COURSE PROGRAM

Academic Year: 2024/2025

Identification and characteristics of the course				
Code	401089	ECTS Credits		6
Course name (English)	Radio planning			
Course name (Spanish)	Diseño y planificación de sistemas radio			
Degree programs	Máster en Ingeniería de Telecomunicación / M.Sc. Degree on Telecommunications Engineering			
Faculty/School	Escuela Politécnica			
Semester	3	Type of course	Compulsory	
Module	Telecomunication Technologies			
Matter	Communications Systems			
Lecturer/s				
Name		Office	E-mail	Web page
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Diego Martínez Solís		34 Teleco	dmartinezsolis@unex.es	www.unex.es
Subject Area	Signal Theory and Communications			
Department	Computers and Communications Technologies			
Coordinating Lecturer (If more than one)	Diego Martínez Solís			

Competencies*
Specific competencies **CETT02 -** Ability to develop radio systems: antenna design, equipment and subsystems, beamforming, calculation and planning links. **CETT05 -** Ability to design radio-navigation and location systems, as well as radar systems
Basic competencies **CB6** - Knowledge and understanding that provide a basis or opportunity for originality in developing and / or applying ideas, often in a research context. **CB10** - Learning skills that enable to continue studying in a way that will be largely self-directed or autonomous.
General competencies **CG4** - Capacity for mathematical modeling, calculation and simulation in technology centers and engineering companies, particularly in research, development and

* The sections concerning competencies, course outline, educational activities, teaching methodologies, learning outcomes and assessment systems must conform to that included in the ANECA verified document of the degree program.

innovation in all areas related to the Telecommunications Engineering and related multidisciplinary fields.
CG8 - Ability to apply the acquired knowledge and solve problems in new or unfamiliar environments in broader and multidisciplinary contexts, being able to integrate this knowledge.

Cross-curricular competencies
CT1 - Innovative and entrepreneurial spirit.
CT4 - Skills to communicate conclusions, along with the knowledge and the reasons behind them, to specialized and non-specialized audiences, both orally and in writing, in Spanish and English.
CT7 - Critical thinking skills and creativity as a means to have the opportunity to be original in the generation, development and / or application of ideas in a research or professional context
CT10 - Focus on quality and continuous improvement.
CT11 - Autonomous learning capacity
CT12 - Ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts.
CT13 - Ability to integrate knowledge and face the complexity of formulating opinions from incomplete or limited information.

Contents

Course outline*

Analysis and design of microwave devices. Antenna analysis and design. Introduction to radiocommunication systems. Radio Propagation. Radio Channel modelling. Advanced methods for radio-link analysis. Quality and availability of a radio-link. Interference. Radio Planning. RADAR fundamentals. Components of RADAR systems. RADAR range equation. RADAR signal advanced processing. Radio navigation and positioning. Air traffic control.

Course syllabus

Name of lesson 1: **Antennas and microwave systems**.
Contents of lesson 1: *Radiation analysis methodology. Auxiliary vector potentials. Electromagnetic theorems for radiation (equivalent and reciprocity problems). Radiation parameters (radiation pattern, directivity, gain, impedance, etc.). Linear antennas. Aperture antennas. Antenna arrays. Antennas in communication systems. Waveguides and transmission lines. Waveguide modes. Waveguide cutoff frequencies. Smith Chart. S parameters. Waveguides and transmission lines in communication systems.*

Name of lesson 2: **RADAR systems**
Contents of lesson 2: *Components of a RADAR system (transmitter, receptor, channel, modulators, power systems). Friis equation. Channel statistical model. RADAR range equation. Radar Cross Section (RCS). Types of RADAR systems (pulsed, CW, …). RADAR detection. RADAR signal processing. High resolution RADAR. Synthetic Aperture Radar (SAR).*
Description of the practical activities of lesson 2: problem resolution with calculator.

Name of lesson 3: **Calculation of radiation through Computational Electromagnetics techniques**.

Contents of lesson 3: *Method of moments (MOM), finite differences in the time domain (FDTD) and frequency domain (FDFD).*
Description of the practical activities of lesson 3: implementation of the above methods in MATLAB.

Name of lesson 4: **Planning of Radio Coverage**.
Contents of lesson 4: Ray *Methods. Empirical Methods. Calculation of LOS. Level calculation over real terrains.*
Description of the practical activities of lesson 4: learning of these methods with MATLAB.

Educational activities *

Student workload in hours by lesson		Lectures	Practical activities				Monitoring activity	Homework
Lesson	**Total**	**L**	**HI**	**LAB**	**COM**	**SEM**	**SGT**	**PS**
1	18	6						5
2	35	12						15
3	60	13			12			50
4	35	12			3			20
Assessment **	2	2						
TOTAL	150	45			15			90

L: Lectures (100 students)
HI: Hospital internships (7 students)
LAB: Laboratory or field practices (15 students)
COM: Computer room or language laboratory practices (30 students)
SEM: Problem classes or seminars or case studies (40 students)
SGT: Scheduled group tutorials (educational monitoring, ECTS type tutorials)
PS: Personal study, individual or group work and reading of bibliography

Teaching Methodologies*

-Master class
-Problem-solving
-Simulation of radiation problems and radio coverage on PC (MATLAB)

Learning outcomes *

Ability to plan, calculate and design products, processes and facilities in all areas of telecommunications engineering.

Ability to lead, plan and supervise multidisciplinary teams.

Capacity for mathematical modelling, calculation and simulation in technology centers and engineering companies, particularly in research, development and innovation in all areas related to the telecommunications Engineering and related multidisciplinary fields.

Capacity for the development, strategic planning, direction, coordination and technical and financial management of projects in all areas of the Telecommunications Engineering, following environmental and quality criteria.

Capacity for the overall direction, technical direction and project management research, development and innovation, in companies and technology centers.

** Indicate the total number of evaluation hours of this subject.

Capacity for implementation, and management of manufacturing processes of electronic and telecommunications, with a guarantee of safety for people and goods, the final quality of the products and their approval.

Ability to apply principles of economics and human resource management and projects as well as legislation, regulation and standardization of telecommunications.

Ability to learn to communicate (oral and written) findings, and the knowledge and rationale underpinning these, to public-skilled and unskilled in a clear and unambiguous way.

Assessment systems *

Course evaluation will be carried out using continuous assessment and final exam. Class and Lab attendance and participation, lab reports, academic essays proposed by the lecturers, expositions in the classroom will be considered. The value of the final exam will have a weight of 50%; 50% for the continuous assessment. The final exam can be replaced by one mid-course examination.

The students can benefit from section 4 of the Extremadura University Exam Regulation which guarantees the student's right to an alternative global exam. In the case of choosing this option, passing the global exam implies passing the course.

Bibliography (basic and complementary)

- Lecture notes and slides provided by professors.
- C.Balanis. "Antenna Theory. Analysis and Design". John Wiley & Sons. 1982.
- R.E. Collin. "Antennas and Radiowave Propagation". Mc. Graw-Hill 1985.
- Cardama, L. Jofre, J.M. Rius, J. Romeu y S. Blanch. Antenas. Ediciones UPC, 1991
- D. K. Cheng. Fundamentos de electromagnetismo para ingeniería. Addison-Wesley, Iberoamericana, 1997
- S. Ramo, J. R. Whinnery y T. Van Duzer. Fields and Waves in Communication Electronics. John Wiley and Sons, 3th ed. 1994.
- J.D. Kraus. Electromagnetics with applications. McGraw-Hill, 5th ed. 2000.
- F.Ivanek. Terrestrial digital microwave communications. Artech House, 1989
- R.L.Freeman. Radio systems for telecommunications. J.Wiley, 1997
- Salema. Microwave radio links: from theory to design. Wiley-Interscience, cop. 2003
- J.M. Hernando Rábanos. "Transmisión por radio". Edición Centro de Estudios Ramón Areces. Madrid. 1993
- J. Hernando Rábanos, "Comunicaciones móviles", Editorial Areces
- J. Mª. Hernando, Cayetano Lluch. "Comunicaciones móviles de 3ª Generación (UMTS)" Telefónica móviles S.A. 2000.

Other resources and complementary educational materials

- M.P.M. Hall, L.W. Barclay y M.T. Hewitt. Propagation of Radiowaves IEE. 1996
- M. Dolukhanov. Propagation of radio waves. URSS. Moscow.1995.
- P. Rohan. Introduction to electromagnetic wave propagation. Artech House, 1991
- J.D. Parsons. The mobile radiopropagation channel, John Wiley and Sons, 2000
- M. Kayton y W. R. Fried, Avionics Navigation Systems, John Wiley and Sons, 1969.

- F. P. Martínez, Sistemas de navegación por satélite, Servicio de Publicaciones de la E.T.S.I.T, Universidad Politécnica de Madrid.
- F. P. Martínez, Sistemas de aproximación y aterrizaje, Servicio de Publicaciones de la E.T.S.I.T, Universidad Politécnica de Madrid