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

Machines and apparatus for chemical and oil refining industries

PROCESSES AND EQUIPMENT

HEAT GENERATION

Syllabus of the academic discipline (Syllabus)

Academic discipline requirements

Level of higher education	***First (bachelor's)***
Discipline	*13 Mechanical Engineering*
Specialty	*133 Industrial mechanical engineering*
Educational program	*Computer-integrated technologies for chemical engineering equipment design*
Discipline status	*Selective*
Form of study	*full-time (day)*
Year of training, semester	*3rd year, spring semester, 2nd year accelerators, spring semester*
Scope of the discipline	*4 credits*
Semester control/control measures	*Credit, MCR, calculation work*
Class schedule	*http://rozklad.kpi.ua/Schedules/ScheduleGroupSelection.aspx*
Language of instruction	*Ukrainian*
Information about course leader/teachers	*Lecturer /Practical:Associate Professor of the Department of MACORI, Candidate of Technical Sciences, Associate Professor A.R. Stepanyuto, < arstepaniuk@gmail.com >*
Course placement	https://ci.kpi.ua/uk/syllabuses-bac-disciplines/#place

Academic discipline program

Description of the academic discipline, its purpose, subject of study and learning outcomes
The purpose of the academic discipline.
The purpose of the academic discipline is to develop students' competence in:

- *The ability to think systematically.*
- *Ability to plan and manage time.*
- *Ability to search, process and analyze information from various sources.*
- *Ability to apply knowledge in practical situations.*
- *Ability to learn and master modern knowledge.*
- *The ability to generate new ideas (creativity).*
- *The ability to think systematically.*
- *Ability to achieve set goals.*
- *Ability to show initiative and creativity in solving assigned tasks.*
- *The ability to express one's point of view in a convincing and clear manner.*
- *The ability to work with information (search, process, evaluate, use, edit, format, present, etc.).*
- *Ability to apply typical analytical methods, quantitative methods of mathematics, physics, engineering sciences, as well as computer software tools to effectively solve chemical engineering problems.*
- *The ability to apply fundamental scientific facts, concepts, theories, and principles to solve professional tasks and practical problems in chemical engineering.*
- *Ability to evaluate and ensure the quality of work performed.*

- *The ability to use knowledge of the physical foundations of mechanical, hydromechanical, thermal and mass transfer processes when solving professionally oriented tasks.*
- *The ability to determine the parameters of chemical and technological processes and make a rational selection of equipment for their implementation and determine its operating modes in given production conditions.*

1.2. Main objectives of the academic discipline.

After mastering the academic discipline, students must demonstrate the following program learning outcomes:

- *Know and understand the principles, approaches and methods of chemical equipment engineering and related technologies and the prospects for their development, be able to analyze engineering objects, processes and methods.*
- *Be able to make creative decisions when designing, developing new and improving known elements of technological equipment.*
- *Apply technical control tools to evaluate the parameters of objects and processes in the manufacture and operation of chemical and related technology equipment.*
- *Understand the physical essence of phenomena, mechanisms of chemical transformations carried out in chemical and related technology equipment, apply mathematical tools for quantitative calculations, on the basis of which to select equipment parameters and modes of its operation.*

1. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of study according to the relevant educational program)

List of disciplines that a student must master (requirements for the level of training) for successful mastery of the discipline:

- *Chemical technology processes and equipment*

list of disciplines that are based on the results of learning in this discipline:

- *Pre-graduate internship*
- *Diploma design*
- *Basics of three-dimensional design*

2. Content of the academic discipline

Section1 CLASSIFICATION OF FURNACES AND THEIR BASIC DIAGRAMS

Topic 1.1 General scheme of the furnace. Thermal processes in furnaces.Classification of furnaces. Classification of tube furnaces.

The definition of industrial devices for generating thermal energy and their main characteristics is given. The general scheme of the furnace is studied. The heat-technical processes in the furnaces are analyzed. The classification of furnaces in the chemical industry is presented according to the following characteristics: by type of production, technological classification, by heat-technical features, by design features. The classification of tubular furnaces is given.

Chapter 2 CHARACTERISTICS OF FUELS AND THEIR COMBUSTION FEATURES

Topic 2.1 Characteristics of fuels used in industrial furnaces. Fuel combustion.

The characteristics of fuels are given, the classification of fuel types is explained, and the composition of fuels used in industrial furnaces is assessed.

Topic 2.2 Calculation of the amount of air for combustion. Combustion temperatures, heat output of fuel.

The theoretical amount of air for combustion of solid, liquid and gaseous fuels is determined. The amount of gases formed during the combustion of 1 kg of fuel and the elemental composition of gaseous fuel are determined. The concepts of higher and lower heat of combustion of fuel, calorimetric, theoretical and actual combustion temperature of fuel and thermal equivalents of various fuels are given.

Chapter 3 FURNACES AND FUEL COMBUSTION DEVICES

Topic 3.1 Features of fuel combustion in furnaces. Classification of furnaces for solid fuel.

Homogeneous and heterogeneous processes are defined, their examples are given. Classification of solid fuel furnaces is given in terms of aerodynamic characteristics of fuel and gas movement.

Topic 3.2 Features of solid fuel combustion. Features of coal dust combustion. Burners for coal dust combustion.

Hypotheses of the carbon oxidation process are presented. Equations of carbon oxidation by water vapor are given. The heterogeneous combustion scheme is analyzed. The pulverized coal combustion process and combustion time are analyzed. Burners for burning coal pulverized are analyzed.

Topic 3.3 Combustion of liquid fuel in furnaces. Fuel atomization.

The classification of fuel oils and their thermophysical characteristics are presented. Methods for the rational use of high-sulfur fuel oil are presented. Schemes of stationary droplet combustion and fuel oil combustion using nozzles are presented. Schemes of atomizing nozzles and designs of mechanical nozzles are presented.

Topic 3.4 Calculation of fuel oil nozzles.

Dependencies are given for calculating mechanical and low-pressure air nozzles, high-pressure air nozzles, and steam nozzles.

Topic 3.5 Features of combustion of gaseous fuels. Kinetic and diffusion regions of combustion.

Ignition conditions, ignition temperatures and concentration limits of ignition of gaseous fuel are determined. The kinetic and diffusion regions of combustion are determined.

Topic 3.6 Flare process of gaseous fuel combustion. Regularities of the flare process of gaseous fuel combustion.

A diagram of a free gas jet is presented, the parameters of the torch during the combustion of gaseous fuel are determined. The influence of the parameters of the combustion process on the length of the torch is determined.

Topic 3.7 Burners for burning gaseous fuels.

The purpose of gas burners is given and methods for forming a combustible mixture are justified. The basic designs of burners for burning gaseous fuel are outlined.

Chapter 4 HEAT EXCHANGE IN FURNACES

Topic 4.1 Heating of material in a furnace. External and internal heat exchange. Heat transfer by convection. Heat transfer by radiation. Heat absorption by a bundle of radiant tubes. Heat exchange in a tubular furnace.

The process of heat transfer in furnaces is substantiated. The definition of external and internal heat transfer, heat transfer by convection and radiation is given. The concepts of absolutely black, absolutely white, transparent, gray, colored and selective bodies are given. The issues of heat absorption by a beam of radiant tubes and the features of heat transfer in tubular furnaces are considered.

Chapter 5 GASES MOVEMENT IN FURNACES

Topic 5.1 Pressure losses.

The concepts of natural and forced draft are presented. General or friction pressure losses and pressure losses on local supports and features of chimney calculation are considered.

Chapter 6 TECHNICAL AND ECONOMIC INDICATORS OF FURNACE OPERATION

Topic 6.1 Material balance of the furnace. Heat balance of the furnace. Expenditure items of the heat balance. Basic thermal characteristics of the furnace operation.

The features of compiling material and heat balances of technological processes occurring in furnaces and the heat balance of furnaces, which are related to the production indicators of furnaces, are given. The cost items of the heat balance of furnaces and the main heat-technical characteristics of the furnaces are considered.

3. Educational materials and resources

5.1. Basic

1. *Lecture notes on the discipline "Furnace equipment in chemical processes" for students of the direction 6.050503 Mechanical engineering: [Electronic resource]: / NTUU "KPI"; layout, A.R. Stepanyuk. – Kyiv: NTUU "KPI", 2016. – 132 p.Full text, pdf, 2.44 MbURI https://ela.kpi.ua/handle/123456789/15245*

2. *Special methods of thermal preparation: workshop [Electronic resource]: a textbook for students studying in the specialty 133 Industrial mechanical engineering, specialization "Computer-integrated technologies for designing chemical engineering equipment" / Igor Sikorsky Kyiv Polytechnic Institute; compiled by A. R. Stepanyuk. – Electronic text data (1 file: 2.53 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 113 p. – Title from the screen.*
3. *Stepanyuk, A. R. Special methods of thermal preparation. Recommendations for performing calculation work [Electronic resource]: a textbook for bachelor's degree applicants, in the educational program "Computer-integrated technologies for designing chemical engineering equipment" specialty 133 "Industrial mechanical engineering" / A. R. Stepanyuk; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file: 1.37 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2024. – 37 p. – Title from the screen.*
4. *Kornienko Ya.M. Processes and equipment of chemical technology 1: textbook /Ya.M. Kornienko, Yu.Yu. Lukach, I.O. Mikulyonok, V.L. Rakytsky, G.L. Ryabtsev – K.: NTUU "KPI", 2011 – Part 1 – 300 p.*
5. *Kornienko Ya.M. Processes and equipment of chemical technology 2: textbook /Ya.M. Kornienko, Yu.Yu. Lukach, I.O. Mikulyonok, V.L. Rakytsky, G.L. Ryabtsev – K.: NTUU "KPI", 2011 – Part 2 – 416 p.*

Educational content

4. Methodology for mastering the academic discipline (educational component)

Lecture classes

Lectures are aimed at:

- *providing modern, holistic in-depth knowledge of the discipline, the level of which is determined by the target setting for each specific topic;*
- *ensuring critical creative work in the process of work together with the teacher;*
- *fostering professional qualities in applicants and developing independent creative thinking in them;*
- *awareness of global trends in the development of science in the field of processes and technology of heat exchange equipment;*
- *awareness of methods of processing information resources and determination of main directions for solving specific scientific and technical problems;*
- *teaching research materials in a clear and high-quality language, observing structural and logical connections, explaining all the given terms and concepts in a way that is accessible to the audience.*

No. salary	Title of the lecture topic and list of main questions (list of didactic aids, references to literature and tasks for the SRS)	Number hours
	Section1 CLASSIFICATION OF FURNACES AND THEIR BASIC DIAGRAMS	
	Topic 1.1 General scheme of the furnace. Thermal processes in furnaces.Classification of furnaces. Classification of tube furnaces.	
1	*The definition of industrial devices for generating thermal energy and their main characteristics is given. The general scheme of the furnace is studied. The heat-technical processes in furnaces are analyzed. The classification of furnaces in the chemical industry is presented according to the following characteristics: by type of production, technological classification, by heat-technical features, by design features. The classification of tubular furnaces is given.* *Literature 1, 2, 3.*	*4*
	Chapter 2 CHARACTERISTICS OF FUELS AND THEIR COMBUSTION FEATURES	
	Topic 2.1.Characteristics of fuels used in industrial furnaces.	
	Givencharacteristics of fuels used in industrial furnaces. *Literature 1, 2, 7.*	*4*
	Topic 2.3.Calculation of the amount of air for combustionCombustion temperatures, fuel heat output.	
2	*Analyzedamount of air for combustionCombustion temperatures, heat outputcombustion of fuels.* *Literature 1, 2, 3.*	*4*
	Chapter 3 FURNACES AND FUEL COMBUSTION DEVICES	
	Topic 3.1Features of fuel combustion in furnaces.Classification of solid fuel furnaces.Features of solid fuel combustion.Features of coal dust combustion.Burners for burning coal dust.	
3	*The features of fuel combustion in furnaces are substantiated. The classification of furnaces for solid fuel is given. The features of solid fuel combustion and the features of coal dust combustion are substantiated. The designs of burners for coal dust combustion are given.* *Literature 1, 2, 3.*	*4*
	Topic 3.2Burning liquid fuel in furnaces.Liquid fuel injectors.Calculation of fuel oil nozzles	
4	*The combustion of liquid fuel in furnaces and fuel atomization are analyzed. An algorithm for calculating fuel oil nozzles is given. The features of gaseous fuel combustion, kinetic and diffusion combustion regions are analyzed.* *Literature 1, 2, 3.*	*4*
	Topic 3.3Features of combustion of gaseous fuel.Kinetic and diffusion regions of combustion.Flaring process of burning gaseous fuel.Regularities of the flare process of gaseous fuel combustion.Burners for burning gaseous fuels.	
	The flare process of gaseous fuel combustion is substantiated. The regularities of the flare process of gaseous fuel combustion are analyzed. Burners for gaseous fuel combustion are characterized.	*4*
	Topic 3.4. Selection of thrust-pressure devices.	
5	*The features of the choice of traction and air-flow devices are substantiated.* *Literature 1, 2, 3.*	
	Chapter 4 HEAT EXCHANGE IN FURNACES	
	Topic 4.1 Heating of material in a furnace. External and internal heat exchange. Heat transfer by convection. Heat transfer by radiation. Heat absorption by a bundle of radiant tubes. Heat exchange in a tubular furnace.	

6	*The process of heat transfer in furnaces is substantiated. The definition of external and internal heat transfer, heat transfer by convection and radiation is given. The concepts of absolutely black, absolutely white, transparent, gray, colored and selective bodies are given. The issues of heat absorption by a beam of radiant tubes and the features of heat transfer in tubular furnaces are considered.* *Literature 1, 2, 3.*	*4*
	Topic 4.2. Features of calculating internal heat transfer.	
7	***The specifics of calculating internal heat transfer are substantiated.*** ***Literature 1, 2, 3.***	
	Chapter 5 GASES MOVEMENT IN FURNACES	
	Topic 5.1 Pressure losses. Smoke exhausters. Basics of smoke exhauster calculation.	
8	*The concepts of natural and forced draft are presented. General or friction pressure losses and pressure losses on local supports and features of chimney calculation are considered.* *Literature 1, 2, 6.*	*4*
	Chapter 6 TECHNICAL AND ECONOMIC INDICATORS OF FURNACE OPERATION	
	Topic 6.1 Material balance of the furnace. Heat balance of the furnace. Expenditure items of the heat balance. Basic thermal characteristics of the furnace operation.	
	The features of compiling material and heat balances of technological processes occurring in furnaces and the heat balance of furnaces, which are related to the production indicators of furnaces, are given. References 1, 2.	*2*
9	*Modular test work.*	*2*

Practical classes

- *They should help applicants develop creative thinking, a creative approach to the scientific substantiation of the direction and methodology of research. The main tasks of the cycle of practical classes:*
- *to help applicants deepen their theoretical knowledge in the field of processes and technology of primary gas and oil refining;*
- *to facilitate training of applicants in the methodology for determining fuel properties;*
- *to form criteria for evaluating the effectiveness of processes of special thermal preparation methods.*

No. salary	***Title of the topic of the practical lesson and list of main questions (list of didactic material, references to literature and tasks for the CTS)***	***Number hours***

No. salary	***Title of the topic of the practical lesson and list of main questions (list of didactic material, references to literature and tasks for the CTS)***	***Number hours***
	Chapter 2 CHARACTERISTICS OF FUELS AND THEIR COMBUSTION FEATURES	
1	*Topic 2.1 Characteristics of fuels used in industrial furnaces. Fuel combustion. Calculation of the amount of air for combustion. Combustion temperatures, fuel heat output.*	
	Calculation of carbon content in fuel components	*2*
	Literature 1, 2, 3, 7.	
2	*Topic 2.1.Characteristics of fuels used in industrial furnaces.*	
	Calculation of the heat of combustion of coal. Determination of the heat of combustion of coking gas.	*2*

	Literature 1, 2, 3, 7.	
	Topic 2.2.Fuel combustion.	
3	*Determination of the heat of combustion of coking gas.*	*2*
	Literature 1, 2, 3, 7.	
	Topic 2.3.Calculation of the amount of air for combustionCombustion temperatures, fuel heat output	
4	*Calculation of the amount of air for combustion*	*2*
	Literature 1, 2, 3, 7.	
	Chapter 3 FURNACES AND FUEL COMBUSTION DEVICES	
	Topic 3.2 Calculation of fuel oil nozzles. Burners for burning gaseous fuel.	
5	*Mechanical injector calculation*	*2*
	Calculation of a low-pressure burner for burning fuel oil	
	Literature 8.	
	Topic 3.3.Features of combustion of gaseous fuel.Kinetic and diffusion regions of combustion.Flaring process of burning gaseous fuel	
6	*Calculation of an injector panel torchless burner*	*2*
	Literature 8.	
	Topic 3.4. Selection of thrust-pressure devices.	
7	*Calculation of the traction device for the furnace installation*	*2*
	Literature 8.	
	Chapter 4 HEAT EXCHANGE IN FURNACES	
	Topic 4.1 External and internal heat exchange. Heat exchange by conduction, convection and radiation.	
8	*Calculation of heat input in the furnace. Calculation of the main dimensions of a shaft furnace*	*1*
	Literature 8.	
	Topic 4.2. Features of calculating internal heat transfer.	
9	*Calculation of furnace insulation.*	*1*
	Literature 8.	

6. Calculation work

Calculation work is necessary for studying the discipline, and is necessary for preparing for the test. The main task of calculation workapplicants– is a deepening of worldview and scientific knowledge in the areas specified in the lectures, by searching for the necessary information, independently performing the necessary calculations. The task of the calculation work and the methodology for its implementation are set out in the manual Special methods of thermal training: practical work [Electronic resource]: a textbook for students studying in the specialty 133 Industrial mechanical engineering, specialization "Computer-integrated technologies for designing chemical engineering equipment" / Igor Sikorsky Kyiv Polytechnic Institute; compiled by A. R. Stepanyuk. – Electronic text data (1 file: 2.53 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 113 p. – Title from the screen..

7. Student's independent work

Independent work accounts for 50% of the study of the credit module, which also includes preparation for the test. The main task of independent workapplicants– is the deepening of worldview and scientific knowledge in the areas defined in the lectures, by searching for the necessary information, developing perseverance and creative search in the formation of working hypotheses to intensify the transfer processes.

Policy and control

8. Academic discipline policy (educational component)

Rules for class attendance and behavior in class

Attendance at classes is mandatory.Applicantsare obliged to take an active part in the educational process, not to be late for classes or miss them without good reason, not to interfere with the teacher conducting classes, and not to be distracted by activities unrelated to the educational process.

Rules for assigning incentive and penalty points

- *Incentive points can be awarded by the teacher exclusively for the completion of creative works and working hypotheses.*
  But their sum cannot exceed 25% of the rating scale.
- *Penalty points are not provided within the framework of the academic discipline.*

Deadline and Rescheduling Policy

In the event of academic arrears in academic discipline or any force majeure circumstances,applicantsshould contact the teacher to agree on an algorithm of actions related to solving existing problems.

Academic Integrity Policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the lack of references when using printed and electronic materials, quotes, opinions of other authors. Hints and copying when writing tests or conducting classes are unacceptable.
The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". More details:https://kpi.ua/code

Academic Conduct and Ethics Policy

ApplicantsThey should be tolerant, respect the opinions of others, formulate objections in a correct form, and adequately provide feedback in class.
The norms of ethical behavior of students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". More details:https://kpi.ua/code

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

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

Semester	Study time		Distribution of teaching hours				Control measures			
	Loans	academic year	Lectures	Practical	Lab work	CRC	MKR	RR	Abstract	Semester control
8	4	120	36	18	–	66	1	1	-	test

A student's rating in a discipline consists of the points he receives for:

The applicant's rating for a credit module consists of the points he receives for his work in practical classes, lectures, and MCR.

The semester test is an exam.

Rating (weighting) points system and evaluation criteria

Rating points system and evaluation criteria:

Weighted score for questions in lectures 1 point each

The weighted score for practical classes is 2 points;

Weighted score for Calculation work 14 points
Weighted score for MCR 6 points
Weighted score for the exam 40 points

Criteria for evaluating the performance of a practical task

Completeness and signs of task completion	***Points for practical***	*Calculation work*
The task is fully completed.	*4*	*6*
Minor deficiencies under point 1	*3*	*5*
Late completion of the task	*2.5*	*4*
Untimely completion of the task, shortcomings under item 1	*2*	*3*
Poor performance of the task	*1*	*1*
Failure to complete the task	*0*	*0*

Thus, the semester rating scale for a credit module is:

$$R = 0.5 \cdot 36 + 2 \cdot 9 + 1 \cdot 6 + 1 \cdot 14 + 1 \cdot 40 = 18 + 18 + 6 + 14 + 40 = 100 \text{ points}$$

According to the results of the training work in the first 7 weeks, the "ideal applicant" should score 40 points. At the first certification (8th week), the applicant receives "passed" if his current rating is at least 20 points.

According to the results of the training work, the "ideal applicant" should score 90 points in 13 weeks of study. At the second certification (week 14), the applicant receives "passed" if his current rating is at least 40 points.

The maximum score is 100. To receive credit for the automatic credit module, you must have a rating of at least 60 points.

Applicants, who scored less than 0.6 R during the semester, as well as those who want to increase their overall rating, take a credit test. In this case, all the points they received during the semester are canceled. The test tasks contain questions that relate to different sections of the credit module. The list of credit questions is given in Section 10.

To obtain a credit score, the sum of all rating points R obtained during the semester is converted according to the table:

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

10. Additional information on the discipline (educational component)

An indicative list of questions that are submitted for semester control

The ticket consists of three questions.

- *What is an industrial furnace?*
- *Schematic diagram of a fuel stove.*
- *Main and auxiliary equipment of industrial furnaces.*

- *Classification of industrial furnaces by type of production.*
- *Classification of industrial furnaces by production organization.*
- *Classification of industrial furnaces according to thermal parameters.*
- *Main methods of obtaining thermal energy in electric furnaces.*
- *What is fuel?*
- *Classification of fuels.*
- *Main characteristics of fuel.*
- *Classification of fuels by origin and condition. Examples.*
- *Features of fuel combustion in industrial furnaces.*
- *Qualitative composition of solid and liquid fuels.*
- *Conversion of the composition of solid and liquid fuels from organic and dry mass to working mass.*
- *Conversion of gaseous fuel from dry mass to working mass.*
- *Sequence of fuel combustion calculation.*
- *Ignition temperature.*
- *What is the concentration limit of ignition?*
- *The calorific value of fuel, its dimensions, and what characteristics affect its size.*
- *Higher and lower caloric content (Qnp and Qvr), the difference between them.*
- *Thermal equivalent, conventional fuel.*
- *Stoichiometric ratio of fuel and air.*
- *Fuel mixture with a given calorific value. Calculation procedure.*
- *The required amount of dry air for CO combustion.*
- *The required amount of dry air for H2 combustion.*
- *The required amount of dry air for CH4 combustion.*
- *Air flow rate for different fuel combustion cases.*
- *Theoretical and actual amount of combustion air*
- *Inflammation.*
- *How to achieve ignition.*
- *Burning temperature.*
- *How to raise the calorimetric combustion temperature.*
- *How to raise the actual combustion temperature.*
- *Determination of the air flow rate coefficient based on the composition of combustion products.*
- *Methods for determining the calorific value of fuel.*
- *Homogeneous and heterogeneous combustion.*
- *Features of solid fuel combustion.*
- *What limits the combustion of solid fuels?*
- *Types of furnaces for burning solid fuel.*
- *Features of liquid fuel combustion.*
- *What limits the combustion of liquid fuel?*
- *Selection and calculation of design parameters of furnaces.*
- *How to increase the viscosity of liquid fuel.*
- *Main methods of spraying liquid fuel.*
- *Purpose of injectors.*
- *The main methods of atomizing liquid fuel in nozzles.*
- *Selection and calculation of design parameters of nozzles.*
- *Features of combustion of gaseous fuel.*
- *What limits the combustion of gaseous fuel?*
- *Diffusion combustion.*
- *Kinetic principle of combustion.*
- *The main methods of forming a mixture of fuel and oxidizer in burners.*
- *Selection and calculation of burner design parameters.*

- *Factors affecting flame length and shape.*
- *External mixing of gas and air, flare length.*
- *Complete internal mixing of gas and air; torch length.*
- *Methods of torch stabilization.*
- *Types of heat transfer.*
- *Main directions of heat utilization and fuel saving in industrial furnaces.*
- *What is a recuperator and a regenerator? The main differences between them.*
- *Known designs of recuperators and regenerators*
- *Main directions of heat utilization and fuel saving in industrial furnaces.*
- *Movement of gases and materials in furnaces. Types of gas movement.*
- *Gas movement in a layer and channel. Flow aerodynamics.*
- *Draft in furnace installations. Fundamentals of calculating pressure losses.*
- *Calculation of chimneys, flue pipes and injectors. Selection of draft devices.*
- *External and internal heat exchange.*
- *Heat exchange by conduction, convection and radiation.*
- *Heat exchange by conduction, convection and radiation.*
- *Features of calculating internal heat transfer.*
- *Technical and economic indicators of furnace operation.*
- *Heat and material balances.*
- *Specific heat energy consumption. Efficiency and fuel utilization factor.*

The working program of the academic discipline (syllabus):

Compiled by Associate Professor of the Department, Candidate of Technical Sciences, Associate Professor Andriy Stepaniuk

Approved by the department (minutes No. 20 dated 12.06.2025)

Approved by the Methodological Commission of the Faculty (Minutes No. 11 dated 06/27/2025)