The National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Department of Ecology and Technology of Plant Polymers

Chemistry of plant polymers

work program of the academic discipline (syllabus)

Details of the academic discipline

Level of higher education	***First (bachelor's)***
Branch of knowledge	*16 Chemical and Bioengineering*
Speciality	*161 Chemical Technology and Engineering*
Educational program	*Industrial ecology and resource efficient cleaner technologies*
Status of discipline	*Selective*
Form of training	*full-time(day)/evening(evening)/part-time/remote/mixed*
Year of preparation, semester	*2nd year, fall semester*
Volume of discipline	*4 credits (120 hours)*
Semester control	*Test*
Schedule of classes	*4 hours a week (2 hours of lectures and 1 hour of practical classes and 1 hour of laboratory work)*
Language of instruction	Ukrainian
Information about kerivnik course / teachers Lecturer:	Lecturer: PhD, professor Valerii Barbash, https://eco-paper.kpi.ua/pro-kafedru/vykladachi/barbash-valerij-anatolijovich.html; Practical classes and laboratory work: PhD, professor Valerii Barbash.
Course placement	*https://campus.kpi.ua/tutor/index.php?mode=mob&show&irid*

Program of discipline

1. Description of the discipline, its purpose, subject of study and learning results

The basis of all living things on earth is mineral and organic polymers - high molecular weight compounds that, together with air and water, form the surrounding world. Macromolecules of polymers contain hundreds and thousands of atoms with a molecular weight that can reach several million. Plant life consists of such high-molecular compounds as cellulose, lignin, and hemicelluloses. Cellulose is the most abundant renewable organic material produced annually in the biosphere. Cellulose is widespread among higher plants and some marine animals. Plant raw materials, unlike other raw materials sources (coal, oil, natural gas), are a continuously renewable resource. Forests and meadows use solar energy, water, minerals and convert a significant amount of carbon dioxide in the air into organic compounds in the process of photosynthesis. About 80% of the world's reserves of organic substances are concentrated in forests alone, of which 95% are cellulose, hemicelluloses and lignin, and about 5% are extractive substances. The complex use of plant raw materials with a reduction in the amount of waste is an important scientific and practical task and a reserve for increasing the profitability of enterprises that process plant raw materials. To solve this problem, it is necessary to create new and improve existing chemical methods of processing plant raw materials, which will make it possible to use scarce pulp products, water, auxiliary chemical materials, labor and energy resources in a more rational and ecologically cleaner way. This also applies to the technologies for the production of synthetic and artificial polymers, the volume of which is constantly increasing, as enterprises for the production of plastic masses, synthetic fibers, synthetic rubber, varnishes and glues, electrical insulating materials, which are obtained both from low molecular weight products and by processing plant polymers, are developing. in particular, cellulose and starch.

The subject of the discipline " Chemistry of plant polymers" *is consists in studying the general characteristics and theoretical foundations of the chemistry of plant polymers, in particular the processes of obtaining synthetic and artificial polymers; the structure, chemical composition and properties of plant raw materials and their individual components, as well as opportunities that open up during various transformations of plant raw materials and their components to improve these processes and create new, more efficient, ecologically cleaner productions that allow more rational use scarce fibrous semi-finished products, water, auxiliary chemical materials, labor and energy resources.*

The purpose of the discipline "Chemistry of plant polymers" *consists in training specialists in the field of chemical technologies and engineering, who are able to solve professional problems in practical situations on the basis of acquired theoretical knowledge, as well as to form students'* ***competencies****:*

- ability to apply knowledge in practical situations (C 02)

- knowledge and understanding of the subject area and understanding of professional activity (C 03);

- the ability to use the provisions and methods of the discipline to solve professional problems, to determine directions for the processing of plant raw materials (C 09);

- the ability to determine the directions of use of plant and pulp, design and implement their processing technologies (C 19);

- the ability to use the basic provisions of the chemistry of plant polymers to predict the quality indicators of pulp, paper and cardboard, intermediate and final products of the chemical technology of processing plant raw materials.

According to the requirements of the program of the academic discipline, after learning the credit module, students must demonstrate the following ***learning outcomes****:*

- correctly use the terminology and basic concepts of chemistry, chemical technologies, processes and equipment for the production of chemical substances and materials based on them in professional activities (PO 02);

- to substantiate the choice of technological schemes of production on the basis of rational use of raw materials, energy, obtaining high-quality products, achieving high productivity with a simultaneous solution of environmental issues, calculating material and heat balances of processes, on their basis, finding costs of raw materials and energy resources (PO 15);

- determine the quality characteristics of plant raw materials, semi-finished products and finished products (PO 16).

2. Prerequisitions and requisition of disciplines (place in the structural and logical scheme of training according to the relevant educational program)

The study of the academic discipline "Chemistry of plant polymers" is preceded by academic disciplines such as: "General and inorganic chemistry", "Organic chemistry", "Chemistry of high molecular compounds", it provides the disciplines "Technology of production of cellulose ethers and esters", "Technology of pulp" , "Chemical methods of analysis of raw materials, products and waste water of pulp and paper production", "Paper and cardboard technology". The educational discipline belongs to the cycle of professional training (selective educational components from the departmental Catalogues).

3. Contents of the discipline

Section 1. Chemistry of high molecular weight compounds

Topic 1. The purpose of the discipline and its tasks in the training of highly qualified pulp and paper engineers. Prospects for the development of the pulp and paper industry. The concept of high molecular weight compounds. Natural and synthetic polymers. Characteristic properties of high

molecular weight compounds. Nomenclature and classification of high molecular weight compounds.

Topic 2. Structure and properties of high molecular weight compounds. Polymer homology series. Degree of polymerization and molecular weight. Polydispersity. Structure of molecules of high molecular weight compounds. Linear, branched and spatial polymers. Amorphous and crystalline regions in cellulose.

Topic 3. Methods of obtaining high molecular weight compounds. Polymerization and polycondensation. Chain polymerization and its mechanism. Stepwise polymerization. Copolymerization. Polycondensation. Mechanism of polycondensation. The influence of functional initial monomers on the nature of the obtained products

Section 2. Physical and chemical properties of plant raw materials

Topic 4. Physical properties of wood. Wood moisture. Specific and volumetric weight of wood. Conductivity. Thermal conductivity. Temperature. Chemical properties of plant raw materials. Elementary composition. Ash content and composition of ash. Chemical composition of wood, bark. Concept and definition of cellulose, hemicellulose, lignin, resins, minerals.

Topic 5. Chemical processing of plant raw materials. Scheme of processing plant raw materials into cellulose and wood pulp. Methods of delignification of vegetable raw materials. Technical hydrolysis of wood. Dry distillation of wood. Extraction of wood with water. Softwood sawdust. Rosin. Turpentine.

Section 3. Chemistry of cellulose

Topic 6. General characteristics of cellulose. Photosynthesis of carbohydrates in plants. The mechanism of cellulose formation. Conformation of cellulose molecules. Hydrogen bonds in cellulose. The structure of cellulose fibers. Molecular heterogeneity and methods of determining the molecular mass of cellulose. Degree of polymerization and fractional composition of cellulose. Determination and production of cellulose. Qualitative and quantitative methods of cellulose determination. Basic chemical reactions. Methods of quality control.

Topic 7. Chemical properties of cellulose. Hydrolysis of cellulose under the action of acids. Scheme of hydrolysis of cellulose and starch. The rate of hydrolysis and factors affecting hydrolysis. Hydrolysis by dilute and concentrated acids. Reversion and inversion of sugars. Hydrocellulose and its properties. Effect of hydrogen chloride and hydrochloric acid on cellulose. Acetolysis of cellulose. Alcoholysis of cellulose.

Topic 8. Oxidation of cellulose. The main directions of cellulose oxidation. Selective oxidation of cellulose. Oxidation with oxygen in an alkaline medium. The role of oxidation reactions in technological processes of obtaining and processing cellulose. Bleaching and refining of cellulose. Oxycellulose and its properties. Determination of the content of carbonyl and carboxyl groups. Products of deep oxidative decomposition of cellulose. Photochemical destruction. Action of alkalis on cellulose. Swelling and dissolution of cellulose in alkali. Alkaline destruction of cellulose.

Topic 9. Degree of esterification. Bath module. Factors affecting the process of cellulose esterification. Complex esters of cellulose. Acetylating agents and catalysts. Methods of cellulose acetylation. Homogeneous acetylation in an acidic medium. Primary and secondary acetates. Properties of cellulose acetates and their application. Cellulose xanthogenate and its production. Viscose. Production of viscose fiber. Viscous cellulose and its requirements.

Topic 10. Simple ethers of cellulose. Classification and methods of obtaining. Properties and areas of use. Solubility of cellulose. Solubility of cellulose in copper-ammonium reagent and other complex bases. Production of copper-ammonia fiber. Solubility of cellulose in aqueous solutions of salts.

Section 4. Chemistry of hemicelluloses

Topic 11. General characteristics. The concept of hemicelluloses and their classification. Pentosans. Quantitative methods. Xylan and Araban. Formation, structure, properties. Hydrolysis of pentosans, production of xylose, xylitol, trioxoglutaric acid

Topic 12. Hexosans, their properties and distribution in plant materials. Mannans, as a mixture of polysaccharides, their properties and methods of determination. Galactan, its properties and methods of determination. Arabogalactan, holocellulose.

4. Training materials and resources

Basic literature

1. Barbash V.A., Deikun I.M. Chemistry of plant polymers. Education manual. 2nd edition, revised. and additional - Kyiv: Caravela, 2018 – 440 p.
2. Barbash V.A., Deikun I.M. Chemistry of plant polymers. Education Guide/Kyiv: Edelweiss, 2014. 437p.
3. Hetmanchuk Y.P., Bratychak M.M. Chemistry and technology of polymers. Lviv: "Beskid Bit" Publishing House, 2006. — 496 p.
4. Yukhymenko N.M., Studzinskyi S.Z. Chemistry of hydrocarbons. K.: Kyiv University, 2019- 112 p.
5. Maslennikova L., Fabulyak F., Grushak Z., Ivanov S. Physico-chemistry of polymers. L.: NAU-print, 2009. — 312 p.

Additional literature

6. Industrial polymers and the basics of technology for the production of polymer materials: a study guide to the discipline and practicals for students of the Faculty of Chemistry / edited by I. O. Savchenko, V. G. Syromyatnikov. – K.: Kyiv University Publishing and Printing Center, 2012. – 112 p.
7. Khoroshilova T.I., Khromyshev V.O., Ryabov S.V. High molecular weight compounds: a textbook. Melitopol, MDPU publishing house, 2013. – 178 p.
8. VV Nyzhnyk Physical chemistry of polymers: textbook / VV Nyzhnyk, T. Yu. Nyzhnyk; MES - Kyiv: Phytosocial Center, 2009. – 424 p.
9. Yu.V. Mygalina, O.P. Kozar. Basics of chemistry and physico-chemistry of polymers. Textbook. — K: Condor, 2010.— 325 p.
10. Barbash V.A., Antonenko L.P., Deikun I.M. Methodical instructions for laboratory work on the chemistry of plant raw materials, Kyiv, KFTP, 2003. – 71 p.

Information resources on the Internet

1. *https://www.yakaboo.ua/fiziko-himija-polimeriv.html*
2. *https://vlp.com.ua/node/4352*
3. *https://library.sspu.edu.ua/wp-content/uploads/2018/04/38.pdf*

Educational contect

5. Methods of mastering the discipline (educational component)

Lecture classes

Lectures are aimed at forming in students a complex of knowledge necessary for qualified management of technological processes of pulp and paper production and chemical processing of plant raw materials, for which it is necessary to know: the structure, chemical composition and properties of plant raw materials and their individual components, as well as the opportunities that open up during various transformations of plant raw materials and their components to improve these processes and create new, more efficient, ecologically cleaner productions.

No s/p	***Title of the lecture topic and list of main questions (list of didactic means, references to literature and tasks on the SRS)***	***Hours***
1	*Topic 1. The purpose of the discipline and its tasks in the training of highly qualified pulp and paper engineers. Prospects for the development of the pulp and paper industry. The concept of high molecular weight compounds. Natural and synthetic polymers. Characteristic properties of high molecular weight compounds. Nomenclature and classification of high molecular weight compounds.*	***2***

	Literature: [1, p. 11-18; 2, p. 36-45] *Tasks on the* SRS: Characteristic properties of high molecular weight compounds. Nomenclature and classification of high molecular weight compounds	
2	*Topic 2. Structure and properties of high molecular weight compounds. Polymer homology series. Degree of polymerization and molecular weight. Polydispersity. Structure of molecules of high molecular weight compounds. Linear, branched and spatial polymers. Amorphous and crystalline regions in cellulose.* *Literature: [1, p. 8-23; 2, p. 58-73].* *Tasks on the SRS. Structure of molecules of high molecular weight compounds. Linear, branched and spatial polymers*	*2*
3	*Topic 3. Methods of obtaining high molecular weight compounds. Polymerization and polycondensation. Chain polymerization and its mechanism. Stepwise polymerization. Copolymerization. Polycondensation. Mechanism of polycondensation. The influence of functional initial monomers on the nature of the obtained products* *Literature: [1, p.24- 34; 2, p. 43-58].* *Tasks on the SRS. The effect of functional initial monomers on the nature of the obtained products*	*4*
4	***Section 2. Physical and chemical properties of plant raw materials*** *Topic 4. Physical properties of wood. Wood moisture. Specific and volumetric weight of wood. Conductivity. Thermal conductivity. Temperature. Chemical properties of plant raw materials. Elementary composition. Ash content and composition of ash. Chemical composition of wood, bark. Concept and definition of cellulose, hemicellulose, lignin, resins, minerals.* *Literature: : [1, p. 72-75; 2, p. 33-39].* *Tasks on the SRS. Concept and definition of cellulose, hemicellulose, lignin, resins, minerals.*	***4***
5	*Topic 5. Chemical processing of plant raw materials. Scheme of processing plant raw materials into cellulose and wood pulp. Methods of delignification of vegetable raw materials. Technical hydrolysis of wood. Dry distillation of wood. Extraction of wood with water. Softwood sawdust. Rosin. Turpentine.* *Literature: [1, p. 86-89; 2, p. 343-353].* *Tasks on the SRS. Dry distillation of wood. Extraction of wood with water. Softwood sawdust. Rosin. Turpentine.*	***4***
6	***Section 3. Chemistry of cellulose*** *Topic 6. General characteristics of cellulose. Photosynthesis of carbohydrates in plants. The mechanism of cellulose formation. Conformation of cellulose molecules. Hydrogen bonds in cellulose. The structure of cellulose fibers. Molecular heterogeneity and methods of determining the molecular mass of cellulose. Degree of polymerization and fractional composition of cellulose. Determination and production of cellulose. Qualitative and quantitative methods of cellulose determination. Basic chemical reactions. Methods of quality control.* *Literature: [1, 129-150; 2, p. 98-148]* *Tasks on the SRS. Methods of determining and obtaining cellulose. Qualitative and quantitative methods of cellulose determination. Basic chemical reactions.*	***4***
7	*Topic 7. Chemical properties of cellulose. Hydrolysis of cellulose under the action of acids. Scheme of hydrolysis of cellulose and starch. The rate of hydrolysis and factors affecting hydrolysis. Hydrolysis by dilute and concentrated acids. Reversion and inversion of sugars. Hydrocellulose and its properties. Effect of hydrogen chloride and hydrochloric acid on cellulose. Acetolysis of cellulose. Alcoholysis of cellulose.*	***4***

	Literature: [2, p. 155-160] *Tasks on the SRS. Hydrolysis by diluted and concentrated acids*	
8	*Topic 8. Oxidation of cellulose. The main directions of cellulose oxidation. Selective oxidation of cellulose. Oxidation with oxygen in an alkaline medium. The role of oxidation reactions in technological processes of obtaining and processing cellulose. Bleaching and refining of cellulose. Oxycellulose and its properties. Determination of the content of carbonyl and carboxyl groups. Products of deep oxidative decomposition of cellulose. Photochemical destruction. Action of alkalis on cellulose. Swelling and dissolution of cellulose in alkali.* *Literature: [1, p. 180-182; 2, p. 155-168]* *Tasks on the SRS. Oxycellulose and its properties. Methods of determining the content of carbonyl and carboxyl groups*	***2***
9	*Topic 9. Degree of esterification. Bath module. Factors affecting the process of cellulose esterification. Complex esters of cellulose. Acetylating agents and catalysts. Methods of cellulose acetylation. Homogeneous acetylation in an acidic medium. Primary and secondary acetates. Properties of cellulose acetates and their application. Cellulose xanthogenate and its production. Viscose. Production of viscose fiber. Viscous cellulose and its requirements.* *Literature:[1 c. 324-348, 2 c. 169-174]* *Tasks on the SRS. Methods of cellulose acetylation. Homogeneous acetylation in an acidic environment. Primary and secondary acetates*	***4***
10	*Topic 10. Simple ethers of cellulose. Classification and methods of obtaining. Properties and areas of use. Solubility of cellulose. Solubility of cellulose in copper-ammonium reagent and other complex bases. Production of copper-ammonia fiber. Solubility of cellulose in aqueous solutions of salts.* *Literature: [1, c. 337-380; 2 c. 174-176]* *Tasks on the SRS. Solubility of cellulose. Solubility of cellulose in copper-ammonium reagent and other complex bases*	***2***
11	***Section 4. Chemistry of hemicelluloses*** *Topic 11. General characteristics. The concept of hemicelluloses and their classification. Pentosans. Quantitative methods. Xylan and Araban. Formation, structure, properties. Hydrolysis of pentosans, production of xylose, xylitol, trioxoglutaric acid* *Literature: [1, c.141-142; 2, c.179-205]* *Tasks on the SRS. Application of xylan, araban and its derivatives*	***2***
12	*Topic 12. Hexosans, their properties and distribution in plant materials. Mannans, as a mixture of polysaccharides, their properties and methods of determination. Galactan, its properties and methods of determination. Arabogalactan, holocellulose* *Literature: [1, c.193-196; 2, c.179-205]* *Tasks on the SRS. Arabogalactan, holocellulose*	***2***
Total		***36***

Practical classes

As part of the teaching of the subject "Chemistry of plant polymers", practical classes are provided, which take 18 hours and make up 25% of the classroom load. The main tasks of practical classes are:

- to help students systematize, consolidate and deepen knowledge of a theoretical nature in the field of chemistry of plant polymers;
- to help students acquire the skills and abilities to perform calculations, graphics and other types of tasks;

- teach students to work with scientific and reference literature, regulatory and technical documents in the field of chemistry of plant polymers.

Topics of practical classes:

No s/p	***The name of the topic of practical training and the list of main questions (list of didactic support, references to literature and tasks to the SRS)***	***Hours***
1	Topic 1. Nomenclature and classification of high molecular weight compounds Literature: [1, p. 8 -23] Tasks on SRS: Natural, artificial and synthetic polymer	***2***
2	Topic 2. Polymerization and polycondensation. Literature: [1, p. 24-36] Tasks on SRS: Chain polymerization and its mechanism	***4***
3	Topic 3. Elemental composition of plant raw materials. Chemical composition of wood and non-wood plant material. Literature: [1, p. 72 - 85] Task on SRS: Chemical composition of bark components. Ash content and composition of ash.	*2*
4	Topic 4. Conformations of cellulose molecules. Hydrogen bonds in cellulose. The structure of cellulose fibers. Molecular heterogeneity and methods of determining the molecular mass of cellulose. Degree of polymerization and fractional composition of cellulose. Literature: [1, p. 161 - 166] Tasks on SRS: Methods of determining and obtaining cellulose. Qualitative and quantitative methods of cellulose determination. Basic chemical reactions.	*2*
5	Topic 5. Hydrolysis of cellulose under the action of acids. Scheme of hydrolysis of cellulose and starch. The rate of hydrolysis and factors affecting hydrolysis. Reversion and inversion of sugars. Literature: [1, p. 180 - 182] Tasks on SRS: Hydrolysis with dilute and concentrated acids	*2*
6	Topic 6. Chemistry of hemicellulose. Pentosans and hexosans. Hemicellulose hydrolysis reactions. Literature: [1, p. 193 - 206] Tasks on SRS: Methods of obtaining and directions of application of xylose, xylitol, trioxoglutaric acid.	*2*
7	***Writing a modular test***	***2***
8	***Test***	***2***
	Total	***18***

Laboratory work

As part of the teaching of the subject "Chemistry of plant polymers", laboratory work is provided, which occupies 25% of the classroom load. During the performance of laboratory work, students acquire practical skills of assimilating methods of chemical analysis of plant raw materials and cellulose and acquiring skills of determining the characteristics of plant polymers.

The main tasks of the cycle of laboratory work:

- *help students consolidate the acquired theoretical knowledge about the composition and chemical properties of the main components of plant raw materials;*
- *to teach students the techniques and features of preparing samples of plant raw materials and cellulose for testing by appropriate methods of determining indicators;*
- *teach students to analyze the obtained experimental results and compare them with scientific and reference literature*

No s/p	The name of the topic of laboratory work and a list of main questions	Hours
1	General rules for performing laboratory work on the chemistry of plant raw materials. Issuance of plant raw materials. Determination of humidity and ash content Tasks on SRS: Physical and chemical properties of plant raw materials Literature: [1, p. 72-85; 11, p. 3-17]	6
2	Determination of substances that are extracted with hot water and alkali Literature: [11, p. 18-21]	6
3	Determination of cellulose content by the nitric acid method Literature: [11, p. 25-26]	6
	Total	18

6. Independent work of a student/postgraduate student

Independent work of students is 48 hours of course study, includes preparation for includes preparation for laboratory and practical classes, writing a modular test and preparation for the assessment.

The main task of students' independent work is the mastery of scientific knowledge in the field of plant polymer chemistry, which was not included in the list of lecture questions, through independent study of the material based on educational literature, personal search for information, formation of active interest in a creative approach in educational work. In the process of independent work within the framework of the credit module, the student must learn to deeply analyze a problem in the pulp and paper industry and, based on the analysis, come to his own well-founded conclusions regarding the technological parameters of the technological process.

No s/p	Name of the topic submitted for self-study	hours
	Section 1. Chemistry of high molecular weight compounds	
1	Basic concepts of high molecular weight compounds Literature: [1, p. 8 -23] Methods of obtaining high molecular weight compounds Literature: [1, p. 24-36] Structure and properties of high molecular weight compounds Literature - [1, p. 57-65]	8
	Section 2. Physical and chemical properties of plant raw materials	
2	Physical and chemical properties of plant raw materials Literature: [1, p. 72 - 85] Technical hydrolysis of wood Literature: [1, p. 89 - 93]	8
	Section 3. Chemistry of cellulose	
5	General characteristics of cellulose. Hydrogen bonds Literature: [1, p. 161 - 166] Chemical properties of cellulose Literature: [1, p. 176 - 190] Oxidation and hydrolysis of cellulose Literature: [1, p. 180 - 182] Complex esters of cellulose Literature: [1, p. 385 - 420] Simple ethers of cellulose	16

	Literature: [1, p. 337 - 384]	
Section 4. Chemistry of hemicellulose		
6	*General characteristics of hemicellulose* *Literature: [1, p. 193 - 200]* *Xylan, Araban. Structure, properties. Hydrolysis of pentosans* *Literature: [1, p. 207 - 212]* *Galactan, its properties and methods of determination* *Literature: [1, p. 205 - 206]*	*8*
7	***Preparation for modular control work on chapters 1-4***	*4*
8	***Preparation for the test***	*4*
Total hours		*48*

Politics and contect

7. Policy of discipline (educational component)

Rules for attending classes and behavior in classes

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

Rules for assigning incentive and penalty points

- *encouraging points can be credited by the teacher only for the performance of creative works in the discipline or additional passage of online specialized courses with the receipt of the appropriate certificate.*

However, their amount cannot exceed 25% of the rating scale. Penalty points within the discipline are not provided.

Deadline and overlay policy

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

Academic Integrity Policy

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. Invalid hints and write-offs when writing tests, conducting classes; passing the credit for another graduate student; copying of materials protected by the copyright system without the permission of the author of the work. The policies 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"https://kpi.ua/code.

Policy of academic behavior and ethics

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

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

8. Types of control and rating system for evaluating learning outcomes (RCOs)

Distribution of educational time by types of classes and tasks in the discipline according to the working curriculum:

Semester	School time		Distribution of training hours				Control measures		
	credits	acad. H.	Lecture	Practical	Lab. Rob..	SRS	FDM	PP	Semester control
3	**4**	**120**	**36**	**18**	**18**	**48**	**1**	**-**	**Test**

The rating system for evaluating learning outcomes (RSO) of a student in a discipline consists of the points he receives for answers during express control at lectures; answers in practical and laboratory classes; execution of a modular control work, which can be divided into two 45-minute or three 30-minute works.

System of rating (weighted) points and evaluation criteria

1) Answers during express control at lectures:
Weight score - 3. Weight coefficient - 0.15. The maximum number of points for all lectures is equal to: 18 lectures (answers) x 3 points x 0.15 = 8 points
Answer evaluation criteria:

Points	Completeness of the answer
3	"excellent", Complete answer (at least 90% of the required information)
2	"good", incomplete disclosure of one of the questions or a complete answer with minor inaccuracies
1	"satisfactory", incomplete disclosure of the question (at least 60% of the required information) and minor errors
0	Unsatisfactory work (does not meet the requirements for 3 Unsatisfactory work (does not meet the requirements for 3 points).

2) Answers in practical classes:
Weight score - 3. Weight factor - 0.37. The maximum number of points in all laboratory classes is equal to: 9 practicals. (answers) x 3 points x 0.37 = 10 points
Answer evaluation criteria:

Points	Completeness of the answer
3	"excellent", Complete answer (at least 90% of the required information)
2	"good", incomplete disclosure of one of the questions or a complete answer with minor inaccuracies
1	"satisfactory", incomplete disclosure of the question (at least 60% of the required information) and minor errors
0	Unsatisfactory work (does not meet the requirements for 3 Unsatisfactory work (does not meet the requirements for 3 points).

3) Answers in laboratory works:
Weight score - 8. Weight factor - 1.0. The maximum number of points for all laboratory classes is equal to: 3 labs (answers) x 8 points x 1.0 = 24 points
Answer evaluation criteria

Бали	Completeness and signs of response
1	knowledge of theoretical material;
1	knowledge of analysis methods;
1	the presence of a work performance protocol in the laboratory journal;
1	when performing laboratory work, reliable results were obtained

1	correctly performed calculations in the report;
1	the availability of conclusions from laboratory work
2	clear answers to questions during the defense of laboratory work;
1	there are inaccuracies and errors in the answer during the defense of laboratory work
0	the answers do not correspond to the formulated topic; all the questions asked remained unanswered. Protection of laboratory work is not included.
8	The maximum amount of points for laboratory work

4) Completion of a modular control work, which consists of answers to 6 questions from different sections of the academic discipline and is performed in written form by one's own hand without the use of computer equipment.

Weight score - 3. Weight factor - 1.0. The maximum number of points for a modular test is: 6 questions x 3 points x 1.0 = 18 points

Answer evaluation criteria:

Points	Completeness of the answer
3	"excellent", Complete answer (at least 90% of the required information)
2	"good", incomplete disclosure of one of the questions or a complete answer with minor inaccuracies
1	"satisfactory", incomplete disclosure of the question (at least 60% of the required information) and minor errors
0	Unsatisfactory work (does not meet the requirements for 3 Unsatisfactory work (does not meet the requirements for 3 points).

Calculation of the rating scale (R).

The rating scale of the discipline (R) is 100 points and is formed as the sum of all the rating points of the starting scale (Rc), received by the student based on the results of current control measures, and the rating scale (Rч) of the rating. The size of the starting scale (Rc) of the Rc rating is 60 points: Rc = 8 + 10 + 24 + 18 = 60 points, and the size of Rз = 40 points. Thus, the rating scale for the discipline is: R = RS + Rz = 60 + 40 = 100 points.

Semester control is test. Criteria: The answer to four questions, each of which has a weighting point of 10. The maximum number of points is 10 x 4 = 40 points.

According to the results of academic work in the first 7 weeks, a student can score 20 points. At the first certification (8th week), the student receives "credited" if his current rating is at least 10 points. According to the results of 13 weeks of study, the student must score 40 points. At the second certification (14th week), the student receives "passed" if his current rating is at least 20 points. Regular positive answers in lectures, practical and laboratory classes, writing a modular test, as well as a starting rating (Rc) of at least 40% of Rc, i.e. 24 points, are a necessary condition for admission to the credit. A student who scored a rating of less than 0.6 Rs during the semester completes a credit test. At the same time, all points received by him during the semester are cancelled. The task of the control work contains questions related to different sections of the program. The list of assessment questions is given in Chapter 9.

In order for a student to receive a passing grade, the sum of all rating points R earned during the semester is converted according to the table:

Number of points	**Evaluation**
95...100	excellent
85...94	very good
75...84	*good*
65...74	satisfactory
60...64	*enough*
RD <60	unsatisfactory

Unfulfilled conditions of admission	are not admitted

9. **Additional information on the discipline (educational component)**

Approximate list of questions submitted for semester control

1. General characteristics of the pulp and paper industry of Ukraine
2. General characteristics of the pulp and paper industry of Ukraine
3. Classification of high molecular weight compounds (HMW)
4. Ways and methods of obtaining the Navy. Polymerization
5. Radical polymerization
6. Industrial methods of carrying out the polymerization process
7. Chain mechanism of polymerization
8. Ionic polymerization
9. Polycondensation. Polycondensation process in industry
10. Chemical composition of wood. Characteristics of the main components
11. Elementary composition of wood. Ashiness Ash composition
12. Photosynthesis in plants
13. Hydrogen bond in cellulose
14. General characteristics of cellulose. Cellulose formula
15. Supramolecular structure of cellulose
16. Conformations in the cellulose macromolecule
17. End links in the cellulose macromolecule
18. Average elementary units of cellulose macromolecules
19. Degree of cellulose polymerization
20. Conformations of cellulose molecules
21. Chemical properties of cellulose. Factors affecting the destruction of cellulose
22. Effect of hydrochloric acid on cellulose
23. Technical hydrolysis of wood. Hydrolysis of cellulose.
24. Effect of hydrogen chloride and hydrochloric acid on cellulose
25. Acetolysis and alcoholysis of cellulose
26. Splitting of cellulose under the action of alkalis
27. Oxidative splitting of cellulose
28. Decomposition of cellulose by bacteria and fungi
29. General characteristics of pentosans. Xylan.
30. Pectin substances, their characteristics. Polyuronic acids
31. Hexosans. General characteristics
32. Simple cellulose ethers
33. Ethyl ethers of cellulose
34. Carboxymethylcellulose
35. Methyl ethers of cellulose
36. Complex cellulose esters
37. Sulfuric acid esters
38. Chemistry of obtaining nitrocellulose
39. Esters of cellulose and acetic acid
40. Esters of cellulose and dithiocarbonic acid

Work program of the academic discipline (syllabus):
Compiled by professor, Ph.D. Barbash Valerii Anatoliyovych
Approved by the ___ETRP___ department *(protocol No. _14_ from _06.08.2022_)*
Agreed by the ECF Methodical Commission *(protocol No. _10_ from _24.06. 2022_)*