UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Course guide
820123 - CSEE - Circuits and Signals

Last modified: 14/06/2023

Unit in charge: Barcelona East School of Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.

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

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Juan Antonio García-Alzórriz Pardo

Others: Primer quadrimestre:
JUAN ANTONIO GARCÍA-ALZÓRRIZ PARDO - Grup: T11, Grup: T12, Grup: T13

Segon quadrimestre:
JUAN ANTONIO GARCÍA-ALZÓRRIZ PARDO - Grup: M11, Grup: M12, Grup: M13

PRIOR SKILLS

Themselves of previous semesters

REQUIREMENTS

SISTEMES ELÈCTRICS - Prerequisit

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEELE-21. Carry out calculations for the design of low and medium voltage electrical installations.

Transversal:
2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

TEACHING METHODOLOGY

The course is divided in lectures (30%), individual work (30%), work in small groups (cooperative, collaborative or other) (20%), and project-based learning (20%).
The self-learning process is developed by using the Athena Digital Campus, which includes resources, self-assessment questionnaires, and specifications for a workgroup that has to be developed throughout the semester.

LEARNING OBJECTIVES OF THE SUBJECT

General objectives:
· To acquire the basic knowledge of electricity and circuit theory applied to the study of electrical circuits and systems.
· To acquire the basic knowledge to understand the principles and techniques of circuit analysis and to be able to apply them, identifying the most appropriate technique to the study of electrical circuits.
· To acquire the basic knowledge to understand and analyze the temporal and frequency behavior of electrical circuits.
· To acquire the basic knowledge and to learn software tools for analysis and circuit design.
· To acquire and to develop skills in experimental techniques for measuring electrical circuits.
· To acquire the ability to learn autonomously new knowledge and techniques to engine and to design circuits.

Transversal competences:
· To acquire the ability to learn autonomously new knowledge and techniques to engine and to design circuits.
· Capacity of analysis and synthesis.
· To acquire computer skills through the use of computer software for analysis and simulation of electrical circuits.
· Capacity for independent learning.
· To gain commitment and organizational skills to work with the group.
· To gain oral and written communication.

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	30.00
Hours small group	15,0	10.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Item 1. Dynamic circuits. Transient analysis of electrical circuits.

Description:
1.1. Capacitors. Properties. Model of ideal capacitor. Voltage-current relationships. Stored energy. Combination of capacitors.
1.2. Inductors. Properties. Model of ideal inductor. Voltage-current relationships. Stored energy. Combination of inductors.
1.3. Linearity and duality.
1.4. Response of a circuit in the time domain. Steady and transient.
1.5. Time response of first order circuits: RC and RL. Characteristic equation. Properties of the exponential function. Time constant. Power and energy. Natural and forced response. Initial conditions. Determination of the complete response.
1.6. Singular functions. Response to a unit step and unit impulse.
1.7. Second order circuits. Characteristic equation. Natural response. Angular frequency and damping. Overdamped, critically damped and underdamped response. Initial conditions. Complete response of second order circuits.

Specific objectives:
· To learn the properties of a capacitor and what is the model of an ideal capacitor: voltage-current relationships, energy stored, combination of capacitors.
· To learn the properties of an inductor and what is the ideal model of an inductor. voltage-current relationships, energy stored, combination of inductor.
· To learn the consequences of linearity the linear in capacitors and inductors.
· To learn the duality between capacitors and inductors.
· What are a permanent and a transient response? What is the reason for a transient response?
· To understand, interpret and learn how to determine the response of RC circuit without sources.
· To know the properties of the exponential function and how to determine the time constant.
· What is the initial condition and how is it calculated? When the voltage of the capacitor may be discontinuous?
· How is the power and energy to the RC components?
· To understand, interpret and learn how to determine the response of RC circuits with sources.
· What is the natural response, forced and complete? Of which depends and how do we calculate it?
· What are the singular functions and how is the response of RC circuits to a unit-step and unit-impulse function.
· To understand, interpret and learn to determine the response of RL circuits with and without sources.
· What is the initial condition and how is it calculated? When the current of the inductor may be discontinuous?
· How the power and energy are in RL components.
· What is the full response of a RL circuit?
· To understand, interpret and know the time response of second order circuits.
· What is the characteristic equation of a second order circuit?
· How is the natural response?
· What is the angular frequency and damping, of which it depends and how it is determined.
· To understand, interpret and learn the overdamped, critically damped and underdamped response.
· How to determine the initial conditions and the complete response of second order circuits.

Related activities:
· Collection of problems
· Laboratory Practice: Transient response in RC and RL circuits
· Laboratory Practice: Transient response in RLC circuits

Full-or-part-time: 35h
Theory classes: 10h
Laboratory classes: 4h
Self study : 21h

Item 2. Magnetically coupled circuits.

Description:
2.1. Magnetic coupling. Self-induction and mutual induction. Self and mutual inductance. Coupling coefficient. Polarity. Convention points. Equivalent circuit in "T".
2.2. Energy considerations.
2.3. Response in transient state. Response to sinusoidal permanent regime.
2.4. Linear transformer. Reflected impedance.
2.5. Ideal transformer. Reflected impedance. Value of change of voltage and current.
2.6. Measurement of mutual inductances own and magnetically coupled circuits.

Specific objectives:
· What is the magnetic coupling?
· What is the self-induction and mutual induction?
· How is the polarity between coupled coils?
· To understand and apply the dot convention.
· What is it and how to determine the coefficient of magnetic coupling?
· What are the energy considerations in circuits with magnetic coupling?
· What are the circuit with mutual inductions equations in transient response.
What are the circuit with mutual inductions equations in sinusoidal steady-state.
· What is it and how to determine the impedance reflected.
· To understand how the transformer is ideal
· What are the relationships between voltages and currents in which the ideal transformer and of which they depend on.
· To know how to measure the mutual inductances and coupling coefficients in magnetically coupled circuits.

Related activities:
· Collection of problems
· Laboratory Practice: Magnetically coupled circuits

Full-or-part-time: 22h 30m
Theory classes: 7h
Laboratory classes: 2h
Self study : 13h 30m

Item 3. title english

Description:
3.1. Introduction.
3.2. Forms of Fourier series: trigonometric and complex. One and two sides spectrum .
3.3. Symmetry properties of functions.
3.4. Complete response to periodic forcing functions.
3.5. Transition of the Fourier series to Fourier transform. Discrete and continuous Spectrum. Fourier Transform, Fast Fourier Transform.

Related activities:
· Collection of problems
· Laboratory Practice

Full-or-part-time: 15h
Theory classes: 4h
Laboratory classes: 2h
Self study : 9h

Item 4. Complex Frequency. Laplace transform and its application in circuit analysis.

Description:
4.1. Complex frequency. The exponentially damped sinusoidal function.
4.2. Laplace transform.
4.3. Properties of the Laplace transform. Differentiation, integration, convolution, shift-time and periodic functions. Translation, differentiation, integration and scaling in the frequency domain.
4.4. Application of the Laplace transform in circuit analysis.
4.5. Inverse transform. Heaviside expansion theorem.
4.6. The initial-value and final-value theorems.
4.7. Convolution and transfer function H(s).

Specific objectives:
· What is a complex frequency?
· To know the exponentially damped sinusoidal and its relationship with the complex frequency.
· What are the Laplace transform and its application to the analysis of circuits?
· To know the properties of the Laplace transform and to apply them to the analysis of electrical circuits.
· To know how to determine the transform of the excitation signals.
· How to transform the simple elements of a circuit in operational domain.
· What are the operational impedance and admittance and how to determine them.
· To understand and to apply the Laplace transform in circuit analyses.
· To know how to determine the complete response in circuits with and without initial conditions.
· To know how to determine the inverse Laplace transform.
· To understand and to apply the initial- value and final-value theorems.
· To know the integral of the impulse response and convolution.
· To know how to determine the transfer function H(s).
· To know how to determine the response of a circuit from the transfer function H(s).

Related activities:
· Collection of problems
· Laboratory Practice: Analysis and simulation of electric circuits by computer

Full-or-part-time: 35h
Theory classes: 12h
Laboratory classes: 2h
Self study : 21h

Item 5. Resonance. Frequency response. Filters.

Description:
5.1. Resonance: Resonance in the parallel circuit theory. Universal resonance curve.
5.2. Quality factor and bandwidth. Series resonance. Other forms resonant. Scales of magnitude and phase. Scaling.
5.3. Magnitude and phase. Poles and zeros. Amplitude and phase diagrams. Bode diagrams.
5.4. Filters. Classification and frequency response.

Specific objectives:
· What is resonance?
· How is the resonance in the parallel circuit theory?
· What are the quality factor and bandwidth and what is their influence on the frequency response of a circuit.
· To know other resonant circuits.
· To know how to determine the influence of frequency on the magnitude and phase.
· To know how to interpret and represent the Bode diagrams.
· To know how to classify filters and their frequency response.

Related activities:
· Collection of problems
· Laboratory Practice: Resonant circuits
· Laboratory Practice: Filters and frequency response

Full-or-part-time: 32h 30m
Theory classes: 9h
Laboratory classes: 4h
Self study : 19h 30m

Item 6. Two-port and multiport networks.

Description:
6.1. Dipole and multi-pole. A network one-port and two-ports.
6.2. Two-ports parameters. Some equivalent networks. Equivalence between parameters. Two-ports combinations.
6.3. Multi-pole circuits: Resistors multi-terminals, the transistor, controlled sources, the transformer and the operational amplifier.

Specific objectives:
· What is a one-port network and multi-port networks and, especially, two-port networks.
· How we can model the behavior of two-port networks. What are the different types of parameters.
· To know how to determine different parameters: admittance, impedance, hybrid and direct transmission and reverse two-port networks.
· To know how to determine the equivalent circuits for different parameters.
· To understand and to apply the transformation and equivalence between parameters.
· To know such combinations between two-port networks and the relationships between different parameters in the two-port networks combinations.
· To provide examples of multi-terminal components: resistors multi-terminals, transistor, controlled sources, transformer, operational amplifier, and what are their equivalent circuits.

Related activities:
· Collection of problems
· Laboratory Practice: Analysis and simulation of electric circuits by computer

Full-or-part-time: 10h
Theory classes: 3h
Laboratory classes: 1h
Self study : 6h

GRADING SYSTEM

The evaluation system consists of a continuous assessment by means of several tests, that detail to continuation, in order to approach it to a system of evaluation continued.

· Two written exams (controls)
· Practices will be qualified based on the attendance and the activities performed in the laboratory together with the preparation and delivery of practice reports.
· Guided activities

The final mark for the course, it is the obtained with the following tests and weights:

· First written exam: 40%
· Second written exam: 40%
· Practical: 20%.

-The course have a re-assessment test.
The students will be able to access the re-assessment test that meets the requirements set by the EEBE in its Assessment and Permanence Regulations
(https://eebe.upc.edu/ca/estudis/normatives-academiques/documents/eebe-normativa-avaluacio-i-permanencia-18-19-aprovat-je-2018-06-13.pdf)

EXAMINATION RULES.

There are no specific rules. Every study guide for each activity provides the actual dynamics.

BIBLIOGRAPHY

Basic:
- Hayt, William H.; Kemmerly, Jack E.; Durbin, Steven M. Análisis de circuitos en ingeniería. 7ª ed. México D.F. [etc.]: McGraw Hill, cop. 2007. ISBN 9789701061077.
- Irwin, J. David. Análisis básico de circuitos en ingeniería. 6ª ed. México [etc.]: Limusa Wiley, cop. 2003. ISBN 9681862953.
- Alexander, Charles K.; Sadiku, Matthew N. O.; Vera Bermúdez, Aristeo. Fundamentos de circuitos eléctricos [on line]. 6a ed. México [etc.]: McGraw-Hill, 2013 [Consultation: 17/03/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8073. ISBN 9781456260897.

Complementary:
- Dorf, Richard C.; Svoboda, James A. Circuitos eléctricos : introducción al análisis y diseño. 3ª ed. Barcelona: Marcombo, cop. 2000. ISBN 8426712711.
- The Electric circuits problem solver: a complete solution guide to any textbook. Piscataway, New Jersey: REA. Research and Education Association, cop. 1980. ISBN 0878915435.

RESOURCES

Hyperlink:
- Apunts de l'assignatura

Other resources:
Notes from the course