program of the educational component (syllabus):

Compiled by Assoc. Prof., Doctor of Technical Sciences, Sokolsky O.L.

Approved by the Department of CPSM (Minutes No. 17 of 04.06.2025)

Approved by the Methodological Commission of the Faculty of Engineering and Chemistry (Minutes No. 11 dated 27.06.2025)