Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Machines and Apparatus of Chemical and Oil Refining Production

# "Computer design of of heat exchange equipment"

## The silhouette of the discipline

| Details of the discipline | |
|---|---|
| **Level of higher education** | **First (bachelor's) degree** |
| **Field of expertise** | 13 - Mechanical engineering |
| **Specialty.** | 133 - Industrial engineering |
| **Educational program** | "Computer-integrated technologies for designing chemical engineering equipment" |
| **Status of the educational component** | Selective |
| **Scope of the discipline** | 120 hours/ 4 ECTS credits |
| **Year of study, semester** | 3 (2 for the accelerated form) year of study, fall semester |
| **Form of study** | Full-time (daytime) |
| **Class schedule** | 1 lecture and 2 computer workshops every two weeks |
| **Semester control / control measures** | Credit / ICR, WGD |
| **Language of instruction** | Ukrainian |
| **Information about the course leader / teachers** | D., Associate Professor, Seminsky Oleksandr Olehovych, forstd@ukr.net , @mahnv_kpi;<br>Byshko Nikita Andreyevich |
| **Placement of the course** | http://ci.kpi.ua |

## Program of the discipline

### 1. Description of the discipline, its purpose, subject matter and learning outcomes

The discipline "Computer-aided design of heat exchange equipment" is designed to expand the basic competencies in the design of heat exchange equipment, which provides a complement to the regulatory component of professional training of students in the program "Computer-integrated technologies for designing chemical engineering equipment" in accordance with the requirements of stakeholders.

***The aim of the discipline*** is to improve competencies in the design of heat exchange equipment.

The discipline forms the following ***competencies***:

- Ability to think abstractly.
- Ability to apply knowledge in practical situations.
- Ability to plan and manage time.
- Ability to generate new ideas (creativity).
- Skills in the use of information and communication technologies.

- Ability to learn and master modern knowledge.
- Ability to apply typical analytical methods and computer software tools for solving chemical engineering problems, effective quantitative methods of mathematics, physics, engineering sciences, as well as appropriate software for solving chemical engineering problems.
- Ability to implement engineering developments in industrial engineering, taking into account technical, organizational, legal, economic and environmental aspects throughout the entire life cycle of machines and devices: from design, construction, operation, maintenance, diagnostics and disposal.
- Ability to use computer-aided design systems and specialized application software to solve problems in chemical engineering.
- Ability to realize creative and innovative potential in project developments in the field of processes and equipment of chemical and related technologies.

The ***program learning outcomes*** after studying the discipline include:
- Analyze engineering objects, processes, and methods.
- Understand the methods and have the skills to design standard equipment, its components and elements in accordance with the task.
- Develop machine parts and assemblies using computer-aided design systems.

## 2. Prerequisites and post-requisites of the discipline (place in the structural and logical scheme of study in the relevant educational program)

The discipline is based on the educational components "Engineering and Computer Graphics" and "Fundamentals of Computer Engineering". It provides special courses of professional training, primarily Calculations and Design of Standard Equipment and Processes and Equipment of Chemical Technology, as well as the educational components Undergraduate Practice and Diploma Design.

## 3. Content of the discipline

1. Design of shell and tube apparatus and their elements.
2. Design of plate and spiral heat exchangers.
3. Design of boilers.
4. Design of heaters.
5. Design of evaporators.
6. Design of apparatus supports.

## 4. Training materials and resources

**Basic literature:**

1. Design and calculation of shell-and-tube heat exchangers [Electronic resource]: a textbook for students majoring in 133 "Industrial Engineering" / Igor Andreev; Igor Sikorsky Kyiv Polytechnic Institute.
2. Design and calculation of supporting units of vessels and apparatus of chemical production [Electronic resource]: a textbook for students majoring in 133 "Industrial Engineering" / I. A. Andreev; Igor Sikorsky Kyiv Polytechnic Institute.
3. (2003). *Heat exchangers. Determination of the performance characteristics of heat exchangers and a general test method for determining the performance characteristics of all heat exchangers: DSTU EN 305-2001 (EN 305:1997, IDT): National Standard of Ukraine: introduced for the first time: in force since 2003-07-01 = Heat exchangers. Determination of performance of heat exchangers and general test method for determining the performance of all heat exchangers = Heat exchangers. Definition of performance of heat exchangers and the general test procedure for establishing performance of heart exchangers*. Kyiv: Derzhspozhyvstandart Ukrainy.
4. (2001). *Collapsible plate heat exchangers. Parameters and main dimensions: DSTU 3949-2000 : State Standard of Ukraine : introduced for the first time (with the abolition of GOST 15518-87 in Ukraine) : in*

*force since 2001-01-01 = Plate heat exchange devices collapsible. Parameters and main dimensions = Plate heat exchanges divisibles. Parameters and basic dimensions*. Kyiv: Gosstandart of Ukraine.

5. Ivanchenko, V.V., Barvin, O.I. and Shtonda, Y.M. (2006). *Design and calculation of shell-and-tube heat exchangers*. Luhansk: V. Dahl Volyn National University.

6. Kulinchenko, V. R., & Mironchuk, V. G. (2014). *Evaporation and evaporators in calculations and design: a textbook for students of higher educational institutions*. Kyiv: Kondor.

## Educational content

### 5. Methods of mastering the discipline

**Calendar and thematic plan**

| *Week* | *The content of the training work* | *SRS (66 hours according to the curriculum)* |
|---|---|---|
| 1, And a week | **Lecture 1:** Design features and classification of shell-and-tube heat exchangers. | Install and configure SolidWorks |
| 2, And a week | **Computer workshop 1.** Design of distribution chambers of heat exchangers. | Practical training on the topic of the class. |
| 3, Week 2 | **Computer workshop 2.** Design of tubes and shells of heat exchangers. | Practical training on the topic of the class. |
| 4, And a week | **Lecture 2:** Highly efficient compact recuperative heat exchangers. | Study the topic of the class. Work with the recommended literature. |
| 5, And a week | **Computer workshop 3.** Design of rotary and outlet chambers of heat exchangers. | Practical training on the topic of the class. |
| 6, Week 2 | **Computer workshop 4.** Design of spiral heat exchangers. | Practical training on the topic of the class. |
| 7, And a week | **Lecture 3** Design of boilers and liquid heaters. | Study the topic of the class. Work with the recommended literature. |
| 8, And a week | **Computer workshop 5.** Designing a boiler with a spiral heater. | Practical training on the topic of the class. |
| 9, Week 2 | **Computer workshop 6.** Designing a boiler with a U-shaped heater. | Practical training on the topic of the class. |
| 10, And a week | **Lecture 4.** Features of calculations of regenerative heat exchangers. | Working out the topic of the lesson.<br>Work with the recommended literature. |
| 11, And a week | **Computer workshop 7.** Design of plate heat exchangers. | Practical training on the topic of the class. |
| 12, Week 2 | **Computer workshop 8.** Design of heaters (air heaters). | Practical training on the topic of the class. |

| *Week* | *The content of the training work* | *SRS (66 hours according to the curriculum)* |
|---|---|---|
| 13, And a week | **Lecture 5.** Design of evaporators. | Working out the topic of the lesson. Work with the recommended literature. |
| 14, And a week | **Computer workshop 9.** Design of an evaporator with an internal heating chamber. | Practical training on the topic of the class. |
| 15, Week 2 | **Computer workshop 10.** Design of an evaporator with a suspended heating chamber. | Practical training on the topic of the class. |
| 16, And a week | **Lecture 6.** Features of installation of thermal equipment. | Working out the topic of the lesson. Work with the recommended literature. |
| 17, And a week | **Computer workshop 11.** Design of an evaporator with a remote heating chamber. | Practical training on the topic of the class. |
| 18, Week 2 | **Computer workshop 12.** Design of a direct-flow evaporator with a rising film. | Practical training on the topic of the class. |
| 19, And a week | **Lecture 7.** Features of the operation of thermal equipment. | Study the topic of the class. Work with the recommended literature. |
| 20, And a week | **Computer workshop 13.** Design of an evaporator with forced circulation. | Practical training on the topic of the class. |
| 21, Week 2 | **Computer workshop 14.** Design of a rotary film apparatus. | Practical training on the topic of the class. |
| 22, And a week | **Lecture 8.** Master class on design. | Study the topic of the class. Work with the recommended literature. |
| 23, And a week | **Computer workshop 15.** Design of supports for heat exchange equipment. | Practical training on the topic of the class. |
| 24, Week 2 | **Computer workshop 16.** Presentations of calculation and graphic works. | Preparing a presentation of the calculation and graphic work. |
| 25, And a week | **Lecture 9.** Master class on design. | Study the topic of the class. Work with the recommended literature. |
| 26, And a week | **Computer workshop 17.** Modular control work. | Preparing for a module test. |
| 27, Week 2 | **Computer workshop 18.** Final lesson. | Preparing for the final lesson. |

## 6. Independent work of the student

The types of independent work are listed in the table in paragraph 5, according to the academic weeks and scheduled classes.

## Policy and control

## 7. Policy of the academic discipline (educational component)

A system of requirements for students:

- **rules for attending classes** - attendance at all types of classes (lectures, computer workshops) is mandatory both in classrooms and in distance learning. In the latter case, classes are held in Zoom conferences and students attend them by connecting to the links provided by teachers;
- **rules of behavior in the classroom** - not to interfere with other students' listening to lectures or working in practical classes by unnecessary activities or conversations (including by phone). In the classroom and during distance learning at home, follow safety rules;
- **rules for crediting practical classes and awarding points for their completion** - the teacher evaluates the student's work during the class, the quality and timeliness of the presentation of the results of the assignment;
- **rules for awarding reward and penalty points** - no reward and penalty points are provided;
- **policy of deadlines and retakes**:
  1) all assignments are submitted and evaluated exclusively during classroom sessions;
  2) passing/retaking of the test is carried out according to the schedule established at the university level within the timeframe determined by the teacher and communicated to students when the rating scores are announced;
- **Policy on Academic Integrity** - students are required to comply with the provisions of the Honor Code and the requirements of academic integrity during the educational process.

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

**Current control**. Students receive points:

1. For completing computer workshops - up to 4 points for each workshop (maximum 60 points for all workshops):

4 points are awarded for excellent completion of the task;

3 points are awarded for good performance of the task;

2 points are awarded for satisfactory completion of the task;

1 point is awarded for a sufficient level of task performance, taking into account the completeness of the task.

2. Up to 20 points for completing a module test. Points are awarded based on the completeness and correctness of the work.

3. Up to 20 points for completing the calculation and graphic work. Points are awarded based on the completeness and correctness of the work.

**Calendar control**: is carried out twice a semester on weeks 7-8 and 14-15 as a monitoring of the current state of fulfillment of SilaBus requirements - a student receives "satisfactory" during the first and second calendar control if his/her current rating is at least 0.5 of the maximum number of points possible at the time of control.

**Semester control** is carried out in the form of a test, which is given at the last practical lesson based on the results of work in the semester in accordance with the student's rating in the discipline.

**Conditions of admission to semester control**:

- admission to the test is possible only in case of successful completion of all computer workshops, writing a module test and submitting a calculation and graphic work;
- students who received a total rating score of < 25 during the semester are not allowed to take the test.

**Table of correspondence between rating points and grades on the university scale**:

| *Number of points* | *Assessment.* |
|---|---|
| 100-95 | Excellent |
| 94-85 | Very good |
| 84-75 | Okay. |
| 74-65 | Satisfactory |
| 64-60 | Enough |
| Less than 60 | Unsatisfactory |
| The conditions for admission are not met | Not allowed |

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

Lectures are held in the form of master classes supplemented by explanations of theoretical material.

Retakes are conducted according to a "soft" scheme (with the points gained during the semester). In this case, 10 penalty points are removed for each retake.

**The silhouette of the discipline:**

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**Approved by the** Methodological Commission of the Faculty of Engineering and Chemistry (Minutes No. 10 of May 26, 2023).