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

Department of Applied Radio Electronics

[RE-348] COMPUTER MODELING IN INTELLIGENT SYSTEMS

Curriculum of the academic discipline (Syllabus)

Course details

Level of higher education	First (bachelor's)
Field of knowledge	17 - Electronics, automation, and electronic communications
Special	172 - Electronic Communications and Radio Engineering
Educational program	Intelligent technologies of radio-electronic engineering
Discipline status	Regulatory
Form of higher education	Full-time
Year of training, semester	4th year, spring semester
Scope of the discipline	4 credits (Lectures 20 hours, Practical work 30 hours, Laboratory work hours, Independent work 70 hours)
Semester control/control measures	Credit
Class schedule	https://schedule.kpi.ua
Language of instruction	Ukrainian
Information about the course leader/teachers	Lecturer: I. O. Prykhodko, Practical training: A. V. Shulga, Independent work: A. V. Movchanuk

Course location https://do.ipo.kpi.ua/user/view.php?id=10308&course=8225

Curriculum

1. *Description of the course, its purpose, subject matter, and learning outcomes*

The discipline **"**Computer Modeling in Intelligent **Systems"** is an important component of the training of technical and engineering specialists. It is aimed at studying the theoretical foundations, methods, and practical means of constructing mathematical models of various physical, technical, and statistical processes, as well as the application of computer technologies for their analysis and optimization.

The course covers modern approaches to the numerical solution of differential and linear equations, methods for finding extrema of functions, as well as statistical modeling of processes in queuing systems and signal detection. Considerable attention is paid to finite difference equations and the finite element method, which are basic tools for modeling complex technical systems and physical processes. Separate sections of the discipline are devoted to electroacoustic and electromechanical analogies, which allow modeling oscillatory processes in different environments, as well as modeling thermal processes using Poisson's equation.

During their studies, students acquire practical skills in using specialized software for numerical modeling, data analysis, and visualization of results. The knowledge gained is the foundation for further study of applied disciplines, scientific research, and solving engineering problems in professional activities.

The aim of ***the credit module*** is to give students a comprehensive understanding of methods of computer and mathematical modeling of physical, technical, and statistical processes, as well as to acquire practical skills in constructing, analyzing, and implementing mathematical models using numerical methods.

The discipline belongs to the Normative Educational Components/Compulsory Components of the Professional Training Cycle.

The discipline develops the following competencies in accordance with the educational program:

General:

GC 04 Knowledge and understanding of the subject area and understanding of professional activities.
GC 07 Ability to learn and acquire modern knowledge
GC 08 Ability to identify, pose, and solve problems

Professional:

PC 01 Ability to understand the essence and significance of information in the development of a modern information society
PC14 Readiness to study scientific and technical information, domestic and foreign experience on the subject of investment (or other) projects in telecommunications and radio engineering
PC20 Ability to choose methods and means of information processing using intelligent technologies.
PC23 Ability to select and apply specialized software tools for simulation modeling and design of radio- electronic equipment
PC25 Ability to reasonably select CAD systems for performing analysis, calculation, optimization of the output characteristics of mathematical and circuit models of analog and digital devices depending on the frequency range, taking into account external factors, use Internet information resources to obtain mathematical and design models of radio components from manufacturers based on an assessment of the characteristics of information transmission in radio networks

Program learning outcomes:

PLO 02 Apply the results of personal search and analysis of information to solve qualitative and quantitative problems of a similar nature in information and communication networks, telecommunications and radio engineering systems;
PLO 04 Explain the results obtained as a result of measurements in terms of their significance and relate them to the corresponding theory
PLO 13 Apply fundamental and applied sciences to analyze and develop processes occurring in telecommunications and radio engineering systems
PLO 18 Find, evaluate, and use information from various sources necessary for solving professional tasks, including reproducing information through electronic search
PLO 21 Ensure the reliable and high-quality operation of information and communication networks, telecommunications and radio engineering systems
PLO 22 Monitor the technical condition of information and communication networks, telecommunications and radio engineering systems during their technical operation in order to identify deterioration in performance or failures, and systematically record this by means of documentation.
PLO 27 Apply basic methods and techniques for obtaining information.

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

According to the educational program "Intelligent Technologies of Radio Electronics," the prerequisites are "Communication Means in Intelligent Radio Electronic Systems."

Post-requisites - Diploma design.

3. *Contents of the academic discipline*

Topic 1: Computer and mathematical modeling

Topic 2: Numerical methods for solving differential and linear equations. Extreme problems.

Topic 3: Mathematical statistics. Modeling solutions to statistical problems in queueing theory and signal detection

Topic 4: Finite difference equations and finite element methods

Topic 5: Electroacoustic and electromechanical analogies. Modeling of oscillations

4. *Teaching materials and resources Main*

literature:

1. Momot, A. I. Mathematical modeling: method. instructions for practical work / A. I. Momot, O. Ya. Olikh. – K.: Publishing and Printing Center "Kyiv University", 2011. – 72 p.
2. Baltovsky, O. O., Foros, G. V., Siforov, O. I. Fundamentals of Mathematical Modeling / Edited by O.
   A. Baltovsky, Doctor of Technical Sciences, Associate Professor. Odessa State University of Internal Affairs, 2023. 125 p.
3. Mathematical modeling of dynamic systems and processes: Instructional and methodological materials for independent work by students of higher education institutions of the second (master's) level of higher education in the specialty 122 Computer Science/ Compiled by: Tamila Kolomiets, Vasyl Mykhailenko, Anatolii Pohorui, Svitlana Postova, Anatolii Franovskyi. Zhytomyr: Ivan Franko Zhytomyr State University Publishing House, 2024. 60 p.
4. Chuiko, G. P. Mathematical Modeling of Systems and Processes: [textbook] / G. P. Chuiko,

O. V. Dvornik, O. M. Yaremchuk. – Mykolaiv: Petro Mohyla Black Sea National University Publishing House, 2015. – 244 p.
5. O. V. Barabash, O. V. Svynchuk, A. P. Musienko. MATHEMATICAL MODELING AND OPTIMIZATION OF PROCESSES AND SYSTEMS. PART 1 – Kyiv: 2023

Additional literature:

Distance learning course: https://do.ipo.kpi.ua/user/view.php?id=10308&course=8225

Ukrainian-language sources

1. Kovalev V.I. Mathematical modeling of radio-electronic systems. — K.: Technika, 2021.
2. Reshetnikova S.M. Fundamentals of computer modeling of telecommunications equipment. — KNURE, 2024.
3. Kravets, I.I. MATLAB and Simulink in the modeling of technical systems. — Lviv: LNU, 2022.
4. Gryshchenko O.M. Numerical methods in electronics. — Kharkiv: NTU "KhPI", 2020.

English-language sources

1. Leonov S.A., Leonov A.I. Handbook of Computer Simulation in Radio Engineering, Communications, and Radar. — Artech House, 2001.
2. Radioelectronics and Communications Systems — Peer-reviewed journal, Springer, Kyiv Polytechnic Institute.
3. Development of Computer Models of Measuring Devices for the Study of Radio Engineering Disciplines — CEUR Workshop Proceedings, 2024.
4. Radio Electronics, Computer Science, Control — Academic journal, Zaporizhzhia Polytechnic, ISSN 2313-688X.
5. Pozar D.M. Microwave Engineering. — Wiley, 4th Edition, 2011.
6. Chapra S.C., Canale R.P. Numerical Methods for Engineers. — McGraw-Hill, 2015.
7. Nocedal J., Wright S.J. Numerical Optimization. — Springer, 2006.
8. MATLAB Optimization Toolbox Documentation — MathWorks, 2025.
9. Reddy J.N. An Introduction to the Finite Element Method. — McGraw-Hill, 2020
10. Nayfeh A.H. Nonlinear Oscillations. — Wiley, 2020
11. Ogata K. Modern Control Engineering. — Prentice Hall, 2021.

Educational content

5. *Methodology for mastering the academic discipline (educational component) List of computer workshops:*

1. Introduction to packages. Solving equations.
2. Solving extreme problems
3. Solving statistical problems.
4. Modeling acoustic and mechanical vibrations.
5. Modeling thermal processes.

6. Independent work

Independent work by students involves familiarizing themselves with the theoretical information for each laboratory assignment on the eve of its implementation.

Policy and control

7. Policy of the academic discipline (educational component)

To successfully complete the course, students must:

- Adhere to academic integrity: complete assignments and tests independently (especially during distance learning);
- Complete computer workshops on time or make up missed classes (in face-to-face learning) within the established deadlines;
- The defense of computer workshop reports in face-to-face learning takes place immediately after their completion (or within the deadlines set by the teacher) in the form of an oral interview. In the case of distance learning, the defense takes the form of a test on the distance learning platform.

Class attendance:

- Lectures are not compulsory to attend. The minimum information required to master the course is provided in the form of presentations and lectures on the distance learning platform. However, attending lectures allows you to gain more in-depth knowledge and simplifies the completion of laboratory work and writing a modular test;
- Attendance at computer workshops is mandatory during face-to-face classes. In the context of distance learning and the asynchronous learning model, students have the right to complete and defend (in the form of tests) computer workshops at a time convenient for them. Deadlines and penalty points are not applied if there are objective reasons for not being able to complete the work on schedule.

Conducting certain types of classes in a distance learning mode:

- Lectures are held according to schedule using Zoom.
- Computer workshops are conducted using specialized software. Access to it is provided by the instructor.
- According to the schedule of computer workshops, a video conference is created in Zoom to explain the task, conduct consultations, etc.
- Modular tests are conducted using the distance learning platform.

8. Types of assessment and rating system for evaluating learning outcomes

Completion and defense of computer workshops — maximum 15 points for each,

15x5=75; Modular test — 25 points.

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

Number of points	*Grade*
100-95	Excellent
94	Very good
84	Good
74-65	Satisfactory
64-60	Sufficient
Less than 60	Unsatisfactory
Admission requirements not met	Not admitted

9. Additional information on the discipline (educational component)

Description of material, technical, and informational support for the discipline

Equipment for laboratory work: Computer classroom with 12 Intel Celeron G540 computers, 2.5 GHz, RAM: 4 GB, HDD: 500 GB Software: MatLAB (Online)

Work program for the academic discipline (syllabus):
Compiled by I. O. Prykhodko; A. V. Shulga; A. V. Movchanuk;
Approved by the PRE Department (Minutes No. 06/2025 dated 06/25/2025)
Approved by the methodological commission of the faculty/research institute (protocol No. 06/2025 dated 26.06.2025)