POLITEHNICA University of Bucharest
Faculty of Electronics, Telecommunications and Information Technology

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	POLITEHNICA University of Bucharest
1.2 Faculty	Faculty of Electronics, Telecommunications and Information Technology
1.3 Department	Telecommunications
1.4 Domain of studies	Electronic Engineering, Telecommunications and Informational Technologies
1.5 Cycle of studies	License
1.6 Program of studies/Qualification	Technologies and Systems of Telecommunications (TSTeng)

2. Course identification information

2.1 Name of the course				Antennas and propagation			
2.2 Lecturer				Assoc. Prof. PhD. Eng Alina Badescu			
2.3 Instructor for practical activities				Assoc. Prof. PhD. Eng Alina Badescu			
2.4 Year of studies	IV	2.5 Semester	7	2.6 Evaluation type	Exam	2.7 Course choice type	Compulsory

3. Estimated time (hours per semester for academic activities)

3.1 Number of hours per week, out of which	3	3.2 course	2	3.3 practical activities	1
3.4 Total hours in the curricula, out of which	42	3.5 course	28	3.6 practical activities	14

Distribution of time	Hours
Study according to the manual, course support, bibliography and hand notes	25
Supplemental documentation (library, electronic access resources, in the field, etc)	3
Preparation for practical activities, homework, essays, portfolios, etc.	6
Tutoring	0
Examinations	2
Other activities	0

3.7 Total hours of individual study	36
3.9 Total hours per semester	78
3. 10 Number of ECTS credit points	3

4. Prerequisites (if applicable)

4.1 curricular	Microwaves Calculus
4.2 competence-based	Knowledge of propagation modes, vectorial calculus, coordinate systems.

5. Requisites (if applicable)

5.1 for running the course	Solving problems for broadband communication networks: propagation in different transmission media, high frequency circuits and equipments (microwave and optical).
5.2 for running of the applications	-

6. Specific competences

Professional competences	General knowledge and specific application of the theory of antennas in various projects. The possibility of determining the feasibility of a solution based on its performance. Understanding the specifics of various types of concrete applications and operating conditions impact on the performance of antennas.
Transversal competences	Methodical analysis of the problems encountered in work, identifying the items for which solutions are established.

7. Course objectives (as implied by the grid of specific competences)

7.1 General objective of the course	Discipline provides students a thorough grounding in antennas and radio wave propagation as well as basic knowledge of the principles and methods used to analyze antennas.
4.2 Specific objectives	The specific objectives provided discipline refers to the presentation of the fundamental principles of antenna theory and their application to the analysis and their characterization. Fundamental parameters of antennas. Presentation and disclosure characteristics of different types of antennas (thin antenna, microstrip antennas, aperture antennas, reflector antennas, antenna systems). Elements of radio wave propagation.

8. Content

8.1 Lecture	Teaching techniques	**Remarks**
1. Introduction 1.1. Types of antennas 1.2. Radiation mechanism 1.3. Current distribution in a wire antenna	Teaching (definitions, demonstrations, properties) of the main theoretical concepts is carried out using the classical method (the board). To facilitate the understanding of physical phenomena, some properties /	2 hours
2. Fundamental parameters of antennas 2.1. Characteristic radiation, types of radiation characteristics and diagrams		4 hours

2.2. The lobes of the radiation characteristic 2.3. Field regions 2.4. The radiation intensity 2.5. Antenna directivity 2.6. Antenna gain 2.7. Efficiency. The efficiency of the antenna 2.7.2. Efficiency lobe 2.7.3. Polarization efficiency 2.7.4. Radiation efficiency 2.7.5. Aperture efficiency 2.8. Lobe opening angle 2.9. Polarization of antenna 2.10. The input impedance of the antenna 2.11. Vector effective length of the antenna 2.12. Effective area 2.12.1. Scattering surface 2.12.2. Loss surface 2.12.3. Catch surface 2.13. The connection between the maximum directivity and effective area 2.14. Antenna temperature	characteristics are presented using the projector, covering communication function demo. Oral communication methods used are expository method and problem-method. On-site course materials are available electronically.	
3. Radiation vector potential functions and integrals 3.1. Magnetic vector potential function 3.2. Electric vector potential function		2 hours
4. Wire antennas 4.1. Radiated electric field for an infinitesimal dipole 4.1.1. Radiation Resistance 4.1.2. directivity 4.1.3. Determination of field regions 4.2 . Dipole of finite length 4.2.1. Current distribution along the antenna 4.2.2. Radiated field 4.2.3. The radiation intensity 4.2.4 . Radiation resistance 4.2.5 . Input resistance 4.2.6 . Effect of non-zero distance between terminals 4.3. Parameters of the half wavelength dipole 4.4 . Infinitesimal dipole above an infinite perfect conductor plane		6 hours

4.4.1. image theory 4.4.2. vertical electric dipole 4.4.2.1. Far field 4.4.2.2. Radiated power, radiation intensity, directivity and radiation resistance 4.4.3. Horizontal electric dipole 4.4.3.1 . Far field 4.4.3.2 . Radiated power, radiation intensity , directivity and radiation resistance 4.5. Ground effect on the radiation characteristic of the antenna 4.5.1. Vertical dipole 4.5.2. Horizontal dipole		
5. Loop antennas 5.1. Circular infinitesimal loop. Radiated field 5.1.1. Radiation Resistance 5.1.2. Directivity 5.2. Square loop		1 hours
6. Broadband antennas & antenna miniaturization 6.1. Biconical antenna 6.2. Cylindrical dipole 6.3. Log-periodic antennas		2 hours
7. Antenna systems 7.1. A two element system. Uniform system of N linear antennas 7.2. Planar antenna system 7.3. Uniform circular N-antenna system		2 hours
8. Printed antennas 8.1. Microstrip rectangular patch. Transmission line model 8.2. Planar inverted-F antenna (PIFA) 8.3. Ceramic chip antennas		2 hours
9. Phased arrays for 5G, Radar and Satellite 9.1 Phase fronts and beamsteering; array configurations 9.2. Digital Beamforming 9.3. RF/Analog Beamforming 9.4. Hybrid Beamforming 9.5. Near/far field and weighting (tapers) 9.5.1. Effect of element spacing 9.5.2. Effect of scan angle		2 hours
10. Aperture antennas 10.1. Horn antennas		2 hour

10.2. Reflector Antennas		
11. Propagation of radio waves 11.1. Propagation in free space attenuation. Budget link 11.2. Propagation through ionosphere 11.2.1. Refraction index 11.3. Antennas for satellite navigation 11.4. Antennas for satellite communications		3 hours
Bibliography 1. A. Badescu, Antenna Engineering, ed. MatrixRom, ISBN 978-606-25-0307-9, 2017 2. E. Nicolau, "Antene şi propagare", ed. Didactică şi Pedagogică, Bucureşti, 1982. 3. C. Balanis, "AntennaTheory – analysis and design", ed. John Wiley&Sons, 1997. 4. J. Kraus, R. Marhefka, Antennas for all applications, ed. McGraw-Hill, 2003 5. course website on moodle platform: http://electronica.curs.pub.ro/2015/course/view.php?id=400		
8.2 Practical applications	**Teaching techniques**	**Remarks**
Lab 1 Matlab: basic parameters characteristic radiation	Teaching is based on the use of the projector (covering communication function and demonstration) Oral communication method used is problem-method used front. Students simulate, implement, test and evaluate independently the same problems with continued use of the computer and software environment. The teaching materials are included in the tutorial lab platforms laboratory electronically.	2 hours
Lab 2 Matlab: half wavelength dipole		2 hours
Lab 3 Matlab: Infinitesimal electric dipole above a perfect conducting plane		2 hours
Lab 4 Matlab: Liniar uniform string of N isotrope antennas		2 hours
Lab 5 NEC: antenna simulator environment –part I		2 hours
Lab 6 NEC: antenna simulator environment –part II		2 hours
Lab 7 Final laboratory test		2 hours
Bibliography 1. R. Cacoveanu, Laboratory guide „Antenna and propagation" 2. R. Tamas, Laboratory guide „Antenna and propagation"		

9. Bridging the course content with the expectations of the epistemic community representatives, professional associations and employers representatives for the domain of the program

The unprecedented development of radio communication systems, wireless sensors and detection systems and the electromagnetic tracking has made radio equipment to be ubiquitous. The structure of any radio system includes at least one antenna. The trend of miniaturization of the equipment or the spectral efficiency requires the development of new types and variants of antennas. The industry has a demand for qualified engineers with specializations radio and a solid foundation in the field of antennas and radio channel modeling, able to develop new products and services.

The course syllabus meet the present requirements for development and progress, subscribed services of the European economy services in Electronics and Telecommunications Engineering, the studying program of Technology and telecommunications systems (TST). In the context of current technological advancement equipment radiofrequency fields concerned are virtually endless, such as applications and consumer goods (mobile terminal "smart -phone"), medical (treatment , imaging), the military (special communications systems integrated radar systems and radio waveguides), the security (surveillance systems), the current highly professional communications and others.

This provides the bachelor graduates skills in line with current needs, a technical and scientific training, enabling rapid employment after graduation. This policy is in accordance with the Polytechnic University of Bucharest, both in terms of content and structure and in terms of skills and international openness offered to graduates.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final mark
10.4 Lectures	- Knowledge of basic theoretical concepts - Knowledge of the application of theory to specific problems - Critical analysis and comparison of techniques and theoretical models	Exam scheduled session. Topics cover all the syllabus of the subject, making a synthesis of comparative theoretical completion of the course and explaining patterns of application exercises.	35%
10.5. Laboratory	- Knowledge of the fundamental parameters of antennas - Analysis of simple pie - Study of antenna systems - Understanding the features of different types of applications and the impact of operating conditions on the performance of concrete antennas	Oral laboratory examination comprises a theoretical and practical component. Theoretical component consists of each student response to a separate set of questions; the practical component is to determine the fundamental parameters of antennas.	30%

10.6. Project	The project goal is for the students to design a RF transmiter- receiver link, starting from the information given during the lectures. The objective of the project is to famialirize the students with the work conditions in a company, that is optimizations of results under certain conditions/constraints.	The following components are graded: the analytical solution of the problem (including stuying the extra literature provided by the lecturer), solving the same problem using specialized simulators (for comparizon and conclusion), and final optimizations.The project is done in teams of 2 students, each team having a different project.	35%
10.7 Minimal performance standard			
-Knowledge of the fundamental parameters of antennas - Analysis and determination of a parameter for a simple wire antenna -Antenna design using a specialized software			

Date	Lecturer	Instructor for practical activities
15.09.2017	Assoc. Prof. PhD. Eng Alina Badescu	Assoc. Prof. PhD. Eng Alina Badescu

Date of approval of Department

25.09.2017

Director of Department

Assoc. Prof. PhD. Eng Eduard Popovici