



Innovative ICT Education for Social-Economic Development (IESED)  
574283-EPP-1-2016-1-LT-EPPKA2-CBHE-JP

# COMPUTER NETWORKS

Minsk 2017

## 1. PLAN OF EDUCATIONAL DISCIPLINE

Course code	Year Of study	Semester	Academic hours					Hours Of coursework	ECTS	Number Of hours
			Total	Lecture	Lab	Practice/ seminar	Independent work			
	2	4	82	20	22		40		3	Full-time
	3	6	18	10	8		64		3	Part-time

## 2. COURSE GOALS:

The main goals of the discipline is to study:

- principles of building and functioning of computer networks;
- methods for organizing shared access to shared resources;
- network technologies used in the Internet.

## 3. COMPETENCES TO BE DEVELOPED IN THE IMPLEMENTATION OF THE EDUCATIONAL PROGRAM

- Organize automated support for various activities.
- Be able to apply basic scientific and theoretical knowledge to solve practical problems.

## 4. EDUCATIONAL AND METHODOLOGICAL MAP (for full-time form of learning)

Section number, topics, classes	Section number, topics, classes; list of issues to be studied	Academic hours				Form of knowledge control
		Lecture	Practical classes (seminar)	Laboratory classes	Controlled independent work of a student	
1	2	3	4	5	6	7
	Topic 1. Introduction to computer networks (CN)	1		2	2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 2. Methods of commutation in networks.	1			2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 3. Open systems interconnection basic reference model (OSI).	1			2	
	Topic 4. Technologies of physical level of local and global networks.	1			4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Theme 5. Network communication equipment of the physical level.	1			2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 6. Link-layer technologies	1		2	2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 7. Bridges and switches of local networks	1		2	2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 8. Ethernet technology.	2			2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 9. Ring technology Token Ring and FDDI.	1				<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul>

						Testing
	Topic 10. Wireless network technologies	2			2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 11. Network layer.	1		2	2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 12. The architecture of the TCP / IP protocol stack. IPv4 protocol	1			2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 13. IPv6 protocol	1		1	2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 14. Routing.	1		3		<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 15. Transport protocols TCP and UDP stack TCP / IP.	1				<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 16. The basics of programming the TCP / IP stack	1		4	4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 17. Application-level services.	1		4	4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	Topic 18. Organization of global networks.	1		2	4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	<b>Total</b>	<b>20</b>		<b>22</b>	<b>40</b>	

## 5. EDUCATIONAL AND METHODOLOGICAL MAP (for part-time form of learning )

Section number, topics, classes	Section number, topics, classes; list of issues to be studied	Academic hours				Form of knowledge control
		Lecture	Practical classes (seminar)	Laboratory classes	Controlled independent work of a student	
1	2	3	4	5	6	7
1	Introduction to computer networks (CN)	2			2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
2	Methods of commutation in networks.				4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
3	Open systems interconnection basic reference model (OSI).				2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
4	Technologies of physical level of local and global networks.	2			2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
5	Network communication equipment of the physical level.	2			4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
6	Link-layer technologies.				2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing

						Testing
7	Bridges and switches of local networks.			2	4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
8	Ethernet technology.	2			4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
9	Ring technology TokenRing and FDDI.				2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
10	Wireless network technologies.				4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
11	Network layer.			2	2	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
12	The architecture of the TCP / IP protocol stack. IPv4 protocol.				4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
13	IPv6 protocol.				4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
14	Routing.			2	4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
15	Transport protocols TCP and UDP stack TCP / IP.	2			4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
16	The basics of programming the TCP / IP stack				6	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
17	Application-level services.			2	4	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
18	Organization of global networks.				6	<ul style="list-style-type: none"> <li>• Tasks on the learning portal.</li> <li>• Forum of the learning portal.</li> </ul> Testing
	<b>Total</b>	<b>10</b>		<b>8</b>	<b>64</b>	

## 6. THE CONTENT OF TOPICS OF THE LECTURES

№	Topic name	Content
1	Introduction to computer networks (CN)	<ol style="list-style-type: none"> <li>1. Concept of CN. Evolution and modern trends in the development of the CN.</li> <li>2. The main software and hardware components of the network.</li> <li>3. Logical structure of the CN.</li> <li>3. Requirements for modern CN.</li> <li>5. Classification of the CN. Local and global networks. 6. peer-to-peer networks and networks based on the server.</li> </ol>
2	Methods of commutation in networks.	<ol style="list-style-type: none"> <li>1. Commutation of channels, packets, messages.</li> <li>2. Frequency multiplexing and time division multiplexing.</li> <li>3. General properties of circuit-switched and packet-switched networks.</li> <li>4. Methods of transmission in packet-switched networks.</li> <li>5. Methods with connection.</li> <li>6. Methods without connection.</li> <li>7. Virtual channel.</li> </ol>
3	Open systems interconnection basic reference model (OSI)	<ol style="list-style-type: none"> <li>1. The protocol, interface, a stack of communication protocols, an open system.</li> <li>2 Model of OSI.</li> <li>3. Tasks and functions of individual levels of OSI.</li> <li>4. Agreement on the description of protocols. 5. Standard stacks of communication protocols.</li> </ol>

		6. Physical and logical network structuring.
4	Technologies of physical level of local and global networks.	<ol style="list-style-type: none"> <li>1. Methods of coding information at the physical level.</li> <li>2. Analog and digital coding of discrete data.</li> <li>3. Traffic, throughput.</li> <li>4. Duplex and half-duplex signal transmission.</li> </ol>
5	Network communication equipment of physical level	<ol style="list-style-type: none"> <li>1. Functions, classification, settings and compatibility of network adapters.</li> <li>2. Repeaters.</li> <li>3. Concentrators.</li> <li>4. Amplifiers.</li> <li>5. Characteristics, basic and additional functions.</li> </ol>
6	Link- layer technologies	<ol style="list-style-type: none"> <li>1. Random access methods. Collisions, domain collisions.</li> <li>2. Access methods with detection and prevention of collisions CSMA / CD, CSMA / CA.</li> <li>3. Deterministic methods of access.</li> <li>4. Standardization of local area network technologies.</li> <li>5. Sublayers of the link layer.</li> <li>6. Logical channel sublayer LLC.</li> </ol>
7	Bridges and switches of local networks	<ol style="list-style-type: none"> <li>1. Principles of bridges.</li> <li>2. Transparent bridges and bridges with routing from the source.</li> <li>3. Features of technical implementation and characteristics of switches.</li> <li>4. Additional functions of switches.</li> </ol>
8	Ethernet technology	<ol style="list-style-type: none"> <li>1. The main characteristics of Ethernet.</li> <li>2. Frame formats of Ethernet.</li> <li>3. Specifications of the physical environment 10 Ethernet, 100 Ethernet, 1000 Ethernet, 10G Ethernet</li> </ol>
9	Ring technology TokenRing and FDDI.	<ol style="list-style-type: none"> <li>1. The main characteristics of TokenRing technology.</li> <li>2. Marker access method. Frame formats.</li> <li>3. Level of technology TokenRing.</li> <li>5. The main characteristics and operating modes of FDDI.</li> <li>6. Fault tolerance of FDDI technology.</li> </ol>
10	Wireless Networks Technologies	<ol style="list-style-type: none"> <li>1. Technologies of Wi-Fi, WiMax, Bluetooth.</li> <li>2. The protocol stack of wireless communication.</li> <li>3. Operating modes of wireless networks</li> </ol>
11	Network layer	<p>The purpose and main functions of the network layer. Addressing nodes in networks. Classes of IP-addresses. Special IP addresses. Group IP addresses. Display IP addresses to local addresses, ARP and RARP protocols.</p>
12	The architecture of the TCP / IP protocol stack. IPv4 protocol	<ol style="list-style-type: none"> <li>1. History of creation and main advantages of TCP / IP.</li> <li>2. Documents of the RFC.</li> <li>3. The structure of the TCP / IP stack.</li> <li>4. Protocol of IP.</li> <li>5. Structure and purpose of separate fields of the IP packet.</li> <li>6. Fragmentation of IP-packets.</li> </ol>
13	Protocol IPv6.	<ol style="list-style-type: none"> <li>1. The need for IPv6.</li> <li>2. The assignment of addresses, the structure of the address, the rules of recording.</li> <li>3. Parallel use of IPv4 and IPv6 addresses: double stack, tunneling, and conversion.</li> </ol>
14	Routing. Main functions and characteristics of routers.	<p>The concept of routing. Routing table. Routing protocols. The ICMP protocol. Promotion of packages on the network. Router functions. Functional model of the router. Router Features. Classification of routers: backbone, boundary, regional, LAN routers, remote office routers, software routers</p>
15	Transport protocols TCP and UDP stack TCP / IP.	<ol style="list-style-type: none"> <li>1. Functions of transport level.</li> <li>2. The concept of the port.</li> <li>3. Distribution of port numbers</li> <li>4. Transmission Control Protocol TCP.</li> <li>5. The structure of the header of the TCP segment. Protocol of UDP datagrams.</li> </ol>
16	Basics of programming the TCP / IP stack	<ol style="list-style-type: none"> <li>1. The client-server model.</li> <li>2. The concept of a socket.</li> <li>3. Implementation of the API socket</li> </ol>

17	Application-levelservices	1. Purpose of the application layer. 2. Principles of work and protocols of a representative level. 3. IMAP protocol.
18	Organizationofglobalnetworks.	1. Primary networks. SDH (Sonet) networks. Equipment, topologies, synchronization. DWDM networks. Work principles. 2. Structure, functions, types of global computer networks. Typical data transmission system. 3. SLIP, HDLC, PPP link layer protocols. 4. Technology FrameRelay, ATM. 5. Methods of connection to the network Internet: analog dial-up telephone lines Dial-up, xDSL - digital subscriber lines, ISDN - dial-up access over the digital telephone network, dedicated analog and digital telephone lines, access via the local network, satellite access, television, wireless technology. Organization of virtual private networks VPN.

## 7. THE CONTENT OF TOPICS OF THE LABORATORYCLASSES

№	Topic name	Content
1	Introduction to computer networks (CN)	Network operating systems. Basic topologies of CN. Physical and logical topology.
2	Link-layer technologies	The Medium Access Control sublayer (MAC) is a sublayer. Structure of the hardware address (MAC - address). Individual, group and broadcast MAC address. The format of the frame of the link layer.
3	Bridges and switches of local networks	Limitations of networks built on switches. Virtual local area networks. Typical schemes for the use of switches in the CN.
4	Network layer.	Automatic assignment of IP addresses. DHCP.
5	Network layer.	Classless addressing (CIDR). The concept of a network mask, gateway.
6	IPv6 protocol	Types of IPv6 addresses. Unicast addresses. Multicast and enicast addresses. The linc-local and loopback addresses.
7	Routing.	Static Routing
8	Routing.	Dynamic Routing Remote-vector protocol RIP. OSPF protocol: advantages and disadvantages. BGP Protocol
9	Routing.	Network Address Translation (NAT)
10	The basics of programming the TCP / IP stack	Local management functions. Communication functions. Data exchange functions (input / output). Functions of closing the connection.
11	Application-levelservices.	SMTP e-mail protocols, POP3.
12	Application-levelservices.	FTP File Transfer Service. HTTP protocol.
13	Application-levelservices.	DNS service. Construction of domain names. Domain name servers. Zones and resource records. The main ways to resolve DNS names. Recursive and iterative schemes.
14	Organization of global networks.	Organization of virtual private networks VPN.

## 8. AN INDICATIVE LIST OF TASKS OF STUDENTS' CONTROLLED INDEPENDENT WORK

1. Media environments in computer networks
2. Operating modes of wireless networks
3. Addressing nodes in networks
4. Routing Protocols
5. Transmission of information via TCP

### **The evaluation criteria of the results on a 10-point scale:**

A ten-point scale, depending on the grade and the mark, includes the following criteria:

#### **10 (ten) points, passed:**

- systematized, deep and full knowledge on all sections of the curriculum of the institution of higher education in the academic discipline, as well as on major issues that go beyond its limits;
- accurate use of scientific terminology (including in a foreign language), competent, logically correct statement of the answer to questions;
- perfect mastering of the tools of the academic discipline, the ability to use it effectively in formulation and solution of scientific and professional problems;
- the expressed ability independently and creatively to solve complex problems in non-standard situations;
- complete and profound studying of basic, additional literature on the subject of the discipline;
- the ability to freely navigate in theories, concepts and directions on the discipline and give them an analytical assessment, use the scientific achievements of other disciplines;
- creative independent work on practical, laboratory classes, active creative participation in group discussions, high level of the culture of performance of tasks.

#### **9 (nine) points, passed:**

- systematized, deep and full knowledge on all sections of the curriculum of the institution of higher education on the academic discipline;
- accurate use of scientific terminology (including in a foreign language), competent, logically correct statement of the answer to questions;
- mastering of the tools of the academic discipline, the ability to use it effectively in formulation and solution of scientific and professional problems;
- ability independently and creatively to solve complex problems in non-standard situations within the curriculum of the institution of higher education on the academic discipline;
- complete studying of basic, additional literature on the subject of the discipline, recommended by the curriculum of the institution of higher education on the discipline;
- the ability to navigate in theories, concepts and directions on the discipline and give them an analytical assessment;
- Systematic, active independent work on practical, laboratory classes, active creative participation in group discussions, high level of the culture of performance of tasks.

#### **8 (eight) points, passed:**

- systematized, deep and full knowledge on all sections of the curriculum of the institution of higher education in the academic discipline in the volume of the curriculum of the institution of higher education on the discipline;
- use of scientific terminology (including in a foreign language), competent, logically correct statement of the answer to questions, the ability to make sound conclusions and generalizations;
- mastering of the tools of the academic discipline (methods of complex analysis, information technology), the ability to use it effectively in formulation and solution of scientific and professional problems;
- ability independently to solve complex problems within the curriculum of the institution of higher education on the academic discipline;

- studying of basic, additional literature, recommended by the curriculum of the institution of higher education on the discipline;
- the ability to navigate in theories, concepts and directions on the discipline and give them an analytical assessment;
- active independent work on practical, laboratory classes, systematic participation in group discussions, high level of the culture of performance of tasks.

**7 (seven) points, passed:**

- systematized, deep and full knowledge on all sections of the curriculum of the institution of higher education on the academic discipline;
- use of scientific terminology (including in a foreign language), competent, logically correct statement of the answer to questions, the ability to make sound conclusions and generalizations;
- mastering of the tools of the academic discipline, the ability to use it effectively in formulation and solution of scientific and professional problems;
- free possession of generic solutions within the curriculum of the institution of higher education on the academic discipline;
- studying of basic, additional literature, recommended by the curriculum of the institution of higher education on the discipline;
- the ability to navigate in basic theories, concepts and directions on the discipline and give them an analytical assessment;
- independent work on practical, laboratory classes, participation in group discussions, high level of the culture of performance of tasks.

**6 (six) points, passed:**

- sufficiently full and systematized knowledge in the volume of the curriculum of the institution of higher education on the discipline;
- use of the necessary scientific terminology, competent, logically correct statement of the answer to questions, the ability to make sound conclusions and generalizations;
- mastering of the tools of the academic discipline, the ability to use it effectively in solution of scientific and professional problems;
- ability independently to apply generic solutions within the curriculum of the institution of higher education on the academic discipline;
- studying of basic literature, recommended by the curriculum of the institution of higher education on the discipline;
- the ability to navigate in basic theories, concepts and directions on the discipline and give them a comparative assessment;
- active independent work on practical, laboratory classes, periodic participation in group discussions, high level of the culture of performance of tasks.

**5 (five) points, passed:**

- sufficient knowledge in the volume of the curriculum of the institution of higher education on the discipline;
- use of scientific terminology, competent, logically correct statement of the answer to questions, the ability to make sound conclusions;
- mastering of the tools of the academic discipline, the ability to use it in solution of scientific and professional problems;
- ability independently to apply generic solutions within the curriculum of the institution of higher education on the academic discipline;



- studying of basic literature, recommended by the curriculum of the institution of higher education on the discipline;
- the ability to navigate in basic theories, concepts and directions on the discipline and give them a comparative assessment;
- active independent work on practical, laboratory classes, periodic participation in group discussions, high level of the culture of performance of tasks;
- independent work on practical, laboratory classes, periodic participation in group discussions, sufficient level of the culture of performance of tasks.

**4 (four) points, passed:**

- sufficient knowledge within the educational standard of higher education;
- studying of basic literature, recommended by the curriculum of the institution of higher education on the discipline;
- use of scientific terminology, logical statement of the answer to questions, the ability to make sound conclusions;
- ability to draw conclusions without essential errors;
- mastering of the tools of the academic discipline, the ability to use it in solution of standard (typical) tasks;
- ability to solve standard (typical) tasks under the guidance of a teacher;
- ability to navigate in basic theories, concepts and directions on the discipline and give them an assessment;
- work under the guidance of a teacher on practical, laboratory classes, the permissible level of the culture of performance of tasks.

**3 (three) points, failed:**

- insufficient knowledge within the educational standard of higher education;
- studying of basic literature, recommended by the curriculum of the institution of higher education on the discipline;
- knowledge of a part of the basic literature, recommended by the curriculum of the institution of higher education on the discipline;
- use of scientific terminology, presentation of answers to questions with significant, logical errors;
- weak possession of the tools of the academic discipline, incompetence in solving standard (typical) tasks;
- inability to navigate in basic theories, concepts and directions on the discipline;
- work under the guidance of a teacher on practical, laboratory classes, the permissible level of the culture of performance of tasks.
- passivity on practical, laboratory classes, low level of the culture of performance of tasks.

**2 (two) points, failed:**

- fragmented knowledge within the educational standard of higher education;
- knowledge of individual literary sources, recommended by the curriculum of the institution of higher education on the discipline;
- inability to use scientific terminology of the academic discipline, the presence in the answer of rude, logical errors;
- passivity on practical, laboratory classes, low level of the culture of performance of tasks.

**1 (one) point, failed:**

- lack of knowledge and (competences) within the educational standard of higher education, failure to answer, failure to appear for attestation without good cause.

**9. METHODS AND MEANS OF IMPLEMENTATION OF THE CONTENT OF THE EDUCATIONAL PROGRAM AND TRAINING OF EDUCATIONAL, TRAINING AND METHODOLOGICAL MATERIALS**

The training will be conducted using distance learning technologies implemented in the eLearning Server. The students will be provided with electronic presentations of lectures, an electronic version of the handouts for laboratory studies.

In the classroom, students will learn the discipline directly in the computer class. The following software (software) will be used during the training:

№	The name of the software	System requirements for the specified software	№ of the topic from the educational and methodical map, for the support of which the specified software will be used	For what purpose will the software be used?
1	MS Windows 7-10, VMware	RAM: 8 GB RAM, 500 GB or more	Topics 1-18	To perform laboratory work

The following tools and technologies were used in the preparation of training, teaching and methodological materials:

- MS Office
- IBM Eclipse
- Graphics editing software
- Software for the formation of SCORM packages.

**10. THE INFORMATION AND METHODOLOGICAL PART****Main literature**

1. В. Олифер, Н. Олифер. Компьютерные сети. Принципы, технологии, протоколы. Учебник для вузов – СПб. Питер, 2015, 992с.
2. Andrew Blum. Tubes: A Journey to the Center of the Internet. Ecco. 2013 304p.
3. Уэнделл Одом. Официальное руководство Cisco по подготовке к сертификационным экзаменам CCNA ICND2 200-101. Маршрутизация и коммутация. – М. Вильямс. 2015, 736с.
4. Christina J. Hogan Strata R Challup Thomas A. Limoncelli The Practice of System & Network Administration – 2013, 944p.
5. Самара Линн. Администрирование Microsoft Windows Server 2012. СПб. Питер, 2014, 304.

**Additional literature**

1. Камер Д. Компьютерные сети и Internet. Разработка приложений для Internet: Пер. с англ. – М.: Изд. дом «Вильямс», 2002. – 640с.
2. Кульгин М. Технологии корпоративных сетей. Энциклопедия – СПб.: «Питер», 2000. – 704с.
3. Компьютерные сети. Учебный курс.-Microsoft Press, «Русская редакция», 1999.- 576с