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

Department of
computer systems
software

COMPUTER LOGIC. Part 1. Applied Theory of Digital Automata

Working program of the academic discipline (Syllabus)

	Details of the academic discipline
Level of Higher Education	***First (Bachelor's)***
Field of Study	*12 Information Technologies*
Specialty	*121 Software Engineering*
Education Program	*Software Engineering of Multimedia and Information Retrieval Systems*
Type of Course	*Normative*
Mode of Studies	*Full-time*
Year of studies, semester	*2nd year of study, 4th semester*
ECTS workload	*4.5 ECTS credits, 135 hours (36 – lectures, 9 – practical classes, 9 – laboratory classes, self-study – 81)*
Testing and assessment	*Exam, modular control work, home control work*
Course Schedule	*http://rozklad.kpi.ua/*
Field of Study	*English*
Course Instructors	Lecturer: *Ph.D., Associate Professor, Onai Mykola* Practical training: *Ph.D., Associate Professor, Onai Mykola*
Placement of the course	*Electronic campus of NTUU "KPI". Materials from the discipline "Computer logic".*

Program of educational discipline

1. Course description, goals, objectives, and learning outcomes

Discipline "Computer Logic. Part 1. Applied Theory of Digital Automata" allows students to develop competencies necessary for solving practical problems of professional activity related to software design (at the abstract and structural levels).

The purpose of the educational discipline is to train highly qualified specialists who possess the methods of presenting and building optimal digital schemes and information processing systems, are able to perform both modeling and development of such schemes and systems based on the obtained theoretical results.

The subject of the educational discipline is the theoretical and practical foundations of the analysis, presentation and synthesis of digital control schemes with and without memory, taking into account the features of the element base.

Discipline "Computer Logic. Part 1. Applied Theory of Digital Automata" forms ***general (GC)*** *and* ***professional competences (PC)*** *in students:*
GC01 *Ability to abstract thinking, analysis and synthesis*
GC02 *Ability to apply knowledge in practical situations*
GC05 *Ability to learn and master modern knowledge.*
PC03 *Ability to develop architectures, modules and components of software systems.*

Program learning outcomes (PLO) *disciplines "Computer Logic. Part 1. Applied Theory of Digital Automata" according to the educational program:*
PLO01 *To analyze, purposefully search and select the necessary information and reference resources and knowledge to solve professional problems, taking into account modern advances in science and technology.*
PLO02 *To know the professional ethics code, understand the social significance and cultural aspects of software engineering and adhere to them in professional activities*
PLO05 *To know and apply relevant mathematical concepts, domain methods, system and object-oriented analysis and mathematical modeling for software development*
PLO10 *To conduct a pre-project survey of the subject area, system analysis of the design object.*
PLO13 *To know and apply methods of developing algorithms, designing software and data and knowledge structures.*

2. Prerequisites and post-requisites of the course (the place of the course in the structural-logical scheme of studies in accordance with educational program)

To the successful study of the discipline "Computer Logic. Part 1. Applied Theory of Digital Automata" precedes the study of the discipline "Mathematical Support of Multimedia and Information Retrieval Systems", "Mathematical Analysis", "Computer Discrete Mathematics", "Theory of Probability".
Received when mastering disciplines «Computer Logic. Part 1. Applied Theory of Digital Automata» theoretical knowledge and practical skills ensure successful study of the discipline "Computer Logic. Part 2. Computer Arithmetic" completion of pre-diploma practice, implementation of course and diploma projects in the specialty 121 Software engineering.

3. Content of the course

Chapter 1. Boolean functions

Topic 1.1. Boolean functions.

Topic 1.2. Minimization of Boolean functions.

Topic 1.3. Representation of functions in other bases.

Chapter 2. Combination schemes

Topic 2.1. Synthesis of combinational circuits.

Topic 2.2. Synthesis of schemes based on special devices.

Chapter 3. Automata with memory.

Topic 3.1. Automata with memory, abstract and structural levels.

Topic 3.2. Stability of machines, control of machines.

4. Educational materials and resources

Basic literature

1. *Huth, M., & Ryan, M. (2004). Logic in Computer Science (2nd ed.). Cambridge University Press. Retrieved from* https://www.perlego.com/book/1693624/logic-in-computer-science-modelling-and-reasoning-about-systems-pdf
2. *Rex Page, Ruben Gamboa (2019). Essential Logic for Computer Science. Random House Publishing Group*
3. *John Y. Hsu (2012). Computer Logic. Design Principles and Applications. Springer New York, NY.*

Educational content

5. Methodology of mastering the discipline (educational component)

No. z/p	*Type of training session*	*Description of the training session*
	Chapter 1. Boolean functions	
1	*Lecture 1*	*Boolean functions, forms of representation of Boolean functions, Shannon expansion.* *Tasks on self-study: item 6 No. 1.*
2	*Lecture 2*	*Functional completeness of Boolean functions, precomplete classes. Schaeffer functions.* *Tasks on self-study: item 6 #2.*
3	*Practical lesson 1*	*Boolean functions. task methods. Forms of representation of Boolean functions. Determining the dependence of a function on its arguments by the truth table.* *Tasks on self-study: item 6 #3.*
4	*Lecture 3*	*Minimization of the representation forms of Boolean functions., Quine-McCluskey method, Blake Poretsky method.* *Tasks on self-study: item 6 #4.*
5	*Lecture 4*	*Veitch diagrams, Conjunctive normal form minimization.* *Tasks on self-study: item 6 No. 5.*
6	*Practical lesson 2*	*Precomplete classes of Boolean functions. Determining whether a function belongs to a functionally closed class. The concept of a functionally complete base.* *Tasks on self-study: item 6 No. 6.*
7	*Lecture 5*	*Nelson's and Petryk's methods* *Tasks on self-study: item 6 #7.*
8	*Lecture 6*	*Multivalued functions and elements* *Tasks on self-study: item 6 #8.*
9	*Practical lesson 3*	*Methods of minimization of Boolean functions. Quine's method.* *Tasks on self-study: item. 6 No. 9.*

10	Lecture 7	Majority and threshold functions and elements. Tasks on self-study: item 6 #10.
11	Lecture 8	Zhigalkin's polynomial, features of defining linear functions. Tasks on self-study: item 6 No. 11.
12	Practical lesson 4	Minimization of incompletely defined functions using Veitch diagrams. Tasks on self-study: item 6 #12.
13	Lecture 9	Single-cycle circuits, basic concepts, basic systems of elements, two-input and multi-input elements, modern circuits, features of their synthesis. Tasks on self-study: item 6 #13.
14	Lecture 10	Minimization in AND-NOT and OR-NOT bases, ratio of possible transformations, features of synthesis of circuits using both elements with different number of inputs. Tasks on self-study: item 6 No. 14.
15	Practical lesson 5	Minimization of conjunctive normal forms. Tasks on self-study: item 6 No. 15.
Chapter 2. Combination schemes		
16	Lecture 11	Definition of decoders, features of their synthesis and schemes based on them. Tasks on self-study: item 6 No. 16.
17	Lecture 12	Multiplexers, features of the synthesis of circuits based on them. Tasks on self-study: item 6 #17.
18	Laboratory session 1	Combination schemes. Synthesis of a combinational circuit based on two input elements OR-NOT and AND-NOT. Tasks on self-study: item 6 #18.
19	Lecture 13	Homogeneous environments, designing circuits that implement Boolean functions on their basis, on the basis of PZP and PLM, contact circuits, asymptotic synthesis methods. Tasks on self-study: item 6 #19.
Chapter 3. Automata with memory		
20	Lecture 14	Abstract automata, methods of representation. Equivalent transformations. Tasks on self-study: item 6 #20.
21	Laboratory lesson 2	Designing combinational circuits using decoders and multiplexers. Tasks on self-study: item 6 #21.
22	Lecture 15	Structural automata, the canonical method of structural synthesis, its main stages and features of the synthesis of automata in the binary structural alphabet. Tasks on self-study: item 6 No. 22.
23	Lecture 16	Stability of automata, elemental structures of computers, the problem of ensuring the stability of automata in a potential elemental structure. Tasks on self-study: item 6 #23.

24	*Laboratory lesson 3*	*Synthesis of digital automata with memory. Abstract automata equivalent to transformations. Designing a structural automaton. Tasks on self-study: item 6 #24.*
25	*Lecture 17*	*Microprogrammed automata, LSA and GSA, transition to the automaton graph, methods of designing microprogrammed automata. Tasks on self-study: item 6 #25.*
26	*Lecture 18*	*Functional control of machines, features of control of machines with and without memory, features of test control. Linear machines. Tasks on self-study: item 6 #26.*
27	*Laboratory session 4*	*Synthesis of microprogrammed automata according to a meaningful graph scheme of the algorithm Tasks on self-study: item 6 #27.*

6. Independent work of student

Discipline "Computer Logic. Part 1. Applied Theory of Digital Automata" is based on independent preparations for classroom classes on theoretical and practical topics.

No. z/p	*The name of the topic submitted for independent processing*	*Number of hours*	*literature*
1	*Preparation for the lecture 1*	*1*	*1-3*
2	*Preparation for lecture 2*	*1*	*1-3*
3	*Preparation for practical class 1*	*1*	*1-3*
4	*Preparation for the lecture 3*	*1*	*1-3*
5	*Preparation for the lecture 4*	*1*	*1-3*
6	*Preparation for practical class 2*	*1*	*1-3*
7	*Preparation for the lecture 5*	*1*	*1-3*
8	*Preparation for the lecture 6*	*1*	*1-3*
9	*Preparation for practical class 3*	*1*	*1-3*
10	*Preparation for the lecture 7*	*1*	*1-3*
11	*Preparation for the lecture 8*	*1*	*1-3*
12	*Preparation for practical class 4*	*1*	*1-3*
13	*Preparation for the lecture 9*	*1*	*1-3*
14	*Preparation for lecture 10*	*1*	*1-3*
15	*Preparation for practical class 5*	*1*	*1-3*
16	*Preparation for lecture 11*	*1*	*1-3*
17	*Preparation for lecture 12*	*1*	*1-3*
18	*Preparation for laboratory session 1*	*1*	*1-3*
19	*Preparation for lecture 13*	*1*	*1-3*

20	Preparation for lecture 14	1	1-3
21	Preparation for laboratory class 2	1	1-3
22	Preparation for lecture 15	1	1-3
23	Preparation for lecture 16	1	1-3
24	Preparation for laboratory class 3	1	1-3
25	Preparation for lecture 17	1	1-3
26	Preparation for lecture 18	1	1-3
27	Preparation for laboratory class 4	1	1-3
28	Topic 1.2. Minimization of Boolean functions. Find 5 Schaeffer functions of 3 variables. Justify your choice. Comparison with other methods of minimization of Boolean functions	3	1-3
29	Topic 1.3. Minimization of Boolean functions. Representation of functions in other bases. Tasks on SRS. Minimal, abbreviated and dead-end forms. Comparison with Quine's method. Examples of implementation of Boolean functions represented by Shannon expansion. Find the simplest form of representation for the function sum modulo 2 of many variables.	3	1-3
30	Topic 2.1. Synthesis of combinational circuits. Comparison with Quine's method. Refer to the course "Computer Electronics" to strengthen knowledge about the basic systems of elements. Determine whether a threshold function is a given specific truth table.	3	1-3
31	Topic 2.2. Synthesis of schemes based on special devices. Features of implementation of functions of many variables. Peculiarities of implementing functions on PLM. Write down the form of the representation of the 4-valued function of the sum modulo 4 of two variables.	3	1-3
32	Topic 3.1. Automata with memory, abstract and structural levels. Transformation of a Moore automaton into a Milli automaton. Implementation based on various triggers.	3	1-3
33	Topic 3.1. Stability of machines, control of machines. To justify why the potential elementary structure beat all others, having serious shortcomings.	3	1-3
34	Preparation for MKR	3	1-3
35	Preparation for DKR	3	1-3
36	Preparation for the exam	30	1-3

Policy and Assessment

7. Policy of academic discipline (educational component)

Attending classes. *Absence from a classroom session does not involve the calculation of penalty points, since the student's final rating score is formed solely on the basis of the evaluation of study results. At the same time, discussion of the results of the thematic tasks, as well as presentation / public speaking and participation in discussions and additions at seminars will be evaluated during classroom classes. In order to actively participate in the work of the seminar, the student prepares for a specific seminar class in literature as recommended by the teacher. Participation in the work of the seminar also involves the preparation of reports and co-reports within all classes.*

Missed evaluation control measures. *Every student has the right to make up lessons missed for a valid reason (hospital, mobility, etc.) at the expense of independent work. More details at the link: https://kpi.ua/files/n3277.pdf .*

The procedure for contesting the results of assessment control measures. *A student may raise any issue relating to the assessment procedure and expect it to be dealt with in accordance with pre-defined procedures. Students have the right to challenge the results of control measures with arguments, explaining which criteria they disagree with according to the evaluation. Calendar control is carried out in order to improve the quality of students' education and monitor the student's fulfillment of the syllabus requirements.*

Academic integrity. *The policy and principles of academic integrity are defined in Chapter 3 of the Code of Honor of the National Technical University of Ukraine "Ihor Sikorsky Kyiv Polytechnic Institute". More details: https://kpi.ua/code .*

Norms of ethical behavior. *Standards of ethical behavior of students and employees are defined in Chapter 2 of the Code of Honor of the National Technical University of Ukraine "Ihor Sikorskyi Kyiv Polytechnic Institute". More details: https://kpi.ua/code .*

Inclusive education. *The acquisition of knowledge and skills in the course of studying the discipline "Research activity in computer engineering" can be accessible to most people with special educational needs, except for students with serious visual impairments that do not allow them to perform tasks with the help of personal computers, laptops and/or other technical means.*

Studying in a foreign language. *In the course of the tasks, students may be recommended to refer to English-language sources. Assigning incentive and penalty points According to the Regulation on the system of evaluation of learning results, the sum of all incentive points cannot exceed 10% of the rating scale.*

All students must attend lectures and practical classes, where you need to actively work on learning the learning material. For objective reasons (for example - illness, international internship), training can take place in an online form individually upon agreement with the head of the course.

Deadlines and Rescheduling Policy:

Works that are submitted late without good reason will be assigned a lower grade. Rearranging modules takes place with the permission of the dean's office if there are good reasons (for example, sick leave).

Policy on academic integrity *:*

All written works are checked for plagiarism and accepted for defense with correct textual borrowings of no more than 20%. Write-offs during control work are prohibited (including using mobile devices).

8. Types of control and rating system of assessment of learning outcomes

1. Current control.

Surveys (surveys are conducted at each practical session during the semester based on the materials of previous lectures). Maximum number of points: 8 points.

Modular test (one 45-minute test per semester). MKR includes 5 questions (5 tasks). The maximum number of points for the answer to each question: 2 points.

Evaluation criteria:

2 points – the decision is well-founded and correctly executed in full;

1.5 points – the decision is correct, but not justified;

1 point – the solution has some minor flaws;

0.5 points – there are errors in the decision, but the course of the decision is correct;

0 – there is no solution, the solution is incorrect.

The maximum number of points for the control work:

2 points × 5 requests. = 10 points.

Home control work (DKR). The test includes 8 questions (8 tasks). The maximum number of points for the answer to each question: 4 points.

Evaluation criteria:

4 points – the decision is well-founded and correctly executed in full;

3.5 points – the decision is correct, but not justified;

2.5 points – the solution has some minor flaws;

2 points – the solution has significant drawbacks;

1.5 points – there are errors in the decision, but the course of the decision is correct;

1 point – the decision is incorrect;

0 - no solution.

The maximum number of points for the control work:

4 points × 8 requests. = 32 points.

The maximum number of points for the current control: 8+10+32=50 points

2. Examination

The examination ticket consists of 3 questions - 2 theoretical and 1 practical. The answer to a theoretical question is valued at 15 points, the answer to each practical question is valued at 20 points.

Evaluation criteria for the theoretical question of the examination paper:

14-15 points – the answer is correct, complete, well-argued;

12-13 points - the answer is correct, detailed, but not very well argued;

9-11 points - in general, the answer is correct, but has flaws;

5-8 points – there are minor errors in the answer;

2-4 points – there are significant errors in the answer;

0 points - there is no answer or the answer is incorrect.

Evaluation criteria for the practical question of the examination paper:

20 points – the answer is correct, the calculations are completed in full;

16-18 points - the answer is correct, but not very well supported by calculations;

13-15 points - in general, the answer is correct, but has flaws;

9-12 points – there are minor errors in the answer;

4-8 points – there are significant errors in the answer;

0-3 points - there is no answer or the answer is incorrect.

The maximum number of points for an answer on the exam:

15 points × 2 theoretical questions + 20 points practical question = 50 points.

3. Calculation of the rating scale (R).

The semester component of the RS rating scale = 50 points, it is defined as the sum of positive points received for answering questions during practical classes, evaluations for modular and homework tests.

Examination component of the RE rating scale = 50 points.

The rating scale for the discipline is equal to: R = RS + RE = 100 points.

Calendar control: is conducted twice a semester as a monitoring of the current state of fulfillment of the syllabus requirements.
At the first certification (8th week), the student receives "credited" if his current rating is at least 27 points (50% of the maximum number of points a student can receive before the first certification).
At the second certification (14th week), the student receives "passed" if his current rating is at least 50% of the maximum number of points that the student can receive before the second certification.

With a semester rating (R_C) of at least 30 points and the admission of all the work of the computer workshop, the student is admitted to the exam. After passing the exam, a grade is assigned according to the table (Table of correspondence of rating points to grades on the university scale).

A prerequisite for admission to the exam is the completion and defense of all laboratory work.

Table of correspondence of rating points to grades on the 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 not met	Not allowed

Work program of the discipline (syllabus):

Is designed by Ph.D., Assoc. Prof., Onai M.V.

Adopted by Computer Systems Software Department (protocol № 12 from 26.04.23)

Approved by the Faculty Board of Methodology (protocol № 10 from 26.05.23)