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

Department of machines and devices of chemical and oil refining industries

Technology of manufacturing, installation and operation of heat exchange equipment

Working program of the academic discipline (Syllabus)

Details of the academic discipline

Level of higher education	***First (undergraduate)***
Branch of knowledge	*13 Mechanical engineering*
Specialty	*133 Industrial engineering*
Educational program	*Computer-integrated technologies of chemical engineering equipment design*
Discipline status	*selective*
Form of education	*daytime*
Year of training, semester	*4th year, autumn semester*
Scope of the discipline	*4 ECTS credits / 120 hours*
Semester control/ control measures	*assessment, modular control work, calculation and graphic work*
Lessons schedule	*3 hours per week (2 hours of lectures and 1 hour of practical classes) https://schedule.kpi.ua/*
Language of teaching	*Ukrainian*
Information about the course leader / teachers	**Lecturer:** *associate professor of the Department of machines and devices of chemical and oil refining industries, candidate of technical sciences Novokhat Oleh Anatoliyovych,* *email: novokhatoleh@gmail.com , telegram:@Novokhat_Oleh* **Practical:** *associate professor of the Department of machines and devices of chemical and oil refining industries, candidate of technical sciences Novokhat Oleh Anatoliyovych,* *email: novokhatoleh@gmail.com , telegram:@Novokhat_Oleh*
Placement of the course	*https://ci.kpi.ua/силабусы/silabus-24-25/*

Program of educational discipline

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

1.1. The purpose of the educational discipline

The purpose of the credit module is to form students' abilities to:

• determine the method and method of manufacturing heat exchange equipment;

• develop technological processes of manufacturing, assembling, testing and quality control of heat exchange equipment;

• to rationally select structural materials in view of manufacturability and economic indicators of mechanical engineering products;

• determine the method and method of installation of heat exchange equipment;

• determine the norms of operation of the equipment to comply with all safety requirements.

1.2. The main tasks of the credit module

After mastering the credit module, students must demonstrate the following learning outcomes:

KNOWLEDGE:

• develop technological equipment;
• develop technological processes of assembly, testing and quality control;
• determine the completeness of the object (machine, vessel or device) being designed;
• determine the method and method of assembling the manufactured object;
• carry out facility tests;
• general principles of modeling and design, development of technical characteristics and layouts of heat exchange equipment of chemical, oil refining, biotechnological and refrigeration industries.

SKILLS:

make a design selection and determine the size and shape of the structural elements of the equipment;

correctly select structural materials in view of manufacturability and economic indicators of mechanical engineering products;

make a choice of rational technological equipment;

using normative, design and technological documentation to develop technological equipment for mechanical processing of large workpieces;

to develop technological processes of assembly, testing and quality control of chemical devices;

determine the method and method of assembling the manufactured object;

The knowledge, skills and experience gained while studying this discipline will be useful for further professional activities.

Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

This academic discipline is optional. To successfully master this discipline, a student must meet all of the following criteria:

- have the ability and skills to work with a personal computer at the level of a confident user;
- know and understand the basic principles of organizing and searching for information in computer systems;
- to know the basics of heat exchange processes and the equipment in which they are implemented.

2. Content of the academic discipline

The educational discipline "Technology of manufacturing, installation and operation of heat exchange equipment" consists of the following topics:

1. Technology of manufacturing elements of typical heat exchange equipment.
2. Basics of installation of typical heat exchange equipment.
3. Measures of safe operation of typical heat exchange equipment.

3. Educational materials and resources

Basic literature

1. Андреєв І.А. Основи надійності та довговічності обладнання хімічних виробництв [Електронний ресурс]: Навчальний посібник. НТУУ «КПІ».– Київ: НТУУ «КПІ», 2013.
2. Мікульонок І. О. Виготовлення, монтаж та експлуатація обладнання хімічних виробництв [Текст] : підруч. [для студ. вищ. навч. закл.]. – К. : НТУУ «КПІ», 2012. – 419 с.: іл. – Бібліогр.: с. 413–415.
3. Методичні вказівки з дисципліни „Монтаж та експлуатація обладнання хімічних виробництв” студентів першого (бакалаврського) рівня вищої освіти спеціальності „Обладнання хімічних виробництв і підприємств будівельних матеріалів”: [Електронний ресурс]: / НТУУ „КПІ‖; уклад. Двойнос Я.Г. – Київ: НТУУ „КПІ ім. Ігоря Сікорського‖, 2016. – 74 с.
4. 3. Андреєв І.А., Мікульонок І.О. Розрахунок, конструювання та надійність обладнання хімічних виробництв: Термінологічний словник.–К.: ІВЦ «Видавництво ”Політехніка”», 2002.–216 с.
5. Мікульонок І. О. Технологія виготовлення обладнання хімічних виробництв / І. О. Мікульонок. — К. : ІЗМН, 2000. — 282 с.
6. 13. ГСТУ 3-17-191–2000 Посудини та апарати стальні зварні. Загальні технічні умови.

7. 14. ДНАОП 0.00-1.07–94 Правила будови та безпечної експлуатації посудин, що працюють під тиском. - К.: Держнаглядохоронпраці, 1998. – 343 с.

Additional literature

8. Мікульонок І. О. Проектування теплової ізоляції обладнання хімічних виробництв : навч. посібник / І. О. Мікульонок. — К. : Наук. думка, 1999. — 152 с.
9. 12. Монтаж нарізних з'єднань : метод. вказівки / уклад. І. О. Мікульонок. — Київ, НТУУ «КПІ», 2005. — 40 с.
10. Виготовлення, монтаж та експлуатація обладнання хімічних виробництв [Текст] : підруч. [для студ. вищ. навч. закл.]. – К. : НТУУ «КПІ», 2012. – 419 с.: іл. – Бібліогр.: с. 413–415.
11. Марчевський В.М. Конструкторська документація курсових і дипломних проектів: Навч. посіб. для студ. вищ. навч. закладів –К.: Норіта-плюс, 2006. – 280с.
12. Маліцький, Ігор Федорович. Технологія машинобудування: навч. посіб. для студ. машинобудівельних спец. / І.Ф. Маліцький ; МОН України, Українська інженерно-педагогічна академія. - Харків, 2011. - 152 с. : іл.
13. Божидарнік, Віктор Володимирович Технологія виготовлення деталей виробів: Навч. посіб. / В. Божидарнік, Н. Григор'єва, В. Шабайкович ; Луцький держ. техн. ун-т. - Луцьк : "Надстир'я", 2006. - 592 с.
14. Технологія машинобудування : підручник для студ. внз за напр. "Комп'ютерні системи, автоматика і управління, " Автоматизація та комп'ютерно-інтегровані технології", "Інженерна механіка" / П.П. Мельничук, А.І. Боровик, П.А. Лінчевський, Ю.В. Петраков ; Житомирський держ. технолог. ун-т. - Житомир : ЖДТУ, 2005. - 882 с.
15. Кольорові метали та сплави : навчальний посібник / Л. Богун [та ін.] ; за загальною редакцією З. Дурягіної ; Міністерство освіти і науки України, Національний університет "Львівська політехніка". - Львів : Видавництво Львівської політехніки, 2017- - ч. : іл., табл.

Educational content

4. Methods of mastering an educational discipline (educational component)

The structure of the credit module

Names of sections, topics	Number of hours				
	In total	including			
		Lectures	Practical training	Laboratory	SRS
Topic 1.Manufacturing technology of elements of typical heat exchange equipment.	64	22	10		32
Topic 2.Basics of installation of typical heat exchange equipment.	32	10	6		16
Topic 3.Measures of safe operation of typical heat exchange equipment.	14	4	2		8
MKR	4				4
Test	6				6
Hours in general	**120**	**36**	**18**		**66**

Lecture classes

No. z/p	The name of the topic of the lecture and a list of main questions (a list of didactic tools, references to the literature and tasks on the SRS)
Section 1. General information about the material and its processing for the manufacture of apparatus for chemical industries.	

Topic 1. Manufacturing technology of elements of typical heat exchange equipment.
Lecture 1. Basic terms, concepts and regulatory documents. Typical heat exchange equipment. Classification of materials. Literature [1, 2, 5]. Tasks on SRS. Modern invented materials. Graphene
Lecture 2. Preparatory operations Literature [1, 2, 5]. Tasks on SRS. Methods of cutting blanks.
Lecture 3. Production of customs Literature [1, 2, 4, 5]. Tasks on SRS. Electric hoists.
Lecture 4. Making bottoms Literature [1, 2, 4, 5]. Tasks on SRS. Marking tool.
Lecture 5. Production of flanges Literature [1, 2, 4, 5]. Tasks on SRS. Types of welding.
Lecture 6. Production of pipe grids and toroidal inserts Literature [1, 2, 4, 5]. Tasks on SRS. Groove milling.
Lecture 7. Production of pipeline parts and equipment parts from pipes Literature [1, 2, 4, 5]. Tasks on SRS. Welding of polymer pipes.
Lecture 8. Assembling typical units and devices Literature [1, 2, 5, 6]. Tasks on SRS. Quality control of welded joints.
Lecture 9. Heat treatment. Coating of metal surfaces. Literature [1, 2, 5, 6]. Tasks on SRS. Production of workpiece holders in furnaces.
Lecture 10. Equipment testing Literature [1, 2, 5, 7]. Tasks on SRS. Normative documentation of state supervision of vessels under excessive pressure.
Lecture 11. Transportation and storage of equipment Literature [1, 2, 5]. Tasks on SRS. Environmental impact of various methods of equipment transportation.
Topic 2. Basics of installation of typical heat exchange equipment.
Lecture 12. General issues of organizing equipment installation Literature [1, 2, 3, 5]. Tasks on SRS. Documentation of installation works.
Lecture 13. Preparation of equipment and foundations for installation Literature [1, 2, 3, 5]. Tasks on SRS. Geodetic survey of the area.
Lecture 14. Installation of equipment on the foundation Literature [1, 2, 3, 5]. Tasks on SRS. Types of software for computer design of the workshop.
Lecture 15. Rigging works Literature [1, 2, 3, 5]. Tasks on SRS. Safety techniques during rigging work.
Lecture 16. Dismantling and disassembly of the product Literature [1, 2, 3, 5].

Tasks on SRS. Ways of disposal of environmentally hazardous and unusable equipment.
Topic 3. Measures of safe operation of typical heat exchange equipment.
Lecture 17. Equipment reliability and operational documentation Literature [1, 2, 5, 7]. Tasks on SRS. The economic factor influencing the choice of material.
Lecture 18. Basics of equipment maintenance and repair Literature [1, 2, 5]. Tasks on SRS. Complaint.

Practical training

No. z/p	The name of the topic of the lecture and a list of main questions (a list of didactic tools, references to the literature and tasks on the SRS)
Topic 1.Manufacturing technology of elements of typical heat exchange equipment.	
Practical lesson 1. Calculation of the dimensions of the sweep of the custom.	
Practical lesson 2. Making an elliptical bottom	
Practical lesson 3. Calculation of reinforcement of holes	
Practical lesson 4. Selection of the type of connection of pipes with pipe grids	
Practical exercise 5. Calculation of compensators on steam and hot water pipelines	
Topic 2. Basics of installation of typical heat exchange equipment.	
Practical lesson 6. Static calculation of column foundation for equipment	
Practical lesson 7. Study of methods of placing axes and height marks during installation of equipment	
Practical lesson 8. Study of manufacturing accuracy and centering of shafts	
Topic 3. Measures of safe operation of typical heat exchange equipment.	
Practical lesson 9. Evaluation of reliability of equipment elements.	

Laboratory classes

According to the curriculum, laboratory classes are not provided.

Modular control work

The modular control work is conducted once at the end of the discipline in the form of a test on the theoretical information provided in the lectures.

Calculation and graphic work

Calculation and graphic work consists in performing the calculation of the heat exchange equipment with a description of the manufacturing algorithm of its constituent parts, the technological scheme of production, the scheme of its assembly and one A1 format. The deadline is before the credit session.

5. Independent work of student

Students' independent work within this course involves:

- preparation for the lecture, which includes familiarization with the provided text of the lecture, identification of poorly understood fragments and theses, identification of questions that, in the student's opinion, need more extensive coverage, preparation of questions to the teacher that are planned to be asked during the lecture (up to 1-2 hours for each lecture) ;

- preparation for practical classes, which includes familiarization with the topic and purpose of the class, task, familiarization with control questions and formation of answers to them (up to 30-60 minutes for each practical work);
- preparation of reports based on the results of work carried out in practical classes (up to 30-60 minutes for each practical class);
- preparation for the modular control work (2 hours);
- preparation for the test (6 hours).

Policy and control

6. Policy of educational discipline

The system of requirements that the teacher sets before the student:

6.1. Attendance and behavior in classes.

- the student must come to class prepared;
- turning off mobile phones or switching them to silent mode in all classes and during consultations is mandatory;
- attendance at lectures on the discipline is welcome and will contribute to better learning of the discipline;
- the student's activity in lectures and the ability to ask questions about the topic of the lecture to the teacher are welcome;
- attending laboratory classes and completing tasks during practical classes is mandatory;
- the use of information search tools is allowed (except for control classes);
- free movement of the audience is allowed during practical (but not lecture) classes.

6.2. Issuance of penalty and incentive points.

- incentive points are awarded to students who completed additional work tasks or tasks of increased complexity during the class;
- incentive points are awarded to students who proposed a different way of completing the task, not provided for in the work plan;
- skipping practical classes without a good reason leads to the issuance of zero points according to its results, but it is absolutely necessary to complete the work tasks;
- skipping the modular test without a good reason leads to the issuance of zero points based on its results.

6.3. Policy of deadlines and rescheduling.

- at the beginning of the next practical session, the student must submit a completed report based on the results of the previous session;
- repeated execution of modular control work is not allowed;
- writing a modular test by students who did not write it on time without a good reason is not allowed;
- retaking the test is allowed only in the manner prescribed by the regulatory documents on the organization of the educational process of KPI named after Igor Sikorsky.

6.4. Academic Integrity Policy.

- students studying the discipline must adhere to the rules and norms of academic integrity when performing all types of work.

7. Types of control and rating system for evaluating learning outcomes (RSO)

The student's credit module rating consists of points obtained for:

1) performance of 9 practical works in classroom classes;
2) execution of modular control work;
3) performance of calculation work.

The total score for the three items listed is 100 points.

8.1. Performance of practical works

A total of 9 practical works are provided during the semester. The weighted point is 5. The maximum number of points for all works is 9×5 = 45 points. Points are awarded as follows:

- work tasks were completed correctly and on time, within the set time of the lesson, correct answers were received - 4-5 points;
- the task of the work was completed partially correctly during the set time of the lesson, and it was not completed completely, in a time exceeding the time of the practical lesson, a part of the correct answers was obtained - 2-3 points;
- work tasks not completed or completed incorrectly - 1 point.

*Note:*if the student was absent from class for a valid reason, which is documented and presented at the next class the completed task of the missed work, the work is considered completed on time.

8.2. Modular control work

The weighted score is 15. The evaluation of the work task is carried out according to the following scale:

- data analysis is correct, the answer is correct - 14-15 points;
- the data analysis is correct, the answer is correct, there are minor inaccuracies - 10-13 points;
- the course of data analysis is generally correct, but there are errors that do not make it possible to get a correct answer, only the analysis algorithm is given, but the analysis itself is missing or completely incorrect - 6-9 points;
- the completed task has a number of critical errors - 1-5 points
- incorrectly selected data analysis method, incorrectly selected analysis algorithm or missing task - 0 points.

8.3. Calculation and graphic work

The weighted score is 40. The evaluation of the work task is carried out according to the following scale:

- work performed in full, on time, a one-time consultation is allowed for each section (stage), there may be some inaccuracies - 35-40 points;
- the work was completed late, there are a number of inaccuracies or non-critical errors - 20-34 points;
- the work contains a number of errors that affected the correct execution, some elements of the work may be missing - 5-19 points;
- the work contains less than 30% of the required amount of execution, contains many critical errors, incorrect execution - 1-4 points;
- the work is not completed or does not correspond to the assigned task - 0 points.

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

The maximum amount of points during the semester is: R = 45 + 15 + 40 points = 100 points.

According to the results of the educational work in the first 7 weeks, the "ideal achiever" should score 15 points. At the first attestation (8th week), the applicant receives "credited" if his current rating is at least 7 points.

According to the results of the educational work for 13 weeks of training, the "ideal achiever" should score 30 points. At the second certification (15th week), the applicant receives "credited" if his current rating is at least 20 points.

The maximum number of points is 100.

Semester control: assessment.

Table of correspondence of rating points to grades on the university scale:

Scores	***Rating***
100 ... 95	*perfectly*

94 ... 85	*very good*
84 ... 75	*fine*
74 ... 65	*satisfactorily*
64 ... 60	*enough*
0 ... 60	*unsatisfactorily*
20	*not allowed*

8. Additional information on the discipline (educational component)

9.1. Completion of credit work

If desired (in order to increase the total final score), it is allowed to complete a credit work. At the same time, points obtained for practical classes and modular control work are canceled. It is impossible to cancel the total score obtained with the completed credit work.

Passing all the practical tasks is the admission to the assessment work.

The maximum score is 60. The credit card consists of 4 theoretical questions according to the topics of lectures and practical classes. The weighted score of each question is 15.

Evaluation of the work task is carried out according to the following scale:

- performing the task correctly and without errors - 15 points;
- the performance of the task is correct and without errors, there are minor inaccuracies - 12-14 points;
- the description is generally correct, but there are non-critical errors - 7-11 points;
- the description of the given question is quite accurate, but there are a number of fairly gross errors - 3-6 points;
- only certain fragments are given correctly, but the task itself was not completed, or was completed completely incorrectly - from 1-2 points;
- the provided description of theoretical information does not correspond to the question asked or it is missing, the work performed in gross violation of the rules and norms of academic integrity is evaluated with a score of 0 points.

9.2. Enrollment of distance or online course certificates

For students who have completed distance learning or online courses on the relevant subject, this training can be counted as studying this academic discipline if all the following conditions are met:

- the student provided a certificate or other document that confirms his completion of a distance or online course and provided an opportunity to verify its authenticity;
- a distance or online course posted on the platform or conducted by an organization that is recommended or recognized by KPI named after Igor Sikorskyi;
- the volume of the distance or online course is at least 108 study hours;
- the list of topics studied in the distance or online course contains at least two topics specified in the content of the academic discipline (item 2 of the syllabus); in the case of a difference in titles, the correspondence of the content of the topics is established on the basis of a comparative analysis with the distance or online course program;
- the student's success rate based on the results of studying a distance or online course is at least 75% of the maximum.

Working program of the academic discipline (syllabus):

composed *associate professor of the Department of machines and devices of chemical and oil refining industries, candidate technical Science* ***Oleh NOVOKHAT***

approved *department of machines and devices of chemical and oil refining industries*

(protocol No. 20 dated June 12, 2025)

agreed *Methodical Commission of the Faculty of Chemical Engineering*

(protocol No. 11 dated June 27, 2025)