Національний технічний університет
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ І

Кафедра
обчислювальної техніки

COMPUTER ARCHITECTURE.
COURSE WORK
Syllabus

Реквізити навчальної дисципліни

Level of higher education	*First (bachelor)*
Branch of knowledge	*12 Information Technologies*
Specialty	*123 Computer Engineering*
Educational program	*Computer Systems and Networks*
Discipline status	*Normative*
Form of education	*full*
Year of training, semester	*3 курс, весняний*
Scope of the discipline	*1 credit/30 hours.*
Semester control/ control measures	*6 sem*
Lessons schedule	*Згідно розкладу на весняний семестр поточного навчального року за адресою rozklad.rpi.ua*
Language of teaching	*Englisch*
Information about	Lectors : ass. prof.*Tkachenko V.* Доцент ass. prof. *Korochkin O.*
Place	*https://bbb.comsys.kpi.ua/b/*

Primary Discipline Program

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

The purpose and main tasks of the course are to study the theoretical foundations, principles and methods of building and using microprocessor systems (MPS). In order to achieve this goal, the cycle of classroom lessons must be complemented by a significant amount of independent work by students.

The purpose of the credit module is to form students' skills:

- perform an analytical review on the topic of the course work;
- develop structural, functional and principle schemes,
- to develop algorithms for the functioning of blocks and the organization of input and output processes, as well as information exchange between blocks in the MPS
- develop software for computers equipped with multi-core processors.

As a result of studying the discipline, the student should obtain the following:

Knowledge:

- knowledge of basic terms and definitions in the field of construction of MPS;
- knowledge of the principles of software management for the organization of computing

processes in microprocessor systems;
- characteristics of microprocessors at the architectural and structural levels;
- knowledge of the principles of construction and operation of microprocessor systems;
- knowledge of methods of organizing input and output processes in microprocessor systems, and also the exchange of information in the MPS among the main blocks;
- concepts of streams, as well as tools for organizing the interaction of streams
- the life cycle of creating software for multi-core computers systems

Skills;
- the ability to use modern mathematical apparatus for solving engineering i scientific tasks that arise during the development and research of microprocessor systems (MPS);
- the ability to develop microalgorithms and microprograms for the implementation of various commands;
- the ability to use languages of different levels to describe hardware and software;
- the ability to use simulation and other types of modeling for research microprocessor systems at various stages of design;
- ability to develop algorithms for exchanging information between MPS devices;
- the ability to develop microalgorithms and microprograms for the implementation of input-output commands data in computers;
- the ability to make calculations necessary to determine the effectiveness of the decisions made
- skills in using modern design automation tools in the industry computer engineering.
- develop optimal parallel algorithms;
- to use various means of organizing the interaction of streams that provide time minimization when solving the task of mutual exclusion and synchronization of flows
- setting up a parallel program, preventing deadlocks (deadlocks);
- testing of a parallel program with the determination of the acceleration coefficient and Download

Experience:

The design of MPS should begin with the analysis of the algorithm for solving the given problem. Initially, the command system includes commands that provide data input and output, work with subprograms, program disclosure, and enable and disable interrupts. After that, the system of commands is distributed by commands that, together with the existing ones, ensure the implementation of the given algorithm. The program model of the processor is compiled, the memory organization is specified, and functional microalgorithms for command execution are developed.

Next, the issues of information exchange with external devices (priority interrupt mode, direct memory access, software exchange mode) are considered. Based on the analysis of the developed microalgorithms of the commands and the selected means of interaction with external devices (software, firmware, hardware), the structural diagram of the MPS is specified.

An important part of KR is the development of software that will ensure optimal use of processors with multi-core architecture.

The study tasks of the credit module are presented in the form of a system of knowledge and skills, gained experience with an indication of a certain level of their formation, which allows you to determine the required level of mastery of the educational material and develop criteria for evaluating the quality of coursework and defense.

Work on KP should ensure the formation and development of the following abilities and skills:

- work with technical and reference literature;
- systematize and analyze various technical information;
- set tasks correctly, give comparative characteristics of various solutions at the design stages;
- defend the adopted technical decision in a professional discussion;
- to conduct an objective analysis of the effectiveness of the adopted technical decisions;
- carry out technical and economic calculations.

The credit module provides the following competencies and program results of the educational program of the first (bachelor) level of higher education (OP): FC1, FC 2, FC 5, FC11-15, PRN2, PRN 4, PRN 7-9, PRN11-12, PRN 14-17, PRN19, PRN 22.

2. Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

When studying the content of the credit module "Computer architecture. Course work » it is advisable to use the knowledge obtained during the study of previous disciplines: "Computer logic", "Computer circuitry", "Data structures and algorithms", "Computer electronics", "Parallel programming". The discipline is basic for the courses: "Computer networks", "Computer systems", "System software"

Work schedule

Weeks	Steps of works	Hours	
		Aud[1].	SRS
1-2	Getting a topic and task		2
3-5	Selection and study of literature		3
	Implementation of Section 1		
7-8	Development of the structural scheme of the MPS		2
8-9	Development of functional schemes of the KPP, KPDP.		3
10-11	Development of the software part		5
12 - 13	Development of a schematic diagram		4
13	Functional diagram of the given node		4
14	Loading into the structure of the FPGA. Nodes (CAD)		2
15	Adjusting the operation of the unit on the work bench.		2
	Implementation of Section 2		
7-8	Overview of a multi-core processor		2
8-9	Development of a parallel mathematical algorithm		4
10-11	Development of flow algorithms		4
11-12	Development of flow interaction scheme		4
13-14	Program development, debugging and testing		8
	Registration and protection of the KR		
15-16	Design		2
17	Submission of a course project (work) for review		
18	Protection of term paper	1	
	In total		30

3.List of topics (options of initial data)

Chapter 2. Develop MPS (taking into account the element base, which is selected according to table 1.1) for solving control problems and various specialized problems (for example: solving various systems of equations, calculating functions by a defined numerical method, etc.; the supervisor assigns a task to each student individually.) . Evaluate the effectiveness of adopted technical decisions.

The development MPS should include a microcontroller (MK), main memory (PP and PD), as well as external devices (ZP), priority interrupt controllers (KPP) and direct memory access (KPDP), as well as a specialized computer (SO). Which is built on the basis of a firmware control unit and an operating unit for the task issued by the head of the KP (development of the processor unit).

Develop a parallel program for a computer with a multi-core architecture (processor type provided).

The initial data for the development of MPS are determined according to the table. 1.1-1.15 and are also issued by the supervisor individually to each student. (In the tables h8...h1 indicate the lower digits of the number of the scorebook presented in the binary numbering system). Data for the development of a shortened system of commands for a specialized computer (CO) is issued by the supervisor individually to each student (task number).

Carry out the development of a specialized computer (CO). CO is built on the basis of a microprogram control unit and an operating unit for the task issued by the head of the KP (development of the processor unit).. Spec. The computer must be added to the structural diagram of the MPS (by connecting it to the system trunk). This SO is used for solving floating-point problems, as well as for a given problem.

The course work is carried out on an individual task and is the student's independent work. It is intended for expansion, consolidation, generalization and practical use of knowledge, abilities and skills acquired by the student while studying the course. In the process of course design, the student should also learn to use reference literature and learn the process of creating design and construction documentation in accordance with current standards.

Designing should begin with the analysis of the algorithm for solving the given problem and the development of the MPS architecture. As an individual task, as a rule, the implementation of a certain numerical method is proposed. If necessary, additional data can be specified (specific calculation scheme, data presentation form, calculation error, etc.).

Initially, the command system includes commands that provide input and output of data, work with subprograms, program branching, enabling and disabling of interrupts. Then the system of commands is expanded with commands that, together with the existing ones, ensure the implementation of the given algorithm. The format of commands is developed, their mnemonic is determined.

Based on the specified accuracy of calculations and other factors, the form and bit rate of data presentation is selected.

A programming model of the processor is compiled, the memory organization is specified, and functional microalgorithms for command execution are developed. The required number of general-purpose registers and working registers is determined.

Based on this, the structural diagram of the microprocessor system is developed.

It should include a processor (P), random access memory (RAM), non-volatile memory (LP), input/output device (I/O), interrupt controllers (KPP) and direct access to memory (KPDP) is a specialized computer (CO) for solving a given problem.

Further, the issues of information exchange with external devices (interruption mode, direct access, organization of data input and output) are considered.

Based on the analysis of the developed microalgorithms for command execution and the selected methods of interaction with external devices (software, firmware, hardware or mixed), the structural scheme of the MPS is clarified.

Next, an individual task is performed, a functional diagram of a given MPS node is developed and loaded into the FPGA structure. At this stage, specialized CAD systems are used, determined by the selected FPGA series.

When evaluating performance, the number of cycles required to execute individual commands is calculated, and the duration of cycles is determined. Based on the frequency of the appearance of individual commands and the combination of processes, the performance of MPS is determined.

The reliability of MPS components is characterized by the intensity of failures and the readiness factor, because the MPS is a renewable system.

List of documents to be developed:

- fame of the project,
- technical task,
- explanatory note,
- microprocessor system, electrical structural scheme;
- memory module, electrical functional circuit;
- data processing unit, basic electrical scheme;

Technical characteristics, set individually for each option:

- memory volume,
- microprocessor kit,
- element base for OZP and PZP,
- amount of PVV,
- types of address and data buses,
- output data for selecting a command system.

CHAPTER 2 Chapter 2 deals with software development for computer system equipped with a multi-core processor.

Input data:

- the structure of a multi-core processor
- a mathematical task
- software creation tools (parallel programming language or library)
- a model of the organization of flow interaction (a model based on common variables or message model)
- means of organizing the interaction of streams.

The student must complete the full cycle of developing a parallel program, which includes the study of the internal parallelism of a mathematical problem, the development of a parallel mathematical algorithm, the development of flow algorithms, the selection of optimal means of flow interaction, the development of a flow interaction scheme, the development and debugging of a parallel program, the testing of the program with the determination of acceleration coefficients and loading (efficiency)

List of documents to be developed:

- the study of the internal parallelism of a mathematical problem
- parallel mathematical algorithm
- flow algorithms
- flow interaction diagram
- parallel program listing
- the results of the study of the effectiveness of the program.

FORMATION OF CW

Approximate content of the explanatory note.

Introduction.

1. Overview of existing technical solutions.
2. Development of MPS architecture and its rationale.
3. Command execution algorithms.
4. Implementation of interruptions.
5. Implementation of direct access to memory.
6. Development of structural, functional and principle schemes.
7. Calculation of MPS productivity.
8. Estimation of consumed power.
9. Programs in a high-level language for studying the characteristics of MPS that given by the method of simulation.
10. Conclusions.

List of references.

Applications (algorithms, microalgorithms, programs, microprograms).

6. Recommended reading

Base

1. Sarcar J. Computer Aided Design . A Conceptual Approach ISBN 9781138885448 Published July 27, 2017 by CRC Press 739 Pages

2.. Zhukov I., Korochkin O. Parallel Computing. – К.: «Korneychuk», 2009. 96 p.

3. Computer Architecture. Course work - / Tkachenko V., Korochkin O. – Kyiv : I.Sycorsky KPI, 2022. – 24 c. Electronics resource. //comsys.*kpi.ua*

Auxiliary

4. Hamacher C., Vranesic Z., Zaky S. Computer organization : 5th edition. – 2022. [Електронний ресурс] Hamacher:ComputerOrganization (mhhe.com), Computer Organization By Carl Hamacher 5th Edition | lulabi.live.

5. Tanenbaum A.S. Structured Computer Organization: 6th Edition – 2013. - [Електронний ресурс.

Information resource

6.STM32 MCU & MPU Eval Tools - STMicroelectronics

Discovery kit with STM32F407VG MCU. (Data brief): STM32F4DISCOVERY - Discovery kit with STM32F407VG MCU * New order code STM32F407G-DISC1 (replaces STM32F4DISCOVERY) – STMicroelectronics Discovery kit with STM32F407VG MCU. UM1472 User manual: Discovery kit with STM32F407VG MCU - User manual STM32F407VG Product overview. https://www.st.com/en/microcontrollers-microprocessors/stm32f407vg.html#overview

8. Rating system for evaluating learning outcomes

RSE coursework is written according to the RSO-2 type and has two components:

• starting Rc – characterizes the quality of the explanatory note, text and graphic (illustrative) material: compliance with the established schedule of course work, modernity and justification of the decisions made, correct application of analysis and calculation methods, quality of design, compliance with the requirements of regulatory documents, quality of graphic material and compliance requirements of standards, etc. The recommended size of the starting component is equal to 60-80 points;

• defense component Rz – characterizes the quality of the coursework defense: the quality of the report, the degree of mastery of the material, the degree of substantiation of the decisions made, the ability to defend one's opinion, the answers to the questions of the members of the semester control committee, etc.

Rk = Rc + Rz

The size of the scale of the first component equals 80 points, and the second component - 20 points.

The criteria for evaluating the components of the explanatory note (Rc) are given in Table 8.1

Table 8.1 – Evaluation criteria for the implementation of the components of the explanatory note

№ етапу	Composite works	The maximum number of points in time	Performance
1	Registration of title sheet	2	100% of the grade if the work schedule is followed 90% in case of delay up to 2 weeks
2	Availability of technical tasks for the KR	2	
3	Availability and content of the description album	2	
4	Availability of content	2	
5	Availability and content of the introduction	2	

6 7	Availability and content of Section 1 Availability and content of Section 2	20 20	80% in case of delay more than 2 weeks
9	Availability and content software application	10	
10	Availability and content test results software application	5	
11	Availability and content conclusions	5	
12	Availability and design list of sources	5	
	In total Rc	**80**	

A student is allowed to defend a coursework on the condition that he has an initial RS component of at least 60% of the maximum value, which is 80 x 0.6 = 48 points

Taking into account the received sum of points, the final grade is determined by the following table:

Points	**Value**
100...95	Perfectly
94...85	Very good
84...75	Okay
74...65	Satisfactorily
64...60	Enough
< 60	Unsatisfactorily
There are uncredited laboratory works or calculation work is not included	Not allowed

The working program of the academic discipline (syllabus) was compiled:

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Ph.D., associate professor Korochkin O.V.

Approved: by the Department of Computing (Protocol No. 10 dated 05/25/2022).

Agreed: by the methodological commission of FIOT (protocol No. 10 dated 06/09/2022).

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