UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
MASTER'S DEGREE (MSC)	ELECTRONICS AND TELECOMMUNICATIONS ENGINEERING (FULLY ONLINE)
SUBJECT	ANTENNAS AND WIRELESS SYSTEMS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50364-Ingegneria elettronica
CODE	20520
SCIENTIFIC SECTOR(S)	ING-INF/02
HEAD PROFESSOR(S)	CINO ALFONSO CARMELO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	162
COURSE ACTIVITY (Hrs)	63
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**CINO ALFONSO CARMELO** Thursday 11:30 13:30 Ufficio del docente (Ed. 9, III Piano) o canale del corso "Campi Elettromagnetici" su Teams

DOCENTE: Prof. ALFONSO CARMELO CINO

PREREQUISITES	Students are expected to have undergraduate level knowledge of Electrical Circuits and Electromagnetic Fields Theory.
LEARNING OUTCOMES	Knowledge and understanding. On completion of this course the student will gain knowledge on the generation and reception of electromagnetic waves for telecommunications. The student, which is supposed to have a previous knowledge of electromagnetics, on course completion will: - have a knowledge of the mechanisms underlying the generation and propagation of electromagnetic waves, taking into account medium properties and atmospheric perturbations; - have a knowledge of most common antenna types used for radio communications and will be able to calculate their basic radiation characteristics; - be able to dimension a radio link so as to meet design specifications; - have a knowledge of specific antenna types used for indoor wireless systems. To meet this objective, the course includes: videe of traditional lectures; analysis and discussion of specific technical applications. Verification of this objective is based on a discussion of course topics during the oral exam. Applying knowledge and understanding. Students will be able to: - make use of calculus tools and software to solve problems where electromagnetic waves play a major role; - carry out design tasks for radiating systems, making proper use of modeling methods to find out correct parameters and specifications. To meet this objective, the course includes: exercise classes on modelling and comparison between circuit and electromagnetic approaches; exercise classes on design problems. Verification of this objective is based on the document for the group work and on a discussion during the oral exam. Making judgements The mix of theoretical and experimental knowledge will give the student the ability to understand complex design scenarios. In particular, he will be able to: - apply his knowledge and understanding to pursue the solution of the most common electromagnetic waves communication technical problems; - correctly read a catalog to choose components, equipment and systems, best suited to proposed specifications for free-space and indoor propagation; - correctly understand electromagnetic measurements in order to respect/meet specifications; - consider performance limitations of the various available technologies. To meet this objective, the course includes: systematic comparison of systemic/ circuit and electromagnetic points of view. Verification of this objective is pursued through the oral exam. Communication skills The student will be able to: - acquire a communication skill appropriate to describe problems regarding the generation and propagation of electromagnetic waves; - identify/use physical parameters and terminology specific to applied electromagnetics; - discuss on current topics pertaining to antenna characteristics and radio communication problems. To meet this objective, the course includes: exercise classes and discussions on the adopted design SW. Verification of this objective is pursued both through the student presentation of its contribution to group work and the following part of oral exam. Learning skills The student will be able to: - begin the study of more complex tasks such as the development of ad hoc devices in the context of telecommunication electronics; - be self-sufficient for the search of specific scientific/application literature; - read and understand correctly professional and specialized books. To meet this objective, the course includes: video of traditional lectures; analysis and group discussion of design and multidisciplinary topics. Verification of this objective is pursued through the oral exam.
ASSESSMENT METHODS	GROUP WORK + ORAL EXAM Oral exam proceeds with a student presentation of its contribution to the group work and, subsequently, with a series of questions which are meant to assess whether the student has acquired the skills and subject knowledge expected from the course; evaluation mark is awarded on a 30-point scale, with around 50% attributed through the evaluation of group work document and the initial presentation. Questions are intended to verify a) the acquired knowledge on electromagnetic

	models of antennas and their limitations; b) the ability to apply models in technical applications scenarios; c) the possession of effective communication skills. In more detail, we can pinpoint the "assessment elements" and the "grades": ASSESSMENT ELEMENTS a) Regarding the verification of knowledge, it is required the ability to establish connections between the different course elements (physical theories, mathematical models, calculation and design tools, etc.). Minimal marks will be given when ability is mainly restricted to calculation and modeling aspects; higher marks when it includes the design perspective. b) Regarding the verification of the ability to apply models, it will be considered the capacity to account for, to take a critical look at and to modify, the design choices. Minimal marks will be given when ability is mainly restricted to clarification of single points of the analysis/design; higher marks when it encompasses the skill to find new and proper design solutions after a change in the system under study. c) Regarding the verification of the communication skills, minimal marks will be given when the student uses a proper techno-scientific language but only at a basic level; higher marks when he/she is clear and articulate with the specific technical context of applied electromagnetics. GRADES 30-30 and laude: Excellent. Full knowledge and understanding of concepts and methods of the discipline, excellent analytical skills even in solving original problems; excellent communication and learning skills. 27-29: Very good. Very good knowledge and understanding of concepts and methods of the discipline; very good communication skills; very good capability of concepts and methods applications. 24-26: Good. Good knowledge of main concepts and methods of the discipline; discrete communication skills; limited autonomy for applying concepts and methods for solving original problems. 21-23: Satisfying. Partial knowledge of main concepts and methods of the discipline; satisfying communication skills; scarce judgment autonomy. 18-20: Acceptable: Minimal knowledge of concepts and methods of the discipline; minimal communication skills; very poor or null judgement autonomy. Non acceptable: Insufficient knowledge and understanding of concepts and methods of the discipline.
EDUCATIONAL OBJECTIVES	The “Antennas and wireless systems” course is aimed to give the student a basic theoretical and design knowledge, based on a treatment as simple and intuitive as possible, regarding the more common antennas used in telecommunication applications. Their analysis and design will be set in the perspective of electromagnetic waves classification and properties. Specific attention will be devoted to antennas used for indoor wireless systems e to some basic SW tools for calculation, analysis and design.
TEACHING METHODS	Video (pre-recorded) of traditional lectures and exercise classes, accompanied by e-tivity, in particular based on calculations and computer simulations with analysis and design software. The overall number of hours for the individual study activities is estimated equal to additional 162 hours, which include the hours required for replaying once the video lectures.
SUGGESTED BIBLIOGRAPHY	Essential 1) Fawwaz T. Ulaby, Umberto Ravaioli: Fundamentals of Applied Electromagnetics, Global Edition, Pearson (2015) ISBN: 1292082445; 2) Lectures slides and readings of a few seminal research papers (available in the course material); 3) Sophocles J. Orfanidis, Electromagnetic Waves and Antennas, free book available at www.ece.rutgers.edu/~orfanidi/ewa/; 4) Michael Steer, Fundamentals of Microwave and RF design, 3d ed. (2019), ISBN: 9781469656892, free book available at repository.lib.ncsu.edu/handle/1840.20/36776. For reference 3) John D. Kraus, Antennas, McGraw-Hill, (1988), ISBN: 0070354227; 4) Constantine Balanis, Antenna Theory: Analysis and Design, Wiley (2016), ISBN: 1118642066; 5) Warren L. Stutzman, Gary A. Thiele, Antenna Theory and Design, Wiley (2012), ISBN: 0470576642; Note: all different editions of the above books also offer the sections required for the course

SYLLABUS

Hrs	Frontal teaching
2	Introduction to the field of RF antennas. Course objectives and applications of interest.

SYLLABUS

Hrs	Frontal teaching
4	Electromagnetic waves sources and propagation: review and new concepts.
2	Electromagnetic potentials.
2	Review of transmission lines properties required fo antenna theory
2	Field generated by an Hertzian dipole; radiation resistance, radiation patterns, directivity.
2	Near and far fields produced by localized sources; far field approximations.
3	Wire and loop antennas
2	Reflector antennas.
2	Receiving antennas.
2	Friis formula and the analysis of a radio link.
2	Antenna arrays.
2	Aperture and printed antennas
4	Small antennas for indoor/local wireless systems

Hrs	Practice
32	Video of exercise classes and e-tivity devoted to the application in simple practical cases of the basic methods and ideas illustrated during videolectures. Analysis and design of specific antenna types will be, if possible, carried out in groups of students and will be largely based on the use of freely available PC programs for numerical electromagnetics. In particular, besides the occasional use of general free math/tech programs (GeoGebra, Scilab, TRLINE, TXLINE, SimSmith,…) the free and widely used 4NEC2 antenna modeling package for Windows will be mainly used. 4NEC2 is an implementation by Arie Voors of the “Numerical Electromagnetics Code 2” (NEC-2) developed at the Lawrence Livermore Laboratory, USA, and now available as public domain code: despite its limitations in comparison with commercial packages, this is considered a good didactical and practical choice, also as it directly opens the way towards the almost effortless use of more recent and powerful (commercial) evolutions of NEC such as NEC-3, NEC-4 and NEC-5. Finally the java-based modules of Ulaby's book companion website will be also used. Evaluation of the work completed by each group of students (i.e. a document with details on methods and results) will give the starting grade (ca. 50%) for the final oral individual examination, consisting of two parts: illustration and comment of respective group work; questions on course theoretical topics.