Course guides
230661 - MC - Microwave Circuits

Last modified: 08/03/2016

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Optional subject).

Academic year: 2016 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: JORDI J. MALLORQUI

Others: ALBERT AGUASCA, LLUÍS PRADELL, NURIA DUFFO, JOAN O'CALLAGHAN.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Ability to conceive and design electronic circuits for signal amplification, for low and high (radio) frequencies, depending on the type of application and targeting specific consumption, noise, linearity, stability, impedance and bandwidth figures.
2. Ability to design, implement and operate high performance laboratory electronic instrumentation, with emphasis on error analysis, calibration and virtual control.
3. Ability to design nonlinear electronic circuits for signal processing and synthesis, including frequency shifting, active filtering, oscillators and phase locked loops.

TEACHING METHODOLOGY

- Lectures
- Application classes
- Laboratory classes
- Laboratory practical work
- Exercises
- Short answer test (Control)
- Extended answer test (Final Exam)

LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

The aim of this course is to train students in the basic methods for the analysis of circuits, systems, instrumentation and CAD tools at RF and microwaves, as well as the study of the available technology and the electronic components that are used in these frequencies. These techniques are then applied to the design of prototypes and the characterization of devices in the laboratory.

Learning results of the subject:

- Knowledge of the basic concepts and techniques related to applications at microwave frequencies in the fields of communications, satellite and remote sensing.
- Specific techniques for the analysis of circuits and systems at RF and microwave frequencies, and their application to the design of passive and active circuits (transmission lines, couplers, splitters, and amplifiers).
- Specific techniques for the simulation of circuits and systems at RF and microwave using CAD programs.
- Specific techniques used to measure circuits and systems at these frequencies by means of specific instrumentation.
- Experimental characterization of devices in the laboratory.

STUDY LOAD

Type	Hours	Percentage
Hours small group	13,0	10.40
Hours large group	26,0	20.80
Self study	86,0	68.80

Total learning time: 125 h

CONTENTS

1. Transmission Lines

Description:
TEM waves, lumped element circuit model for a Transmission Line, wave propagation on a transmission line, transmission line parameters, reflection coefficient, lossy transmission lines, power in a transmission line, planar transmission lines (microstrop, stripline, etc.).

Full-or-part-time: 19h
Theory classes: 4h
Laboratory classes: 2h
Self study : 13h

2. Smith Chart

Description:
Reflection coefficient representation, combined impedance/admittance smith chart, basic calculations with Smith chart.

Full-or-part-time: 6h
Theory classes: 2h
Self study : 4h

3. Impedance Matching

Description:
Matching for maximum power transfer, matching with lumped elements, single-stub tuning, quarter-wave transformer.

Full-or-part-time: 15h
Theory classes: 2h
Laboratory classes: 2h
Self study : 11h

4. Microwave Network Analysis: Scattering Matrix

Description:
Scattering matrix, reciprocal networks and lossless networks, shift in reference planes, generalized scattering parameters, the Vector Network Analyzer.

Full-or-part-time: 13h
Theory classes: 4h
Self study : 9h

5. Passive devices

Description:
Two-port networks, attenuator design, three-port networks, the Wilkinson power divider/combiner, resistive divider/combiner, four-port networks, directional couplers, hybrids, coupled line directional couplers, couplers characterization: coupling-isolation-directivity, reflectometer design and calibration.

Full-or-part-time: 26h
Theory classes: 8h
Laboratory classes: 2h
Self study : 16h

6. Microwave Amplifiers

Description:
Characteristics of Microwave Transistors, gain and stability, single-stage transistor amplifier design, maximum gain with conjugate matching, constant gain circles (unilateral approximation), noise in amplifiers.

Full-or-part-time: 21h
Theory classes: 4h
Laboratory classes: 2h
Self study : 15h

7. Microwave Oscillators

Description:
Oscillator design, one-port negative resistance oscillators, transistor oscillator.

Full-or-part-time: 6h
Theory classes: 2h
Self study : 4h

8. Microwave Instrumentation

Description:
Vector Network Analyser (VNA), Spectrum Analyser (SA), Noise Figure Analyser (NFA).

Full-or-part-time: 19h
Theory classes: 1h
Laboratory classes: 4h
Self study : 14h

ACTIVITIES

LABORATORY

Description:
- CAD design and simulation of microwave circuits
- Characterisation of microwave circuits with VNA, SA and NFA.

EXERCISES

Description:
- Exercises to strengthen the theoretical knowledge.

SHORT ANSWER TEST (TEST)

Description:
- Partial evaluation test with theoretical questions and short exercises.

EXTENDED ANSWER TEST (FINAL EXAMINATION)

Description:
Final examination.

GRADING SYSTEM

Final examination: 60%
Partial examinations and controls: 20%
Individual assessments: 10%
Laboratory assessments: 10%

BIBLIOGRAPHY

Basic:
- Elliott, R.S. An introduction to guided waves and microwave circuits. Englewood Cliffs, NJ: Prentice Hall, 1993. ISBN 0130136166.
- Pozar, D.M. Microwave engineering. 4th ed. Hoboken: Wiley, 2012. ISBN 9780470631553.

Complementary:
- Weber, R.J. Introduction to microwave circuits: radio frequency and design applications. New York: IEEE, 2000. ISBN 0-7803-4704-8.
- Bahl, I.; Bhartia, P. (eds.). Microwave solid state circuit design. 2nd ed. New York: Wiley-Interscience, 2003. ISBN 0471207551.
- Soares, R. (ed.). GaAs MESFET circuit design. Boston: Artech House, 1988. ISBN 0890062676.