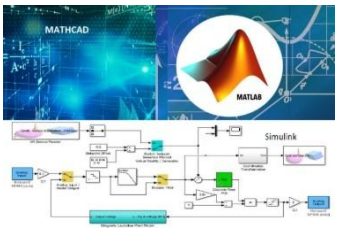
Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Radio Engineering Systems

[RE-314] COMPUTER MATHEMATICS SYSTEMS IN RADIO ENGINEERING



Curriculum of the academic discipline (Syllabus)

Course details

Level of higher education	First (bachelor's)
Field of knowledge	17 - Electronics, Automation, and Electronic Communications
Specialization	172 - Electronic Communications and Radio Engineering
Educational program	All educational programs
Discipline status	Elective (F-catalog)
Form of higher education	Full-time
Year of training, semester	Available for selection starting from the 2nd year, fall semester
Scope of the discipline	4 credits (Lectures 18 hours, Practical classes 36 hours, Laboratory work 36 hours, Independent work 66 hours) Semester
Control/control measures	Credit
Class schedule	https://schedule.kpi.ua
Language of instruction	Ukrainian
Information about the course leader/teachers	Lectures: Golovin V. A., Lab: Golovin V. A., Independent work: Golovin V. A.
Course location	https://do.ipo.kpi.ua/course/view.php?id=4356

Curriculum

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

Brief description of the course. During the course, students will be required to perform complex calculations of radio engineering devices and their models, construct graphs, use series, approximation and interpolation of measurement results, and perform statistical processing of results.

The course "Computer Mathematics Systems in Radio Engineering" will help higher education students acquire basic knowledge and practical skills in using modern

Mathcad and Matlab mathematical packages for solving engineering problems and the basic algorithms for solving linear and nonlinear problems.

Studying this discipline helps develop the ability to perform complex calculations for radio engineering devices, supplement calculations with 2D and 3D graphs, analyze the results obtained, and construct and investigate the characteristics of complex radio engineering devices and communication channels.

Objective: The objective of the course is to develop skills and practical abilities in studying the basic provisions of the Mathcad, Matlab, and Simulink mathematical packages and their computational and graphical functions necessary for design, engineering, and research professional activities.

Competencies: to provide skills in applying modern information technologies
Knowledge:

- basic features and capabilities of Mathcad, Matlab
- basic algorithms of typical numerical methods for solving mathematical problems • program development in Mathcad and Matlab
- modeling in Simulink

skills:

- perform numerical and analytical calculations
- construct graphs in various coordinate systems, including three-dimensional ones • solve systems of linear and nonlinear algebraic and differential equations
- process measurement results in Mathcad and Matlab • programming in languages
- use the help system and Internet resources

Experience:

- practical use of Mathcad and Matlab software packages for solving applied problems, constructing graphs, and building models in Simulink

General competencies	KC 1 Ability to think abstractly, analyze, and synthesize KC 2 Ability to apply knowledge in practical situations KC 3 Ability to plan and manage time GC 5 Ability to communicate in the official language, both orally and in writing
Professional competencies of the specialty	PC 2 Ability to solve standard professional tasks based on information and bibliographic culture using information and communication technologies and taking into account the basic requirements of information security. PC 3 Ability to use basic methods, means, and tools for obtaining, transmitting, processing, and storing information. PC 4 Ability to perform computer modeling of devices, systems, and processes using universal application software packages.
Program learning outcomes KNOWLEDGE	KNOWLEDGE 16 modern means of computer modeling and calculation of parameters of telecommunications and radio engineering devices;

SKILLS	SK 2 Apply the results of personal research and analysis of information to solve qualitative and quantitative problems of a similar nature in information and communication networks, telecommunications and radio engineering systems SK 6 competently apply terminology in the field of telecommunications and radio engineering; SKILL 17 find, evaluate, and use information from various sources necessary for solving professional tasks, including reproduction of information through electronic search;

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

Prerequisites

The effectiveness of studying the discipline depends on the level of knowledge and skills acquired during university studies, such as mathematics, programming, foreign language (preferably English), and computer skills

Post-requisites

The knowledge and skills acquired by applicants for higher education (bachelor's degree) when studying this course are used in the process of studying for a bachelor's degree, master's degree, engineering, and scientific work

3. Contents of the academic discipline

No.	Title of topics and list of main questions (list of teaching aids, references to literature, and assignments for independent study)
1	Development of software for mathematical calculations. Main characteristics of Maple, MatLab, and Mathcad mathematical packages. Use of mathematical packages in solving mathematical and radio engineering problems. Mathcad package interface. Main menu. Working document. Toolbars. Workspace setup. Recording and moving expressions. Text recording. The concept of regions. Sequence of reading and executing entries in a working document. Saving information to disk.
2	Goals, real, complex, text constants. System variables. Calculations in calculator mode. Format for outputting calculation results. Variables, variable names. Building and editing expressions. Operators for assigning values to variables. Standard functions. User functions. Discrete variables. Building tables. Building flat graphs. Building 3D graphs. Formatting graphs [1] Vectors and matrices. Entering vectors and matrices , indexing elements, operations and functions with vectors and matrices. Basic operations with matrices. Operations for creating new vectors and matrices from previously entered ones. Scalar and vector products. Matrix determinant, inverse matrix. Solving systems of linear equations. Writing and reading from disk.
3	Element-by-element operations. Vectorization operation. Searching for polynomial roots, constructing a zero map. Numerical solution of nonlinear algebraic equations. Selection of initial value, convergence of methods, accuracy of solution. Constructing a graph around the solution point. Searching for extreme points of functions of one variable. [1] pp. 70-85 Solution of systems of nonlinear algebraic equations. Solution of inequalities. Given-Find, Givev-Mineer block. Verification of solutions. Approximate solution of systems of equations. Search for extreme points of functions of several variables. Solution of differential equations. Given-Odesolve block.
4	Symbolic algebraic calculations. Simplification of expressions, expansion into series, solving equations and systems of equations. Symbolic matrix operations. Symbolic toolbar. Dimensions. Assignments for independent study. Operations for transforming expressions

5	Approximation, interpolation of tabular data. Regression. Mathematical statistics functions. Programming basics. Operators. Development of programs and program functions. Program debugging. Assignments for independent study. Programming functions. Debugging programs. Animation. Control elements. Document formatting. Text entry, formatting text regions. Document protection. Assignments for independent study. Text formatting
6	Matlab package interface. Main menu. Main windows: Command Windows, Workspace, Command History, Current Directory. Configuring window placement, fonts, basic parameters.
7	Entering constants and expressions in Command Windows, editing. Calculations, output formats. Checking and changing data in Workspace. Standard functions. Help command. Executing commands from Command History. Creating an m-file from Command History entries . Saving to MD.
8	M-file editor, scripts, and m-functions. Recording commands and expressions, editing, executing commands and expressions from the M-file editor . Data types. Arithmetic operations. Arrays. Array indexing. Element-by-element operations . Functions for working with arrays. Forming arrays from previously created ones. Solving systems of linear equations.
9	Construction of 2D and 3D graphs. Graph window, menu, selection of graphic objects, graph formatting.
10	Operations with polynomials, searching for polynomial roots. User functions. Rules for writing m-functions. Solving nonlinear equations. Solving systems of nonlinear equations. Selecting initial values. Questions of convergence of methods. Solving differential equations. Searching for the maximum or minimum of functions of several variables
6	Programming, language operators. Working with files, writing and reading data. Data input and output formats. Debugging programs.
13	Symbolic calculations. Symbolic data types. Expression conversion operations. Performing basic mathematical operations. Matrix operations. Solving systems of equations. . Calculating and plotting symbolic functions

4. Teaching materials and resources

Electronic versions of basic textbooks, methodological guidelines for laboratory work, examples of problem solving, graph construction, and reference systems are available to students on the department server.

Basic literature

1. Algorithmization and programming. MathCAD Tutorial. Second edition. Lviv: Lviv Polytechnic Publishing House, 2012.– 312 p.
2. S. S. Zabara Modeling Systems in MATLAB. Kyiv. University "Ukraine." 2011– 137 p.
3. Lazarev Yu. F. Modeling of dynamic systems in Matlab. Electronic textbook. – Kyiv: NTUU "KPI", 2011. – 421 p.
4. A. D. Kozhukhivsky, Simulation Modeling of Cybersecurity Systems and Processes in MATLAB G. I. Haidur, O. A. Kozhukhivska, V. V. Marchenko, S. O. Alexenko https://dut.edu.ua/uploads/l_2166_52628776.pdf

Information resources

1. RTPS Department Server (methodological guidelines, electronic versions of textbooks)
2. NTUU "KPI" Campus (programs, methodological guidelines)

Educational content

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

Calendar and thematic plan (scheme) of the academic discipline Lectures 9. Practical classes 9. Laboratory work 9.

Calculation work.

Week	Type and number of classes	Topic of the class or assignment for independent work	K-hours
1	Lecture	Basics of working in Mathcad. Main menu. Working document. Toolbars. Setting up the workspace. Recording and moving expressions. Recording text. The concept of regions. The sequence of reading and executing working document records. Saving information to disk. Standard functions. User functions. Discrete variables. Building tables. Creating flat graphs. Creating 3D graphs. Formatting graphs	2
2	Lecture 2	Vectors and matrices. Introduction to vectors and matrices, indexing elements, operations and functions with vectors and matrices. Basic operations with matrices Element-by-element operations. Vectorization operation. Searching for polynomial roots, constructing a zero map. Numerical solution of nonlinear functions of one variable. Given- Find, Givev-Mineer block. Given-Odesolve block	2
2	Laboratory work 1	Calculations and operations in Mathcad. Construction and formatting of graphs. Text editor.	2
3	Lecture 3	Symbolic algebraic calculations. Programming	
3	Laboratory work 2	Solving elementary math problems One-dimensional and two-dimensional arrays. Solving equations, systems of linear and nonlinear equations. nonlinear equations	4
4	Lecture 4	Series expansion, approximation, interpolation, smoothing. Statistical processing of measurement results measurements. Histogram.	2
4	Laboratory work 3	Arrangement in a row, approximation, interpolation, smoothing. Statistical processing of measurement results measurements. Histogram.	4
5	Lecture 5	Recording constants and expressions in Command Windows, editing . Calculations, output formats. Controlling and changing data in Workspace. Standard functions. Help command. Executing commands from Command History. Creating an m-file from Command History records. Saving to MD.	2
5	Laboratory work 4	Programming.	4
6	Lecture 6	M-file editor, scripts, and m-functions. Recording commands and expressions, editing, executing commands and expressions from the M-file editor. Data types. Arithmetic operations. Arrays. Array indexing. Element-by-element operations. Functions for working with arrays. Forming arrays from previously created ones. Solving systems of linear equations. Constructing 2D and 3D graphs. Graphical window, menu, selection of graphical objects, graph formatting Operations with polynomials, searching for polynomial roots. User functions. Rules for recording m-functions. Solving nonlinear equations.	2
6	Laboratory work 1	Recording in Command Windows. Performing calculations Expressions in Command Windows	2

7	Lecture 7	Solving systems of nonlinear equations. Choosing initial values. Questions of convergence of methods. Solving differential equations. Finding the maximum or minimum of functions of several variables. Symbolic computation. Symbolic data types. Expression conversion operations. Performing basic mathematical operations. Matrix operations. Solving systems of equations. Calculating and plotting of symbolic functions	2
7	Laboratory work 2	Plotting and formatting 2D and 3D graphs	4
8	Lecture 8	Programming, language operators. Working with files, writing and reading data. Data input and output formats. Debugging programs. Object-oriented programming. Descriptor graphics. Graphic objects and their properties. Commands for defining and setting object properties. Building dialog programs. Graphic interfaces GUIDE, AppDesigner	2
8	Laboratory work 3	Operations with vectors and matrices. Solving systems equations. Solutions to differential equations	2
8	Laboratory work 4	Programming m-files, functions	2
9	Lecture 9	Block programming. Simulink, block libraries. Main menu of the model window. Signal generator blocks, signal processing blocks, observation blocks. Building simple models. Block parameters, selection of solution methods, solution accuracy. Connection to Command Windows and Workspace.	2
9	Laboratory work 5	Simulink interface. Toolbox. Block programming. Development of simple models.	2
9	Laboratory work 6	AppDesigner. Development of graphical user interface (GUI)	2
Total for the content module - 150 hours. (Lectures - 18 hours, laboratory work 36 hours, independent work - 96 hours)			

6. Independent work by students

No. of the week	Type and number of classes	Lesson topic or assignment for independent work	Number hours
	Laboratory work	Completion and defense of assignments	18

Policy and control

7. Policy of academic discipline (educational component)

- Independent completion of educational tasks, current and final assessment tasks;
- defense of completed assignments on a PC in the environment Mathcad, MatLab;
- high-quality and early completion of educational tasks is encouraged with additional points; • references to sources of information when using ideas, developments, statements, information;
- compliance with copyright and related rights legislation
- providing reliable information about the results of one's own (scientific, creative) activities, research methods used, and sources of information.

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

Assessment scale for academic discipline

No	Types of work performed by the applicant	Assessment
1.	Completion of laboratory work assignments	0-45
2	Completion of individual assignments for independent work. Modular test.	0-15
3	Calculation work.	0-20
4	Credit.	0-20
Total for academic discipline		**0-100**

Conditions for admission to the final assessment (credit):

1) Students who have attended all classroom sessions provided for in the curriculum for the discipline and have earned at least 60 points while working on the educational material of the content modules are admitted to the final assessment.
2) For higher education students who have missed classes for valid reasons, adjustments are made to their individual study plans and they are allowed to make up for their academic debt by a specified deadline.

Assessment criteria for each type of work

The assessment of knowledge is based on the completeness and correctness of the tasks performed.

The form of control over the work on the course material is the completion of practical tasks, with a maximum score of 5 points that a higher education student can receive for each task.

The maximum score for completing the module test is 15 points. The maximum score is awarded for a test completed without errors, in full, demonstrating a sufficiently high level of knowledge and skills in using computational and graphical capabilities.

The applicant receives a score of 10 for complete work with minor errors and poor-quality graphs.

The applicant receives a score of 5 for complete work with minor errors, poor-quality graphs, and work completed after the deadline (> 20%).

The maximum grade for the completion of each individual assignment that a higher education applicant can receive is 20 points. The applicant receives the maximum grade for an individual assignment completed without errors, in full, demonstrating a sufficiently high level of mastery of the educational material, as well as developed practical skills. The work must be formatted in accordance with the specified requirements and submitted for review within the established deadline.

The applicant receives a score of 10 points for an individual assignment completed in full, which has minor flaws, such as failure to comply with some requirements for the graphic part of the work or minor errors. The work must be submitted for review within the established deadline.

The applicant receives a score of 5 points for an individual assignment completed in full, without errors or with minor errors, but submitted after the deadline.

The assessment uses a rating system and linear normalization of criteria indicators

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)

List of questions for the test:

1. Numerical and symbolic calculations.
2. Vectors and matrices. Element-by-element operations.
3. Calculations with complex numbers.
4. Plotting and formatting graphs.
5. Solving linear and nonlinear equations.
6. Solving systems of linear and nonlinear equations.
7. Solving first- and second-order differential equations.
8. Interpolation and approximation of measurement results.
9. Statistical processing of measurement results.
10. Development and debugging of programs and functions

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

Computer classrooms of the Department of Radio Engineering Systems.

Work program of the academic discipline (syllabus):
Compiled by Golovin V. A.;
Approved by the RTS Department (Minutes No. 11/24 dated 14.06.2024)
Approved by the methodological commission of the faculty/research institute (protocol No. 06-2024 dated 28 June 2024)