**Syllabus**
**selective component**

**Simulation modeling**

| | |
|---|---|
| Subjects: | **Simulation modeling** |
| Level of higher education: | **First (undergraduate)** |
| Course page in Moodle: | **https://dl2022.khadi-kh.com/course/view.php?id=905** |
| The scope of the educational component | **3 credits (90 hours)** |
| Final control form | **test** |
| Consultations: | **on schedule** |
| Name of the department: | **Department of Automation and Computer-Integrated Technologies** |
| Teaching language: | **Ukrainian** |
| Course leader: | **Ihor Henrikhovich Ilhe, Ph.D., associate professor** |
| Contact phone number: | **(050) 4019169** |
| E-mail: | **ilge_igor@ukr.net** |

**Brief content of the educational component:**
The purpose of studying the educational component is to provide future specialists with knowledge about the principles, laws and technologies of building simulation models, their implementation in specialized software environments, planning a computer experiment and analyzing its results.
**Subject:** a pedagogically adapted system of concepts about the principles of developing simulation models and their application in the professional field of activity.

**The main tasks of studying an academic discipline are:**
- substantiation and presentation of the theoretical and methodological foundations of building simulation models;
- study of the principles, regularities and technology of building simulation models of technological processes and automatic control systems;
- formation of skills for implementing simulation models in specialized software environments;
- forming the skills of planning a simulation experiment and analyzing the results of the conducted research.

**Prerequisites for studying the educational component:** Higher mathematics; Informatics; Physics, Theory of probability, System analysis.

**Competencies acquired by the acquirer:**

**General competences:**

Ability to conduct research at the appropriate level.
The ability to generate new ideas (creativity).
Ability to abstract thinking, analysis and synthesis.
Ability to write and speak in Ukrainian and foreign languages.

***Special (professional) competences:***

Ability to apply modeling and optimization methods to research and improve the efficiency of management systems and processes of complex technological and organizational and technical objects;

The ability to analyze production and technological systems and complexes as objects of automation, to determine methods and strategies for their automation and digital transformation.

Ability to apply specialized software and digital technologies to solve complex tasks and problems of automation and computer-integrated technologies.

The ability to identify the scientific essence of problems in the professional field, to plan and carry out relevant scientific and applied research.

**Learning outcomes according to the educational program:**

Apply modern approaches and methods of modeling and optimization for research and creation of effective automation systems of complex technological and organizational and technical objects.

Analyze production and technical systems in a certain field of activity as objects of automation and determine the strategy of their automation and digital transformation.

Apply modern mathematical methods, methods of automatic control theory, reliability theory and system analysis for research and creation of automation systems of complex technological and organizational-technical objects, cyber-physical productions.

Develop and use specialized software and digital technologies to create automation systems of complex organizational and technical objects, professionally own special software tools.

**Thematic plan**

| Topic No | Name of topics (Lectures (LC), laboratory work (LW), practical works (PW), independent work (IW) | Number of hours | |
|---|---|---|---|
| | | ocular | extramural |
| 1 | LC Models of the system. Classification of models. Features of simulation modeling | 2 | 0,5 |
| | PW - | - | - |
| | IW. Principles of description of dynamics in iconic models | 8 | 12 |
| 2 | LC Modeling algorithm. Principles of simulation time management. Structure and stages of simulation modeling. | 2 | 0,5 |
| | PW Technology of developing a simulation model and carrying out a model experiment | 4 | 2 |
| | IW Application of the principle of sequential execution of orders | 8 | 12 |
| 3 | LC Description of system behavior in the simulation model. Conceptual model as a basis for describing system dynamics. Modeling random factors. | 2 | 2 |
| | PW Modeling random factors - | 4 | 1 |
| | IW Using random factor generators in the MATLAB environment | 10 | 14 |
| 4 | LC Management of model time. Selection of the modeling step. | 2 | 0,5 |
| | PW Management of model time | 4 | 1 |
| | IW Management of simulation completion | 10 | 14 |

| Topic No | Name of topics (Lectures (LC), laboratory work (LW), practical works (PW), independent work (IW) | Number of hours | |
|---|---|---|---|
| | | ocular | extramural |
| 5 | LC Modeling of parallel processes. Methods of description of parallel processes. Lists of events. | 2 | 0,5 |
| | PW Modeling of parallel processes | 2 | 1 |
| | IW - | - | - |
| 6 | LC Planning of model experiments. Strategic and tactical planning of simulation experiments. | 4 | 2 |
| | PW - | - | - |
| | IW Planning an experiment in the MATLAB system | 12 | 14 |
| 7 | LC Processing and analysis of simulation results. Model calibration. | 2 | 0,5 |
| | PW - Study of the stability and sensitivity of the simulation model | 2 | 1 |
| | IW Built-in MATLAB tools for processing and analyzing simulation results | 10 | 14 |
| **Total** | LC | 16 | 4 |
| | PW | 16 | 6 |
| | IW | 58 | 80 |

**Individual educational and research task (if available):**

**Teaching methods:**
1) verbal: 1.1 traditional: lectures, explanations, stories, etc.;
1.2 interactive (non-traditional): problem lectures, discussions, etc.;
2) visual: method of illustrations, method of demonstrations
3) practical: 3.1 traditional: practical classes, seminars;
3.2 interactive (non-traditional): business and role-playing games, trainings, seminars-discussions, "round table", brainstorming method.

**Evaluation system and requirements:**

**Current performance**
1 The current success of applicants for the performance of educational types of work in training sessions and for the performance of independent work tasks is evaluated using a four-point rating scale with subsequent transfer to a 100-point scale. During the evaluation of the current academic performance, all types of work provided by the educational program are taken into account.
1.1 Lecture classes are evaluated by determining the quality of performance of specified tasks.
1.2 Practical classes are evaluated by the quality of performance of a control or individual task, performance and design of practical work.
1.3 Laboratory classes are evaluated by the quality of reports on the performance of laboratory work.
1.4 Seminar classes are evaluated by the quality of individual assignment/abstract.
2 The current performance of higher education applicants is assessed at each practical session (laboratory or seminar) on a four-point scale ("5", "4", "Z", "2") and entered in the journal of academic performance.
– “excellent”: the winner mastered the theoretical material flawlessly, demonstrates deep

knowledge of the relevant topic or academic discipline, the main provisions;
- "good": the applicant has mastered the theoretical material well, has the main aspects from primary sources and recommended literature, presents it in a reasoned way; has practical skills, expresses his thoughts on certain problems, but certain inaccuracies and errors are assumed in the logic of the presentation of theoretical content or in the analysis of practical ones;
- "satisfactory": the applicant has basically mastered the theoretical knowledge of the educational topic or discipline, orients himself in primary sources and recommended literature, but answers unconvincingly, confuses concepts, answers additional questions uncertainly, does not have stable knowledge; when answering questions of a practical nature, reveals inaccuracy in knowledge, does not know how to evaluate facts and phenomena, connect them with the future profession;
- "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, hardly orients himself in primary sources and recommended literature, lacks scientific thinking, practical skills are not formed.
3 The final score for the current activity is recognized as the arithmetic mean sum of points for each lesson, for individual work, current control works according to the formula:

$$K^{n_1} = \frac{K1 + K2 + \ldots + Kn}{n},$$

де $K^{n_1}$ – final assessment of success based on the results of current control;
$K1, K2, \ldots, Kn$ – evaluation of the success of the current control measure;
$n$ – number of ongoing control measures.
Assessments are converted into points according to the calculation scale (table 1).

**Table 1 –** Recalculation of the average grade for the current activity into a multi-point scale

| 4-point scale | 100-point scale | 4- point scale | 100- point scale | 4- point scale | 100- point scale | 4- point scale | 100- point scale |
|---|---|---|---|---|---|---|---|
| 5 | 100 | 4,45 | 89 | 3,90 | 78 | 3,35 | 67 |
| 4,95 | 99 | 4,4 | 88 | 3,85 | 77 | 3,3 | 66 |
| 4,9 | 98 | 4,35 | 87 | 3,80 | 76 | 3,25 | 65 |
| 4,85 | 97 | 4,3 | 86 | 3,75 | 75 | 3,2 | 64 |
| 4,8 | 96 | 4,25 | 85 | 3,7 | 74 | 3,15 | 63 |
| 4,75 | 95 | 4,20 | 84 | 3,65 | 73 | 3,1 | 62 |
| 4,7 | 94 | 4,15 | 83 | 3,60 | 72 | 3,05 | 61 |
| 4,65 | 93 | 4,10 | 82 | 3,55 | 71 | 3 | 60 |
| 4,6 | 92 | 4,05 | 81 | 3,5 | 70 | from 1.78 to 2.99 | from 35 to 59 |
| | | | | | | reassembly | |
| 4,55 | 91 | 4,00 | 80 | 3,45 | 69 | from 0 до 1,77 | from 0 to 34 |
| 4,5 | 90 | 3,95 | 79 | 3,4 | 68 | repeated study | |

**Final assessment**

1 A student of higher education receives a credit in the last lesson in the discipline based on the results of the current assessment. The average score for the current activity is converted into points on a 100-point scale, according to the conversion table (table 1).
Applicants for higher education who have a current grade point average in the discipline

lower than "3" (60 points) can increase their current grade by taking tests in the discipline in the last session.
Assessment of the knowledge of applicants through testing is carried out according to the following scale:
– "Excellent": at least 90% of correct answers;
– "Very good": from 82% to 89% of correct answers;
– "Good": from 74% to 81% of correct answers;
– "Satisfactory": from 67% to 73% of correct answers;
– "Satisfactory enough": from 60% to 66% of correct answers;
– "Unsatisfactory": less than 60% of correct answers.
2 The condition for obtaining credit is:
- making up for all missed classes;
– the average current grade in the discipline is not lower than "3" (60 points).
3 For performing individual independent work and participation in scientific events, additional points are awarded to the winners.
3.1 Additional points are added to the sum of points scored by the student of higher education for the current educational activity (for disciplines for which the final form of control is a credit), or to the final grade in the discipline for which the final form of control is an exam.
3.2 The number of additional points awarded for different types of individual tasks depends on their volume and importance:
- prizes in the discipline at the international / all-Ukrainian competition of scientific student works - 20 points;
- prize places in the discipline at the All-Ukrainian Olympiads - 20 points;
- participation in the international / all-Ukrainian competition of scientific student works - 15 points
- participation in international / all-Ukrainian scientific conferences of students and young scientists - 12 points;
- participation in all-Ukrainian Olympiads in the discipline - 10 points
- participation in Olympiads and scientific conferences of the Khnadu in the discipline - 5 points;
- performance of individual scientific and research (educational and research) tasks of increased complexity - 5 points.
3.3 The number of additional points cannot exceed 20 points.
4 The learning result is evaluated (select is required):
– on a two-point scale (passed/failed) according to table 2;
– on a 100-point scale (for differentiated assessment) according to table 3.
The final grade together with additional points cannot exceed 100 points.

**Table 2 –** Scale for transferring points to the national evaluation system

| On a 100-point scale | On a national scale |
|---|---|
| from 60 points to 100 points | counted |
| less than 60 points | not counted |

**Table 3 –** The scale for evaluating the knowledge of students based on the results of the final control of the academic discipline

| Score in points | Evaluation on a national scale | | Evaluation according to the ECTS scale | |
|---|---|---|---|---|
| | examination | test | Rating | Criteria |
| **90-100** | **Perfectly** | **Enrolled** | **A** | The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have been formed, all educational tasks provided for in the training program have been completed, the quality of their performance has been assessed with a number of points close to the maximum |
| **80–89** | **Okay** | **Enrolled** | **B** | The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have mainly been formed, all educational tasks provided for by the training program have been completed, the quality of most of them has been assessed with a number of points close to the maximum |
| **75-79** | | | **C** | The theoretical content of the course has been mastered in its entirety, without gaps, some practical skills of working with the mastered material have not been formed enough, all educational tasks provided for by the training program have been completed, the quality of none of them has been assessed with a minimum number of points, some types of tasks have been completed with errors |
| **67-74** | **Satisfactorily** | | **D** | The theoretical content of the course is partially mastered, but the gaps are not of a significant nature, the necessary practical skills for working with the mastered material are basically formed, most of the educational tasks provided by the training program have been completed, some of the completed tasks may contain errors |
| **60–66** | | | **E** | The theoretical content of the course has been partially mastered, some practical work skills have not been formed, many of the educational tasks provided by the training program have not been completed, or the quality of some of them has been assessed with a number of points close to the minimum. |

| Score in points | Evaluation on a national scale | | Evaluation according to the ECTS scale | |
|---|---|---|---|---|
| | examination | test | Rating | Criteria |
| **35–59** | **Unsatisfactorily** | **Not counted** | **FX** | The theoretical content of the course has been partially mastered, the necessary practical work skills have not been formed, most of the prescribed training programs of educational tasks have not been completed, or the quality of their implementation has been assessed with a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of the performance of educational tasks (with the possibility of retaking) |
| **0–34** | **Unacceptable** | | **F** | The theoretical content of the course has not been mastered, the necessary practical work skills have not been formed, all completed educational tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of the performance of educational tasks (with a mandatory repeat course). |

**Course policy:**

– the course involves working in a team, the environment in the classroom is friendly, creative, open to constructive criticism;

- mastering the discipline involves mandatory attendance of lectures and practical classes, as well as independent work;

- independent work involves the study of individual topics of the academic discipline, which are presented in accordance with the program for independent study, or were considered briefly;

– all tasks provided by the program must be completed within the set time;

- if the student of higher education is absent from classes for a good reason, he presents the completed tasks during independent preparation and consultation of the teacher;

– the coursework must be protected no later than a week before the beginning of the examination session (**indicated if available**);

- while studying the course, students of higher education must adhere to the rules of academic integrity set forth in the following documents: "Rules of academic integrity of participants in the educational process of the KHNADU" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_dobroch_1.pdf), "Academic integrity. Checking the text of academic, scientific and qualification works for plagiarism" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_85_1_01.pdf), "Moral and ethical code of participants in the educational process of the KHNADU (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_MEK_1.pdf).

- in case of detection of plagiarism, the applicant receives 0 points for the task and must repeat the tasks provided for in the syllabus;
- writing off during tests and exams is prohibited (including using mobile devices). Mobile devices are allowed to be used only during online testing.

**Recommended Literature:** (Literature not later than 10 years except 1 fundamental classic textbook or monograph)


1. D.V. Kelton, A.M. Lowe, Simulation modeling, 847 p. (2004)
2. Methodological instructions for the implementation of practical work in the discipline "Simulation modeling" for students of the specialty 151 "Automation of computer-integrated technologies" / Compilers: I.H. Ilge, D.O. Markozov, O.S. Kononykhin - Kharkiv, Khnadu, 2017. – 44p. (Access mode:URL: https://dl2022.khadi-kh.com/pluginfile.php/62152/mod_resource/content/1/%D0%86%D0%BC%D1%96%D1%82%D0%B0%D1%86%20%D0%BC%D0%BE%D0%B4%D0%B5%D0%BB_%D0%BF%D1%80%D0%B0%D0%BA%D1%82%D0%B8%D1%87%D0%BD%D1%96_%D1%80%D0%B0%D0%B1.pdf)
3. Simulation modeling of cyber security systems and processes in the MATLAB environment: Workshop [Electronic resource] (For students of technical special higher education institutions) / [A.D. Kozhukhivskyi, G.I. Haydur, O.A. Kozhuhivska, V.V. Marchenko, S.O. Aleksenko]; Ministry of Education and Science of Ukraine, State University of Telecommunications. - K: DUT, 2020. - 78 p. (Access mode: https://dut.edu.ua/uploads/l_2166_52628776.pdf)
4. Makhney O. V. Mathematical modeling: teaching. manual Ivano-Frankivsk: V. P. Suprun, 2015. 372 p. (Access mode: URL: http://194.44.152.155/ elib/local/1962.pdf)
5. Gamayun I. P., Cherednichenko O. Yu. Modeling of systems: teaching. manual for students of specialties 6.050103 "Software engineering", 6.050101 "Computer science". Kharkiv: Fakt, 2015. 228 p.
6. Obod I. I. Mathematical modeling of systems: educational host/ 1. I. Obod, GE Zalodko, 1. V. Svid. - Kharkiv: Madrid printing house, 2019. - 268 p. ISBN 978-61 7-7683-93-2


**Additional sources:**


1. distance course:
https://dl2022.khadi-kh.com/course/view.php?id=905
2. Modeling of control systems in SIMULINK: учеб. allowance / [V. A. Bogomolov, A. G. Gurko, V. I. Klymenko, D. N. Leontiev, A. N. Krasiuk]; Ministry of Education and Science of Ukraine, Khnadu. - Kharkiv: Khnadu, 2018. - 220 p. - ISBN 978-966-303-693-9 (Access mode:https://dspace.khadi.kharkov.ua/ dspace/handle/123456789/2533)


Developer(s)
the syllabus of the academic discipline _____ Ilge I.H.
signature

Head of Department _____ Gurko O.G.
signature