Course guide
230008 - CL - Linear Circuits

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

Degree: BACHELOR'S DEGREE IN ELECTRONIC SYSTEMS ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2015 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: MARGARITA SANZ POSTILS

Others: JORGE GARCIA MATEOS
ORESTES MAS CASALS
JOSÉ MARIA MIGUEL LÓPEZ
FRANCESC XAVIER MONCUNILL GENIZ
OLGA MUÑOZ MEDINA
MARGARITA SANZ POSTILS

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:
1. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
2. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.

TEACHING METHODOLOGY

Lectures
Laboratory sessions
Group work (distance learning)
Individual work (distance learning)
Long answer exams (Control)
Long answer exam (Final Exam)
Laboratory Practice

LEARNING OBJECTIVES OF THE SUBJECT

The main goal of the course is the study of linear circuits as analog processors of electrical signals. With this aim, systematic methods of time- and frequency-domain analysis are developed, that are applied with special emphasis to the analysis and design of selective circuits in frequency of common use in electronic and communications systems.

To achieve this goal, concepts of major importance in all engineering related with information and communications technology are presented, such as the Network Function, frequency response of circuits or the signal description from a frequency point of view.

At course's end, students will:

* Understand and dominate the basic concepts of linear systems and related functions and transforms, theory of electrical circuits and electronic circuits.

* Perform the tasks on schedule, according to the guidelines set by the teacher or tutor.

* Identifiy the progress and the degree of accomplishment of learning objectives.

* Correctly raise the problem from the proposed statement and identify options for resolution. Apply suitable resolution method and identify the correction solution.

* Know and use correct tools, software tools and applications available at core subjects laboratories and carry out correctly analyze the data collected.

* Apply basic physical principles described in BB-F2 competence to solving engineering problems.

* Know the following basic concepts:
- Definition of circuit model and circuit element
- Laplace transformed circuit
- Network Function
- Stability
- Sinusoidal steady state
- Frequency response, filtering

* Be able to implement the following skills:
- Effectively analyze linear circuits both in transient and steady state
- Characterize the behavior of a circuit in the time and frequency domains from its network function, and be able to relate the answers in the two domains
- Make basic designs of passive and active circuits
- Build experimental prototypes from circuital schematics, do significant measurements using laboratory equipment and interpret the results

STUDY LOAD

Type	Hours	Percentage
Self study	85,0	56.67
Hours large group	52,0	34.67
Hours small group	13,0	8.67

Total learning time: 150 h

CONTENTS

Topic 1. Basic concepts of linear circuits. The operational amplifier

Description:
Linear Circuit: definition and properties. Elements of passive linear circuit and active. The operational amplifier: ideal model, operation zones, virtual short circuit formation. Analysis and design of basic circuits with operational amplifiersl. Systematic analysis of circuits with OA.

Related activities:
Laboratory:
- Application of the operational amplifier to the signal amplification.

Full-or-part-time: 16h
Theory classes: 6h
Laboratory classes: 2h
Self study : 8h

Topic 2. Study of the time-domain response of dynamic linear circuits

Description:
Problem overview. Algebrization techniques. Laplace Transformed Circuit. Definition of Impedance and Admittance. Concept of Network Function. Pole-zero diagram. Concept of impulse response. Free- and forced- responses. Stability. Transient and steady-state responses. Study of the time-domain response. First- and second-order circuits. Simulation of the time-domain response. Two-ports.

Related activities:
Laboratory:
- Dynamic circuit simulation using SPICE: principles of operation, usage and applications. Visualization and measures of the time-domain response.

Full-or-part-time: 39h
Theory classes: 14h
Laboratory classes: 2h
Self study : 23h

Topic 3. Circuits in Sinusoidal Steady State (SSS)

Description:
Sinusoidal Steady State response. Concepts of amplification and phase shift. Phasor representation of signals. Phasor Transformed Circuit. Impedance and Admittance in SSS. Resonance. Circuit simulation in SSS. SSS power. Concepts of effective (rms) value, dB and dBm. Maximum power transfer. Impedance conversion and matching.

Related activities:
Laboratory:
- Study of the circuit behaviour in SSS. Amplification and phase shift measures.
- SSS power measures.

Full-or-part-time: 40h
Theory classes: 13h
Laboratory classes: 4h
Self study : 23h

Topic 4. Frequency Response of circuits

Description:
Magnitude and phase curves. Graphical representation techniques: analytical and from the network function pole-zero diagram. Frequency-selective circuits. Resonant circuits. Concept of filter: pass- and stop-bands, cutoff frequency. Lowpass, highpass, bandpass, bandstop and allpass characteristics. Descriptive parameters of filters (bandwidth, quality factor, etc.). Concepts of gain and attenuation. Bode plots: building and interpretation. Obtaining the frequancy response by simulation. Frequency analysis of basic amplifier stages based on transistors and operational amplifiers. Realization of basic active and passive filters.

Related activities:
Laboratory:
- Study of the frequency response of circuits.

Full-or-part-time: 39h
Theory classes: 14h
Laboratory classes: 2h
Self study : 23h

Topic 5. The circuit as a signal processor in the frequency domain.

Description:
Frequency representation of signals. Basic filter design from specifications. Applications in simple electronic and communication systems equipment.

Related activities:
Laboratory:
- Application of filtering to signal processing

Full-or-part-time: 13h
Theory classes: 4h
Laboratory classes: 2h
Self study : 7h

ACTIVITIES

(ENG) Pràctica de laboratori

(ENG) Pràctica de laboratori

(ENG) Pràctica de laboratori

(ENG) Pràctica de laboratori

(ENG) Pràctica de laboratori

(ENG) Pràctica de laboratori

(ENG) Proves de resposta llarga (Control)

(ENG) Proves de resposta llarga (Examen Final)

GRADING SYSTEM

The final mark will be obtained from continuous evaluation (assignments suggested by teacher throughout the course, and laboratory work) and the final exam, according to the following criteria:

- Professor-proposed assignments: 20%

- Laboratory sessions: 20%

- Final exam: 60%

This course will assess the following generic skills:

- Efficient use of information resources (Elementary)

- Self learning (Elementary)

BIBLIOGRAPHY

Basic:
- Thomas, R.E.; Rosa, A.J.; Toussaint, G.J. The analysis and design of linear circuits. 7th ed. Hoboken, NJ [etc.]: John Wiley & Sons, 2012. ISBN 9781118065587.
- Ulaby, F.T.; Maharbiz, M.M. Circuits. 2nd ed. [Allendale, New Jersey]: National Technology and Science Press, 2013. ISBN 9781934891193.