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

Computer Systems Software Department

COMPUTER SYSTEMS AND NETWORKS FUNDAMENTALS

Syllabus

Requisites of the Course	
Cycle of Higher Education	***First cycle of higher education (Bachelor's degree)***
Field of Study	*F Information Technologies*
Speciality	*F2 Software engineering*
Education Program	*Software engineering of multimedia systems and smart technologies*
Type of Course	*Normative*
Mode of Studies	*full-time*
Year of studies, semester	*1 year (2 semester)*
ECTS workload	*5 credits (ECTS). Lectures: 30 hours, laboratory practical: 30 hours, independent work: 90 hours.*
Testing and assessment	*Exam, modular test , calendar control*
Course Schedule	*Classes by the timetable http://roz.kpi.ua/*
Language of Instruction	*English*
Course Instructors	*Lecturer: PhD, Associate Professor, Liubov Oleshchenko, oleshchenkoliubov@gmail.com* *Laboratory work: 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 "Computer Systems and Networks Fundamentals" 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 "Computer Systems and Networks Fundamentals" 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 "Computer Systems and Networks Fundamentals" are switching and routing technologies for computer systems and networks.*

The study of the discipline "Computer Systems and Networks Fundamentals" 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.*

The study of the discipline "Computer Systems and Networks Fundamentals" 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 technologies for data processing, storage and transmission.*
PLO21 *To know, analyze, choose, competently apply the means of ensuring information security (including cybersecurity) and data integrity in accordance with the applied tasks being solved and the software systems being created.*

2. Prerequisites and post-requisites of the course

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

The discipline "Computer Systems and Networks Fundamentals" is a discipline of the professional training cycle.

Prerequisites: discipline "Discrete Mathematics for Computer Science", "Algorithms and Data Structures. Part 1. Basic of Algorithmization".

Post-requisites: "Programming. Part 2. Fundamentals of web programming and mobile application development".

To successfully master the discipline requires a basic level of English not less than A2.

3. Content of the course

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

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

Topic 2. Switching and routing technologies.

Modular control work.

Exam.

4. Coursebooks and teaching resources

Basic references:

1. *Oleshchenko, L. M. Computer Systems and Networks Fundamentals [Electronic resource]: textbook for higher education students studying in the specialty F2 «Software Engineering» / L. M. Oleshchenko ; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data. – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute; Prosvita Ltd, 2026. – 409 p. https://ela.kpi.ua/handle/123456789/81870*
2. *Oleshchenko L. M. 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/handle/123456789/52413*

***Additional references**:*

1. *Data Communication and Computer Network / https://www.tutorialspoint.com/data_communication_computer_network*
2. *Understanding IP Addresses, Subnets, and CIDR Notation for Networking / https://www.digitalocean.com/community/tutorials/understanding-ip-addresses-subnets-and-cidr-notation-for-networking*
3. *BIND Open Source DNS Server / https://www.isc.org/downloads/bind/*
4. *Dynamic Trunking Protocol / http://www.ciscopress.com/articles/article.asp?p=2181837&seqNum=8*
5. *IEEE 802.3 ETHERNET WORKING GROUP / http://www.ieee802.org/3/*
6. *IP Calculator / http://jodies.de/ipcalc*
7. *NAT / https://www.fortinet.com/lat/resources/cyberglossary/network-address-translation*

Educational content

5. Methodology

No.	Type of training session	Description of the lesson	Hours
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 network topology. Cloud computing. Data centers. Network protocols and industry standards. OSI and TCP/IP models. Comparison of OSI and TCP/IP models.*	*2*
2	*Laboratory work 1. Network Devices and Communications. Cisco*	*Lesson 1. Installing the Cisco Packet Tracer environment. Simulation environment capabilities. Familiarization with network devices and connection types.*	*2*

	Packet Tracer Modeling Environment	*Task: install the Cisco Packet Tracer environment, create a network of two computers connected via a switch. Configure IP addresses manually and check the network operation using the ping command.*	
		Lesson 2. Creating a local area network using a router. Task: create a network of two subnets connected via a router. Assign IP addresses to devices in each subnet.	*2*
		Lesson 3. DHCP server in Cisco Packet Tracer. Task: deploy a DHCP server on the network (on a router or a separate server). Configure automatic issuance of IP addresses to network clients. Check that all computers receive settings automatically. Check the operation of the network.	*2*
		Lesson 4. Building a local area network and checking connectivity. Task: create a local area network with several PCs and a switch. Assign IP addresses to computers according to the option and check connectivity between them using the ping command. In simulation mode, monitor the operation of the ICMP and ARP protocols.	*2*
		Lesson 5. Protocol analysis in simulation mode. Task: build a network with several PCs and a switch, assign IP addresses according to the option. Perform ping between the specified nodes and in simulation mode, monitor the movement of packets. Explain the role of ARP and confirm the reachability of all hosts on the network.	*2*
3	*Lecture 2. Network Operating System and Its Functions*	*Network OS. Functions of the IOS operating system. Console access method. Access methods using Telnet, SSH and AUX. Terminal emulation programs. CISCO IOS operating system operating modes. IOS operating system command structure. Basic commands for configuring and checking network devices.*	*2*
4	*Laboratory work 2. Tracing the route to a remote server from the command line, software and web tools*	*Lesson 1. Installing and exploring network diagnostics software. Task: install and explore the capabilities of the VisualRoute program, explore the possibilities of using the OS command line to check the connection to the web server.*	*2*
		Lesson 2. Comparing the results of route tracing using different tools. Task: check the possibility of connecting to a remote server, learn how to determine routes to a remote server using the command line, software and web tools.	*2*
5	*Lecture 3. Physical layer*	*Rules for data transmission in the network. Logical and physical address. Basic principles and means of data transmission of the physical layer. Characteristics of copper cables. Features of laying fiber optic cables. Features of the wireless environment.*	*2*

6	*Lecture 4. Information encoding in local networks*	*Return-to-zero coding (RZ). Manchester coding. Non-return-to-zero coding (NRZ). Biphase code. Other codes. Analog coding. Signal transmission methods. Types of signal modulation.*	*2*
7	*Lecture 5. Ethernet technologies*	*Link layer sublayers LLC and MAC. Purpose and structure of the MAC address. Structure of the Ethernet frame. MAC and IP addresses. Functions and principles of the ARP protocol. Switch MAC address table. Configuring full-duplex and half-duplex data transmission. Comparison of layer 2 and 3 switching.*	*2*
8	*Lecture 6. Network layer*	*Network layer processes and protocols. IPv4 protocol. IPv6 protocol. Default gateway. Routing tables. Router structure and functions.*	*2*
9	*Lecture 7. Transport layer*	*Purpose of the transport layer. TCP protocol. UDP protocol. TCP and UDP port addressing. TCP and UDP segmentation. TCP server processes and requests. UDP server processes and requests. Applications that use TCP and UDP protocols.*	*2*
10	*Laboratory work 3. Data Collection and Analysis ICMP protocol using Wireshark*	*Lesson 1. Intercepting ICMP packets on a local network. Task: install and run the Wireshark program, select the active interface, and collect traffic when executing the ping command between two local computers. Determine the source and destination IP addresses, as well as the MAC addresses of Ethernet frames.*	*2*
		Lesson 2. Analyzing the structure of ICMP messages. Task: filter ICMP traffic in Wireshark using the icmp filter. Analyze the structure of ICMP Echo Request and Echo Reply, highlight the service fields (type, code, checksum). Explain the meaning of each of them in the report.	*2*
		Lesson 3. Collecting and analyzing ICMP traffic from remote nodes. Task: execute the ping command from the local computer to a remote server (for example, google.com). Use Wireshark to intercept packets, determine the IP addresses of intermediate nodes and the MAC addresses of devices on the local network. Explain the difference between local and remote ICMP exchange.	*2*
11	*Lecture 8. IP addressing. Subnetting an IP network*	*Network and node parts of an IPv4 address. Bitwise operation I. Unicast, broadcast and multicast transmission. Public and private IPv4 addresses. Outdated classful addressing, its limitations. Classless addressing. IP address assignment. Need for IPv6. Introduction to IPv6. Subnetting a network. Traditional subnetting. Subnetting a subnet into multiple subnets using a variable-length subnet mask.*	*2*
12	*Laboratory work 4. IP Addressing. Network subnetting*	*Lesson 1. Basics of IP Addressing. Task: represent IP addresses in binary format, determine the class of a given IP address, identify the network and host parts of the address.*	*2*

		Lesson 2. Subnetting a network. *Task: calculate the number of subnets and hosts for a given subnet mask prefix (CIDR). Build a table with the network, the first and last host addresses, and the broadcast address.*	*2*
		Lesson 3. Manually calculate subnets. *Task: calculate IP address ranges for multiple subnets without using a calculator. Verify the results using an online subnetting tool.*	*2*
		Lesson 4. Address space planning. *Task: based on a given number of users in different departments of the organization, perform subnetting so that each department has its own subnet. Optimize the use of address space.*	*2*
		Lesson 5. Calculating network data using a subnet calculator. *Task: calculate the number of subnets and nodes by subnet prefix, calculate the network address, and also use an online calculator to calculate the main quantitative and qualitative indicators of given networks.*	*2*
13	*Lecture 9. Application layer protocols and services. Network security tools*	*TCP/IP application layer functions and protocols. Peer-to-peer networks. HTTP and HTTPS protocols. SMTP, POP, and IMAP protocols. Domain Name Service. Dynamic Host Configuration Protocol. File Transfer Protocol (FTP). Server Message Block Exchange Protocol. Categories of network security threats. Cyberattacks and cybersecurity tools. Backup, update, and patching. Authentication, authorization, and accounting. Firewalls. Securing endpoints and network devices. Enabling SSH. Using special commands. Basics of wireless security.*	*2*
Topic 2. Switching and routing technologies.			
14	*Lecture 10. Local area networks. Switching technologies. Designing virtual local area networks*	*Switch operation principles. Switch forwarding methods. Collision and broadcast domains. Reducing network congestion. Basic switch settings. Network access layer problems. Common security threats. Network security tools and testing. Purpose and benefits of virtual local area networks. Types of virtual local area networks. Tagging Ethernet frames for VLAN identification. VLAN ranges on switches. Creating a virtual local area network. DTP protocol. VLAN issues. VLAN design recommendations.*	*2*
15	*Lecture 11. Routing technologies. Static and dynamic routing*	*Purpose of routing. Basic functions of routers. Configuring basic router parameters. Routing table and entries. Static and dynamic routes. VLAN routing. Features of configuring VLAN routing. Advantages and purpose of static routing. Configuring a static route. Default static route. Purpose and role of dynamic routing protocols. Principle of operation of dynamic routing*	*2*

		protocols. Classification of routing protocols. Distance-vector routing protocols. Link-state routing protocols.	
16	*Lecture 12. Configuring OSPF routing*	*Development and characteristics of the OSPF protocol. Components and principle of operation of the OSPF protocol. OSPF for single and multiple areas. OSPF encapsulation and packet types. Establishing adjacency relationships with neighboring devices. Synchronizing OSPF databases. Configuring the OSPF process. Verifying OSPF process data.*	*2*
17	*Lecture 13. Access Control Lists (ACLs)*	*Defining and assigning access control lists. Communication session and data exchange via TCP protocol. Standard and extended ACL lists. Applying a template mask. Recommendations for using ACL lists. Configuring standard ACL lists. Using an ACL list to control access to VTY. Creating extended ACL lists. Examples of finding and eliminating common ACL list errors.*	*2*
18	*Lecture 14. DHCP protocol. NAT technology.*	*DHCP protocol assignment. DHCPv4 operation. DHCPv4 message format. Configuring a simple DHCPv4 server. DHCPv4 relay. Configuring a router as a DHCPv4 client. Troubleshooting DHCPv4. Definition and necessity of NAT technology. NAT terminology. Network address translation mechanisms. Comparison of NAT and PAT technologies. Advantages and disadvantages of NAT. Configuring static NAT. Configuring and testing PAT.*	*2*
19	*Lecture 15. Final lesson.*	*Review of the studied material. Modular test.*	*2*

6. Self-study

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

№	*Type of activity*	*Hours*	*Literature*
1	*Preparation for Lecture 1. Types of computer systems and networks. Network components. Network protocols and standards. OSI and TCP/IP models*	*3*	*[1], pp. 11–41.*
2	*Preparation for Laboratory work 1. Network Devices and Communications. Cisco Packet Tracer Modeling Environment*	*3*	*[1], pp. 46–59, 133–145; [2], pp. 5–30.*
3	*Preparation for Lecture 2. Network Operating System and Its Functions*	*3*	*[1], pp. 46–59.*
4	*Preparation for Laboratory work 2. Tracing the route to a remote server from the command line, software and web tools*	*3*	*[1], pp. 50–59, 133–145, 191–213; [2], pp. 39–49.*
5	*Preparation for Lecture 3. Physical Layer*	*3*	*[1], pp. 64–90.*
6	*Preparation for Lecture 4. Information Encoding in Local Networks*	*3*	*[1], pp. 96–110.*
7	*Preparation for Lecture 5. Ethernet Technologies*	*3*	*[1], pp. 115–129.*

8	*Preparation for Lecture 6. Network Layer*	*3*	*[1], pp. 133–145.*
9	*Preparation for Lecture 7. Transport Layer*	*3*	*[1], pp. 148–164.*
10	*Preparation for Laboratory work 3. Data Collection and Analysis of ICMP Protocol Using Wireshark*	*3*	*[1], pp. 115–129, 133–145, 148–164; [2], pp. 52–65.*
11	*Preparation for Lecture 8. IP Addressing. IP Network Subnetting*	*3*	*[1], pp. 170–187.*
12	*Preparation for Laboratory work 4. IP Addressing. Network Subnetting*	*3*	*[1], pp. 170–187; [2], pp. 69–70.*
13	*Preparation for Lecture 9. Application Layer Protocols and Services. Network Security Tools*	*3*	*[1], pp. 191–237.*
14	*Preparation for Lecture 10. Local Area Networks. Switching Technologies. Designing Virtual Local Area Networks*	*3*	*[1], pp. 241–278.*
15	*Preparation for Lecture 11. Routing Technologies. Static and Dynamic Routing*	*3*	*[1], pp. 281–318.*
16	*Preparation for Lecture 12. Configuring OSPF Routing*	*3*	*[1], pp. 321–333.*
17	*Preparation for Lecture 13. Access Control Lists (ACLs)*	*3*	*[1], pp. 337–360.*
18	*Preparation for Lecture 14. DHCP Protocol. NAT Technology*	*3*	*[1], pp. 363–399.*
19	*Preparing for modular test*	*6*	*[1], cmop. 11-430.*
20	*Preparing for Exam*	*30*	*[1], cmop. 11-430.*

Policy and Assessment

7. Course policy

Forms of organizing the educational process, types of training sessions and assessment of learning outcomes are regulated by the Regulations on the Organization of the Educational Process at the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute".

***Class attendance policy**. Attendance at lecture classes is mandatory. Attendance at laboratory classes may be occasional and required for the defense of laboratory work. The presence or absence of a student at a class is not assessed by awarding or deducting points. If a student cannot attend classes, he or she is still responsible for studying the theoretical material and completing practical assignments.*

***Policy on ethical norms in the classroom**: discipline; compliance with subordination; honesty; responsibility; respect for those present, turning off phones.*

***Policy on assessing learning outcomes**. The policy on assessing learning outcomes is regulated by the Regulations on the system of assessing learning outcomes at Igor Sikorsky Kyiv Polytechnic Institute. According to the Regulations, each grade is given in accordance with the criteria developed by the teacher and announced to students in advance. If a student fails to complete all four laboratory tests, he/she will not be allowed to take the test. Failure to pass the current control measure (modular test) without good reason is assessed as 0 points.*

The policy and principles of academic integrity are regulated by the norms set of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (https://kpi.ua/files/honorcode_en.pdf); Regulations on the Organization of the Educational Process, Regulations on the System for Preventing Academic Plagiarism, Regulations on the Commission on Ethics and Academic Integrity. Plagiarism and other forms of violation of the principles of academic integrity are

unacceptable. The student must complete all laboratory practical tasks independently using open sources of information and acquired knowledge and skills.

Plagiarism and other forms of violation of the principles of academic integrity are unacceptable. All work for current and semester tests must be completed independently by the student using open sources of information and the acquired knowledge and skills.

All works that violate the principles of academic integrity (the program code does not match the assignment option, the identity of the program code among different works, etc.) are evaluated at 0 points. To gain access to the test, the student must independently complete the laboratory work (without changing the current rating).

***Policy on appealing the results of assessment of control measures**. According to the "Regulations on resolving conflict situations at Igor Sikorsky Kyiv Polytechnic Institute" (https://osvita.kpi.ua/sites/default/files/downloads/regulations_resolving_conflict_situations_2020.pdf) , students have the right to appeal the results of control measures with arguments, explaining which criterion they disagree with according to the assessment. A student can raise any issue related to the procedure of control measures and expect that it will be considered in accordance with predetermined procedures.*

***Policy on assigning incentive points**. According to the "Regulations on the system of assessing learning outcomes at Igor Sikorsky Kyiv Polytechnic Institute", incentive points are not included in the main scale, and their sum cannot exceed 10 points.*

Incentive points are awarded for a creative approach in performing laboratory work (the maximum number of points for all work is 10 points), as well as for participation in scientific projects and conferences related to the topic of this course.

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 works:

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 4 points.

Criteria for evaluating each theoretical question of the module test:

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

2 points - there are minor errors in the answer;

0 points - no answer or the answer is incorrect.

Maximum number of points for modular test:

4 points × 3 theoretical questions + 4 points × 2 practical questions = 20 points.

The rating scale for the discipline is equal to:

R_s *= 40 points + 20 points = 60 points.*

The examination work consists of 5 questions - three theoretical and two practical.

The maximum number of points for the examination work:

8 points × 3 theoretical questions + 8 points × 2 practical questions = 40 points.

According to the description: $R = R_{lab.works} + R_{\ modular\ test} + R_{exam}$ *= 40 + 20 + 40 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 (20 points) that the student can receive before the second attestation.

Semester control: ***exam****.*

Conditions for admission to semester control:

with a semester rating (rC) of at least 60% (36 points) and the inclusion of all the work of the laboratory workshop. A necessary condition for admission to the exam is the completion and defense of a laboratory work.

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

9. Additional information on the discipline (educational component)

According to the Regulations on the recognition of learning outcomes acquired in non-formal/informal education at Igor Sikorsky Kyiv Polytechnic Institute https://osvita.kpi.ua/node/179, during the study of the discipline, it is possible to enroll in an online course or other element of non-formal education in the discipline.

Having a certificate of completion of a similar course is estimated as 10 points (if the course topic corresponds to the topic of the workshop), writing articles or participating in conferences/projects on the relevant topic is also estimated as an additional 5 points.

For example, a computer workshop can be automatically credited as 10 points by sending to the classroom certificates of completion of such courses as ***Cisco Networking Academy****:*

Networking Essentials. https://www.netacad.com

CCNA: Introduction to Networks

https://www.netacad.com/courses/ccna-introduction-networks

Networking Devices and Initial Configuration

https://www.netacad.com/courses/networking-devices-and-initial-configuration

or ***Coursera***

The Bits and Bytes of Computer Networking. https://www.coursera.org/learn/computer-networking

Introduction to Networking. https://www.coursera.org/learn/introduction-to-networking-nvidia

etc.

Syllabus of the course

Is designed by teacher PhD, Associate Professor, Liubov Oleshchenko

Adopted by Computer Systems Software Department (protocol № 15, 15.04.2026)

Approved by the Faculty Board of Methodology (protocol № 11, 22.05.2026)