



TECHNOLOGY OF COMPOSITE MATERIALS

Work program of the educational component (Syllabus)

Details of the educational component

Higher education level	Second (Master's)
Field of Knowledge	13Mechanical Engineering
Speciality	G11 Mechanical Engineering
Educational program	OPP Engineering of Innovative Industry Equipment
Component Status	Custom
Form of study	full-time (full-time)
Year of preparation, semester	1st year, spring semester
Component volume	4(120)
Semester control / control measures	Passed
Class schedule	3 hours per week (1 hour of lectures, 2 hours of practical classes)
Language of instruction	English
Information about the course leader / teachers	Lecturer: PhD, Vytvytskyi Viktor Myronovych, https://intellect.kpi.ua/profile/vvm56 Practical: PhD, Vytvytskyi Viktor Myronovych, https://intellect.kpi.ua/profile/vvm56
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 "Technology of Composite Materials" is compiled in accordance with the educational and professional program for the training of masters of the specialty G11 Mechanical Engineering under the educational program of the OPP "Engineering and Computer-Integrated Technologies for the Design of Innovative Industry Equipment".

The educational component belongs to the cycle of professional training.

The subject of the educational component is a set of information for performing actions for the analysis, comparison and selection of composite materials and their components (matrices, fillers), the most suitable for the manufacture of products with appropriate properties.

The purpose of the educational component "Technology of Composite Materials" is to form a new and expand the previously acquired complex of knowledge of students regarding technologies, design features and methods of calculating equipment for the manufacture of composite polymer and building materials and products;

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 the field of mechanical engineering, which involves conducting research on processes, equipment and/or innovations in this field and is characterized by uncertainty of conditions and requirements;

- 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 of industrial engineering and sustainable development (SC 02);
- awareness of the promising tasks of modern production aimed at satisfying the needs of consumers, possession of trends in the innovative development of industry technologies (SC 04).

According to the requirements of the program of the educational component **"Technology of Composite Materials"**, students after mastering it must strengthen and demonstrate the following program learning outcomes:

Knowledge:

- knowledge and understanding of the principles of technological, fundamental and engineering sciences that underlie the branch engineering of the relevant industry (PRN 01);
- knowledge of modern problems of sustainable development regarding approaches to the development of technologies and equipment for industrial engineering (PRN 09);

Skill:

- to carry out engineering calculations to solve complex problems and practical problems in industrial engineering (PRN 04).

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)

This educational component is an applied development of educational components that were taught to students: *Technology of packaging and storage of packaged products*, *Technology of polymeric materials*, *Equipment of polymeric materials*, *Rheology*, *Processes, apparatus and machines of the industry*, etc. The educational component **"Technology of Composite Materials"** is a prerequisite for the study of such educational components as *Polymer Equipment*.

3. Content of the educational component

Chapter 1. General information about composite materials

Topic 1.1. Definition of basic terms and concepts.

Definitions of the concepts of "phase", "material", "product", "heterophase system", "disperse system", "multicomponent system", "composite material", "composite material", "composite", "macroscale", "macroscope", "microscale", "microscopy", "layered material", "composite material", "composite material", "composite", "nanocomposite". "Compositional construction".

Topic 1.2. Classification of composites.

Classification of composites by: origin; the nature of the components; Purpose; the nature of the matrix; Structure; aggregate state of the filler; type of reinforcement with one- or two-dimensional filler; by the nature of physical and chemical transformations that occur in the polymer phase at the stages of production and processing: Multilayer, combined, hybrid and polymatrix materials. Areas of application of composites.

Chapter 2. Polymer composite materials

Topic 2.1. General information about polymer composite materials.

Matrices and fillers of composite materials. The main types of polymer composite materials: thermoplastics, reactoplasts, thermoplastic elastomers. Rubber, latex, rubber compound, rubber, latex compound.

Topic 2.2. Fillers of polymer composite materials (PCM).

Dispersed-filled, reinforced, gas-filled and liquid-filled PCMs. Separation of PCM by the nature of the filler. Types: PCM fillers (inert, active, functionalized). General requirements for fillers. Classification of dispersed fillers by chemical composition. Classification of particles of dispersed fillers by shape. Classification of thermoplastic PKM fillers (TpKM). The density of the particle packing in the source bulk material and in the filled composition. The degree of marginal packaging. Dependence of the strength of the RMB on the content of the filler of different types. The length and tortuosity of the fibrous filler. Critical fiber length. PCM fillers with special properties.

Topic 2.3. Features of polymer-polymer composite materials

Polymer compatibility. Phase reversal in a mixture of polymers. Interfacial layer and its effect on the properties of PCM.

Topic 2.4. Gas-filled polymer composite materials (GPCM).

General information. Separation of GPCM by structure (foams, foams, integral foams, syntactic foams). Features of fropods from the point of view of the term "composite material"). Separation of GPCM by the value of apparent density. Separation of GPCM by the value of the imaginary modulus of elasticity. Separation of elastic GPCM. General classification of GPCM. Obtaining GPCM (with foaming, without foaming). The main mechanisms of foaming. Physical and chemical patterns of foaming polymers. Foaming substances are gas-forming agents (physical, chemical). Processing of GPCM.

Chapter 3. Ceramic and carbon-carbon composite materials

Topic 3.1. Ceramic composite materials (CCM).

The main properties of KCM. Methods of obtaining and areas of application of cash registers. Features of fiber-reinforced cash registers (cash registers with metal fibers; cash registers with carbon fibers; cash registers with silicon carbide fibers). Features of cash registers reinforced with dispersed particles

Topic 3.2. Carbon-carbon composite materials (UVCM).

General information about VVCM. Main properties of VVCM. Methods for obtaining VVCM (liquid-phase, gas-phase, combined). Areas of application of VVCM.

Chapter 4. Methods of modification of reactoplastic polymer composite materials.

Topic 4.1. Methods for modifying liquid reactoplastic compositions.

Chemical modification of epoxy compositions. Physicochemical modification of epoxy compositions. Physical modification of epoxy compositions.

Topic 4.2. Ultrasonic modification of liquid reactoplastic compositions.

Means of sonication of polymers. Repair technologies and epoxy compositions used to connect and restore polymer pipelines.

Chapter 5. Production of preregs based on impregnating and drying equipment.

Topic 5.1. Means for the production and processing of preregs.

Domestic and foreign equipment for the production and processing of preregs.

Topic 5.2. Ensuring energy efficiency of prepreg production by combined ultrasound application.

Effective modes of ultrasonic production of preregs.

Chapter 6. Innovative composite materials. Nanostructures. Fullerenes and carbon nanotubes.

Modern trends in the development of nanotechnology in relation to polymers.

Topic 6.1. Basic information about nanostructures.

Carbon and its allotropic forms. Fullerene C60 and its analogues. Carbon nanotubes. Carbon nanofibers.

Topic 6.2. Methods for obtaining carbon nanotubes.

Possible areas of practical application of nanotubes.

Topic 6.3. The main modern directions of nanotechnology development in relation to polymer materials science.

Recent trends in the development of nanotechnology.

4. Training materials and resources

Basic literature

1. Kolosov O.E. *Formation of polymeric composite materials using physicochemical modification (in two parts). Part 1. Study of the prerequisites for the directed implementation of physicochemical modification* / Kolosov O.E. — K.: NTUU "KPI", 2005. — 251 p. (in Russian).
2. Kolosov O.E. *Formation of polymeric composite materials using physicochemical modification (in two parts). Part 2. Effective modes and equipment for the implementation of physicochemical modification* / O.E. Kolosov, V.I. Sivetsky. — KYIV: NTUU "KPI", 2006. — 196 p. (in Russian).

3. Kolosov O. E. *Technology of Obtaining Multicomponent Epoxypolymers with the Application of Directed Physicochemical Modification* / Kolosov O. E., Sivetskyi V. I., Panov E. M. – K: NTUU KPI, 2010. – 220 p. (in Russian).
4. Kolosov O.E., Sivetskyi V.I., Panov E.M., Mikulonok I.O., Klyavlin V.V., Sidorov D.E. *Mathematical modeling of basic processes of manufacturing polymeric composite materials using ultrasonic modification (monograph)*. Kyiv, Edelweiss Publ., 2012. – 268 p. (in Russian).
5. Sidorov D.E., Sivetskyi V.I., Kolosov O.E., Mikulonok I.O. *Production of corrugated polymer pipes (monograph)*. Kyiv, Edelweiss Publ., 2012. – 154 p. (in Russian).
6. Kolosov O.E. *Obtaining high-quality traditional and nanomodified reactoplastic polymer composite materials (monograph with the stamp of NTUU "KPI")*. Kyiv: VPK "Polytechnic" NTUU "KPI", 2015. – 227 p. (in Russian).
7. Kolosova O.P., Vanin V.V., Kolosov O.E., Virchenko G.A. *Modeling of the processes of manufacturing reactoplastic compositional-fibrous materials (monograph with the stamp of NTUU "KPI")*. Kyiv: VPK "Polytechnic" NTUU "KPI", 2016. – 164 p. (in Russian).
8. Sivetskyi V.I., Kolosov O.E., Sokolskyi O.L., Ivitskyi I.I. *Technologies and Equipment for the Formation of Products from Traditional and Intelligent Polymer Composite Materials (monograph with the stamp of the Academic Council of Igor Sikorsky Kyiv Polytechnic Institute)* Kyiv: KPI. Igor Sikorsky, 2017. – 120 p. (in Russian).
9. Kolosova O.P., Vanin V.V., Kolosov O.E., Sivetskyi V.I. *Modeling of processes and equipment for the manufacture of reactoplastic materials (monograph with the stamp of the Academic Council of Igor Sikorsky Kyiv Polytechnic Institute) [electronic edition]*. Kyiv: KPI. Igor Sikorsky, 2017. – 235 p. [electronic edition]. Title from the screen. – Access: <http://ela.kpi.ua/jspui/handle/123456789/20533>

Further reading

1. Sivetskyi V.I., Kolosov O.E., Sokolskyi O.L., Ivitskyi I.I. *Technologies and Equipment for the Formation of Products from Traditional and Intelligent Polymer Composite Materials (monograph with the stamp of the Academic Council of Igor Sikorsky Kyiv Polytechnic Institute)* Kyiv: KPI. Igor Sikorsky, 2017. – 120 p. (in Russian).
2. Kolosova O.P., Vanin V.V., Kolosov O.E., Sivetskyi V.I. *Modeling of processes and equipment for the manufacture of reactoplastic materials (monograph with the stamp of the Academic Council of Igor Sikorsky Kyiv Polytechnic Institute) [electronic edition]*. Kyiv: KPI. Igor Sikorsky, 2017. – 235 p. [electronic edition]. Title from the screen. – Access: <http://ela.kpi.ua/jspui/handle/123456789/20533>
3. Kolosov O.E. *Processes and equipment for the production of reactoplastic polymer composite materials using ultrasound (textbook)*. KYIV: NTUU KPI, 2015. – 247 p. (in Russian). (Letter of the Ministry of Education and Science of Ukraine No. 1/11-12849 of 29.07.2014).
4. Kolosov O.E. *Obtaining Reactoplastic Polymer Composite Materials Using Ultrasound: Textbook [for Students of Higher Education; Electronic Edition]*. KYIV: NTUU KPI, 2016. – 198 p. Title from the screen. –Access: <http://ela.kpi.ua/handle/123456789/14442>
5. Kolosov O.E. *Composite and Nanomaterials [electronic edition] Approved by the Academic Council of Igor Sikorsky Kyiv Polytechnic Institute as a textbook for postgraduate students studying in the specialty "Industrial Engineering" (protocol No. 6 of 12.06.2017) [electronic edition]* Kyiv: KPI. Igor Sikorsky, 2017. – 224 p. – Title from the screen. –Access: <http://ela.kpi.ua/handle/123456789/19767>
6. Kolosova O.P., Vanin V.V., Kolosov O.E., Sivetskyi V.I. *Ultrasonic Processing of Technological Raw Materials of Polymer Composite Materials [electronic edition] Approved by the Academic Council of Igor Sikorsky Kyiv Polytechnic Institute as a textbook for postgraduate students studying in the specialty "Industrial Engineering" (protocol No. 6 of 12.06.2017) [electronic edition]* Kyiv: KPI. Igor Sikorsky, 2017. – 188 p. Title from the screen. –Access: <http://ela.kpi.ua/jspui/handle/123456789/20534>
7. Kolosov O.E. *Technologies of composite materials. Laboratory Practicum [Electronic resource] : study. Manual. for the training of students studying in the specialty 131 – "Applied Mechanics", specialization – "Engineering, computer modeling and design of packaging equipment"; specialty 133 – "Industrial Engineering", specialization "Engineering, computer modeling and equipment design for the production*

of polymer and building materials and products". Electronic text data. – Kyiv: KPI. Igor Sikorsky, 2018. – 86 p. Stamp provided by the Methodological Council of KPI. Igor Sikorsky (minutes No. 8 dated 19.04.2018).

Information resources on the Internet

1. Electronic archive of KPI <https://ela.kpi.ua>
2. Website of the Department of Chemical Engineering, <http://cpsm.kpi.ua/mr.html>
3. Electronic campus of KPI. Igor Sikorsky, <http://login.kpi.ua/>
4. Sikorsky distance learning platform <https://sikorsky-distance.kpi.ua/>
5. It is possible to conduct On-line classes using the Zoom platform.

Educational content

5. Methods of mastering the educational component

Lectures

Lectures are aimed at:

- providing modern, holistic, interdependent knowledge on the educational component **"Technology of Composite Materials"**, the level of which is determined by the target setting for each specific topic;
- ensuring the creative work of students together with the teacher during the lecture;
- education of students' professional and business qualities and the development of independent creative thinking;
- formation of students' necessary interest and provision of direction for independent work;
- determination at the current level of development of science and technology in the field of technology and equipment for the manufacture of polymer-composite materials;
- 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 the materials of the component in a clear and high-quality language in compliance with structural and logical connections, explanation of all newly introduced terms and concepts;
- accessibility for perception by this audience.

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	Lecture 1. Definition of basic terms and concepts. Definitions of the concepts of "phase", "material", "product", "heterophase system", "disperse system", "multicomponent system", "composite material", "composite material", "composite", "macroscale", "macroscope", "microscale", "microscopy", "layered material", "composite material", "composite material", "composite", "nanocomposite". "compositional construction". Classification of composites. Classification of composites by: origin; nature of components; purpose; nature of the matrix; structure; aggregate state of the filler; type of reinforcement with one- or two-dimensional filler; by the nature of physical and chemical transformations that occur in the polymer phase at the stages of production and processing: Multilayer, combined, hybrid and polymatrix materials. Fields of application of composites. Literature [1, 2, 5]. Tasks on the SRS: Definition of terms and concepts of "composite material", "composite	1

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
	material", "composite" in foreign sources of information. The latest fields of application of composites.	
2	Lecture 2. General information about polymer composite materials. Matrices and fillers of composite materials. The main types of polymeric composite materials: thermoplastics, reactoplasts, thermoplastic elastomers. Rubber, latex, rubber mixture, rubber, latex mixture. Fillers of polymer composite materials (PCM). Dispersed-filled, reinforced, gas-filled and liquid-filled PCMs. Separation of PCMs by the nature of the filler. Types: PCM fillers (inert, active, functionalized). General requirements for fillers. Classification of dispersed fillers by chemical composition. Classification of particles of dispersed fillers by shape. Classification of thermoplastic PCM fillers (TpCM) Density of particle packing in the initial bulk material and in the filled composition. Degree of limit packaging. Dependence of the strength of the RMB on the content of the filler of different types. The length and tortuosity of the fibrous filler. Critical fiber length. PCM fillers with special properties. References [1–5]. CPC tasks: The latest types of thermoplastic elastomers and their applications. The latest types of fillers and their applications.	2
3	Lecture 3. Features of polymer-polymer composite materials. Polymer compatibility. Phase reversal in a mixture of polymers. Interfacial layer and its effect on PCM properties. Gas-filled polymer composite materials. General information. Separation of GPCM by structure (foams, foams, integral foams, syntactic foams). Features of foam boards from the point of view of the term "composite material"). Separation of GPCM by the value of apparent density. Separation of GPCM by the value of the imaginary modulus of elasticity. Separation of elastic GPCM. General classification of GPCM. Obtaining GPCM (with foaming, without foaming). The main mechanisms of foaming. Physical and chemical patterns of foaming polymers. Foaming substances are gas-forming agents (physical, chemical). Processing of GPKM. References [1–5]. Tasks on the CPC: The latest types of polymer-polymer composite materials and the fields of their application. The latest types of gas-filled polymer composite materials and the fields of their application.	1
4	Lecture 4. Ceramic composite materials. Main properties of cash registers. Methods of production and areas of application of cash registers. Features of cash registers reinforced with fibers (cash registers with metal fibers; cash registers with carbon fibers; cash registers with silicon carbide fibers). Features of cash registers strengthened with dispersed particles. Carbon-carbon composite materials. General information about VVCM. Main properties of VVCM. Methods for obtaining VVCM (liquid-phase, gas-phase, combined). Areas of application of VVCM.	2

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
	Literature [1, 2, 4]. Tasks on the CPC: The latest types of ceramic composite materials and the fields of their application. The latest types of carbon-carbon composite materials and the fields of their application.	
5	Lecture 5. Methods for modifying liquid reactoplastic compositions. Chemical modification of epoxy compositions. Physicochemical modification of epoxy compositions. Physical modification of epoxy compositions. Ultrasonic modification of liquid reactoplastic compositions. Means of sonication of polymers. Repair technologies and epoxy compositions used to connect and restore polymer pipelines. Literature [1, 2]. Tasks for SRS: The feasibility of using certain methods of modification of liquid reactoplastic compositions. The main mode parameters of ultrasonic treatment of liquid polymers.	1
6	Lecture 6. Means for the production and processing of preregs. Domestic and foreign equipment for the production and processing of preregs. Literature [1, 2]. Tasks on the CPC: Features of impregnating and drying equipment MPT-3m. Terms and conditions of storage of preregs.	2
7	Lecture 7. Ensuring energy efficiency of prepreg production by combined ultrasound application. Effective modes of ultrasonic production of preregs. Carbon-carbon composite materials. General information about VVCM. Main properties of VVCM. Methods for obtaining VVCM (liquid-phase, gas-phase, combined). Areas of application of VVCM. Literature [1, 2]. Tasks on SRS: Advantages and disadvantages of ultrasonic preparation of preregs. The latest types of carbon-carbon composite materials and their applications.	1
8	Lecture 8. Basic information about pronanostructure. Carbons and its allotropic forms. Fullerene C60 and its analogues. Carbon nanotubes. Carbon nanofibers. Methods for obtaining carbon nanotubes. Possible areas of practical application of nanotubes. Literature [1, 2].	2

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
	<i>Tasks on CPS: the main types of carbon nanotubes. Advantages and disadvantages of existing methods for obtaining carbon nanotubes.</i>	
9	Lecture 9. Nanotechnologies in Polymer Materials Science. <i>The main modern directions of nanotechnology development in relation to polymer materials science.</i> Promising directions for the development of technology of polymer composite materials. <i>Literature [1, 2].</i> <i>Tasks on the SRS: Areas of use of nanomaterials. Advantages and disadvantages of pultrusion technology.</i>	2
Just		14

Practical classes

The main goals of the cycle of practical work (computer workshop) are to consolidate the theoretical provisions of the educational component by students and to acquire skills and abilities for their practical application.

No. s/p	Title of the practical work (computer workshop)	Hours
1	<i>Introduction to the cycle of practical work. Safety precautions.</i>	2
2	<i>Acquaintance with the characteristics and principle of operation of a digital electronic photo-video microscope (on the example of the "Supereyes B011" model). Auxiliary devices.</i>	2
3	<i>Determination of indicators of mechanical properties of elementary fibers.</i>	2
4	<i>Determination of structural parameters of unidirectional and woven fibrous fillers.</i>	2
5	<i>Dispersed powdered fillers. Determination of moisture content in dispersed powdered fillers.</i>	3
6	<i>Thermosetting polymer materials. Preparation of a binder based on thermosetting oligomers.</i>	3
7	<i>Determination of viscosity and density of liquid thermosetting polymer binders, as well as the density of hardened epoxypolymers.</i>	3
8	<i>Study of the process of impregnation of capillary-porous bodies. Determination of the content of fiberglass filler in epoxy fiberglass.</i>	3
9	<i>Reception of practical work.</i>	3
10	<i>Modular control work</i>	3
11	<i>Acceptance of reports on practical classes</i>	4
Just		30

Laboratory classes

According to the working curriculum for the preparation of masters in this component, laboratory classes are not provided.

6. Independent work of a student

The main task of students' independent work is to master the issues that are not included in the list of lectures, through personal search for information, the formation of an active interest in a creative

approach in educational work. At the expense of the time of the SRS, reports on laboratory work, diagrams, diagrams, registration of calculation results, etc., are formed.

No. s/p	Name of the topic submitted for independent study	Number of CPC hours
1	Topic 1.1. Definition of basic terms and concepts. Definition of terms and concepts of "composite material", "composite material", "composite" in foreign sources of information. Literature [6–9]	4
2	Topic 1.2. Classification of composites. The latest areas of application of composites. Literature [6–9]	4
3	Topic 2.1. General information about polymer composite materials. The latest types of thermoplastic elastomers and their applications. Literature [6–9]	4
4	Topic 2.2.Fillers of polymer composite materials. The latest types of fillers and their applications. Literature [6–9]	4
5	Topic 2.3. Features of polymer-polymer composite materials. The latest types of polymer-polymer composite materials and their applications. Literature [6–9]	4
6	Topic 2.4. Gas-filled polymer composite materials. The latest types of gas-filled polymer composite materials and their applications. Literature [6–9]	4
7	Topic 3.1. Ceramic composite materials. The latest types of ceramic composite materials and their applications. Literature [6–9]	4
8	Topic 3.2.Carbon-carbon composite materials. The latest types of carbon-carbon composite materials and their applications. Literature [6–9]	4
9	Topic 4.1.Methods for modifying liquid reactoplastic compositions. Chemical modification of epoxy compositions. Physicochemical modification of epoxy compositions. Physical modification of epoxy compositions. Literature [6–9]	4
10	Topic 4.2.Ultrasonic modification of liquid reactoplastic compositions. Means of sonication of polymers. Repair technologies and epoxy compositions used to connect and restore polymer pipelines. Literature [6–9]	5
11	Topic 5.1.Means for the production and processing of prepregs. Domestic and foreign equipment for the production and processing of prepregs. Literature [6–9]	5
12	Topic 5.2.Ensuring energy efficiency of prepreg production by combined ultrasound application. Effective modes of ultrasonic production of prepregs. Literature [6–9]	5
13	Topic 6.1.Basic information about pronanostructure.	5

No. s/p	Name of the topic submitted for independent study	Number of CPC hours
	Carbons and its allotropic forms. Fullerene C60 and its analogues. Carbon nanotubes. Carbon fiber. <i>Literature [6–9]</i>	
14	Topic 6.2. Methods for obtaining carbon nanotubes. Possible areas of practical application of nanotubes. <i>Literature [6–9]</i>	5
15	Topic 6.3. The main modern directions of nanotechnology development in relation to prepolymer materials science. Recent trends in the development of nanotechnology. <i>Literature [6–9]</i>	5
16	Preparation for the modular test work	4
17	Preparation for the test <i>References [1–9].</i>	6
Together		76

Policy and control

8. Educational Component Policy

Rules for attending classes and behavior in the classroom

Attendance at 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's conduct, not to be distracted by actions not related to the educational process.

Rules for assigning incentive and penalty points

Incentive points can be awarded by the teacher only for the performance of creative (optional) work on the component.

Deadline and retake policy

In case of debts from the educational component or any force majeure circumstances, bachelors must 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. All tasks designed for individual performance must be performed personally by the student. Hints and cheating during writing tests, control, conducting classes are unacceptable; defense of laboratory work, passing a test 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". Read more: <https://kpi.ua/code>

Academic Conduct and Ethics Policy

Students should be tolerant, respect the opinions of others, formulate objections in the correct form, and 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". 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 component:

Semester	Study time		Distribution of training hours					Control measures
	Loans	Acad. H.	Lecture	Lab. Rob.	Practical classes	CPC	FDM	Semester control
2	4	120	14	-	30	76	-	Passed

Current control: *express surveys, reports on practical classes.*

Calendar control: *carried out twice a semester as a monitoring of the current state of fulfillment of the requirements of the syllabus.*

Semester control: *credit.*

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

- 1) answers to the questions of express control of theoretical material (2 express controls are carried out);*
- 2) implementation of project and calculation tasks in practical classes (6 in total);*
- 3) Current test work.*

System of rating (weight) points and evaluation criteria

1. Express control:

- "excellent", complete answer (at least 90% of the required information) – 9-10 points;*
- "good", a sufficiently complete answer (at least 75% of the required information), or a complete answer with minor inaccuracies - 5-8 points;*
- "satisfactory", incomplete answer (at least 60% of the required information) and minor errors – 4 points;*
- "unsatisfactory", unsatisfactory answer (does not meet the requirements for 1 point) – 0 points.*

2. Practical classes:

- "excellent", creative performance of the task, fluency in the material – 9-10 points;*
- "good", completing the task in full, but with minor errors - 5-8 points;*
- "satisfactory", completion of the task with individual errors – 4 points;*
- "unsatisfactory", failure to complete the task – 0 points;*

3. Modular control work.

- complete answer (at least 90% of the required information) – 18-20 points;*
- a sufficiently complete answer (at least 75% of the required information or minor inaccuracies) – 13-17 points;*
- incomplete answer (at least 60% of the required information and some errors) – 10-12 points;*
- Unsatisfactory answer – 0 points.*

One or two best students can be added 1-2 incentive points at each practical lesson; +5 incentive points for a report on the results of studying the component at a student conference or publication in a journal.

The maximum sum of points of the starting component is 100. A prerequisite for admission to the test is the enrollment of all tasks of practical classes and the delivery of modular control work and a starting rating of at least 25 points.

According to the results of educational work for the first 7 weeks, the "ideal student" should score 25 points. At the attestation (8th week), a student receives "enrolled" if his current rating is at least 12 points.

According to the results of 15 weeks, the "ideal student" should score $r_c = 50$ points. At the second attestation (14th week), the student receives "enrolled" if his current rating is at least 25 points.

The maximum sum of points for semester R is 100 (where $R = r_{e-kp} \cdot 2 + r_{pr} \cdot 6 + r_{mkr} = 10 \cdot 2 + 10 \cdot 6 + 20 = 20 + 60 + 20 = 100$

On the test, students perform a written test. Each task contains 2 theoretical questions and 1 practical one. The list of questions is given in the methodological recommendations for mastering the educational component. Each theoretical question is evaluated at 30 points, and the practical question is evaluated at 40 points.

System for evaluating theoretical issues: (r_{T1}, r_{T2})

- "excellent", complete answer (at least 90% of the required information) – 28-30 points;
- "good", a sufficiently complete answer (at least 75% of the required information or minor inaccuracies) – 19-27 points;
- "satisfactory", incomplete answer (at least 60% of the required information and some errors) – 16-18 points;
- "unsatisfactory", unsatisfactory answer – 0 points.

Practical task evaluation system (r_{pr}) :

- "excellent", complete error-free solution of the problem (at least 90% of the necessary information) – 38-40 points;
- "good", complete solution of the problem with insignificant inaccuracies (at least 75% of the required information or minor inaccuracies) – 25-37 points;
- "satisfactory", the task was completed with certain shortcomings (at least 60% of the necessary information and some errors) – 22-24 points;
- "unsatisfactory", the task was not completed – 0 points.

The maximum rating of the test test is

$$r_E = r_{T1} + r_{T2} + r_{pr} = 30 + 30 + 40 = 100 \text{ Points.}$$

Conditions for admission to semester control: semester rating of at least 50 points.

To obtain a score, the sum of all received rating points **R** is converted according to the table:

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

10. Additional information on the educational component

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

QUESTIONS FOR MODULAR TEST WORK

1. Provide a classification of composites by origin. Give examples from each element of the classification and possible areas of their application.
2. Provide a classification of composites according to the nature of the components. Give examples from each element of the classification and possible areas of their application.
3. Provide a classification of composites by purpose. Give examples from each element of the classification and possible areas of their application.
4. Provide a classification of composites according to the nature of the matrix. Give examples from each element of the classification and possible areas of their application.
5. Provide a classification of composites by structure. Give examples from each element of the classification and possible areas of their application.
6. Provide a classification of composites according to the aggregate state of the filler. Give examples from each element of the classification and possible areas of their application.
7. To classify composites by type of reinforcement with a one- or two-dimensional filler (fibrous, rod, tape, flat). Give examples from each element of the classification and possible areas of their application.
8. To provide a classification of polymer composites according to the nature of physical and chemical transformations that occur in the polymer phase at the stages of production and processing. Give examples from each element of the classification and possible areas of their application.
9. Provide a classification of thermoplastic composite materials. Give examples from each element of the classification and possible areas of their application.
10. Provide a classification of dispersed fillers by chemical composition. Give examples from each element of the classification and possible areas of their application.
11. Provide a classification of dispersed filler particles by shape. Give examples from each element of the classification and possible areas of their application.
12. Provide a classification of fillers of thermoplastic composite materials. Give examples from each element of the classification and possible areas of their application.
13. Provide a classification of gas-filled polymer composite materials. Give examples from each element of the classification and possible areas of their application.
14. Provide a classification of layer materials. Give examples of each element of classification and possible areas of their application.
15. Provide a classification of compositional structures (structures). Give examples from each element of the classification and possible areas of their application.

Approximate list of questions that can be put to the test

1. To define the term "composite" and to indicate the fields of application of composites.
2. Provide general information about polymer composites.
3. Analyze the separation of composites depending on the type of filler.
4. To analyze the main types of dispersed, reinforced and dispersed-reinforced composites.
5. Provide a classification of composites by origin, by the nature of the components, by purpose, by the nature of the matrix.
6. To provide a classification of composites by structure, by the aggregate state of the filler.
7. To classify composites by type of reinforcement with a one- or two-dimensional filler (fibrous, rod, tape, flat).
8. To provide a classification of polymer composites according to the nature of physical and chemical transformations that occur in the polymer phase at the stages of production and processing.
9. To characterize the difference between thermoplastic and reactoplastic composite materials.
10. Provide a classification of dispersed fillers by chemical composition, by shape.
11. Analyze multilayer, combined, hybrid, and polymatrix materials.
12. Analyze continuous fibrous reinforcing fillers by shape.
13. To analyze the role of fillers in polymer composites.
14. Analyze the requirements for composites fillers.

15. *To substantiate the concept of the interfacial layer of a composite and its effect on the properties of composites (adhesion, cohesion).*
16. *To analyze the types of one-dimensional (fibrous) fillers and their impact on the physical and mechanical properties of polymer composite materials.*
17. *To analyze the methods of obtaining and areas of application of carbon-carbon composite materials.*
18. *To analyze the methods of obtaining and areas of application of ceramic composite materials.*
19. *Evaluate ceramic composite materials and their basic properties.*
20. *Provide general information about carbon-carbon composite materials.*
21. *To analyze the methods of production, properties and areas of application of carbon composite materials.*
22. *To analyze the most common methods of modification of liquid reactoplastic compositions.*
23. *To characterize the ultrasonic modification of liquid reactoplastic compositions.*
24. *To characterize the means of sonication in the production of reactoplastic polymers.*
25. *To characterize the features of the manufacture of preregs on the basis of impregnating and drying equipment.*
26. *To characterize the means for the production and processing of preregs.*
27. *To characterize the existing domestic and foreign equipment for the production and processing of preregs.*
28. *To substantiate the achievement of energy efficiency in obtaining preregs by the combined use of ultrasound.*
29. *Characterize nanostructures. To give possible areas of practical application of nanotubes.*
30. *Characterize carbon and its allotropic forms. Fullerene C₆₀ and its analogues. Carbon nanotubes. Carbon nanofibers.*
31. *To characterize the features of the process of impregnation of fibrous fillers with solutions of reactoplastic polymers.*
32. *To characterize intelligent polymer composite materials.*
33. *To characterize the process of obtaining glass fibers.*
34. *To characterize the process of obtaining organic fibers.*
35. *To characterize the process of obtaining carbon fibers.*
36. *To characterize the features of production and properties of metal composites.*
37. *To characterize the factors influencing the processing of PCM products.*
38. *To give the technological sequence of obtaining reactoplastic products from PCM.*
39. *To characterize the requirements for the reactoplastic binder.*
40. *To characterize the technological operation of seepage.*
41. *To classify the winding process according to the kinematic feature.*
42. *To classify the winding process by the type of fiber laying.*
43. *To characterize the technological operation of "wet" winding.*
44. *To characterize the technological operation of "dry" winding.*
45. *To characterize the technological operation of spiral winding.*
46. *To characterize the technological operation of longitudinal winding.*
47. *Describe the most common methods of impregnation.*
48. *To characterize the technological operation of direct pressing.*
49. *To characterize the technological operation of injection molding.*
50. *To characterize the technological operation of injection molding.*
51. *To characterize the technological operation of extrusion.*
52. *To characterize the technological operation of contact forming.*
53. *To characterize the technological operation of vacuum forming.*
54. *To characterize the technological operation of autoclave forming.*
55. *To characterize the technological operation of forming using pressure rollers.*
56. *To characterize the features of the hardening of the reactoplastic binder.*
57. *To characterize the methods of mandrel removal in the formation of reactoplastic composites.*
58. *To characterize the procedural aspects of quality control of PCM products.*

59. *To analyze the method for determining the indicators of mechanical properties of elementary fibers. Determination of destructive stress during stretching of a thread (elementary fibers)*
60. *To characterize the method for determining the structural parameters of unidirectional and woven fibrous fillers*
61. *To characterize dispersed (powder) fillers, their properties. To analyze the method for determining the moisture content in dispersed fillers.*
62. *To characterize the method for determining the conditional viscosity and density of liquid thermosetting polymer binders, as well as the density of hardened epoxypolymers.*
63. *To characterize the method of studying the behavior of capillary-porous fibrous materials during impregnation.*
64. *To characterize the method for determining the content of fiberglass filler in hardened epoxy fiberglass.*
65. *To characterize the main parameters of ultrasound action and analyze the method for their determination.*
66. *To characterize the method for evaluating the effectiveness of ultrasonic cavitation.*
67. *To characterize the ultrasonic capillary effect, its practical application and to analyze the method of its study.*

Work program of the educational component (syllabus):

Compiled by Assoc., PhD, Vytvytskyi V.M.

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

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