



Rolling machines

Work program of the educational component(Syllabus)

Educational component details

Level of higher education	First (bachelor's)
Discipline	<i>13 Mechanical Engineering</i>
Specialty	<i>131 Applied Mechanics</i>
Educational program	<i>OPP Packaging and Packaging Equipment Engineering</i>
Status educational component	<i>Selective</i>
Form of study	<i>full-time (day)</i>
Year of training, semester	<i>4th year, fall semester</i>
Amount educational component	<i>4(120)</i>
Semester control/control measures	<i>Test</i>
Class schedule	<i>2 hours per week (1 hour of lectures, 1 hour of practical classes)</i>
Language of instruction	<i>Ukrainian</i>
Information about the course leader/teachers	Lecturer: <i>Prof., Ph.D., Sivetsky Volodymyr Ivanovych, https://cpsm.kpi.ua/sivetskij-volodimir-ivanovich.html?tmpl=component</i> Practical/Seminar: <i>Prof., Ph.D., Sivetsky Volodymyr Ivanovych, https://cpsm.kpi.ua/sivetskij-volodimir-ivanovich.html?tmpl=component</i>
Course placement	<i>Sikorsky Platform: https://do.ipk.kpi.ua/course/view.php?id=4395</i>

Academic discipline program

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

The educational component belongs to the cycle of professional training disciplines, to the educational component of professional and practical training.

Polymer engineering occupies a special place in the field of mechanical engineering due to its wide connections with others and a large range of equipment used in various sectors of the national economy: chemical, petrochemical, light, electrical and other industries.

The processing of plastics and rubber mixtures is a set of various technological processes by which the initial polymer material is transformed into a product with predetermined performance properties. Subjected educational component "Rolling machines" - equipment for producing linoleum, rubber tapes, preparatory equipment for tire production. Basic kinematic and hydraulic diagrams, design features of rolling equipment. The educational component "Rolling machines" orients students to the modern world level of scientific and technical developments in the fields of application of equipment for the production of polymer and building materials.

The purpose of the educational component of the training "Rolling machines»

The purpose of studying this educational component is to form in bachelors a complex of knowledge regarding the design features of equipment for the production of polymer and building materials and products.

In accordance with the goal, the training of bachelors in this specialty requires strengthening the competencies formed in students:

Integral competence:

The ability to solve complex specialized tasks and practical problems in applied mechanics or in the process of learning, which involves the application of certain theories and methods of mechanical engineering and is characterized by the complexity and uncertainty of the conditions.

ZK1 Ability to abstract thinking, analysis and synthesis. ZK2 Knowledge and understanding of the subject area and understanding of professional activity. ZK12 Ability to search, process and analyze information from various sources. ZK13 Ability to evaluate and ensure the quality of work performed. ZK14 Ability to exercise one's rights and obligations as a member of society, to realize the values of a civil (free democratic) society and the need for its sustainable development, the rule of law, the rights and freedoms of man and citizen in Ukraine. ZK15 Ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and engineering, to use various types and forms of physical activity for active recreation and leading a healthy lifestyle.

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

- develop structural and kinematic hydraulic diagrams and drawings of machines and their components;*
- perform parametric calculations of technological equipment, as well as the strength of basic parts.*

According to the requirements of the educational and professional program, students after mastering the educational component have the following learning outcomes to demonstrate:

knowledge:

PH1 Select and apply suitable mathematical methods to solve problems of applied mechanics; PH3 Perform calculations on the strength, endurance, stability, durability, rigidity of machine parts; PH4 Assess the reliability of machine parts and structures during static and dynamic loading; PH5 Perform geometric modeling of parts, mechanisms and structures in the form of spatial models and projection images and formulate the result in the form of technical and working drawings;

skills:

RN11 Understand the principles of operation of automated control systems for technological equipment, in particular microprocessor-based ones, select and use optimal automation tools; RN12 Skills in the practical use of computer-aided design (CAD), production preparation (CAM) and engineering research (CAE) systems; RN13 Assess the technical and economic efficiency of production; RN14 Make the optimal selection of equipment and complete set of technical complexes;

2. Prerequisites and post-requisites of the educational component

Studyeducational component «Rolling machines» is based on the principles of integrating various knowledge obtained by students during the bachelor's degree when studying educational components, in particular: "Technology of composite materials", "Rheology", "Technology of polymer processing", "Mechanics of a solid deformed body", "Theory of mechanisms and machines", "Theoretical mechanics", "Hydromechanics and hydraulics", "Installation, operation and reliability of

technological equipment", "Technological foundations of mechanical engineering", "Occupational safety and civil protection".

3. Content of the educational component

Topic 1. Waltz.

Topic 2. Distribution of viscous flow velocity and material viscosity in the roll gap.

Topic 3. Calculation of expansion forces and drive power.

Topic 4. Calenders.

Topic 5. Design and calculation of basic roller mechanisms.

Topic 6. Design features and manufacturing technology of rolls and calenders.

Topic 7. Calculation of rolls for strength and stiffness.

Topic 8. Thermal calculations of rolling machines

4. Educational materials and resources

Basic literature

1. Sivetsky V.I. Rolling machines. Sivetsky V.I., Sidorov D.E., Shvachko D.E.: tutorial. – Electronic text data (1 file: 4.5 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 120 p. – Title from the screen. electronic form: <https://ela.kpi.ua/handle/123456789/62811>
2. Nazarenko I.I. Machinery and equipment of building materials enterprises: Designs and basics of operation: Textbook / I.I. Nazarenko, O.V. Tumanovskaya. – K.: Vyscha shkola, 2004. – 590 p. 2.
3. A.I. Dubynin, Equipment of chemical production and building materials enterprises: a manual / A.I. Dubynin, V.M. Atamanyuk, V.P. Duleba, D.M. Symak; edited by prof. A.I. Dubynin. – Lviv: Lviv Polytechnic Publishing House, 2013. – 292 p.
4. I.V. Kovalenko, Basic processes, machines and apparatuses of chemical production: Textbook / I. V. Kovalenko, V. V. Malinovsky. — K.: Inres: Volya, 2005. — 264 p.: ill. — Bibliography: p. 253—255. ISBN 966-8329-26-0
5. Technological foundations of processing of polymeric materials [Electronic resource]: textbook. I. O. Mikulyonok. 2nd ed., revised and supplemented; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file: 7.21 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2020. – 292 p. – Bibliography: p. 287–288.
6. D.E. Walsh Do It Yourself Vacuum Forming for the Hobbyist, Workshop Publishing, Lake Orion, MI, 2002
7. Soroka, W Fundamentals of Packaging Technology. — IoPP, 2002. — ISBN 1-930268-25-4
8. Yam, K Encyclopedia of Packaging Technology. — John Wiley & Sons, 2009. — ISBN 978-0-470-08704-6

Additional literature

9. Sivetsky V.I. Polymer processing equipment. Lecture notes. — Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2018. — 68 p.
10. Sivetsky V.I. Computer design of polymer equipment. Educational center. K.: "Polytechnics", 2003. — 184 p.
11. Sivetsky V.I. Sokolsky O.L. Methodological instructions for practical classes on the course. Technological equipment of chemical, polymer and silicate production, NTUU "KPI", 2007.
12. V.Yu. Shcherbyna, O.S. Sakharov, V.I. Sivetsky, O.V. Gondlyakh CAD. Application of the VESNA software complex in calculations of processes and equipment taking into account thermal power loads. Textbook – K.: Publishing house "EKMO", 2009. – 180 p.

13. Technological equipment for the production of construction and polymer products - 2. Equipment for polymer processing. Laboratory practical course on the academic discipline: a textbook / V. I. Sivetsky, V. M. Kurylenko, I. I. Ivitsky. — Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2018. — 39 p.
14. Mechanical processes and equipment for the production of polymer and building materials and products. Preparation of raw materials and equipment for mixing and molding. Textbook. Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, Sivetsky V., Shcherbyna V. Gondlyakh O. 2022. — 131 p. URL: <https://ela.kpi.ua/handle/123456789/45734>

Information resources on the Internet

18. Association of Manufacturers of Profiled Polymer Products - <https://www.bau.com.ua/f/appm/>
19. Ukrainian Association of Polymer Products Manufacturers - <https://opendatabot.ua/c/44034222>

Educational content

5. Methodology for mastering the educational component

Lectures are aimed at:

- providing modern, holistic, interdependent knowledge of the educational component, 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;
- fostering professional and business qualities in students and developing their independent creative thinking;
- developing the necessary interest in students and providing direction for independent work;
- determination of the current level of development of science and technology in the field of numerical calculation methods;
- reflection of the methodological processing of the material (highlighting the main ideas and provisions, underlining conclusions, repeating them in different formulations);
- acquisition of visual, combining if possible with the demonstration of audiovisual materials, models, models and samples;
- teaching in clear and concise language, explaining all newly introduced terms and concepts; accessibility for audience perception.

No. of the com pany	Title of the lecture topic and list of main questions (list of didactic aids, references to literature and tasks for the SRS)	Hours
Section1.Rolling machines		

1.	TOPIC 1. Waltz. <i>Purpose, classification, design, principle of operation and performance of rollers.</i> <i>References: 1 [10-30].</i> <i>Tasks for the CTC: Structural diagrams of rollers.</i>	2
2.	TOPIC 2. <i>Distribution of viscous flow velocity and material viscosity in the roll gap.</i> <i>Velocity field and speeds in the roll gap.</i> <i>References: 1 [25-35].</i> <i>Task on the CTS: Kinematic diagrams of the VM drive.</i>	2
3.	TOPIC 3. Calculation of expansion forces and drive power. <i>Drive torque and power.</i> <i>References: 1 [38-100].</i> <i>Tasks for the SRS: Layout diagrams of rollers.</i>	2
4.	TOPIC 4. Calenders <i>Purpose, classification, design, operating principle and performance of calenders.</i> <i>References: 1 [17-25].</i> <i>Tasks for the CTC: Kinematic and layout diagrams of calenders</i>	2
5.	TOPIC 5. <i>Design and calculation of basic calender mechanisms.</i> <i>Rolls, bearing units, clearance adjustment mechanisms. Roll deflection compensation.</i> <i>References: 1 [38-100].</i> <i>Tasks for the CTC: Kinematic diagrams of calender mechanisms.</i>	2
6.	TOPIC 6. <i>Design features and manufacturing technology of rolls and calender assemblies.</i> <i>Roll deflection compensation devices, calender drive, emergency safety auxiliary devices</i> <i>References: 1 [5-50].</i> <i>Tasks for the CTC: Structural diagrams of rolls.</i>	2
7.	TOPIC 7. <i>Calculation of rolls.</i> <i>Calculation of rolls for strength and stiffness. Calculation of rolls for roll deflection.</i> <i>References: 4 [38-100].</i> <i>Task on the CTC: Kinematic diagrams of roll bending compensation mechanisms.</i>	2
8.	TOPIC 8. <i>Thermal calculations of rolling machines.</i> <i>Heat balance of rolls. Thermal calculation of a calender roll</i> <i>References: 4 [101-108].</i> <i>Task on the CTC: Thermal calculation of a roll</i>	2
9.	MKR	2
	Total	18

Practical classes

The purpose of the cycle of practical classes in the educational component is to consolidate theoretical knowledge and develop skills in conducting parametric calculations and thermal

calculations, as well as calculations for the strength and reliability of components and parts of equipment.

The main tasks of the practical training cycle:

- To help students systematize, consolidate and deepen their knowledge theoretical in the field of chemical engineering and polymer processing;
- to teach students techniques for solving practical problems, to promote the acquisition of skills and abilities for performing calculations, graphics and other types of problems;
- teach them to work with scientific and reference literature, documentation and diagrams;
- to form the ability to learn independently, that is, to master the methods, means and techniques of self-study, self-development and self-control.

No of the com pon ent	Title of the topic of the practical lesson and list of main questions (list of didactic material, references to literature and tasks for the CTCs)	Hours
1.	Calculation of roller drive power. Tasks for the CTC: Drive designs of the Vltisv and calculation methods.	4
2.	Calculation of expansion forces in the gap between the rolls. Literature:[1] Tasks for the CTC: Calculation method expansion forces in the gap between the rolls.	4
3.	Calculation of rolls for strength and stiffness. Literature:[1] Tasks for the CTC: Methodology for calculating rolls for strength and stiffness.	5
4.	Thermal calculation of the roll Literature:[1] Tasks for the CTC: Calculation method ash calculation of the roll	5
5.	Total	18

Laboratory classes

According to the working curriculum, students are not required to perform laboratory work on the educational component "Rolling Machines".

6. Independent work of a higher education student

Independent work of students takes 70% of the time of studying the course, also includes preparation for the exam. The main task of independent work of students is to master scientific knowledge in the field of modern methods of calculating machines for tableting, rolling and calendering, which are not included in the list of lecture questions, through personal search for information, the formation of active interest in a creative approach in educational work and in the performance of course work. In the process of independent work within the framework of the credit module, the student must learn to deeply analyze the problem of choosing effective methods of calculating chemical production equipment and, based on calculations, come to their own substantiated conclusions.

No.	Title of the topic to be studied independently	Number
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of the company		of hours of CTC
Section 1. Rolling machines		
1.	Structural diagrams of rolling machines. Kinematic diagrams of the VM drive. Layout diagrams of 2-5 roll calenders. Kinematic diagrams of the ignition adjustment mechanisms. Kinematic diagrams of the roll bending compensation mechanisms. Kinematic diagrams of feeding and receiving mechanisms for finished products. References: 1 [10-110], 2,4.	10
2.	Distribution of viscous flow velocity and material viscosity in the roll gap. Velocity field and velocities in the roll gap. References: 1 [25-35].	10
3.	Calculation of expansion forces and drive power. Torque and drive power. References: 1 [38-100].	10
4.	Calenders. Purpose, classification, design, operating principle and performance of calenders. References: 1 [17-25].	10
5.	Design and calculation of basic calender mechanisms. Rolls, bearing units, clearance adjustment mechanisms. Roll deflection compensation. Kinematic diagrams of calender mechanisms. References: 1 [38-100].	10
6.	Design features and manufacturing technology of rolls and calender assemblies. Devices for compensating roll deflection, calender drive, emergency safety auxiliary devices. Structural diagrams of rolls. References: 1 [5-50].	8
7.	Calculation of rolls for strength and stiffness. Calculation of rolls for roll deflection. Kinematic diagrams of roll deflection compensation mechanisms. References: 4 [38-100].	8
8.	Heat balance of rolls. Thermal calculation of a calender roll References: 4 [101-108].	8
9.	Preparation for the modular test	4
10.	Preparation for the test	6
11.	Total hours	84

Policy and control

7. Educational component policy

Rules for class attendance and behavior in class

Attendance is a mandatory component of assessment. Students are required to actively participate in the learning process, not be late for classes or miss them without a valid reason, not interfere with the teacher conducting classes, and not be distracted by activities unrelated to the learning process.

Rules for assigning incentive and penalty points

- Incentive points can be awarded by the teacher exclusively for performing creative works in the educational component or for additional completion of online specialized courses with the receipt of the corresponding certificate:
- <https://www.coursera.org/learn/water-treatment>;
- <https://croapaia.com/water-treatment-pro/>;
- <https://www.shortcoursesportal.com/studies/56436/introduction-to-drinking-water-treatment.html>).

But their sum cannot exceed 25% of the rating scale.

- Penalty points are not provided within the framework of the academic discipline.

Deadline and Rescheduling Policy

In the event of arrears for the educational component or any force majeure circumstances, students must contact the teacher via available (provided by the teacher) communication channels to resolve problematic issues and agree on an algorithm of actions for work-out.

Academic Integrity Policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the lack of references when using printed and electronic materials, quotes, opinions of other authors. Hints and copying when writing tests, conducting classes are unacceptable; taking credit for another student; 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". More details: <https://kpi.ua/code>

Academic Conduct and Ethics Policy

Students should be tolerant, respect the opinions of others, formulate objections in a correct form, and provide constructive feedback in class.

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 details: <https://kpi.ua/code>

8. 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 working curriculum:

Semester	Study time		Distribution of teaching hours				Control measures		
	Loans	academic year	Lectures	Practical	Lab work	CRC	MKR	RR	Terminal CONTROL
7	4	120	18	18	–	84	1	–	test

Student rating for the educational component consists of the points he receives for:

The rating for the educational component consists of the points he receives for work in practical classes and for MCR.

Rating (weighting) points system and evaluation criteria

1. Performing practical work.

Weighted score – 10 points. The maximum number of points for all practical work is:

10 points x 9 points/year = 90 points

Criteria for assessing student knowledge

Mark	Completeness of the answer
10-9	Timely and complete completion of the task, preparation of all programs, calculations, registration and protection without flaws

8-7	Minor flaws in the programs that do not affect the calculation results
6-4	Untimely completion of the task, shortcomings in programs, calculations and design
3-0	Failure to complete the task

2. Completion of modular test work.

Weighted score – 10 points. . The modular test has two tasks, each task is evaluated at 5 points. The maximum number of points on the modular test is:

10 points x 1 MCR = 10 points

Criteria for assessing student knowledge

Mark	Completeness of the answer
10-9	Timely and complete completion of the task, preparation of all programs, calculations, registration and protection without flaws
8-6	Minor flaws in the programs that do not affect the calculation results
5-4	Untimely completion of the task, shortcomings in programs, calculations and design
3-0	Failure to complete the task

Students who have a rating of less than 60 points at the end of the semester, as well as those who want to improve their grade, take a final exam. A "hard" system is used, where the student loses their starting rating, and the grade for the discipline is given based on the completion of the final exam.

At the test, students complete a written test. Each task contains two theoretical questions. The list of questions is given in the methodological recommendations for mastering the educational component. Each theoretical question is evaluated at 50 points.

Evaluation system for theoretical questions RT1, RT2 ::

"excellent", complete answer (at least 95% of the required information) – 50–48 points;

"good", sufficiently complete answer (at least 75% of the required information or minor inaccuracies) – 47–38 points;

"satisfactory", incomplete answer (at least 60% of the required information and some errors) – 37-30 points;

"unsatisfactory", unsatisfactory answer – 0 points.

The maximum rating for the test is

$RE = RT1 + RT2 = 50 + 50 = 100$ points.

Admission requirements for semester control: enrollment of all practical work.

The sum of the starting points and/or points for the credit test is converted into the credit score according to the table:

To obtain a credit score, the sum of all rating points received during the semester R_{is} is translated according to the table:

Number of points	Rating
95...100	perfectly
85...94	very good
75...84	good
65...74	satisfactorily
60...64	enough
$RD < 60$	unsatisfactorily
Admission conditions not met	not allowed

9. Additional information on the educational component

<https://cpsm.kpi.ua/>

Approximate list of questions that can be asked on the MCR and credit

1. Define a roller machine. Main types and their purpose.
2. What technological processes are implemented on roller machines in the polymer industry?
3. Classification of rollers by design, roller placement and direction of rotation.
4. Describe the structure of a roll and the main materials used to make it.
5. How does the geometry of the roll gap affect the product forming process?
6. What is viscous flow and how is the velocity distributed in the roll gap?
7. What is polymer rheology and how is it taken into account when calculating rolls?
8. What forces act in the roller gap? How are the expansion forces calculated?
9. Methodology for determining the power of the roller machine drive.
10. Describe the layout diagrams of a windrower (WO).
11. Purpose and functions of clearance adjustment mechanisms.
12. Describe the essence and list the varieties of roll forming methods.
13. Present the structural diagrams of a three-roll calender.
14. Describe the sequence of calculating the parameters of a roller machine.
15. Draw a structural and kinematic diagram of the rollers.
16. Draw the kinematic diagrams of the VM drive.
17. Draw a layout diagram of an S-shaped calender.
18. Draw a layout diagram of a Z-shaped calender.
19. Draw a layout diagram of an L-shaped calender.
20. Draw a layout diagram of an L-shaped calender.
21. Draw kinematic diagrams of clearance adjustment mechanisms.
22. Draw kinematic diagrams of roll bending compensation mechanisms.
23. Draw examples of calender roll designs.
24. Provide a methodology for calculating the mechanisms for adjusting the clearances of the VM.
25. Describe the velocity distribution of viscous flow in the roll gap.
26. Draw the design of the rollers.
27. Describe the calculation of the expansion forces in the roller gap.
28. Give a method for calculating the basic parameters of rollers.
29. Give a method for calculating the basic parameters of calenders.
30. Describe the design and manufacturing technology of roller mills.
31. Describe the design and manufacturing technology of calenders.
32. Give the method for calculating the strength of rolls.
33. Give the method for calculating the stiffness of rolls.
34. Name the methodology for calculating the MPR.
35. Name the calculation method for the pressure screw MPZ.
36. Draw a kinematic diagram of the roller bellows adjustment.
37. Draw a kinematic diagram of the roll crossing mechanisms.
38. Show the diagram of the mechanisms for compensating for the deflection of calender rolls.
39. List the types of methods and schemes of mechanisms for compensating roll deflection.
40. Provide structural diagrams and calculation bases for sealing elements.
41. Provide structural diagrams and calculation bases for roller frames.
42. Provide structural diagrams and the basis for calculating the calender frame.
43. List the design features of emergency and safety devices of the VM.
44. Give the method of thermal balance of rolling machines.
45. What is a calender? Its structural types and applications.
46. Explain the design features of calenders for the production of polymer films and sheets.

47. The main components of the rollers: drive, supports, adjustment system. Their functions and interrelationships.
48. Methodology for calculating rolls for strength and stiffness.
49. What are the typical faults that occur in windrowers? Methods for diagnosing them.
50. What are the requirements for roll balancing? Balancing methods.
51. Features of the technology for manufacturing rolls from heat- and wear-resistant materials.
52. What parameters are taken into account when designing roller machines?
53. What are the main differences between rolling polymers and rubber compounds?
54. Rolling process control and automation devices. Their significance.
55. Evaluation of the efficiency of the windrower. Technical and economic indicators.
56. What structural and kinematic schemes of rolling machines are used in industry?
57. Explain the effect of the temperature regime of the rolls on the quality of processing of polymer material.
58. What are the features of operating roller machines in explosive and fire hazardous conditions?
59. Describe the principle of operation of the roll gap adjustment system.
60. What hydraulic systems are used in windrowers? Explain their purpose.
61. What is a device for heating or cooling rolls? Its role in the rolling process.
62. How is uniform loading along the length of the swath ensured?
63. Name the basic requirements for the installation and adjustment of rolling machines.
64. What is the automation of polymer rolling processes?
65. What are the promising directions for the development of rolling equipment in the polymer industry?

Work program educational component (syllabus):

Compiled Prof., Ph.D., Sivetsky V.I.

Approved by the department ___KhPSM___ (minutes No. 17 dated 04.06.2025)

Agreed Methodological Commission of the Faculty of Chemical Engineering (Minutes No. 11 dated 06/27/2025)