Ministry of Science and Higher Education of the Russian Federation
Federal State Autonomous Educational Institution of Higher Education
Perm National Research Polytechnic University

APPROVED BY
Pro-rector for Academic Affairs
_____ N.V. Lobov
"___" _____ 2021

ACADEMIC COURSE WORKING PROGRAM

Academic course: Information Networking and Telecommunications
(Name)

Form of education: Full-time
(full-time / part-time / correspondence)

Level of higher education: Bachelor's program
(Bachelor's program / Specialist program / Master's program)

Workload in hours (in credits): 252 (7)
(Hours (CU))

Training program (degree): 15.03.06 Mechatronics and Robotics
(Code and denomination of degree)

Direction: Mechatronics and Robotics
(Title of curriculum)

Perm 2021

1 General Provisions

1.1 Goals and Objectives of the Course

The goal of the course is to develop understanding of information networking and telecommunications principles. The objectives of the course are:

- to study the information networks construction and operation basis;
- to form the ability of choosing network technologies to achieve the required characteristics of data exchange protocol;
- to master the skills of telecommunication systems configuration, implementing the specified properties of communication means.

1.2 Prescribed Objects of the Course

- Open System Interconnection Model (OSI RM);
- Flow control and error correction mechanisms;
- Switching and routing principles;
- Protocols and interfaces;
- Wired and wireless communication.

1.3 Starting Conditions

Unstipulated

2 Planned Results of the Course Training

Competence	Indicator's Index	Planned Results of the Course Training (to know, to be able to, to master)	Indicator of Attaining Competence which the planned results of training are correlated with	Means of Assessment
PC-2.5	**IA-1$_{PC-2.5}$**	**To know** the Open System Interconnection Model; information network principles; flow control and error correction mechanisms; switching and routing principles; protocols and interfaces; strategies of overload managing and ways to ensure the reliable and efficient functioning of telecommunications systems.	**Knows** principle of operation, technical characteristics and methods of calculating basic characteristics of flexible production system components.	Grading test
PC-2.5	**IA-2$_{PC-2.5}$**	**To be able to** analyze and understand the use of data transfer technologies; to search, select, systematize, analyze and generalize the scientific information in the field of "information networking and telecommunications"; to work with connection testing utilities and protocol analyzers.	**Is able to** develop technical projects using design automation and competitive product development best practices; draw up technical documentation.	Course project

PC-2.5	**IA-3$_{PC-2.5}$**	**To master the skills** of calculating required system parameters for windowing the data flow control; configuring VLAN, STP and Trunk in industrial Ethernet infrastructures, configuring network protocols and end-system interfaces.	**Has mastered the skills** of developing functional diagrams of flexible production systems components; explanatory note of flexible production systems' engineering design.	Internship report

3 Full time and forms of academic work

Form of academic work	**Hours in all**	**Distribution in hours according to semesters**
		Number of semester
		6
1 Holding classes (including results monitoring) in the form: 1.1 Contact classwork, including:	104	104
- lectures (L)	44	44
- laboratory work (LW)		
- practice, seminars and/or other seminar-type work (PW)	54	54
- control of self-work (CSW)	6	6
- test		
1.2 Students' self-work (SSW)	148	148
2 Intermediate attestation		
Exam		
Grading test	9	9
Test (Credit)		
Course Project (CP)	36	36
Course Work (CW)		
Workload in hours	**252**	**252**

4 Course contents

Name of the units with the course outline	Full time of classroom activity in hours according to the forms			Full time of extracurricular work in hours according to the forms
	L	LW	PW	SSW
6th semester				
Unit 1. Information network design	10	0	0	10
Topic 1. Open System Interconnection Reference Model (OSI RM). OSI RM Model Levels. Topic 2. Multiplexing. Circuit Switching and Packet Switching. Time Division Multiplexing (TDM), Frequency (FDM), Wavelength (WDM) and Code (CDM) in circuit switching systems. Topic 3. Pulse-code modulation (PCM). Topic 4. Digital speed hierarchies evolution. Plesiochronous (PDH), synchronous (SDH), and optical transport (OTH) hierarchies.				
Unit 2. L2 OSI RM. HDLC/Ethernet	10	0	22	20
Topic 5. Aspects of the data link layer. Frame synchronization. Flow control: Stop-and-Wait and Sliding-Window. Error control: Parity Check and CRC. Error correction: Stop-and-Wait ARQ, Go-Back-N ARQ, Selective-Reject ARQ, FEC, Hybrid ARQ. Topic 6. Ethernet technology. Structure of standards IEEE 802. *. Access methods: CSMA/CD (IEEE 802.3) and CSMA/CA (802.11). Ethernet frame formats, types of MAC- and SAP-address. Rates of FE, GE, 10-40-100GE. Topic 7. VLAN, Trunks, STP spanning tree protocol. Topic 8. Industrial ETHERNET Parallel Redundancy Protocol (PRP) and Media Redundancy Protocol (MRP) ring, High-availability Seamless Redundancy (HSR).				
Unit 3. L3/L4 OSI RM. TCP/I protocol stack	12	0	22	10
Topic 9. IP protocol IP service, IP address, options. Related protocols ARP, RARP, DHCP. Topic 10. IP addressing IP address classes, special IP addresses. Classless IP addressing model, concept of network/subnet mask, principles of VLSM (Variable Length Subnet Mask) masking. Topic 11. IP routing Routing Algorithms and Protocols Routing. Routing Table Structure. Direct and indirect routing. Topic 12. Internet routing hierarchy. Core, ISP, peering, Autonomous System (AS), intra and inter routing AS, near peer warfare. Routing policies. Topic 13. TCP and UDP protocols. Provided services and their purpose. Format and purpose of header fields.				

Establishment and termination of TCP-connection. Window flow control principle . TCP protocol options. Topic 14. Domain Name System (DNS). Name Translation Process in DNS. Operation Schemes (Primary and Secondary, Recursive, and Non-Recursive servers). The concept of the root name system and root server organization system. SOA records. DNS development: IDN, clones.				
Unit 4. Industrial interfaces, protocols and networks	6	0	0	48
Topic 15. Asynchronous interfaces: RS-232/485. Topic 16. CAN/DCON/PROFIBUS/MODBUS Networking Technologies. Topic 17. Telecommunication equipment of world developers (EtherWAN, Advantech, Hirschman, Simens, ZHAW) and areas of use.				
Unit 5. Wireless Technologies and Protocols for IoT	6	0	10	60
Topic 18. Wireless networks Coding, modulation and signal propagation. Principles of radio frequency spectrum distribution and application. Fundamentals of IEEE 802.11 (WiFi), IEEE 802.11 a/b/g/n/ac/ad Topic 19. Mobile networks Introduction to cellular networks: 1G/2G/3G. Features of 4G/LTE-Advanced/ 5G. Trends and perspectives. Topic 20. Wireless IoT Technologies Bluetooth/IEEE 802.15.4 WPAN/ZigBee. Ways to increase data transfer speed, to reduce delay and to increase distance.				
Total with regard to 6th semester	**44**	**0**	**54**	**148**
Total with regard to the course	**44**	**0**	**54**	**148**

Topics of exemplary practical work

№	Topic of practical (seminar) work
1	Channel Layer Flow Control and Error Correction
2	Spanning tree topology management in Ethernet technologies
3	IP Address Space Allocation
4	Routing IP configuration
5	Analyzing Flow Control Mechanisms and Correcting Errors in Transmission Control Protocol (TCP)

Topics of exemplary course projects / works

№	Topic of course projects / works
1	On-board networks of mobile objects
2	Routing to Multi-Agent Robotics systems
3	Communication requirements in autonomous robot control systems
4.	Remote Control Protocols for autonomous robot control systems

5 Organizational and Pedagogical Conditions

5.1 Educational Technologies Used for Competences Formation

Holding lectures in the discipline is based on the active method of training in the process of which students are not passive but active participants of the lesson answering questions of the teacher. Teacher's questions are aimed at activating the process of learning material as well as at the development of logical thinking. The questions stimulating associative thinking and connecting new material with the previous one are formulated by the teacher in advance.
Practical lessons are held by realization of the method based on active training: problem areas are determined, groups are formed. The following aims are pursued in the process of practical education: use of definite disciplines knowledge and creative methods in solving problems and decision-making; students' skill-building of teamwork, interpersonal communication and development of leadership skills; consolidation of the basic theoretical knowledge.
Interactive lectures, group discussions, role-playing games, training sessions, and analysis of situations and simulation models are used in academic studies.

5.2 Students' Manual for the Course Study

Learning the course, it is advisable for students to implement the following recommendations:
1. Learning of the discipline should be done systematically.
2. After learning one of the course units with the help of the text-book or lecture notes it is recommended to reproduce the basic terms, definitions, notions of the unit from memory.
3. Special attention should be paid to the reports on practical studies and individual complex tasks for self-work.
4. The topics list for individual study is given by the teacher at the lectures. The teacher also provides students with literary sources (first of all, new ones in the periodical scientific literature) for a more detailed under-standing of the issues presented at the lectures.

6 List of Teaching Materials and Information Supply for Students' Self work in the Discipline

6.1 Paper-based courseware

№	Bibliographic entry (author, title, mode of publication, place, publishing house, year of publication, number of pages)	Number of copies in the library
	1 Basic literature	
1	Coll E. TCO CTNS Certified Telecommunications Network Specialist Study Guide. Teracom Training Institute, 2021.	
2	Meter R. van Quantum Networking (Networks and Telecommunications). Wiley-ISTE 1st Edition, 2014.	
3	Tanenbaum A., Wetherall D. Computer Networks. Pearson; 5th edition, 2010.	
	2 Additional literature	

2.1 Educational and scientific literature		
1	Halabi S. Internet Routing Architectures. Cisco Press; 2nd edition, 2000.	
2.2 Standardized and Technical literature		
3 Students' manual in mastering discipline		
4 Teaching and learning materials for students' self-work		

6.2 Electronic Courseware

Kind of literature	Name of training tool	Reference to information resource	Accessibility of EBN (Internet / local net; authorized / free access)
Additional literature	Fundamentals of Telecommunications	http://edu.eap.gr/pli/pli23/documents/Parallila_Keimena/Fundamentals_of_Telecommunications.pdf	internet, free access
Additional literature	Fundamentals of Telecommunications	https://doc.lagout.org/network/4_Telecommunications/Telecommunications%20Fundamentals%2C%202nd%20Edition.pdf	internet, free access

6.3 License and Free Distributed Software used in the Course Educational Process

Type of Software	Software branding
Operating systems	MS Windows 8.1 (Azure Dev Tools for Teaching)
Office applications	Microsoft Office Professional
Office applications	Adobe Acrobat Reader DC
General Purpose Application Software	JPerf
General Purpose Application Software	WinDump
General Purpose Application Software	WinRAR (lic.879261.1493674)
General Purpose Application Software	Wireshark

6.4 Modern Professional Databases and Inquiry Systems Used in the Course Educational Process

Branding	Reference to information resource
Elsevier "Freedom Collection" Database	https://www.elsevier.com/
Web of Science Database	http://www.webofscience.com/
Electronic library system Database (eLIBRARY.RU)	https://elibrary.ru/

Scientific Library of Perm National Research Polytechnic University	http://lib.pstu.ru/
Lan' Electronic library system	https://edanbook.com/
IPR books Electronic library system	http ://www.iprbookshop.ru/
Information resources of the Network ConsultantPlus	http://www.consultant.ru/
Digital library of dissertations of the Russian State Library	http://www.diss.rsl.ru/

7 Logistics of the Course Educational Process

Type of classes	Name of the necessary basic equipment	Number of units
Course Project	Computers, Patch Panel, Cisco2801/2811 Routers, Catalyst 2950/2960	18
Lecture	Computer equipment and projector	1
Practical class	Computers, Patch Panel, Cisco2801/2811 Routers, Catalyst 2950/2960	18

8 Fund of the Course Evaluating Tools

Described in a separate document