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	Telecommunications

2. Date despre disciplină

2.1 Course name (ro) (en)				Medii de transmisiune Transmission Media			
2.2 Course Lecturer				Conf. Dr. Nicolae Gheorghe Militaru			
2.3 Instructor for practical activities				Conf. Dr. Nicolae Gheorghe Militaru			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M1.O.18-03		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3.5	Out of which: 3.2 course	1.50	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	49.00	Out of which: 3.5 course	21	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.					41
Tutoring					0
Examinations					10
Other activities (if any):					0

3.7 Total hours of individual study	51.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Completion of the following disciplines: Mathematical analysis Linear algebra Physics
4.2 Results of learning	Accumulation of basic knowledge about: Electromagnetic field; Propagation Characterization of RF devices and circuits Sinusoidal signals Differential and integral computation Matrix calculation

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

5.1 Course	The course will take place in a room equipped with blackboard/whiteboard, a video projector and a computer.
5.2 Seminary/ Laboratory/Project	The laboratory will take place in a room with specific equipment (measurement line in rectangular waveguide and PCs). The power supply circuit must include grounding.

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 discipline provides master's students with thorough training in the field of electromagnetic wave propagation through various transmission media (transmission lines, metallic and dielectric waveguides), as well as knowledge of the basic principles and methods used in the analysis and synthesis of circuits, in the field of radio, microwave, and optic frequencies.

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	Demonstrates basic knowledge in the field of electromagnetic field propagation in free space as well as in waveguide media (metallic, respectively dielectric). Apply knowledge in practice in order to solve a concrete problem. 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. 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. Oral and written communication in Romanian: uses the scientific vocabulary specific to the field, in order to communicate effectively, in writing and orally. 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 to solve problem situations of medium complexity. Autonomy and critical thinking: the ability to think in scientific terms, search and analyze data independently, and draw and present conclusions / identify solutions. Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a process of systematic analysis. Respect the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity. 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.)*

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.* It lists the most important stages that marked the development of the field. Defines domain-specific notions. Describes/classifies notions/processes/phenomena/structures. It highlights consequences and relationships.
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).* Select and group relevant information in a given context. Reasonably uses specific principles in view of abc. Work productively in a team. Elaborate a scientific text. Experimentally verify identified solutions. Solve practical applications. Interpret causal relationships appropriately. Analyze and compare abc. Identifies solutions and develops resolution/project plans. Formulate conclusions to the experiments carried out. Argue the identified solutions/workarounds.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Select appropriate bibliographic sources and analyze them. Respect the principles of academic ethics, correctly citing the bibliographic sources used. 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/context or the problem situation to be solved. Demonstrates social responsibility through active involvement in student social life/involvement in academic community events. Promotes/contributes through new solutions related to the specialized field to improve the quality of social life. Realizes the value of its contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (social responsibility). Apply principles of professional ethics/deontology in the analysis of the technological impact of the solutions proposed in the specialized field on the environment. Analyzes and capitalizes on business/entrepreneurial development opportunities in the specialty area. 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 feedback construction mechanisms, as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs.
Teamwork skills will be practiced to solve different learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**

1	Transmission lines: Wave propagation along transmission lines, propagation constant, characteristic impedance Distribution of voltages and currents along loss-less transmission lines Input impedance of a transmission line. Smith Chart The transmitted power, efficiency 1.5. Transmission lines, as circuit elements at high frequencies. Lines as resonators. Matching circuits with transmission lines	9
2	Waveguides: Plane waves. Plane waves in lossy dielectrics. Plane waves in metals Wave propagation in uniform waveguides: longitudinal and transversal components of the field, linking relations between them. TEM, TE, TM waves. Properties of the TEM waves. Properties of the TE, TM in ideal metallic waveguides. Cutoff frequency, phase and group velocities, wave impedance Propagation study of the waves in rectangular waveguide: dominant H10, normal working bandwidth, field's structure, superficial currents,. Wave propagation in circular waveguide. Excitation, detection and filtration of the modes Transmitted power along the waveguides, the maximum transmissible power. Propagation in low-losses waveguides Coaxial waveguide. Planar waveguides. Strip line. Microstrip line. Coplanar waveguide Single mode and multimode optical fibers. Intermodal dispersion and intramodal (chromatic) dispersion.	8
3	Fundamental notions of the theory of linear radio frequency circuits: Equivalent voltages and currents in waveguides. Power waves 1-port devices characterization. The scattering matrix, [S], of a linear multiport devices Determination of the scattering matrix, [S] Properties of the matrix [S]. [S]-matrix of reciprocal devices. [S]-matrix of passive devices. [S]-matrix of conservative devices	4
	Total:	21

Bibliography:

Militaru, N., Petrescu, T., Medii de transmisiune. Teorie și aplicații, Ed. Politehnica Press, București 2010
Petrescu T., Militaru N., Microunde, Ed. Politehnica Press, Bucuresti 2021
Pozar D.M., Microwave Engineering, 4th Edition, JohnWiley & Sons, Inc., 2012.

LABORATORY

Crt. no.	Content	No. hours
1	The use of X-band measurement instrumentation and general-purpose measurement instruments in the study of guided electromagnetic field propagation	4
2	Study of signal amplitude distributions using the measurement line in the rectangular waveguide	2
3	Measuring the wavelength in the rectangular waveguide by various methods	2
4	Measurement of frequency with the X-band measuring line	2
5	Measurement of standing wave ratio with the measurement line	2
6	Measurement of reflection coefficient and load impedance with X-band measuring line	4

7	Study of simple matching networks with transmission lines, by circuit simulation	2
8	Study of matching networks with transmission lines, for complex loads	2
9	Measurement of optical fiber parameters using OTDR. Measurement of chromatic dispersion and power on optical fibers.	4
10	Final assessment (theoretical al practical) laboratory activity (interview)	4
	Total:	28

Bibliography:

Militaru, N., Petrescu, T., Medii de transmisiune. Teorie și aplicații, Ed. Politehnica Press, București 2010

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	- Knowledge of fundamental theoretical notions - Knowing how to apply the theory to specific problems - Critical and comparative analysis of theoretical techniques and methods	Exam scheduled in the session. The subjects completely cover the analytical curriculum of the discipline, realizing a synthesis between the comparative theoretical course and the explanation of the application models through exercises and problems.	50%
11.5 Seminary/laboratory/project	Laboratory: - Analysis of microwave circuits by circuit simulation. - Knowing the essential aspects of propagation phenomena in the field of microwaves and optical signals. - Knowledge of specific methods of investigation of these phenomena.	Final laboratory colloquium, comprising a theoretical component and a practical component. The theoretical component consists of the answer given by each student to a distinct set of questions; the practical component consists in the measurement by each student, with the help of the measuring line/OTDR, of a specific parameter, using a method presented in the laboratory.	50%
11.6 Passing conditions			

Exam:
• Obtaining at least 45% (22 points) of the score assigned to the exam (50).
Laboratory:
• Obtaining at least 50% (25 points) of the total score allocated to the laboratory activity (50). The total score for the laboratory activity has two components: the grade obtained at the colloquium (weight of 50% of the total score) and the arithmetic mean of the reports corresponding to the laboratory works (weight of 50% of the total score).

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)

Through the activities carried out, the master's students develop skills to offer solutions to problems and to propose ideas to improve the situation of existence in the case of telecommunications applications that involve remote transmission/processing of radio frequency signals.
In the development of the content of the discipline, the knowledge and phenomena described in the specialized literature were taken into account.
The abc activities aim to develop the graduate's skills to manage practical situations that he may face in real life in order to increase his contribution to the improvement of the socio-economic environment.

Date	Course lecturer	Instructor(s) for practical activities
12.10.2024	Conf. Dr. Nicolae Gheorghe Militaru	Conf. Dr. Nicolae Gheorghe Militaru

Date of department approval	Head of department
27.10.2024	Conf. Dr. Serban Georgica Obreja

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