Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

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)				Reţele şi servicii			
2.2 Course Lecturer				Prof. Dr. Eugen Borcoci			
2.3 Instructor for practical activities							
2.4 Year of studies	4	2.5 Semester	1	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	04.S.07.O.304		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	4	Out of which: 3.2 course	2	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	56	Out of which: 3.5 course	28	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.					59
Tutoring					0
Examinations					10
Other activities (if any):					0

3.7 Total hours of individual study	69.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Data Structures and Algorithms, Theory of Information Transmission, Transmission Media, Analogue and Digital Transmission, Micrprocessor architecture, Microcontrollers, Computer System Architectures, Architectures and Communication Protocols
4.2 Results of learning	Computer programming, basic knowledge of operating systems, basic knowledge on analog and digital communications, communication protocols

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 Windows (or Linux) operating system and video projector. The network emulator GNS3 and the 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)*

To offer students knowledge on principles, models, architectures and protocols used in integrated networks. This course is a continuation of the course Architectures, Architectures and Communication Protocols. Specfic topics: operational business models, multiple plane architectures (examples form IEEE 802.16, MPLS, NGN, etc.). Routing algorithms and protocols (RIP, OSPF, AODV, UAV, BGP, etc). are studied. Principles, models methods for QoS assurance and controm for media streams in TCP/IP networks are studied. Advanced technologies are introduced such as SDN, NFV, 4G,IoT, 5G, cloud and edge computing.

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	Multiple plane architectures. Description, analysis and explanation of the the architecture and the operation of networks and services based on standard technologies and protocols used in the Internet and telecom mobile networks., Introductory knowledge on novel technologies like SDN, NFV, 4G, 5G, IoT, IoV, Cloud/Edge/Fog computing, for networks and services.
Transversal (General) Competences	Analysis of the problems encountered in the field of networks an services 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 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.

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.* Capabilities to apply knowledge on network architectures and services in different specific cases ofsystems for fixed and mobile communications. All development phases can be supported: requirements, business model, architectural specification, system design, implementation and integration.

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 telecommunications and computer networks. Analyzes, describes and explains the purpose and operation of the main components of a network (devices, protocols), using specific terminology. Development of systems using novel.technologies like like SDN, NFV, 4G, 5G, IoT, IoV, Cloud/Edge/Fog computing, for networks and services.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Selects and understands relevant bibliographic sources. - Observes the principles of academic ethics, such as correctly citing the bibliographic sources. - Demonstrates responsiveness to new learning contexts. - Collaborates with colleagues and instructors during the 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 viableandsustainable solutions to solve problems in social and economic life (social responsibility). - Analyzes and capitalizes on business/entrepreneurial opportunities in the specialization field. - Demonstrates management skills real-life situations.

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 general teaching process will use both expository (lecture) and conversational-interactive teachingmethods,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 lectures activity uses mixed (text and figures) presentations to facilitate understanding information. Each lecture will revisit shortly the previous material linked with the current one.

In the lab,the students build and configure using an emulator examples of networks and systems that are small-scalemodels of the networks and systems used in the integrated networks. The students will perform experiments that allow them to examine and analyze the evolution of the state of each device and the interactions between them (e.g., the discovery of destinations and routes in IP-based networks,

Moodle and Teams platforms will provide lecture and lab notes and documents and support exposures.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	1. Multiple plane architectural concepts for networks and services : Data Plane ; Control plane; Management plane. Integration of the architectural planes. Business models- examples (Multimedia system , Cloud computing, virtualization systems, 5G). SLA contracts. Examples of architectures IEEE 802.16, MPLS, NGN.	6

2	2. Routing algorithms and protocols Classification. Basic centralized algorithms (Dijkstra, Ford, etc.) Distributed algorithms. Combinations and extensions. UAV routing problems. Internet hierarchical architecture. Routing protocols examples: RIP, OSPF, AODV, BGP. IPV6, ICMPV6	8
3	3. QoS Technologies in TCP/IP Introduction. Service types. Arch8itectural frame for QoS control. Specific functions in the Data plane. Specific functions in the Control plane. QoS guarantees. Differentiated and integrated services. Specific mechanisms: RED, classification, policing, shaping, scheduling.	8
4	Recent networki architectures and technologies. SDN, NFV, Virtualization, 4G, 5G, Edge computing, IoT.	6
5	Annexes	28
	Total:	

Bibliography:

[1]E.;Borcoci “Note de curs RS” -platforma Moodle, Teams
[2] Andrew Tanenbaum, “Computer Networks”, 5th ed. Prentice Hall, 2008, (Andrew Tanenbaum, Retelede calculatoare, Ed. a 4-a, Editura BYBLOS, 2003).
[3]Larry Peterson, Bruce Davie, “Computer Networks. A systems approach”, 4th ed. Morgan Kaufmann,2007.
[4]Martin W. Murhammer, et.al., “TCP/IP Tutorial and Technical Overview”, IBM Books, 1998
[5]A. FARREL “The Internet and Its Protocols A Comparative Approach” Ed, Morgan Kaufmann, 2004
[6]ITU-T Rec. Y.2001, “General Overview of NGN”
[7]ITU-T Rec. Y.2011, “General Principles and General Reference Model for Next Generation Network.”
[8]Keith Knightson, Naotaka Morita, NGN Architecture:Generic Principles, Functional Architecture,and Implementation”, IEEE Communications Magazine , October 2005
[9] Peter Mell , Timothy Grance, The NIST Definition of Cloud Computing, Special Publication 800-145,Recommendations of the National Institute of Standards and Technology , 2011
[10] Fang Liu, Jin Tong, Jian Mao, Robert Bohn, John Messina, Lee Badger and Dawn Leaf,Recommendations of the National Institute of Standards and Technology, NIST “Cloud ComputingReference Architecture”, Special Publication 500-292 , 2011
[11] ETSI GS NFV 002 v1.2.1 2014-12, NFV Architectural Framework
[12] Kreutz D., Ramos F., Verissimo P., Rothenberg C.E, Azodolmolky S., Uhlig S. ‘Software-DefinedNetworking: A Comprehensive Survey’. 2014, http://arxiv.org/pdf/1406.0440.pdf
[13] J.Matias, J.Garay, N.Toledo, J.Unzilla, and E.Jacob,”Toward an SDN-Enabled NFV Architecture”,IEEE Communications Magazine, April 2015
[14] Documents online IETF (http://www.ietf.org).
[15] Documents online ITU-T www.itu-t.org
[16] Documents online ETSI www.etsi.org
[17] Documents online IEEE www.ieee.org
[18] Documente online 3GPP www.3gpp.org
[19] E.Borcoci, Tutorial “Software Defined Networking and Architectures”, NetWare 2013, -Barcelona, Spain, http://www.iaria.org/conferences2013/TutorialsAFIN13.html
[20] E.Borcoci , “Network Function Virtualization and Software Defined Networking Cooperation” InfoSys Conference 2015, Rome, http://www.iaria.org/conferences2015/InfoSys15.html
[21] EBorcoci; autor- capitol : „Survey on Software-Defined Networking and Network FunctionsVirtualisation in 5G emerging mobile computing „ , Book: „Cloud and Fog Computing in 5G MobileNetworks: Emerging Advances and Applications”, Institute of Engineering and Technology (IET),Academic Books, UK, 2017; Editors: E.Markakis, G.Mastorakis, C. Mavromoustakis, E. Pallis
[22] E.Borcoci, „Managementul si planificarea resurselor pentru asigurarea calitatii serviciilor incomunicatii multimedia”, Monografie, ED. Politehnica Press 2013

LABORATORY

Crt. no.	Content	No. hours
1	CISCO Routers configuration	4
2	Statica routing, RIP dynamic routing, ACL basics	4
3	Extended ACL, OSPF dynamic routing	4
4	IPv4, IPv6 addressing	4
5	Radio Operation and Maintenance Center (OMC-R	4

6	QoS technologies	4
7	Final examination	4
	Total:	28

Bibliography:

[1] Cisco CCNP1 v3.0, cap. 9
[2] Using the Border Gateway Protocol for Interdomain Routing (document online Cisco - icsbgp4.pdf)
[3] Cisco IOS Configuration Guide (document online Cisco – 1cfbook.pdf)
[4] Cisco IOS Network Address Translation Overview (document online Cisco)
[5] Cisco Feature Navigator, http://tools.cisco.com/ITDIT/CFN/jsp/index.jsp
[6] Cisco CCNA Exploration 4.0, modulul 4, cap. 7
[7] RFC3587, RFC2574 IPv6 global unicast address format
[8] RFC3879, Deprecating Site-local addresses
[9] Tunneling IPv6 through an IPv4 network (document online Cisco)
[10] Administering Cisco QoS in IP Networks, Syngress, 2001
[11] Introduction to IP QoS, Cisco Systems, 2001
[12] RFC791, Internet Protocol
[13] RFC2474, Definition of the Differentiated Services Field
[14] RFC2475, An architecture for Differentiated Services
[15] Cisco Feature Navigator, http://tools.cisco.com/ITDIT/CFN/jsp/index.jsp
[16] CCNP4, v5.0.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Knowledge on architectures, for systems, technologies and protocols presented in the lectures.		50%
	Interactive participation to lectures		10%
11.5 Seminary/laboratory/project	The ability to set up, test, analyzeand debug networks and services that use the protocols studied in the laboratory.	Test based on the casestudies and experiment in the laboratory.	40%
11.6 Passing conditions			
Min. 20 points out of 40 for lab. Total min 50% out of 100% for passing.			

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 offers professional bases for engineers who perform research, design, development, maintenance and exploitation of systems and advanced technologies in integrated telecom and computer networks , for a large range of applications and services.

Date Course lecturer Instructor(s) for practical activities

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21.09.2026 Prof. Dr. Eugen Borcoci

Date of department approval Head of department

22.09.2026 Conf. Dr. Serban Georgica Obreja

Date of approval in the Faculty Council Dean

22.09.2026 Prof. Dr. Mihnea Udrea