National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Computer Systems Software Department

FUNDAMENTALS OF COMPUTER SYSTEMS AND NETWORKS

Syllabus

Requisites of the Course	
Cycle of Higher Education	***First cycle of higher education (Bachelor's degree)***
Field of Study	*12 Information Technologies*
Speciality	*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	*1 year (2 semester)*
ECTS workload	*5 credits (ECTS). Time allotment - 150 hours, including 72 hours of classroom work, and 78 hours of self-study.*
Testing and assessment	*Exam*
Course Schedule	*Classes by the timetable http://rozklad.kpi.ua/*
Language of Instruction	*English*
Course Instructors	*Lecturer: PhD, Associate Professor, Liubov Oleshchenko, oleshchenkoliubov@gmail.com* *Teacher of computer workshop: PhD, Associate Professor, Liubov Oleshchenko, oleshchenkoliubov@gmail.com*
Access to the course	*Google classroom: Access is given to registered students.*

Outline of the Course

1. Course description, goals, objectives and learning outcomes

The study of the discipline "Fundamentals of Computer Systems and Networks" allows students to form the competencies necessary for solving practical problems of professional activity related to the creation and configuration of computer networks of varying complexity.

***The purpose** of studying the discipline "Fundamentals of Computer Systems and Networks" is the formation of students' ability to analyze the network by its logical topology; choose computer network hardware and software according to certain requirements; configure network devices and services; use distributed data, programs and resources of computer networks in professional activities.*

***The subject** of the discipline "Fundamentals of Computer Systems and Networks" are switching and routing technologies for computer systems and networks.*

*The study of the discipline "Fundamentals of computer systems and networks" contributes to the formation of the following **professional competences** (PC) in students according to the educational program:*

***PC6** Ability to analyze, select and apply methods and tools to ensure information security (including cybersecurity).*
***PC8** Ability to apply fundamental and interdisciplinary knowledge to successfully solve software engineering problems.*
***PC 17** Ability to develop software for information retrieval systems.*
***PC 19** Ability to develop software for multimedia and mulsemedia systems.*

*The study of the discipline "Fundamentals of computer systems and networks" contributes to the formation of the following **program learning outcomes** (PLO) for students 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.*
***PLO07** To know and to apply in practice the fundamental concepts, paradigms and basic principles of the functioning of language, instrumental and computational tools of software engineering.*
***PLO18** To know and be able to apply information technology of processing, storage and transmission of data.*
***PLO21** To know the tools, analyze, select, skillfully apply the information security (including cybersecurity) and data integrity means in accordance with the applied tasks and software systems.*
***PLO38** To be able to apply programming technologies for multimedia and information retrieval systems software development.*

2. Prerequisites and post-requisites of the course

(the place of the course in the scheme of studies in accordance with curriculum)

Successful study of the discipline "Fundamentals of Computer Systems and Networks" is preceded by the study of discipline "Discrete Mathematics for Computer Science", the curriculum for bachelors in 121 Software Engineering. The theoretical knowledge and practical skills obtained during the mastering of the discipline "Fundamentals of Computer Systems and Networks" are necessary for the study of the discipline "Network Software Design and Development" of the curriculum for the preparation of masters in the specialty 121 Software Engineering. To successfully master the discipline requires a basic level of English not less than A2.

3. Content of the course

The discipline "Fundamentals of Computer Systems and Networks" involves the study of the topics:

Topic 1. Types of computer networks. Network components. Network protocols and standards.

Laboratory works 1-4.

Topic 2. Switching and routing technologies.

Modular test.

Exam.

4. Coursebooks and teaching resources

Basic references:

1. *Liubov M. Oleshchenko. Computer Systems and Networks Fundamentals: Laboratory Work Tutorial: tutorial is aimed at students of the speciality 121 "Software Engineering" (educational program «Software Engineering of Multimedia and Information Retrieval Systems») / Igor Sikorsky Kyiv Polytechnic Institute;. – Electronic text data. – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 85 p. https://ela.kpi.ua/bitstream/123456789/52413/1/Computer_Systems_Networks_Fundamentals.pdf*

2. Data Communication and Computer Network / https://www.tutorialspoint.com/data_communication_computer_network

3. Understanding IP Addresses, Subnets, and CIDR Notation for Networking / https://www.digitalocean.com/community/tutorials/understanding-ip-addresses-subnets-and-cidr-notation-for-networking

4. BIND Open Source DNS Server / https://www.isc.org/downloads/bind/

5.Dynamic Trunking Protocol / http://www.ciscopress.com/articles/article.asp?p=2181837&seqNum=8

***Additional references**:*

1. *IEEE 802.3 ETHERNET WORKING GROUP / http://www.ieee802.org/3/*
2. *IP Calculator / http://jodies.de/ipcalc*
3. *Subnet Calculator / https://www.iplocation.net/subnet-calculator*
4. *IP Address, Get my IP, IPv4, IPv6, Internet Protocol / http://www.ip-adress.eu/*

Educational content

5. Methodology

№	Type of training session	Description of the lesson
	Topic 1. Types of computer systems and networks. Network components. Network protocols and standards	
1	*Lecture 1. Types of computer systems and networks. Network components. Network protocols and standards. OSI and TCP / IP models*	*Computer systems. Types of computer systems and networks. Internet access technologies. Network requirements. Network components. Network representation. Physical and logical topology of networks. Cloud computing. Data centers. Network protocols and industry standards. OSI and TCP / IP models. Comparison of OSI and TCP / IP models.*
2	*Laboratory work 1. Network devices and communication. Packet Tracer simulation environment*	*Task: to learn basic network devices and network data tools using the Packet Tracer simulation environment, learn how to create and deploy devices, connect, configure devices, and test connections.*

3	*Laboratory work 2. Tracking the route to a remote server from the command line, software and web tools*	*Task: to test the possibility of connecting to a remote server, learn to determine the routes to the remote server using the command line, software and web tools.*
4	*Lecture 2. Network operating system*	*Network OS. IOS operating system functions. Console access method. Access methods using Telnet, SSH and AUX. Terminal emulation programs. Operating modes of the CISCO IOS operating system. IOS operating system command structure. Basic commands for setting up and testing network devices.*
5	*Lecture 3. Physical layer*	*Network data transfer rules. Logical and physical address. Basic principles and means of physical layer data transmission. Characteristics of copper cables. Features of laying fiber optic cables. Features of the wireless environment.*
6	*Lecture 4. Coding of information in local networks*	*Coding with zero return RZ. Manchester coding. Non-zero encoding (NRZ). Biphasic code. Other codes. Analog coding. Signal transmission methods. Types of signal modulation.*
7	*Lecture 5. Ethernet technologies*	*LLC and MAC channel layer sublayers. Purpose and structure of the MAC address. Ethernet frame structure. MAC and IP addresses. Functions and principles of operation of the ARP protocol. Table MAC -address of the switch. Full-duplex and half-duplex data transmission settings. Comparison of level 2 and layer 3 switching.*
8	*Lecture 6. Network layer*	*Network layer processes and protocols. IPv4 protocol. IPv6 protocol. Default gateway. Routing tables. The structure and functions of the router.*
9	*Lecture 7. Transport layer*	*Assignment of transport layer. TCP protocol. UDP protocol. Addressing TCP and UDP ports. TCP and UDP segmentation. TCP server processes and requests. UDP server processes and requests. Applications that use TCP and UDP protocols.*
10	*Laboratory work 3. Collection and analysis of ICMP protocol data using Wireshark*	*Task: to learn to use the program Wireshark to collect and analyze ICMP data, to intercept the IP address of data packets ICMP and MAC addresses of Ethernet frames on local and remote nodes.*
11	*Lecture 8. IP addressing. Partitioning the IP network on the subnet*	*Network and host parts of IPv4 addresses. Bitwise operation I. Unicast, broadcast and multicast. Public and private IPv4 addresses. Obsolete class addressing, its limitations. Classless addressing. IP address assignment. Need for IPv6. IPv6 representation. Network partitioning on the subnet. Traditional network subnetting. Split a subnet into several subnets using a variable length subnet mask.*
12	*Laboratory work 4. IP addressing. Network subnetting*	*Task: learn to use an online calculator to calculate the maximum and minimum number of subnet nodes, as well as manually calculate the number of subnets and nodes by subnet prefix, calculate the network address.*

13	Lecture 9. Protocols and services of the application layer	TCP / IP application layer functions and protocols. Peer-to-peer networks. HTTP and HTTPS protocols. SMTP, POP and IMAP protocols. Domain name service. Dynamic network node configuration protocol. File Transfer Protocol (FTP). Server message block exchange protocol.
14	Lecture 10. Network security tools	Categories of network security threats. Backup, update and install fixes. Authentication, authorization and accounting. Firewalls. Protection of edge and network devices. Enable SSH. Using special commands. Basics of wireless connection security.
Topic 2. Switching and routing technologies		
15	Lecture 11. Local area networks. Switching technologies	Principles of operation of the switch. Switching methods on the switch. Conflicting and broadcast domains. Reduce network congestion. Basic switch settings. Network access problems. Common security threats. Network security tools and testing.
16	Lecture 12. Design of virtual local area networks	Purpose and benefits of virtual local area networks. Types of virtual local area networks. Tag Ethernet frames to identify VLANs. VLAN bands on switches. Creating a virtual local area network. DTP protocol. VLAN issues. Recommendations for VLAN design.
17	Lecture 13. Routing technologies. VLAN routing	Routing. The main functions of routers. Configure the basic parameters of the router. Routing table and records. Static and dynamic routes. VLAN routing. Features of VLAN routing configuration.
18	Lecture 14. Static and dynamic routing	Advantages and purpose of static routing. Static route settings. Default static route. Purpose and role of dynamic routing protocols. The principle of operation of dynamic routing protocols. Classification of routing protocols. Remote-vector routing protocols. Channel routing protocols.
19	Lecture 15. Configuring OSPF routing	Development and characteristics of the OSPF protocol. Components and principle of operation of the OSPF protocol. OSPF for one and more areas. Encapsulation and types of OSPF packets. Establish a relationship of adjacency with neighboring devices. OSPF database synchronization. OSPF process settings. OSPF process data validation.
20	Lecture 16. Access Control Lists (ACLs)	Definition and task of access control lists. TCP communication session and data exchange. Standard and advanced ACL lists. Applying a template mask. Recommendations for using ACL lists. Configure standard ACL lists. Use an ACL to control access to VTY. Creating advanced ACL lists. Examples of finding and troubleshooting common ACL lists.
21	Lecture 17. DHCP protocol. NAT technology	DHCP protocol. DHCPv4 operation. DHCPv4 message format. Setting up a simple DHCPv4 server. DHCPv4 relay. Configure the router as a DHCPv4 client. DHCPv4 troubleshooting. Definition and need to use NAT technology. NAT terminology. Network address conversion mechanisms.

		Comparison of NAT and PAT technologies. Advantages and disadvantages of NAT. Static NAT settings. RAT settings and verification.
22	*Lecture 18. Final lecture.*	*Final lecture. Modular test.*

6. Self-study

The discipline "Fundamentals of Computer Systems and Networks" is based on independent preparation for classroom classes on theoretical and practical topics.

№	*The name of the topic that is submitted for independent study*	*Hours of study*	*References*
1	*Preparing for Topic 1.*	*24*	*[1], pp. 1-48.*
2	*Preparing for Topic 2.*	*24*	*[1], pp. 49-97.*
3	*Preparing for Exam.*	*30*	*[1], pp. 1-97.*

Policy and Assessment

7. Course policy

- *Attendance at lectures is mandatory.*
- *Rules of conduct in the classroom: activity, respect for those present, turning off the phones.*
- *Adherence to the policy of academic integrity.*
- *Rules for protecting the work of the computer workshop: the work should be done according to the option of the student, which is determined by number in the group list.*

8. Monitoring and grading policy

During the semester, students perform 4 laboratory works.

Maximum number of points for each laboratory work: 10 points.

Points are awarded for:

- quality of laboratory work: 0-4 points;

- answer during the defense of laboratory work: 0-4 points;

- timely submission of work to the defense: 0-2 points.

Performance evaluation criteria:

3-4 points - the work is performed qualitatively, in full;

1-2 point - the work is performed qualitatively, in full, but has shortcomings;

0 points - the work is not performed in full, or contains significant errors.

Response evaluation criteria:

3-4 points - the answer is complete, well-argued;

1-2 point - there are significant errors in the answer;

0 points - no answer or the answer is incorrect.

Criteria for assessing the timeliness of submission of work to the defense:

1-2 point - the work is submitted for defense no later than the specified period;

0 points - the work is submitted for defense later than the specified deadline.

Maximum number of points for the performance and defense of laboratory workshops:

10 points × 4 lab. works = 40 points.

The task for the modular test consists of 5 questions - 3 theoretical and 2 practical.

The answer to each theoretical/ practical question is evaluated by 2 points.

Criteria for evaluating each theoretical question of the module test:

2 points - the answer is correct, complete, well-argued;

1 points - there are minor errors in the answer;

0 points - no answer or the answer is incorrect.

Maximum number of points for modular test:

2 points × 3 theoretical questions + 2 points × 2 practical questions = 10 points.

The rating scale for the discipline is equal to:

R_s *= 40 points + 10 points = 50 points.*

The examination work consists of 5 questions - three theoretical and two practical. The maximum number of points for the examination work:

10 points × 3 theoretical questions + 10 points × 2 practical questions = 50 points.

According to the description: $R = R_{lab.works} + R_{test} + R_{exam} = 40 + 10 + 50$ *points = 100 points*

Calendar control: conducted twice a semester as a monitoring of the current state of compliance with the requirements of the syllabus.

At the first attestation (8th week) the student receives "credited" if his current rating is not less than 50% of the maximum number of points that the student can receive before the first attestation (10 points).

At the second attestation (14th week) the student receives "credited" if his current rating is not less than 50% of the maximum number of points (15 points) that the student can receive before the second attestation.

Semester control: exam.

The final performance score or the results of the Exam Fail/ Pass are adopted by university grading system as follows:

Score	*Grade*
100-95	*Excellent*
94-85	*Very good*
84-75	*Good*
74-65	*Satisfactory*
64-60	*Sufficient*
Below 60	*Fail*
Course requirements are not met	*Not Graded*

Syllabus of the course

Is designed by teacher PhD, Associate Professor, Liubov Oleshchenko

Adopted by Computer Systems Software Department (protocol № 12 , 26 April 2023)

Approved by the Faculty Board of Methodology (protocol № 10, 26 May 2023)