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	Masters
1.6 Programme of studies	Advanced Wireless Communications

2. Date despre disciplină

2.1 Course name (ro) (en)				Comunicații prin satelit Satellite Communications			
2.2 Course Lecturer				Prof. Dr. Alina Badescu			
2.3 Instructor for practical activities				Prof. Dr. Alina Badescu			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DS	2.9 Course code	UPB.04.M3.O.21-23		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	1.50	3.3 seminary/laboratory	1.5
3.4 Total hours in the curricula	42.00	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 Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					0
Tutoring					20
Examinations					10
Other activities (if any):					3

3.7 Total hours of individual study	33.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Microwaves, Calculus, Signals and Systems.
4.2 Results of learning	Knowledge of spherical geometry, modulations, and access techniques.

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

5.1 Course	-
5.2 Seminary/ Laboratory/Project	Mandatory laboratory activities (according to the internal regulations of POLITEHNICA University of Bucharest).

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 aims to provide students with a thorough understanding of the fundamental principles in designing global satellite systems for communication purposes.

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	The courses cover the most relevant aspects of satellite communications, with an emphasis on recent applications and developments. Specific applications of satellites are also explored, including satellites for mobile communications and satellites for the Internet. Additionally, the possibility of determining the feasibility of a communication solution based on its performance is analyzed.
Transversal (General) Competences	Methodical analysis of the problems encountered in work, identifying the elements for which solutions are established.

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.* **The result of assimilating information through learning in the "Satellite Communications" course consists of acquiring essential knowledge for the design and operation of satellite communication systems. The knowledge gained in this course represents a set of facts, principles, theories, and practices related to the field of global communications. Students will understand both the theoretical fundamentals, such as modulations, satellite system architecture, and access techniques, as well as practical aspects, such as the application of satellites for mobile communications and the Internet. This knowledge will be essential for assessing the performance and feasibility of satellite communication solutions in real-world contexts.**

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).* **In the course of satellite communications, the ability to apply knowledge and utilize the acquired know-how is essential for completing tasks and solving problems specific to the field. The skills developed in this course are of two types:** **Cognitive: This involves using logical, intuitive, and creative thinking to analyze and design satellite communication systems. Students will learn to evaluate satellite performance, identify innovative solutions to challenges in telecommunications, and apply theoretical principles in complex scenarios.** **Practical: This involves acquiring manual dexterity and using specific methods, materials, tools, and instruments. Students will be able to use specialized software for simulating satellite networks, interpret technical data, and implement effective solutions in real-world global communication contexts.** **These skills will ensure a comprehensive and practical approach to the issues in the field of satellite communications.**
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* In the course of satellite communications, the student's ability to autonomously and responsibly apply their knowledge and skills is essential for success in this dynamic field. Students are encouraged to develop a proactive approach to learning, which enables them to take initiatives in problem-solving and propose innovative solutions. Students will have the opportunity to experience various practical scenarios where they can apply their theoretical knowledge about satellite system architecture, modulations, and access techniques. This experience will provide them with the confidence necessary to make informed decisions and to tackle challenges in the field of satellite communications with a sense of responsibility and professional ethics. Additionally, through projects and group work, students will learn to collaborate effectively, communicate clearly, and manage resources responsibly. This combination of knowledge, practical skills, and the ability to work autonomously will prepare them to become competent and responsible professionals in the field of satellite communications.

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.)*

In the course of satellite communications, there is a strong emphasis on student-centered teaching methods that encourage active participation and direct involvement of students in the learning process. These methods are designed to stimulate critical thinking and creativity, providing students with opportunities to explore theoretical concepts and apply them in practical contexts.

1. **Project-based learning**: Students will work on practical projects in groups, tasked with developing solutions for real problems encountered in satellite communications. This approach not only facilitates collaboration but also helps them develop time management and presentation skills.

2. **Case studies**: Analyzing concrete case studies will allow students to better understand the applications of satellites in various fields, such as mobile communications, satellite television, or the Internet. This method will help them develop analytical skills and make decisions based on concrete data.
3. **Discussions and debates**: Active learning through discussions and debates will encourage students to express their opinions and argue their viewpoints regarding emerging technologies and trends in satellite

communications. This will stimulate critical thinking and improve communication skills.
4. **Collaborative learning**: Students will be encouraged to collaborate with each other, share ideas, and learn from one another. Through group activities and feedback sessions, a supportive learning environment will be created that facilitates knowledge assimilation.
5. **Utilization of technology**: Online platforms and specialized software will be integrated to facilitate simulations and analyses, allowing students to experience the design and implementation processes of satellite communication systems in an interactive way.
Through these student-centered teaching methods, the satellite communications course will not only provide theoretical knowledge but also shape professionals capable of adapting and innovating in this dynamic field.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction. Course objectives. Definitions. Principles of satellite communications. Space segment. Ground segment.	2
2	Satellite services. Point-to-point services - TV and video, data and voice transmissions, radio, e-learning. Mobile services - maritime, cellular services, portable terminals.	2
3	Orbits. Unperturbed orbits. Parameters of satellites. On-orbit perturbations. Classification of orbits: LEO, MEO, HEO, and GEO. The area covered by a satellite. The time interval between two successive satellite transmissions. Delay, delay variation. Characteristics of orbits. GEO systems. Elliptical systems. MEO systems, LEO systems.	6
4	Satellite links. Received power - characteristics of emitters, characteristics of the antenna. Noise - equivalent noise temperature, amplifier noise. Interferences and intermodulations. Power budget, signal-to-noise ratio. Mutual perturbations between terrestrial communication systems and satellite systems, as well as between space systems.	4
5	Sources of signal perturbations. Absorption factors. Diffusion factors. Equivalent atmospheric height. Other factors.	2
6	Relations between bandwidth and data rate. Sampling and quantization. Sampling in the base bandwidth. Capacity in bits per second, Shannon's capacity.	2
7	Multiple access techniques: FDMA, TDMA, and CDMA.	2
8	Antennas for satellite transmissions. The uplink. The downlink. Intersatellite connections.	1
	Total:	21

Bibliography:

1.S. Ohmori, H. Wakana, S. Kawase,Mobile Satellite Communications,Artech House, 1998
2. E. Altman, A. Ferreira, J. Galtier,Les réseaux satellitaires de télécommunication: Technologies etservices, Dunod, 1999
3. M. O. Kolawole,Satellite Communication Engineering, Marcel Decker, 2002
4. * * *Manuel sur les télécommunications par satellite (Ouvrage collectif de l'Union internationale destélécommunications), John Wiley, 2002
5. G. Baudoin, Radiocommunications numériques, Dunod, 2007
6. K. Borre, D. M. Akos, N. Bertelsen, P. Rinder, S.H. Jensen, A Software-Defined GPS and GalileoReceiver , Birkhauser, 2007

LABORATORY		
Crt. no.	**Content**	**No. hours**
1	Matlab: elements of spherical geometry.	2
2	Matlab: types of orbits.	2
3	Matlab: satellite coverage area.	2
4	Matlab: Atmospheric attenuation.	2
5	Matlab: Noise.	2
6	Practical application: satellite receiver for TV.	2
7	Test	2
8	Project 1-Orbits	3
9	Project 2- Mission	4
	Total:	21
Bibliography: 1. Alina Badescu, Teodor Petrescu, Laboratory platform		

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Knowledge of basic theoretical concepts. Knowledge of the application of theory to specific problems. Critical analysis and comparison of techniques and theoretical models.	The topics cover the entire syllabus of the subject, providing a synthesis of the comparative theoretical completion of the course and explaining the patterns of application exercises.	40

11.5 Seminary/laboratory/project	Discussing useful orbits for various satellite communication tasks. Discussing various types of antennas useful in satellite communications. Describing radio signal propagation and disturbances. Describing signal-to-noise ratios in satellite communications. Calculating complete link budgets.	Test	30
	Team project of the "defend/contest" type in which they must present/contest a satellite system.	presentation	30
11.6 Passing conditions			
Minimum 50 points			

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)

In the satellite communications course, special emphasis is placed on correlating the content of the discipline with the expectations of employers and relevant professional associations in the field of communications. It is essential for students to be prepared for the current challenges of the job market and to acquire competencies that meet the specific requirements of employers.

Thus, the course syllabus is designed in close connection with internationally recognized standards and best practices, taking into account the current state of knowledge in the addressed scientific field. This includes not only fundamental theoretical concepts but also relevant practical applications that reflect recent developments in satellite technology.

Collaboration with higher education institutions within the European Higher Education Area allows for the integration of the latest research and innovations into the curriculum, so that students benefit from a quality education tailored to the current and future needs of the communications sector.

Through these measures, we aim to ensure a rigorous academic training that facilitates the professional integration of graduates and contributes to the sustainable development of the satellite communications field.

Date	Course lecturer	Instructor(s) for practical activities
	Prof. Dr. Alina Badescu	Prof. Dr. Alina Badescu

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Date of department approval	Head of department
27.10.2024	Conf. Dr. Serban Georgica Obreja
Date of approval in the Faculty Council	Dean
25.10.2024	Prof. Dr. Mihnea Udrea