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	Bachelor/Undergraduate
1.6 Programme of studies	Technologies and Telecommunications Systems

2. Date despre disciplină

2.1 Course name (ro) (en)				Radar (lb. română)			
2.2 Course Lecturer				Prof. Dr. Andrei Anghel			
2.3 Instructor for practical activities				Prof. Dr. Andrei Anghel			
2.4 Year of studies	4	2.5 Semester	I	2.6. Evaluation type	V	2.7 Course regime	Op
2.8 Course type		S	2.9 Course code	04.S.07.A.220		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	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	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 Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					27
Tutoring					0
Examinations					6
Other activities (if any):					0

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	Completion of the following subjects: Signals and systems Digital Signal Processing Microwaves
4.2 Results of learning	Basic knowledge of signal processing and electromagnetic waves.

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 a video projector
5.2 Seminary/ Laboratory/Project	The laboratory will take place in a room with specific equipment, which must include computers and specific equipment for each laboratory work (for example, signal generator, spectrum analyzer, system for measuring the radiation pattern of antennas, frequency modulated continuous wave radar).

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 RADAR subject is studied within the field of Electronic Engineering, Telecommunications and Information Technology / specialization Telecommunications Technologies and Systems and aims to familiarize students with the basic principles, models and explanatory theories regarding detection systems by electromagnetic means, used in solving practical applications and problems, which aim to stimulate the learning process.
The discipline addresses the following basic notions regarding RADAR systems: the fundamental principles and ideas underlying radar systems, radar cross-section, antennas used in radar systems, confusion noise and specific electromagnetic waves propagation phenomena, elements of detection theory, radar with synthetic aperture, frequency modulated continous wave radar. Some of the concepts and principles specific to radar systems are similar to those used in telecommunications systems and help providing to the students an overview of the methodological and procedural aspects related to radio engineering.

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 of radar systems Correlate the acquired knowledge for various applications Creating skills to evaluate a radar system. The possibility to indicate the frequency band and the type of radar necessary for an application or to implement a radio service based on detection by electromagnetic means. Argues and analyzes coherently and correctly the context of application of the basic knowledge of the field, using key concepts of the discipline and 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	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. Adaptation to new technologies and professional development, through continuous training using printed documentation sources, specialized software and electronic resources.

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.* • Enumerate and classify the most important types of radar systems. • Defines notions specific to the field of radio engineering. • Describes the main functional blocks of a radar system and the specific elements of electromagnetic wave propagation from the perspective of detection systems.
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).* • Selects and groups relevant information in a given context. • Reasonably uses specific principles in order to characterize a radar system. • Elaborates a scientific text. • Experimentally verifies the identified solutions. • Solves practical applications. • Adequately interprets causal relationships. • Analyzes and compares radar systems. • Formulates conclusions of the performed experiments. • Argues/defends the identified solutions.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Selects appropriate bibliographic sources and analyzes them. • 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. • Realizes the value of his contribution in the field of engineering by identifiying viable/sustainable solutions to solve problems in social and economic life (social responsibility). • Demonstrates real-life situation management skills (time management, collaboration vs. conflict in solving a practical problem).

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 the 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 and indirect exploration 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 begin with the recapitulation of some elements from the chapters already covered, with an emphasis on the notions covered in the last course.
The lectures use images and diagrams so that the information presented is easy to understand and assimilate.
Active listening and assertive communication skills will be used, as well as feedback construction mechanisms, as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs.
The ability to work in a team will be practiced to solve different laboratory works.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction	2
2	Principles of radio detection systems	4
3	Radar antennas	4
4	Electromagnetic waves propagation and the radar range equation	4
5	Clutter analysis	2
6	Elements of Detection Theory. The Ambiguity Function	6
7	Synthetic Aperture Radar	4
8	Frequency Modulated and Continous Wave Radar	2
	Total:	28
Bibliography: Anghel Andrei, Radar, electronic laboratory materials, https://curs.upb.ro/2021/course/view.php?id=9672		

LABORATORY		
Crt. no.	**Content**	**No. hours**
1	Range measurement	2
2	Analysis of the pulse radar transmitted signal	2
3	Radar antennas	2
4	The Ambiguity Function	2
5	Analysis of Synthetic Aperture Radar Images	2
6	Frequency Modulated Continous Wave Radar	2
7	Laboratory assessment	2
	Total:	14
Bibliography: Anghel Andrei, Radar, electronic laboratory materials, https://curs.upb.ro/2021/course/view.php?id=9672		

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Knowledge of the basic theoretical principles.	Written test (multiple choice, synthesis subject or problem solving).	30%
	The ability to solve specific problems.	Written test (multiple choice, synthesis subject or problem solving).	30%
11.5 Seminary/laboratory/project	-Knowledge of the main topics studied in the laboratory sessions	Ongoing evaluation based on lab activity and reports.	20%
	-The ability to understand and characterize certain radar signals.	Final lab test composed of a set of questions and problems regarding the activities in the laboratory sessions.	20%
	-The ability to understand and characterize certain radar signals.	Final lab test composed of a set of questions and problems regarding the activities in the laboratory sessions.	
11.6 Passing conditions			
Obtaining 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 course/lab activities, students develop skills to offer solutions to problems and to propose ideas to improve state of the art in the field of detection systems by electromagnetic means.
• Knowledge / aspects / phenomena described by recent specialized literature and own research published in prestigious international journals were both taken into account in the development of the content of the discipline.
• The course has a similar content to the courses held at the Technical University of Munich in Germany or TU Delft in the Netherlands.

Date	Course lecturer	Instructor(s) for practical activities
	Prof. Dr. Andrei Anghel	Prof. Dr. Andrei Anghel

Date of department approval

Head of department

Date of approval in the Faculty Council Dean