Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Telecommunications**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Networks and Telecommunications Software

2. Date despre disciplină

2.1 Course name (ro) (en)				Arhitecturi şi protocoale de comunicaţii			
2.2 Course Lecturer				Conf. Dr. Octavian Catrina			
2.3 Instructor for practical activities				Conf. Dr. Octavian Catrina			
2.4 Year of studies	3	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	04.S.06.O.313		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	5	Out of which: 3.2 course	3.00	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	70.00	Out of which: 3.5 course	42	3.6 seminary/laboratory	28
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					27
Tutoring					0
Examinations					3
Other activities (if any):					0

3.7 Total hours of individual study	30.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Data Structures and Algorithms, Theory of Information Transmission.

4.2 Results of learning	Computer programming, basic knowledge of operating systems (for the laboratory)

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	Lecture hall equipped with video projector, screen, blackboard/whiteboard.
5.2 Seminary/ Laboratory/Project	Laboratory equipped with computers with Linux operating system and video projector. The software used in the lab, the network emulator Netkit (or Kathara) and protocol analyzer Wireshark are free.

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

This course offers an introduction to architectures and protocols used in telecommunications networks, in order to provide core knowledge needed for network analysis, design, configuration, and operation, as well as the background required by follow-up specialization courses in this area. The knowledge acquired in this course is extended and deepened in the follow-up course Networks and Services (next semester) and master courses.
Emergence of digital communications technologies was followed by gradual integration of different types of networks and services. During the last decades, we have witnessed fast progress towards this integration, using as core technologies packet switching and Internet protocols (the TCP/IP protocol stack). The contents of this course have been selected to match these trends in the evolution of the networks, by focusing on core technologies and protocols used in local area networks and the Internet.
The theoretical knowledge of packet-switched networks is illustrated through a comprehensive suite of examples that represent the main technologies and protocols used in local area networks and the Internet. Furthermore, laboratory work provides practical knowledge and experience in building, configuring, analyzing and troubleshooting networks.
Coursework and laboratory work focus on the fundamental, general aspects of computer-to-computer communications, to enable the students to extend and deepen their knowledge in subsequent networking courses in the undergraduate and master's programs or through individual study, and to understand other technologies and protocols used in telecommunications networks, currently and in the future.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	This course extends the generic competences of the study program with specific competences for technologies based on packet switching used in local area networks and the Internet: - Application of basic knowledge, concepts and methods regarding the architecture of computer systems, microcontrollers, programming languages and techniques. The students learn in this course fundamental concepts of about the communication subsystem of the computers and networing devices, based on layered architectures, as well as the main protocols used in local networks and the Internet, in a top-down, intuitive presentation, from the commuication requirements of the applications and the Application layer protocol, down to the Data-link layer. - A comprehensive view of data, voice, video, multimedia services, based on understanding and using the fundamental concepts in the field of communications and information transmission. The course contents emphasize fundamental principles of computer communications, to enable the students to extend and deepen their knowledge oabout telecommunications networks during the next courses, at bachelor and master level, or by individual study, to understand other communications technologies and protocols used in current and future networks. - Selection, installation and operation of fixed or mobile telecommunications equipment and site design for common telecommunications networks. The course offers the students specific basic knowledge and skills needed to identify, understand and solve (elementary) problems that occur during the cofiguration and operation of telecomunications networks.
Transversal (General) Competences	- Methodical analysis of the problems encountered in the activity, identifying the elements for which there are established solutions, and thus ensuring the fulfillment of professional tasks. - Ability to adapt to new technologies and to document oneself (in English and Romanian), for professional and personal development, through continuous training. - Ability to reason using scientific concepts and domain specific terminology, to independently explore and analyze information, as well as to find and present conclusions and/or solutions. - Ability to analyze and summarize the acquired knowledge by systematic analysis.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* - Know the rigorous definitions of domain-specific notions: layered architectures, protocols, connection-oriented and connectionless communications, addressing, multiplexing, packet switching and routing, error control, flow control, congestion control, types of network devices, etc. -Know representative examples of technologies, algorithms, protocols and services used in local area networks and the Internet. - Know how the network components interact and cooperate to fulfill the usersț communication requirements.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* - Identifies and formulates the basic functional requirements of a telecommunications system. - Analyzes, describes and explains the purpose and operation of the main components of a packet-switching network (devices, protocols), using specific terminology. - Develops basic implementation solutions or configuration solutions for the main components of a data network based on the TCP/IP protocol stack.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* - Selects appropriate bibliographic sources and analyzes them. - Respects the principles of academic ethics (for example, correctly citing the bibliographic sources). - Demonstrates responsiveness to new learning contexts. - Demonstrates collaboration with other colleagues and teaching staff in carrying out teaching activities - Demonstrates autonomy in organizing the learning situation or in solving problems. - Realizes the value of his contribution in the field of engineering to the identification of viable and sustainable solutions to solve problems in social and economic life (social responsibility). - Analyzes and capitalizes on business/entrepreneurial development opportunities in the field. - Demonstrates real-life situation management skills.

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

The teaching process will use both expository (lecture) and conversational-interactive teaching methods, based on discovery learning models facilitated by direct and indirect exploration (experiment, demonstration, modeling), but also using action-based methods, such as exercise, hands-on activities and problem-solving.
The teaching activity uses lectures based on PowerPoint presentations illustrated with images and diagrams (architectures, messages, algorithms, interactions), so that the information is easier to understand and to assimilate. PowerPoint presentations are supplemented with examples built interactively on the board. The introductory presentations of the courses and laboratory papers highlight the connection with the notions presented earlier.
In the lab, the students build and configure using an emulator examples of networks and systems that are small-scale models of the networks and systems used in the Internet. Then, they carry out experiments that allow them to examine and analyze the evolution of the state of each device and the interactions between

them (e.g., the DNS system, the e-mail system, IP networks, switched Ethernet LANs).
The teaching process takes into account the important differences between computer communications and the other courses in the area of electronics and telecommunicatios engineering: the students have to cope with a different kind of systems and technologies, essentially large, complex distributed systems with many components that run in parallel, interact and communicate locally and remotely in order to fulfill their various communications functions. The analysis and understanding of the operation of these distributed systems require the experimental study mentioned above. The experiments are greatly facilitated by the network emulators and protocol analyzers that are currently available.
The lectures include many examples of experiments similar to those erformed in the laboratory, ensuring that these two teaching approachesare better connected. Moreover, the network emulator and the protocol analyzer used in the lab are free software and the students can install them on their own computers for further practice.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Network architectures and devices. Layered architectures, types of communications and services, types of networks and devices, examples of physical and layered architectures, the OSI-RM and TCP/IP protocol stacks.	6
2	Application-layer protocols (I): Introduction to the DNS system. Adressing at the application layer. Architecture and implementation of the DNS system, the DNS protocol, typical communication scenarios for achieving the DNS service, optimizations (DNS caching).	3
3	Application-layer protocols (II): Introduction to the e-mail system. Architecture of the e-mail system, SMTP and IMAP4 protocols, typical communication scenarios for e-mail delivery.	3
4	Application-layer protocols (III): The HTTP protocol, typical communication scenarios, optimizations (HTTP caching).	2
5	Transport-layer protocols (I): Addressing at the transport layer. Connectionsless services using UDP. Introduction to connection-oriented service using TCP.	4
6	Transport-layer protocols (II): TCP functions and mechanisms: connection management, error control, flow control.	4
7	Network-layer protocols (I): Addressing and packet forwarding in IPv4 networks. IPv4, ICMP and ARP protocols.	6
8	Network-layer protocols (II): . Automatic network configuration using DHCP. Private addressing, NAT and NAPT techniques. Introduction to IPv6.	4
9	Congestion control in the Internet. Congestion in IP networks and countemeasures. TCP congestion control mechanisms.	2
10	Local Area Networks (I): Architectures, protocols and devices for local area networks. Ethernet networks (CSMA/CD, IEEE 802.3). WiFi networks (CSMA/CA, 802.11).	4
11	Local Area Networks (II): Local networks with Ethernet switches (bridges, IEEEE 802.1D). The STP protocol. Virtual local area networks.	4
	Total:	42

Bibliography:
1. Catrina Octavian, Arhitecturi și Protocoale de Comunicații, suport de curs electronic (platforma Moodle): https://curs.upb.ro/2021/course/view.php?id=9158
2. O. Bonaventure. Computer Networking: Principles, Protocols and Practice, 2011-2019. Carte disponibilă online gratuit: https://www.computer-networking.info/
3. J.. Kurose, K. Ross. Computer Networking. Ed. a 6-a, Pearson, 2013 (EN).
4. Specificații ale protocoalelor din suita TCP/IP publicate de IETF online (http://www.ietf.org).

LABORATORY

Crt. no.	Content	No. hours
1	Network architectures and devices. Introduction to the software platform used in the lab. Experiments that illustrate fundamental aspects of network architectures and devices.	4
2	The Domain Name System (DNS). DNS architecture and protocol. Experiments with a scaled down model of the DNS.	4
3	The E-mail System. E-mail system architecture and protocols (SMTP, IMAP4). Experiments with a scaled down model of the e-mail system.	4
4	IP networks - Part I. Isolated IP network. Address allocation (CIDR), construction of the routing tables, and IP packet forwarding. Configuration of the interfaces and static routes. ARP and ICMP protocols. Automatic configuration using DHCP.	4
5	IP networks - Part II. IP network connected to the Internet. Private IP addresses. Internet access using NAPT. Dynamic routing using RIP.	4
6	Local area networks with Ethernet switches. Frame forwarding in LANs built using Ethernet switches (bridges). Spanning Tree Protocol (STP). Virtual LANs (VLANs).	4
7	Final lab examination.	4
	Total:	28

Bibliography:
Catrina Octavian, Communications Architectures and Protocols, electronic course support (Moodle platform): https://curs.upb.ro/2021/course/view.php?id=9688

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	- Knowledge of the concepts, methods, algorithms, architectures and protocols studied in the course. - Solving concrete, practical problems by applying the acquired knowledge (examples of networks and communication scenarios)	Written exam	50%

11.5 Seminary/laboratory/project	Network and protocol configuration, testing and analysis for typical scenarios using network emulator and protocol analyzer.	Oral, practical examination. Communications scenarios similar to those in the labs.	50%
11.6 Passing conditions			
The students must obtain minimum of 50/100 for the exam paper and minimum 50/100 for the laboratory examination.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

The course provides fundamental knowledge on network architecture and protocols, focusing on core technologies that are widely used in private networks and service provider networks (fixed and mobile).
This knowledge is necessary for graduates that are interested in working for network software and network equipment manufacturers/vendors, as well as for network service providers.

Date	Course lecturer	Instructor(s) for practical activities
10.10.2024	Conf. Dr. Octavian Catrina	Conf. Dr. Octavian Catrina

Date of department approval	Head of department
22.10.2024	Conf. Dr. Serban Georgica Obreja

Date of approval in the Faculty Council	Dean
01.11.2024	Prof. Dr. Mihnea Udrea