Last update: 05-07-2019

230084 - CSL - Linear Circuits and Systems

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 Compulsory)

ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: ORESTES MAS CASALS

Others: NURIA DUFFO UBEDA
JORGE GARCIA MATEOS
ORESTES MAS CASALS
OLGA MUÑOZ MEDINA

Prior skills

Resolution of algebraic equations, Basic trigonometric relations and operations, Complex number arithmetic, Logarithms, Basic resistive circuit analysis.

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.

Teaching methodology

Lectures
Laboratory sessions
Group work (distance learning)
Individual work (distance learning)
Short answer exams (Quizzes)
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, circuits are studied from both temporal and frequential point of view with special emphasis to the analysis and design of frequency selective circuits which are extensively used in electronic and communications systems.

To achieve this goal, important concepts presented in all engineering related to information technology and communications, such as network function, frequency circuits response or the signal description from a frequency point of view, are gradually introduced.

Quite a lot of importance to the design of simple circuits is also given, using simulation tools, like Spice, Octave, ... to validate them and arrive, in some specific cases, to their experimental verification in the laboratory sessions.

230084 - CSL - Linear Circuits and Systems

Obviously, all this process leans on the use of electronic devices regularly used such as the AO, the BJT...

At course's end, students will:

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

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

* Apply studied basic principles to resolve typical engineering problems.

* Know the following basic concepts:
  - Definition of circuit model and circuit element
  - Laplace transformed circuit
  - Impedance and admittance. Network Function
  - First and second order circuits dynamics. Stability
  - Sinusoidal steady state. Phasor Domain Circuit
  - Amplification and phase shift
  - Resonance
  - Frequency response
  - Gain (dB) . Bode plots
  - Filtering : Cutoff Frequency, pass-band and band rejected. Bandwidth and quality factor
  - Periodic signals spectra. Harmonics
  - RMS. Average power and available generator power. (dBm)
  - Impedance matching.
  - Two-port networks characterization

* 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 circuit designs
  - Validate the results by simulating the circuits
  - Build experimental prototypes from circuital schematics, do significant measurements using laboratory equipment and interpret the results

Last update: 05-07-2019

230084 - CSL - Linear Circuits and Systems

Study load

Total learning time: 150h	Hours large group:	52h	34.67%
	Hours small group:	13h	8.67%
	Self study:	85h	56.67%

Last update: 05-07-2019

230084 - CSL - Linear Circuits and Systems

Content

Topic 1. Linear circuits. Conceptual framework

Learning time: 8h

Theory classes: 6h
Self study : 2h

Description:
Concept of signal. Type of signals.
Modelling and study of components and electrical systems.
- Scope of application. Circuit definition. Small and large circuits.
- Passive and active circuit elements . Relationship with the modelled physical phenomena
- Linear and nonlinear circuits .
- Concept of signal. Signal types.
- Modelling and study of components and electrical systems.

Topic 2. Introduction to Linear Circuits and Systems dynamics.

Learning time: 20h

Theory classes: 6h
Laboratory classes: 2h
Self study : 12h

Description:
- Time domain analysis of dynamic circuits (Differential equations systems)
- Algebritzation techniques:
  · Discretization. Circuits Simulation.
  · Laplace transform.
- Laplace transformed circuit. Impedance and admittance concepts.

Topic 3. Study of dynamic circuits time-domain response

Learning time: 20h

Theory classes: 6h
Laboratory classes: 2h
Self study : 12h

Description:
- Circuit time-domain response.
- Zero-Input and Zero-State responses.
- Network function. Relationship with impulse response. Circuit order.
- Free and forced responses.
- Pole-zero diagram.
- Stability.
- Transient and steady-state responses.
- Step response of first and second order circuits.

230084 - CSL - Linear Circuits and Systems

Topic 4. Circuits in Sinusoidal Steady State (SSS)

Learning time: 20h

Theory classes: 6h
Laboratory classes: 2h
Self study : 12h

Description:
- Sinusoidal signals description. Response calculation.
- Amplification/attenuation and phase shift concepts.
- Phasors. Phasor diagram.
- Phasor Transformed Circuit. H(jw). Impedance and Admittance in RPS.
- Study of circuits with sources of several frequencies applied simultaneously.
- Reading and interpretation of oscillograms. Phase shift relation with advance/retard.
- Models series/parallel of immitàncies.
- Resonance.

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.

Topic 5. Frequency response of linear circuits and systems

Learning time: 41h

Theory classes: 14h
Laboratory classes: 2h
Self study : 25h

Description:
- Freqüencial description of signals with several frequency sinusoidal components. Spectra.
- Freqüencial description of circuits. Magnitude and phase curves. Decibels.
- Concept of filter: Band, pass- and stop-bands,. Cutoff frequency. Bandwidth. Resonance peak.
- Bode plots. Logarithmic scales: decade and octave concepts. Obtention from pole/zero diagram of H(s).
- Detailed study of first and second order lowpass, highpass, bandpass, bandstop and allpass characteristics. Specific parameters (Q...)
- First and second order passive and active filters design.

Topic 6. Response to non-sinusoidal periodic signals

Learning time: 14h

Theory classes: 4h
Laboratory classes: 2h
Self study : 8h

Description:
- Fourier series for periodic signals. Relevant cases.
- Linear circuits response to periodic signals.
- Simple signal processing examples from the frequency point of view.

Last update: 05-07-2019

230084 - CSL - Linear Circuits and Systems

Tema 7: Power analysis	Learning time: 20h Theory classes: 6h Laboratory classes: 2h Self study : 12h

Description:
- Instantaneous power. Average power.
- Average power in a resistor. Root-mean-saquare value (rms)
- Relationship between dBm and dB.
- AC Power. Maximum poer transfer. Maximum available power of a generator. Impedance matching. Solutions based on LC networks and transformers.

Tema 8: Two-port networks	Learning time: 6h Theory classes: 2h Self study : 4h

Description:
- Two-port network definition. Need of a parametric characterization.
- Z, Y, T and hybrids parameters. Equivalent models.
- Two-port connections: series, parallel and cascade.
- Study of loaded two-port networks.

Observations:	Learning time: 0h Theory classes: 0h

Description:
The proposed topics order is indicative and may be modified according to the needs of their own educational course or other taught in parallel.
The examples used in the development of the different subjects include devices like the Operational Amplifier, transistors MOS and BJT and transformers. Their circuit models as well as the specific features that arise in the analysis are treated just at the time they are needed and have therefore transversal presence in the different issues of CSL.

Last update: 05-07-2019

230084 - CSL - Linear Circuits and Systems

Qualification system

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

- Professor-proposed scoring tasks: 30%. A non-exclusive list of such activities follows:
  - Moodle Quizzes
  - Synthesis assignments
  - In-classroom exams
  - Other

- Laboratory sessions: 20%.
  (Note: In order to pass the course it is mandatory to have carried out all the laboratory works as well as the preliminary studies and the associated reports with a minimum quality)

- Final exam: 50% (Written test which assesses the knowledge of the whole course)

Students with a continuous assessment greater than or equal to 8 (of 10) may choose not to take the final exam. In this case, the overall rating will be approved 5. However, this score may be completed up to 10 , performing some specific activity at teacher's discretion.

This course will assess the following generic skills:

- Self learning (Elementary)

In the event that a student takes the reevaluation test, continuous assessment will not be taken into account, and the criteria to calculate the overall mark in this case will be the following:

- Laboratory sessions: 20% The obtained in the completed last quarter within the academic year laboratory grade will remain. (Note: In order to pass the course it is mandatory to have carried out all the laboratory works as well as the preliminary studies and the associated reports with a minimum quality)

- Final exam: 80% (Written test which assesses the knowledge of the whole course)

Generic skills will not be reappraised.

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.

Complementary:

Davis, A.M. Linear Circuit Analysis. Mason, OH: Cengage Learning, 1998. ISBN 9780534950958.

Others resources:

http://circuits.upc.edu