Mobile and satellite communications

General information

Scope	Telecommunications Engineering
Language	INGLESE
Didactic Activity Type	Lecture
Holders	OLIVERI GIACOMO
Length	48 hours (48 hours Lecture)
Subject area	ING-INF/02

Contents

Part 1. Introduction and Fundamentals of Antennas for Mobile and Satellite Communications
Antenna Recap: Antenna definition and characterization. Types of radiating systems. Fundamental Parameters of antennas: Directivity, Antenna efficiency, Gain, Input impedance, Polarization and polarization loss, Radiation pattern, beam width angle, Effective isotropic radiated power (EIRP). Far-field and near-field regions.
Characterization of applicative scenarios for mobile and satellite communications. Received signal strength (Generalized Friis Equation). Characteristics and definitions of noise and antenna noise temperature. Effects of the propagation medium and environment. Examples of uplink and downlink antenna requirements in mobile and satellite scenarios.

Part 2. Microstrip Antennas: Analysis and Design
Introduction to microstrip antennas for mobile communications. Antenna configurations (patches, microstrip dipoles, printed slot antennas, microstrip traveling wave antennas). Feeding techniques. Analytical models for analysis and design of mobile communications antennas. Design of rectangular patch antennas. Printed slot antennas. Techniques for bandwidth enhancement.

Part 3. Antenna Elements for Satellite Communications
Analysis of antennas for satellite communications. Aperture antennas, horn antennas, reflector antennas. Advanced antenna systems for satellite communications: reflectarrays. Applicative examples.

Part 4. Antenna Arrays for Mobile and Satellite Communications
Analysis of Antenna Arrays. Receiving array in the time domain. Array reception in the frequency domain and Array factor (AF). AF features: nulls, maxima, and grating lobes. Visible and invisible range. AF of uniformly and non-uniformly weighted linear array. Planar and Circular arrays.
Synthesis of Antenna Arrays. Formulation of pattern synthesis problems: field synthesis; power synthesis; mask-constrained power synthesis; external and internal array synthesis. Synthesis approaches: Test and trial approaches: amplitude tapering; z-transform. Amplitude and phase taper: Fourier synthesis; Schelkunoff's method; Woodward-Lawson synthesis; least-square method. Analytical solutions: binomial taper; Dolph-Chebyshev taper; Taylor taper; Bayliss taper. Iterative procedure: iterative projection method. Introduction to advanced synthesis methods for sparse, clustered, and thinned arrays.

Bibliography/Study materials

- C. A. Balanis, Antenna Theory, John Wiley & Sons, 1997.
- R. J. Mailloux, Phased Array Antenna Handbook, 2nd Ed. Artech House, 2005.
- R. L. Haupt, Antenna Arrays: A Computational Approach, John Wiley & Sons, 2010.
- R. S. Elliott, Antenna Theory and Design, John Wiley & Sons, 2003.
- R. E. Collin and F. J. Zucker, Antenna Theory, Mc-Graw-Hill, 1969.
- G. Franceschetti, Electromagnetics. Theory, Techniques, and Engineering Paradigms, KluwerAcademic/Plenum Publishers, 1997.
- G. Conciauro, Introduzione alle onde elettromagnetiche, Mc-Graw-Hill, 1993.
- G. Maral and M. Bousquets, Satellite Communications Systems: Systems, Techniques, and Technology, Ed: John Wiley & Sons, 1998.
- T. Kitsuregawa, Advanced Technology in Satellite Communication Antennas: Electrical and Mechanical Designs, Ed: Artech House,

2001.
- D. Roddy, “Satellite Communications”. Ed: McGraw-Hill, 2006.
- E. R. Bruce, “Introduction to Satellite Communication”. Ed: Artech House, 2008.

Course objectives and learning outcomes

The course presents the fundamental principles of antennas and phased arrays in electromagnetic engineering, introduces the main figures of merit for characterizing complex radiating devices, and illustrates basic and advanced antenna analysis and synthesis methods for mobile and satellite applications, with main emphasis to communication scenarios. To this end, the course features theoretical, methodological, and practical aspects, and it introduces the most challenging applicative problems in these frameworks. The course consists in lectures and software/hardware emulator exercitations. Additional seminars given by relevant experts from other Universities, Agencies, and Companies will be advertised during the course.

Entrance requirement

Basic electromagnetic fields modules.

Teaching and learning methods and activities

The teaching activity is organized as follows:
- 50% of theoretical frontal lessons related to the basic theory and methodological approaches for the analysis and solution of the problems that will be presented as case studies during the course;
- 25% of lessons dedicated to the development of exercises and the solution of case studies, also linked to examples of practical application;
- 25% of software exercises will complete the theoretical lessons and the exercises.

The educational material (e.g., exercises, in-depth material) will be made available on the course website indicated by the teacher at the beginning of the course.

Other information

Teaching Materials
During the course, handouts, handbooks, HW-SW experiences, and the collections of presented exercises will be made available on the site http://eledia.disi.unitn.it. Additional material (e.g., handouts, lab exercises) will be made available during the course on the site https://www.eledia.org/eledia-unitn/course/ .

Communications/Notices
In order to optimize the communication between teachers and students, all communications and notices (change in class schedule, calendar, exams, availability of teaching materials, etc ...) will be done via e-mail sent to the mailing list of the course which students are invited to register at the beginning of the lessons through the website https://www.eledia.org/eledia-unitn/course/ .

Additional details regarding the course can be found https://www.eledia.org/eledia-unitn/course/ .

Test and assessment criteria

The exam consists of the development of a short project and the execution of a written questionnaire. More specifically:

Short Project
The short project consists in the development of an activity which regards the topics described in the course as well as innovative aspects in the field of mobile and satellite communications. The maximum mark of the project part is 15. The activity at the choice of the student can be requested through a notification by email to the course holder. During the development of the project, the student will be assisted by a tutor identified at the beginning of the project.

Written Questionnaire
The written test consists of multiple-choice questions on the whole program of the course. The maximum mark of the written exam part is 15. During the written exam the use of notes, texts, or programmable calculators is not allowed. The useful formulas are summarized in a document available on the webpage of the course or will be made available the day of the exam.

The final mark is computed as the summation of the marks acquired in the project and written exam parts.