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

Department of Machines and Apparatus for Chemical and Oil Refining

Computer simulation transfer processes

Work program of the discipline (Syllabus)

Details of the discipline

Level of higher education	**Third (graduate)**
Branch of knowledge	13 - Mechanical engineering
Specialty	133 - Industry engineering
Educational program	"Industrial Engineering"
Status of the educational component	Selective
The scope of discipline	150 hours / 5 ECTS credits
Year of preparation, semester	2nd year, spring semester
Form of study	Eye (day)
Timetable	2 lectures per week, 1 computer workshop every two weeks
Semester control / control measures	Test
Language of instruction	Ukrainian
Information about course leader / teachers	Ph.D., Associate Professor, Seminsky Alexander Olegovich,forstd@ukr.net , @mahnv_kpi
Course placement	http://ci.kpi.ua

Curriculum of the discipline

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

Computer modeling is a modern approach to the study of processes and features of their implementation, taking into account the specifics of technological solutions and selected equipment. It is widely used to solve scientific and engineering problems. Therefore, computer modeling methods are being actively developed and improved. Computer modeling allows you to get more information about the object of modeling, reduce the cost and complexity of experimental research, obtain data on new objects based on similar known objects, reduce time for development and improvement of technologies and equipment, and simplify the search for ways to increase their efficiency.

The purpose of the discipline is to study methods and tools for modeling hydromechanical, thermal and mass transfer processes using computer automated systems, principles and approaches to analytical processing of modeling results and their comparison with data obtained from the study of real objects.

The discipline forms the following competencies:

- ability to apply standard analytical methods and computer software for scientific research and solving engineering problems of industrial engineering;

- ability to conduct analytical and experimental scientific activities; organize, plan and forecast the results of scientific research;
- ability to initiate, organize and conduct comprehensive theoretical and experimental research in the field of research and innovation, which lead to the acquisition of new knowledge.

The program learning outcomes after studying the discipline include:

- withlaying the fundamental foundations of the theory of hydrodynamics, heat and mass transfer;
- inability to develop and research conceptual mathematical and computer models of processes taking into account the properties of a continuous environment;
- inability to analyze the state of the continuous environment and substantiate working hypotheses to improve the efficiency of transfer processes;
- ability to develop and analyze conceptual models of processes using computer technology, the results of which can be effectively used to create innovative processes and equipment.

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

The study of the discipline is based on professional knowledge within the study of the normative part of the educational program. The discipline helps to provide the scientific component of the training program for doctors of philosophy.

3. The content of the discipline

Topic 1. Introduction to computer simulation.

Topic 2. Modeling of capacitive equipment.

Topic 3. Modeling of hydromechanical processes.

Topic 4. Modeling of heat transfer processes.

Topic 5. Improving equipment and increasing the efficiency of mass transfer processes.

Topic 6. Practical aspects of application of computer modeling results.

4. Training materials and resources

Basic literature:

1. Exclusion of Ya.I. Modeling of complex systems: a manual / Ya.I. Exclusive, R.M. Kaminsky, VV Beekeeper. - Lviv: New World-2000, 2017. - 403 p.
2. Kondratov SO Mathematical modeling and optimization of chemical technology objects: a textbook / S.O. Kondratov, IV Sitak, T.M. Mateiko. - Kharkiv: Leader Publishing House, 2019. - 564 p.
3. Kotovsky VY Computer modeling of physical processes. Creation and research of physical models by numerical method / V.Y. Kotovsky, L.Yu. Цибульский. - Kyiv: KPI named after Igor Sikorsky, 2019. - 130 p.
4. Sidorenko SI Theory of heat and mass transfer in materials: a textbook / S.I. Сидоренко, С.М. Cornflower. - K .: KPI them. Igor Sikorsky, 2020. - 199 p.
5. Khalatov AA Fundamentals of the theory of the boundary layer: a textbook / AA Khalatov, EV Mochalin, NF Dimitrieva. - Kyiv: National Technical University of Ukraine "Kyiv Polytechnic Institute named after Igor Sikorsky", 2019. - 191 p.

Additional literature:

1. Amidon G. Transport Processes In Pharmaceutical Systems / G. Amidon. - Taylor and Francis, 2007. - 752 p.

2. Bear J. Modeling Phenomena of Flow and Transport in Porous Media / J. Bear. - Springer, 2018. - 761 p.
3. Bird R. Transport phenomena / R. Bird, W. Stewart, E. Lightfoot. - New York: Wiley, 2007. - 920 p.
4. Blazek J. Computational fluid dynamics. Principles and Applications / J. Blazek. - Amsterdam: Elsevier Ltd., 2015. - 466 p.
5. Das MK Modeling Transport Phenomena in Porous Media with Applications / MK Das, PP Mukherjee, K. Muralidhar. - Springer International Publishing AG, 2018. - 250 p.
6. De Souza-Santos ML Analytical and Approximate Methods in Transport Phenomena / ML De Souza-Santos. - CRC Press Taylor & Francis Group, 2008. - 577 p.
7. Luyben WL Process modeling, simulation for chemical engineers / WL Luyben. - McGraw-Hill Publishing Company, 1996. - 752 p.
8. Saatdjian E Transport Phenomena: Equations and Numerical Solutions / E. Saatdjian. - Willey, 2000. - 426 p.
9. Nikitenko NI Investigation of heat and mass transfer processes by the grid method / N.I. Nikitenko. - К .: Наукова думка, 1978. - 212 с.

Educational content

5. Methods of mastering the discipline (educational component)

Calendar-thematic plan

Week	*Content of educational work*	*VTS (96 hours according to the curriculum)*
Topic 1. Introduction to computer simulation.		
1, And a week	**Lecture 1.** Features of computer modeling as a method of research of transfer processes in branch mechanical engineering. Means of computer modeling. Tools for constructing geometric objects.	Elaboration of the subject of the lesson.
2, Week II	**Lecture 2.** Basic equations describing transfer processes and methods of their solution. Grid methods for solving equations: finite element method (beginning). **Practical lesson 1.** Construction of geometric objects. Bringing real objects to a model form: a virtual interpretation of boundary conditions.	Elaboration of the subject of classes. Testing the geometric construction of objects.
3, And a week	**Lecture 3**. Grid methods for solving equations: finite element method (end), finite volume method.	Elaboration of the subject of the lesson.
4, Week II	**Lecture 4.** Features of construction of calculation grids for solving equations: automatic and "manual" methods. Grid optimization. **Practical lesson 2.** Construction and optimization of grids.	Elaboration of the subject of classes. Working out of construction and optimization of grids on arbitrary objects.

Week	*Content of educational work*	*VTS (96 hours according to the curriculum)*
Topic 2. Modeling of capacitive equipment.		
5, And a week	**Lecture 5.**Modeling of capacitive equipment and its elements.	Elaboration of the subject of the lesson. Testing models.
6, Week II	**Lecture 6.**Calculation of pipeline structures. Modeling of fluid motion in flowing parts of pipelines and their elements. **Practical lesson 3.**Modeling of capacitive equipment and pipelines. Analysis of results.	Elaboration of the subject of classes. Practice of calculations and analysis of results.
Topic 3. Modeling of hydromechanical processes.		
7, And a week	**Lecture 7.**Determination of hydraulic losses and energy losses of objects due to overcoming the resistance to motion in the fluid.	Elaboration of the subject of the lesson.
8, Week II	**Lecture 8.**Features of modeling the motion of the fluid through the porous layers. **Practical lesson 4.**Testing of motion models with the use of fluids. Presentation and analysis of calculation results.	Elaboration of the subject of classes. Practice of calculations and analysis of results.
9, And a week	**Lecture 9.**Taking into account the features of the mechanics of non-Newtonian media. Non-Newtonian models and their choice. Examples of calculations.	Elaboration of the subject of the lesson.
10, Week II	**Lecture 10.**Modeling of hydrodynamic machines. Features of construction and definition of areas of rotation. Taking into account the phenomenon of cavitation. **Practical lesson 5.** Determination of modes of operation of hydrodynamic machines.	Elaboration of the subject of the lesson. Practice of calculations and analysis of results.
11, And a week	**Lecture 11.**Modeling of devices for mixing. Models of mixing methods. Features of modeling of mechanical mixing devices.	Elaboration of the subject of the lesson.
12, Week II	**Lecture 12.**Simulation of the filter installation. Simulation of the fluidized bed apparatus. **Practical lesson 6.** Modeling of hydrodynamic processes in technological equipment.	Elaboration of the subject of classes. Practice of calculations and analysis of results.
Topic 4. Modeling of heat transfer processes.		
13, And a week	**Lecture 13.**Features of heat exchange modeling. Heating and cooling.	Elaboration of the subject of the lesson.

Week	*Content of educational work*	*VTS (96 hours according to the curriculum)*
14, Week II	**Lecture 14.**Radiation heat transfer and its modeling. **Practical lesson 7.** Applied aspects of heat exchange modeling.	Elaboration of the subject of classes. Practice of calculations and analysis of results.
15, And a week	**Lecture 15.**Non-stationary heat exchange. Boundary and conjugate heat transfer problems.	Elaboration of the subject of the lesson.
16, Week II	**Lecture 16.**Features of modeling of heat exchangers of various designs. **Practical lesson 8.** Determining the efficiency of the heat exchanger.	Elaboration of the subject of classes. Practice of calculations and analysis of results.
Topic 5. Improving equipment and increasing the efficiency of mass transfer processes.		
17, And a week	**Lecture 17.**Improving equipment and increasing the efficiency of mass transfer processes.	Elaboration of the subject of the lesson.
Topic 6. Practical aspects of application of computer modeling results.		
18, Week II	**Lecture 18.**Data verification. Accuracy of calculations and the choice of a rational number of calculations. Practical use of simulation results. **Practical lesson 9.** Presentation by graduate students of the possibilities of computer modeling of processes on the topics of dissertation research. Credit lesson.	Elaboration of the topic of the lecture. Preparation for the test.

6. Independent work of a student / graduate student

Types of independent work are listed in the table in paragraph 5, according to the training weeks and scheduled classes.

Policy and control

7. Course policy (educational component)

System of requirements for students:

- **rules for attending classes**- Attendance of classes of all kinds (lectures, practical classes) - is obligatory both at training in classrooms, and at a distance mode of training. In the latter case, classes are held in the mode of Zoom-conferences and graduate students "visit" them by connecting to the links provided by teachers;

- **rules of conduct in the classroom**- not to interfere with unnecessary activities, conversations (including telephone) to other graduate students to listen to lectures or work in practical classes. Follow safety rules in classrooms and distance learning at home;

- **rules for crediting practical classes and accruing points for their performance** - the teacher evaluates the work of the graduate student during the lesson, the quality and timeliness of the presentation of the results of the task;

- **rules for the protection of individual tasks** - projects on research topics are presented at the last lecture and mandatory discussion of the presented results;

- **rules for assigning incentive and penalty points**- incentive points are not provided; 4 penalty points are awarded for absence from class without good reason, in case of untimely performance of practical tasks or untimely presentation of the project on the research topic;

- **policy of deadlines and rearrangements**:

1) delivery and evaluation of the results of all tasks takes place exclusively during classroom classes;

2) re-grading is carried out according to the schedule established at the university level in the terms determined by the teacher and reported to postgraduate students at the announcement of rating points;

- **academic integrity policy** - Postgraduate students are obliged to comply with the provisions of the Code of Honor and the requirements of academic integrity during the educational process.

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

Current control: evaluation of work in practical classes (performance of tasks in each of the classes is evaluated up to 8 points, the maximum for all practical classes is 64 points), preparation and presentation of the project on the research topic is estimated at a maximum of 36 points.

Calendar control: conducted twice a semester for 7-8 and 14-15 weeks as monitoring of the current state of compliance with the requirements of the syllabus - the student receives "satisfactory" during the first and second calendar control, if his current rating is not less than 0.5 of the maximum number of points , possible at the time of control.

Semester control: credit.

Conditions of admission to semester control:

- admission to the test is possible only in the case of successful completion of all practical classes and project presentation on the research topic;
- graduate students who received during the semester total rating score <25 before the test is not allowed;
- if at the beginning of the practical lesson 9 the graduate student has a total rating score <60, he can not get a positive result in the test.

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

Scores	*Rating*
100-95	Perfectly
94-85	Very good
84-75	Fine
74-65	Satisfactorily
64-60	Enough
Less than 60	Unsatisfactorily
Admission conditions are not met	Not allowed

9. Additional information on the discipline (educational component)

Rearrangement is carried out according to the "rigid" scheme (with cancellation of previous points) and consists in performance of the control task consisting of one theoretical question (on a lecture material) which is estimated at a maximum of 40 points, and one practical question (applied task) which is estimated maximum of 60 points.

Evaluation of the control task is as follows. For the answer to the question, points are accrued in accordance with the completeness and validity of the answer in proportion to the corresponding maximum number of points. If the answer contains less than 30% of the required information, it is considered unsatisfactory, and it is awarded 0 points. The credit score is defined as the sum of points for answering both questions.

Work program of the discipline (syllabus):

Folded Associate Professor of MAHNV, Ph.D., Associate Professor Seminsky Alexander Olegovich.

Approved at the meeting of the Department of Machines and Apparatus of Chemical and Oil Refining (Protocol № 26 of 19 June 2021)

Agreed metodic commission of the Faculty of Engineering and Chemistry (Protocol № 11 of June 25, 2021)