**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 | Masters |
| 1.6 Programme of studies | Services and Network Management |

## 2. Date despre disciplină

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.1 Course name (ro)<br>(en) | | | | Sisteme integrate de management<br>Integrated Management Systems | | | |
| 2.2 Course Lecturer | | | | Prof. Dr. Eugen Borcoci | | | |
| 2.3 Instructor for practical activities | | | | Prof. Dr. Marius-Constantin Vochin | | | |
| 2.4 Year of studies | 2 | 2.5 Semester | 1 | 2.6. Evaluation type | E | 2.7 Course regime | Ob |
| 2.8 Course type | | DS | 2.9 Course code | UPB.04.M3.O.11-31 | | 2.10 Tipul de notare | Nota |

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

| | | | | | |
|---|---|---|---|---|---|
| 3.1 Number of hours per week | 3 | Out of which: 3.2 course | 2 | 3.3 seminary/laboratory | 1 |
| 3.4 Total hours in the curricula | 42 | Out of which: 3.5 course | 28 | 3.6 seminary/laboratory | 14 |
| Distribution of time: | | | | | hours |
| Study according to the manual, course support, bibliography and hand notes<br>Supplemental documentation (library, electronic access resources, in the field, etc)<br>Preparation for practical activities, homework, essays, portfolios, etc. | | | | | 54 |
| Tutoring | | | | | 0 |
| Examinations | | | | | 4 |
| Other activities (if any): | | | | | 0 |

| | |
|---|---|
| 3.7 Total hours of individual study | 58.00 |
| 3.8 Total hours per semester | 100 |
| 3.9 Number of ECTS credit points | 4 |

## 4. Prerequisites (if applicable) (where applicable)

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|---|---|
| 4.1 Curriculum | Course on programming, telecommunications and computer technologies and computernetworks in the undergraduate program that includes the TCP/IP networks. |
| 4.2 Results of learning | Basic knowledges on programmimg, computer architectures and operating systems,telecommunication technologies, architectures of computer networks, protocols andtechnologies. |

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

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|---|---|
| 5.1 Course | Lecture room 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. Software for networks and services and specialised modules for management and control |

**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)*

The course will provide students knowledge on main concepts, models, architectures, methods and systemsfor orchestration, management and control of communication networks and services. The graduated students will sufficiently skilled to work in exploitation activities , maintenance, development of OMC systems for various network and services types.

**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.)*

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|---|---|
| **Specific Competences** | Describe, analyze and explain the architecture and the operation of OMCsystems fornetworks and services based on standard technologies and protocols.<br>Developefficient and scalable solutions for management and control adapted to different usecases using OMC standard technologies. |
| **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.<br>- Ability to adapt to new technologies and to document oneself (in English and Romanian), for professional and personal development, through continuous training.<br>- 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.<br>- Ability to analyze and summarize the acquired knowledge by systematic analysis.<br>- Ability to cooperate with other specialiss and work in a team; efficient communication and coordination with the other team members.<br>- Observe academic ethics principles, such as citing correctly the bibliographical sources used during documentation |

**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.*<br>- Knowledge on concepts, architectures, methods, protocols and implementation of the orchestration management and control subsystems in circuit and packet networks, including the modern 4G, 5Gwireless technologies.- Knowledge on modern technologies applied in OMC (policy based management, autonomic and cognitive management, AI/ML , SDN and NFV technologies applied in OMC) |
| **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).*<br>Identifies and formulates the basic functional requirements of users and providers for networkandservces<br>- Analyzes, describes and explains the purpose and operation of the OMC main components ofanetwork<br>- Identifies, implements and tests OMC solutions for integrated networks . |
| **Responsability and autonomy** | *The student's capacity to autonomously and responsably apply their knowledge and skills.*<br>Selects and understands relevant bibliographic sources.<br>- Observes the principles of academic ethics, such as correctly citing the bibliographic sources.<br>- Demonstrates responsiveness to new learning contexts.<br>- Collaborates with colleagues and instructors during the teaching activities.<br>- Demonstrates autonomy in organizing the learning situation or in solving problems.<br>- 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).<br>- Analyzes and capitalizes on business/entrepreneurial opportunities in the specialization field.<br>- 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 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 presentations illustrated with images and diagrams(architectures, messages, algorithms, interactions), so that the information is easier to understand and to assimilate. The presentations are supplemented with examples built interactively on the board. The introductory presentations of the courses and laboratory work highlight the connection with the notions presented earlier.

**10. Contents**

| **COURSE** | | |
|---|---|---|
| **Chapter** | **Content** | **No. hours** |

| | | |
|---|---|---|
| 1 | Introduction in management and control (M&C) for networks and services<br>Basic functions of M&C<br>Layered M&C architecture; role of the Management Plane and Control Plane.<br>Management functions for network services and high level services<br>Orchestration, Management and Control-(OMC) - concepts and obiectives<br>New Trends in OMC (PBM, ANM, AI, SDN, NFV, etc.) | 4 |
| 2 | Telecommunication Network M&C<br>Function, Physical, Information and Logical Layered Architecture in TMN<br>Abstract languages basics for M&C information<br>representation(ASN1)Implementation examples | 4 |
| 3 | Chap.3 Current Internet Management and Control SNMP framework (SNMP1, 2, 3).<br>Remote Monitoring 1, 2. Management Information Base organization and access.<br>Comparison TMN versus Internet SNMP framework CMIP over TCP/IP<br>Main TCP/IP control protocols- revision (routing, resource reservation, mobility, higher layer protocols) | 6 |
| 4 | Chap.4 Policy-based, autonomic and cognitive management<br>Policy-based management (PBM)-concepts, arhitecture<br>IBM arhitecture, IRTF/IETF model<br>Generic autonomic management arhitecture( GANA). Artificial intelligence and machine learning in OMC- introduction | 6 |
| 5 | Advanced techniques in OMC<br>Virtualization concepts and methods<br>Software defined Networking- SDN in OMC<br>Network Function Virtualization (NFV) in OMC | 4 |
| 6 | Chap 6 Management in 5G<br>General 5G architecture<br>Slicing concepts and architectures<br>Resources and services management in 5G sliced networks<br>SDN and NFV used in 5G OMC | 4 |
| 7 | Annexes | 0 |
| | **Total:** | 28 |

**Bibliography:**

Bibliography:
ITU-T Recommendation, SERIES M 3000: Telecommunications management network Principlesfortelecommunications management network
ITU-T Rec. Y.2011, “General Principles and General Reference Model for Next Generation Network.”
Jianguo Ding, 2010, Advances in Network Management, CRC Press , Auerbach Publications, 2010.
http://en.wikipedia.org/wiki/Element_management_system
http://en.wikipedia.org/wiki/Simple_Network_Management_Protocol
N. Agoulmine, et. Al., Autonomic Network Management Principles: From ConceptstoApplications.Academic Press, 2010.
J. Strassner, “DEN-ng: achieving business-driven network management”, in NetworkOperationsandManagement Symposium, 2002.NOMS , pp. 753–766, 2002.
L. Stojanovic, J. Schneider, A. Maedche, S. Libischer, R. Studer, Th.Lumpp, A. Abecker, G. BreiterandJ.Dinger, “The role of ontologies in autonomic computing systems”, IBM Syst. J. , vol. 43, n. 3, pp.598–616,2004.
G. Tesauro, “Reinforcement Learning in Autonomic Computing: A Manifesto and CaseStudies”, IEEEInternet Comput. , vol. 11, n. 1,pp. 22–30, Jan.-Feb. 2007.
N. Samaan and A. Karmouch, “An Automated Policy Based Management FrameworkforDifferentiatedCommunication Systems”, IEEE J.Select. Areas Commun. , vol. 23, n. 12, pp. 2236–2247, December 2005.
Diao Y., J. Hellerstein, S. Parekh, R. Griffith, G.E. Kaiser and D. Phung, “control theory foundationforself-managing computing systems”, IEEEJ. Select. Areas Commun. , vol. 23, n. 12, pp. 2213 – 2222, Dec.2005.
Jianguo Ding, 2010 Advances in Network Management, CRC Press , Auerbach Publications, 2010.
http://en.wikipedia.org/wiki/Simple_Network_Management_Protocol
IRTF Autonomic Networking - Definitions and Design Goals, draft-irtf-nmrg-autonomic-network-definitions-04.txt, October 2014
N.McKeown, T.Anderson, et. Al., OpenFlow: Enabling Innovation în Campus Networks, - http://www.openflow.org/documents/openflow-wp-latest.pdf.
M.Mendonca, et. al., A Survey of Software-Defined Networking: Past, Present and Future of Programmable Networks, http://hal.inria.fr/hal-00825087/
Software-Defined Networking: The New Norm for Networks ONF White Paper April 13, 2012
ONF 2014 OF-CONFIG 1.2 OpenFlow Management and Configuration Protocol
Han B., Gopalakrishnan V., Ji L., and Lee S., ‘Network Function Virtualisation: Challenges and Opportunities for Innovations’, IEEE Communications Magazine, February 2015, pp. 90-97
ETSI GS NFV 002 v1.2.1 2014-12, NFV Architectural Framework
ONF, “OpenFlow-Enabled SDN and Network FunctionsVirtualisation,”https://www.opennetworking.org/images/stories/downloads/sdn-resources/solutionbriefs/sb-sdn-nvf-solution.pdf
Reid A., ‘Network Functions Virtualisation and ETSI NFVISG’, http://www.commnet.ac.uk/documents/commnet workshop networks/CommNets EPSRCworkshopReid.pdf
J. Ordonez-Lucena et al., "The Creation Phase in Network Slicing: From a Service Order to an Operative Network Slice", European Conference on Networks and Communications(EuCNC),2018, https://arxiv.org/abs/1804.09642
ETSI GR NFV-EVE 012, Release 3 “NFV Evolution and Ecosystem; Report on Network Slicing Support with ETSI NFV Architecture Framework”, Technical Report, V3.1.1, December, 2017.
A. Galis, “Network Slicing- A holistic architectural approach, orchestration and managementwithapplicability inmobile and fixed networks and clouds”, http://discovery.ucl.ac.uk/10051374/

| **LABORATORY** | | |
|---|---|---|
| **Crt. no.** | **Content** | **No. hours** |
| 1 | Network Devices monitoring system Nagios (Remote Plugin Executor and SNMP | 4 |
| 2 | Hosts management and monitoring through Microsoft Active Directory | 4 |
| 3 | nternet services monitoring tools: Advanced web statistics tool, Multi Router Traffic Grapher | 4 |
| 4 | Evaluation | 4 |
| | **Total:** | 14 |

**Bibliography:**
Bibliography:
M.Vochin, R.Lupu- SIMC lab. platforms data sheets- on Moodle and Teams platforms
IETF RFCs for IPPM and MIBs
Nagios documentation
Monitoring tools documentation – for active/passive measurements

**11. Evaluation**

| Activity type | 11.1 Evaluation criteria | 11.2 Evaluation methods | 11.3 Percentage of final grade |
|---|---|---|---|
| 11.4 Course | - Knowledge of the OMCconcepts,methods, architectures andprotocolsstudied in the course.<br>- Ability to describe, analyze, andexplainnetwork and services OMCoperation indifferent systems l by applyingthe theaquired knowledge (examples ofnetworks,services) | Written exam | 30% |
| | Applying OMC methods to real networks<br>- Ability to describe, analyze, andexplainnetwork and services OMCoperation indifferent systems l by applyingthe the aquired knowledge (examples ofnetworks,services) | Written exam | 20% |
| | Interactive participation | | 20 |
| 11.5 Seminary/laboratory/project | Ability to configure, test, analyze and run OMC subsystems for netwoks and services that use the methods and protocols presented in the course | Laboratory evaluation on platforms (running examples) | 30% |
| 11.6 Passing conditions | | | |
| MIn 15 pts for applications<br>Min 50% out of the total | | | |

**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 complex communication networks and services, interconnecting fixed and mobile terminals requireanimportant OMC support. In the real IT&C world an important effort – human and financial (CAPEXandOPEX) is spent by the operators/providers on OMC activities. These course and laboratory providestudentsa background for ability to work in exploitation, maintenance and development of IT&C systems

| Date | Course lecturer | Instructor(s) for practical activities |
|---|---|---|
| 25.09.2025 | Prof. Dr. Eugen Borcoci | Prof. Dr. Marius-Constantin Vochin |

| Date of department approval | Head of department |
|---|---|
| 26.09.2025 | Conf. Dr. Serban Georgica Obreja |

| Date of approval in the Faculty Council | Dean |
|---|---|
| 26.09.2025 | Prof. Dr. Mihnea Udrea |