UNIVERSITÀ DI PISA

WIRELESS SYSTEMS TECHNOLOGIES

PAOLO NEPA

Anno accademico	2023/24
CdS	TELECOMMUNICATIONS ENGINEERING
Codice	899II
CFU	9

Moduli	Settore/i	Tipo	Ore	Docente/i
TECNOLOGIE ELETTROMAGNETICHE PER I SISTEMI WIRELESS	ING-INF/02	LEZIONI	90	ANDREA MOTRONI PAOLO NEPA

Learning outcomes

Knowledge
Students will have acquired knowledge about the main design criteria and characteristic parameters of main electromagnetic guiding structures (coaxial cables, printed lines, waveguides), the propagation properties of voltage/current waves in a transmission line, the characteristic parameters of RF and microwave devices (scattering matrix, ABCD matrix), the implementation techniques of some passive devices (as for example: impedance matching networks, power dividers/combiners, directional couplers), antenna characteristic parameters.

Assessment criteria of knowledge
Discussions with students during course classes

Skills
By the end of the course the students will know how to choose and design the most suitable passive device forte transceiver of a wireless system, radar or communication system.

Assessment criteria of skills
During the lab classes, small excercises/projects will be carried out.

Behaviors
Students will acquire and/or develop an awareness of how the basic electromagnetic theory can be applied to the analysis and design of passive devices used in the tansceivers of the wireless systems.

Assessment criteria of behaviors
Discussion with students during course classes

Prerequisites
Fundamental theorems of electromagnetic fields, characteristic parameters of the electromagnetic propagation, tools for the analysis of the electrical circuits

Teaching methods
Lectures

Syllabus
Introduction to electromagnetic guiding structures, modal expansion of the electromagnetic solutions. TEM mode, relationships between voltage/current and electric/magnetic fields. Transmission line theory: analysis based on the equivalent electric circuit, wave equation, stationary wave, characteristic impedance, propagation constant and wavelength. Transmission line closed on an arbitrary load: reflection coefficient, impedance transformation equation, VSWR. Examples with specific load conditions: short circuit, open circuit, matched load, resistive load, reactive load. Power transmitted in a transmission line. Power attenuation in a low-loss transmission line. The Smith Chart for normalized impedance/admittance. Transients in an ideal transmission line.

Impedance matching networks: single and double stubs, series or parallel connection. Quarter-wave transformer.
Coaxial cable: characteristic parameters of the equivalent electric circuit, TEM mode and higher-order modes, attenuation constant. Microstrips, CPW, stripline: effective dielectric constant, dispersion diagram, design criteria. Rectangular and circular waveguides: fundamental mode, cut-off frequencies, power flux, dispersion diagram, mode surface currents.
RF and microwave passive junctions: scattering matrix (definition, properties, relationships with impedance/admittance matrix and ABCD matrix). Description of some passive devices: phase shifters, attenuators, power dividers/combiners, directional couplers, circulators.
Introduction to antennas and their characteristic parameters (gain, directivity, radiation efficiency, radiation patterns, input impedance, impedance bandwidth, etc.). Equivalent electric circuit of an antenna (transmitting or receiving antenna). Derivation of the link budget equation. Definition of the RCS of a target and derivation of the radar equation.
Numerical exercises related to the course topics, measurements with a VNA, presentation of a numerical tool for the EM analysis and design of passive RF/microwave passive devices (ADS).

Bibliography

David M. Pozar, Microwave Engineering, Wiley

Assessment methods

The exam is made up of a written test and an oral test. The written test takes three hours and is about some numerical excercises. Admission to the oral est requires an evaluation of at least 18/30. During the oral test the candidate is required to discuss with (at least) two professors about a few course topics that are chosen by the professors. On average, the interview takes between half-an-hour and one hour.

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