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

# COURSE DESCRIPTION

## 1. Program identification information

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| 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 | Mobile Communications |

## 2. Date despre disciplină

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|---|---|---|---|---|---|---|---|
| 2.1 Course name (ro)<br>(en) | | | | Tehnologii radio de acces | | | |
| 2.2 Course Lecturer | | | | Prof. Dr. Ion Marghescu Conf. Dr. Alexandru Rusu | | | |
| 2.3 Instructor for practical activities | | | | Conf. Dr. Alexandru Rusu | | | |
| 2.4 Year of studies | 1 | 2.5 Semester | 2 | 2.6. Evaluation type | E | 2.7 Course regime | Ob |
| 2.8 Course type | | S | 2.9 Course code | 3 | | 2.10 Tipul de notare | Nota |

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

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|---|---|---|---|---|---|
| 3.1 Number of hours per week | 3 | Out of which: 3.2 course | 1.5 | 3.3 seminary/laboratory | 1.5 |
| 3.4 Total hours in the curricula | 42 | Out of which: 3.5 course | 21 | 3.6 seminary/laboratory | 21 |
| 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. | | | | | 46 |
| Tutoring | | | | | 0 |
| Examinations | | | | | 4 |
| Other activities (if any): | | | | | 8 |

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| 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 | Attending and/or passing the following lectures:<br>Mobile Communcations<br>Radioccommunications Systems and Equipment<br>Signals and Systems<br>Antennas<br>Digital Signal Processing<br>Analogic and Digital Communications |

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| 4.2 Results of learning | Accumulation of the following knowledge:<br>• general knowledge about analog and digital signals,<br>• fundamental knowledge of information transmission,<br>• fundamental knowledge about radio signals propgation,<br>• the ability to understand the operation of a block diagram of a communcationsystem,<br>• fundamental knowledge of information transmission,<br>• the ability to use measurement equipment in communications,<br>• the ability to use simulations of communications systems in different programming media and to interpret the results. |

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

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| 5.1 Course | The course will take place in a room equipped with video projector and computer. |
| 5.2 Seminary/ Laboratory/Project | • The laboratory will take place in a room with specific equipment, which must include: PCs on which the Matlab/Simulink environment will be installed, teaching RF emission/reception modules, test radio receivers, RF signal generators, spectrum analyzers , multimeters.<br>• Attendance at the laboratories is mandatory (according to the regulation of university undergraduate studies in UPB). |

**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 discipline is studied within the master program Advanced Wireless Communications and aims to familiarize students with the main approaches, models and explanatory theories in the field of mobile radiocommunications, used in solving practical applications and problems, with relevance for stimulating the learning process in students.

This discipline is studied within the mobile communications master program and aims to transmit to students knowledge about the main technologies applied to allow access to the Internet using the propagation of radio waves.

For this purpose, the main characteristics, components and functions of several communication systems based on representative, and currently encountered, radio access technologies from the WPAN, WLAN,WMAN classes are analyzed. In each case, the basic levels of the protocol stack (PHY and MAC), the network architecture, specific services and applications are analyzed.

Along with radio technologies, modulation techniques specific to broadband radio channels are also addressed.

All these contribute to the transmission/formation to/to the students of an overview of the methodological and procedural landmarks related to the field.

**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** | Demonstrates basic/advanced knowledge of radio communication systems and equipment.<br>Correlate knowledge<br>Apply knowledge in practice<br>It applies standardized methods and tools, specific to the field, to carry out the evaluation and diagnosis process of a situation, depending on the identified/reported problems, and identifies solutions.<br>It argues and analyzes coherently and correctly the context of application of the basic knowledge of the field, using key concepts of the discipline and the specific methodology.<br>Oral and written communication in Romanian: uses the scientific vocabulary specific to the field, in order to communicate effectively, in writing and orally.<br>Oral and written communication in a foreign language (English): demonstrates understanding of subject-related vocabulary in a foreign language. |
| **Transversal (General) Competences** | Works in a team and communicates effectively, coordinating efforts with others tosolve problem situations of medium complexity.<br>Autonomy and critical thinking: the ability to think in scientific terms, search andanalyze data independently, and draw and present conclusions / identify solutions.<br>Ability to analyze and synthesize: presents the acquired knowledge in a syntheticway, as a result of a process of systematic analysis.<br>Respect the principles of academic ethics: correctly cite the bibliographic sourcesused in the documentation activity.<br>Puts elements of emotional intelligence into practice in the appropriate social-emotional management of real-life/academic/professional situations, demonstrating self-control and objectivity in decision-making or stressful situations. |

**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.)*

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| **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>• Lists the most important stages that marked the development of the field.<br>• Defines domain-specific notions.<br>• Describes/classifies notions/processes/phenomena/structures.<br>• Highlights consequences and relationships. |

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| **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>Selects and groups relevant information in a given context.<br>• Work productively in a team.<br>• Elaborate a scientific text.<br>• Experimentally verifies identified solutions.<br>• Solve practical applications.<br>• Adequately interpret causal relationships.<br>• Identifies solutions and develops solution/project plans.<br>• Formulates conclusions to the experiments carried out.<br>• Argue the identified solutions/solutions. |
| **Responsability and autonomy** | *The student's capacity to autonomously and responsably apply their knowledge and skills.*<br>Select appropriate bibliographic sources and analyze them.<br>• Respect the principles of academic ethics, correctly citing the bibliographic sources used.<br>• Demonstrates responsiveness to new learning contexts.<br>• Demonstrates collaboration with other colleagues and teaching staff in carrying out teachingactivities<br>• Demonstrates autonomy in organizing the learning situation/context or the problem situation to besolved<br>• Demonstrates social responsibility through active involvement in student social life/involvementin academic community events<br>• Promotes/contributes through new solutions related to the specialized field to improve the qualityof social life.<br>• Realizes the value of his contribution in the field of engineering to the identification ofviable/sustainable solutions to solve problems in social and economic life (social responsibility).<br>• Apply principles of professional ethics/deontology in the analysis of the technological impact ofthe proposed solutions in the specialized field on the environment.<br>• Analyzes and capitalizes on business/entrepreneurial development opportunities in the specializedfield.<br>• Demonstrates real-life situation management skills (collaborative vs. conflict time management). |

**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.)*

Starting from the analysis of students' learning characteristics and their specific needs, the teaching process will explore both expository (lecture, exposition) and conversational-interactive teaching methods, based on discovery learning models facilitated by direct exploration and indirect of reality (experiment, demonstration, modelling), but also on action-based methods, such as exercise, practical activities and problem solving.

In the teaching activity, lectures will be used, based on Power Point presentations or different videos that will be made available to the students. Each course will start with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.

Presentations use images and diagrams so that the information presented is easy to understand and assimilate.

This discipline covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a climate conducive to discovery learning.

It will be considered the practice of active listening and assertive communication skills, as well as feedbackconstruction mechanisms, as ways of regulating behavior in various situations and adapting the pedagogicalapproach to the students' learning needs.

Teamwork skills will be practiced to solve different learning tasks.

**10. Contents**

| **COURSE** | | |
|---|---|---|
| **Chapter** | **Content** | **No. hours** |
| 1 | Access Technologies Overview:<br>1.1. Evolution of the access technologies<br>1.2. IEEE 802.xx Standards family.<br>1.3. Mobile and fix networks: peculiar aspects .<br>1.4. Mobile access networks: Examples<br>1.5. The evolution towards the fourth generation and beyond. | 2 |
| 2 | Single carrier modulation techniques (recap)<br>2.1. Base band modulation techniques;<br>2.2. RF modulation techniques.<br>2.3. Modulated signal constellation<br>2.4. Amplitude, phase and frequency digital modulated signals;<br>2.5. Examples of digital modulated signals: OOK, BPSK, DQPSK, QAM, MSK. | 4 |
| 3 | Multicarrier modulation techniques: OFDM<br>3.1 OFDM basic principle<br>3.2 Guard time interval<br>3.2 An OFDM System Block Diagram<br>3.4 Timing and Frequency Synchronization;<br>3.5 The Peak-to-Average Power Ratio<br>3.6 OFDMA;<br>3.7 Conclusions: OFDM Pros and Cons | 5 |
| 4 | 4<br>WLAN: Wireless Local Area Networks<br>3.1. General aspects;<br>3.2. Basic concepts for IEEE 802.11 standards: topology; evolution; PHY level; radiochannels; OFDM signal parameters: received signal processing; receiver training.<br>3.3. IEEE 802.11 MAC level: overview; specific procedures; MAC frame structure; the association of a station to an AP; synchronization and power saving procedures. | 4 |
| 5 | Zig Bee Technology<br>5.1. General Aspects<br>5.1 PHY layer,modulation techniques, frequency bands, radio chnnels.<br>5.3 MAC sub-layer.<br>5.4 Network topologies. Routing techniques.<br>5.5 Applications | 3 |

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| 6 | LoRaWAN technology<br>5.1. General aspects<br>5.2. PHY layer, LoRa Modulation technique;<br>5.3 MAC sub-layer.<br>5.4 Applications | 2 |
| 7 | WiMAX Technology<br>4.1. Overview. Specific aspects of WiMAX technology<br>4.2. WiMAX PHY layer: OFDM signal parameters; subchannelization; framestructure; AMC.<br>4.3. Short analysis of WiMAX MAC layer; radio channel access mechanisms; Qualityof Service; mobility; security;<br>4.4. Advanced procedures to raise the network performance: SAE; HARQ; improvedfrequency reuse; | 1 |
| | **Total:** | 21 |
| **Bibliography:** | | |

| **LABORATORY** | | |
|---|---|---|
| **Crt. no.** | **Content** | **No. hours** |
| 1 | Single carrier digital modulations | 0 |
| 2 | Single carrier digital modulations | 0 |
| 3 | Simulation of DVB-T technology in Matlab Simulink | 3 |
| 4 | Modulation and coding schemes used by 802.11 standard | 3 |
| 5 | ZigBee technology | 3 |
| 6 | WiFi Technology | 3 |
| 7 | DVBT Technology | 3 |
| 8 | WiMAX Technology | 3 |
| 9 | Final test | 3 |
| | **Total:** | 21 |
| **Bibliography:** | | |

**11. Evaluation**

| Activity type | 11.1 Evaluation criteria | 11.2 Evaluation methods | 11.3 Percentage of final grade |
|---|---|---|---|

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|---|---|---|---|
| 11.4 Course | knowledge of the concepts,principles and performance of themost spread modulationtechniques used in the advancedradio access technologies. | One MCQ based exam,at the mid of thesemester | 25% |
| | - knowledge of the operating andorganizational principles forcurrent radio access technologies,their performance andapplications. | One MCQ based exam,during the examsession | 25% |
| 11.5 Seminary/laboratory/project | Detailed analysis of an accesstechnology (theoretical andapplicative aspects). | Defence of the reportrelatede to thehomework. in a specialsession at the end of thesemester | 25% |
| | - Knowledge, configuration andsimulation of the main digial radioacess technologies; measurementof the quality of service andphysical layer parameters | Final lab test | 10% |
| | - The configuration, measurementsand answers to the questionsspecified in the laboratorydocuments | Turning in thelaboratory sheetscontaining themeasured values andthe answers to thequestions | 15% |
| 11.6 Passing conditions | | | |
| • Obtaining 50% of the total score.<br>• Obtaining 50% of the score related to the activity during the semester.<br>Faculty regulations must be followed. | | | |

**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)**

Internet access technologies (guided or wireless) have been and will continue to be an important componentof the global communications system. The use of IoT concepts is based on a variety of highly diverse accesstechnologies through range, data transmission rate, power consumption. The labor market is extremelyinterested in specialists in developing data collection solutions optimized on the application. Then theobservation of technological solutions in their evolution allows students an assimilation of the necessaryfundamental knowledge with greater ease.

The course curriculum responds to the current requirements of development and evolution, subscribed to theEuropean and world evolution in the field of communications and information technology (ICT). In thecontext of the current technological progress of electronic devices, the targeted fields of activity arepractically unlimited, from "consumer" applications (smart home, intelogente cities, mobile terminal remotecontrols), to the professional ones in the field of satellite communications, RFID, radio relays, etc.

Thus, the graduates are provided both with adequate skills with the needs of the current qualifications and amodern, quality and competitive scientific and technical training, allowing them to be quickly hired aftergraduation. This approach is perfectly included in the policy of the Polytechnic University of Bucharest,both in terms of content and structure, as well as in terms of skills and international openness offered tostudents.

Through the activities carried out within this discipline, students develop skills to provide solutions toproblems and to propose ideas to improve the existing situation in the field of access radio technologies andequipment. It is also envisaged to develop the skills of the graduate to manage practical situations that hemay face in real life in order to increase his contribution to the improvement of the socio-economicenvironment.

| Date | Course lecturer | Instructor(s) for practical activities |
|---|---|---|
| 21.09.2026 | Conf. Dr. Alexandru Rusu | Conf. Dr. Alexandru Rusu |

| 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 |