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230814 - CAF - High Frequency Circuits

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications
Academic year: 2019
Degree: BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Teaching unit Optional)
ECTS credits: 6 Teaching languages: English

Teaching staff

Coordinator: JORDI J. MALLORQUI

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

Total learning time: 150h	Hours large group:	39h	26.00%
	Hours small group:	13h	8.67%
	Self study:	98h	65.33%

Content

1. Transmission Lines	Learning time: 19h Theory classes: 4h Laboratory classes: 2h Self study : 13h

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.).

2. Smith Chart	Learning time: 6h Theory classes: 2h Self study : 4h

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

3. Impedance Matching	Learning time: 15h Theory classes: 2h Laboratory classes: 2h Self study : 11h

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

4. Microwave Network Analysis: Scattering Matrix	Learning time: 13h Theory classes: 4h Self study : 9h

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

5. Passive devices	Learning time: 26h Theory classes: 8h Laboratory classes: 2h Self study : 16h

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.

6. Microwave Amplifiers	Learning time: 21h Theory classes: 4h Laboratory classes: 2h Self study : 15h

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.

7. Microwave Oscillators	Learning time: 6h Theory classes: 2h Self study : 4h

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

8. Microwave Instrumentation	Learning time: 19h Theory classes: 1h Laboratory classes: 4h Self study : 14h

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

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Planning of 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.

Qualification 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.