Course guide
820225 - TCME - Circuit Theory and Electrical Machines

Last modified: 02/10/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: ALFONSO CONESA ROCA

Others: Primer quadrimestre:
ALFONSO CONESA ROCA - Grup: T21, Grup: T22, Grup: T23, Grup: T24, Grup: T25

PRIOR SKILLS

The previous abilities are those typical of the compulsory subjects of the previous semesters

REQUIREMENTS

SISTEMES ELÈCTRICS - Prerequisit

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEEIA-19. Understand the applications of electrical technology.
CEEIA-20. Understand the fundamentals and applications of analogue electronics.

Transversal:
05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

TEACHING METHODOLOGY

The methodologies used for the development of the subject are as follows:
- Lecture with multimedia support, in order to provide information to the student so synthesized and organized.
- Class participatory exhibition, in which and in order that the student is not merely a passive element in the learning process, the teacher performs direct questions or debates on points considered particularly relevant or conceptual difficulty proposed.
- Problem-based learning, either individually or in a group in which the teacher proposes the resolution of exercises.
- In the experimental laboratory sessions the methodology adopted is that of small cooperative groups in which students acquire skills in simulation techniques and testing of circuits.

LEARNING OBJECTIVES OF THE SUBJECT

Acquire knowledge of the principles and techniques of circuit analysis, and be able to apply to the study of electrical and electronic circuits.
To acquire the knowledge to analyze time and frequency behavior of electronic circuits with different signals.
Perform an introduction to basic electronic devices (diodes, transistor, operational amplifier), to common electronic circuits (amplifiers, filters, ...) and their associated models.
Acquire basic knowledge of electrical machines and their application in electrical systems.
Acquiring skills in experimental assay techniques circuits and electrical systems.
Acquire knowledge in software tools of analysis and study of circuits.

As well:
Acquiring the ability to learn autonomously new concepts and techniques in the study and synthesis of circuits.
Acquiring the ability and commitment to organize group tasks.

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

Unit 01: Circuit analysis techniques.

Description:
Basics concepts: voltage, current, resistance, conductance, Ohm's law, power and energy.
Basics elements on electrical circuits: voltage sources, current, resistors.
Basic analysis techniques: Laws of Kirchhoff, equivalent circuits, voltage divider and current analysis of branches, loops and knots. Examples of application in electrical engineering.
Theorems and conversion circuits: linearity, superposition theorem, source transformation, Thevenin's theorem, Norton theorem. Examples of applications in electrical engineering.
Interconnection between loads and generators: loading effects theorem and maximum power transfer.
controlled sources (VCVS, CCVS, VCCS and CCCS) and analysis.
Controlled source applications in modeling operational amplifiers and transistors: practical examples.
Important parameters of amplifier stages based on op.amp. and transistors: input impedance, output impedance, gain, bandwidth, etc.
Waveform generators.

Full-or-part-time: 17h
Theory classes: 6h
Laboratory classes: 2h
Self study : 9h

Unit 02: First and second order circuits.

Description:
RC and RL circuits.
First-order circuits step response.
Initial and final conditions.
First-order circuit response to exponential and sinusoidal inputs.
The series and parallel RLC circuit.
Second order circuit step response.

Full-or-part-time: 19h
Theory classes: 6h
Laboratory classes: 4h
Self study : 9h

Unit 03: Sinusoidal steady-state response. Phasors.

Description:
Senoidal excitation function. Phasor concept.
Circuit theorems and analysis with phasors.
Energy and power analysis.

Related activities:
Problems collection
Analysis and simulation of electric circuits by computer.

Full-or-part-time: 7h 30m
Theory classes: 3h
Self study : 4h 30m

Unit 04: Laplace transforms.

Description:
Concepts and physical meaning.
Signal waveforms and transforms.
Basic properties.
Pole-zero diagrams.
Inverse Laplace transforms.
Circuits response using Laplace transforms.
's' domain circuit analysis.
Network functions and basic waveforms response.
Impulse response and convolution.

Specific objectives:

Related activities:
Problems collection
Analysis and simulation of electric circuits by computer.

Full-or-part-time: 11h 15m
Theory classes: 4h 30m
Self study : 6h 45m

Unit 05: Frequency response.

Description:
Bode Diagrams.
First-order low-pass and high-pass responses.
Bandpass and bandstop responses.
Others frequency responses in RLC circuits.
Bode diagrams from poles and zeros.
Frequency response and step response.
Overview of Fourier analysis.
Fourier coefficients.
Waveform symmetries.
Circuit analysis using the Fourier series.
Fourier Transforms.
Circuit analysis using Fourier transforms.

Specific objectives:

Full-or-part-time: 17h
Theory classes: 6h
Laboratory classes: 2h
Self study : 9h

Unit 06: AC power systems.

Description:
Study of powers: average power, reactive power and complex power.
Single-phase power circuits analysis in sinusoidal steady-state.
Three-phase power circuits analysis in sinusoidal steady-state

Full-or-part-time: 7h 30m
Theory classes: 3h
Self study : 4h 30m

Unit 07: Basic principles of electrical machines.

Description:
Revision of the electro-magnetic principles of electrical machines
Transformers and magnetically coupled circuits: mutual inductance
Transformers: characteristics, mathematical analysis and applications

Related activities:

Full-or-part-time: 10h
Theory classes: 4h
Self study : 6h

Unit 08: Rotating electrical machines.

Description:
DC machine: fundamentals, characteristics, mathematical analysis and applications.
Different excitation systems on DC machine.
Three-phase AC asynchronous machine: fundamentals, characteristics, mathematical analysis and applications.
Machine model, power balance and torque-speed characteristic.
Special machines in Electronics and Automation Engineering: single-phase induction motor, stepper motors, PMSM, servomotors, etc.
Introduction to control: linear control, PWM control pulse control, etc.

Full-or-part-time: 31h 30m
Theory classes: 11h
Laboratory classes: 4h
Self study : 16h 30m

GRADING SYSTEM

The evaluation system consists on the following ratings with the partial weights:
- Partial Exam 1 (EP1): 20 %
- Partial Exam 2 (EP2): 20 %
- Final Exam (EF): 40 %
- Laboratory (Lab): 20 %

Partial Exams 1 and 2 are tests carried out during the course.
The Final Exam is carried out after classes have ended and its date is established by academic order.
The course grade (Nota_Curs) is the one obtained with the previous weights:
Nota_Curs = EP1 *0.2 +EP2 *0.2 +EFinal *0.4 +Lab *0.2

This subject does not have a Reassessment Exam.

EXAMINATION RULES.

The performance of the different tests consists of:
- The partial and final exams are individual written tests based on the theory and problems worked on in the subject.
- Laboratory activities are mandatory for student attendance. Although they are worked in groups, they will be evaluated individually, considering the cooperative work modality, the degree of involvement, the pace of progress and the degree of completion of the work done.

BIBLIOGRAPHY

Basic:
- Thomas, Roland E; Rosa, Albert J; Toussaint, Gregory J. The Analysis and design of linear circuits. 7th ed. Hoboken, NJ [etc.]: John Wiley & Sons, cop. 2012. ISBN 9781118065587.
- Thomas, Roland E; Rosa, Albert J. Circuitos y señales : introducción a los circuitos lineales y de acoplamiento. Barcelona [etc.]: Reverté, DL 1991. ISBN 8429134581.
- Ulaby, Fawwaz T; Maharbiz, Michel M. Circuits. [Allendale, New Jersey]: National Technology and Science Press, cop. 2009. ISBN 9781934891193.
- Fraile Mora, Jesús. Máquinas eléctricas [on line]. 5a ed. Madrid [etc.]: McGraw-Hill, cop. 2012 [Consultation: 29/04/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=4297. ISBN 9781456218454.
- Hayt, William H.; Kemmerly, Jack E.; Durbin, Steven M. Análisis de circuitos en ingeniería [on line]. 7ª ed. México D.F. [etc.]: McGraw Hill, cop. 2007 [Consultation: 04/03/2021]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=5122. ISBN 9789701061077.
- Dorf, Richard C.; Svoboda, James A. Circuitos eléctricos : introducción al análisis y diseño. 3ª ed. México: Alfaomega, cop. 2000. ISBN 9701505174.
- Fraile Mora, Jesús; Fraile Ardanuy, Jesús. Problemas de máquinas eléctricas. Madrid [etc.]: McGraw-Hill, cop. 2005. ISBN 8448142403.
- Moreno, Narciso; Bachiller, Alfonso; Bravo, Juan Carlos. Problemas resueltos de tecnología eléctrica. Madrid: International Thomson, cop. 2003. ISBN 8497321944.

Complementary:
- Nahvi, Mahmood; Edminister, Joseph A. Circuitos eléctricos y electrónicos. 4ª ed. Madrid [etc.]: McGraw-Hill, cop. 2005. ISBN 8448145437.
- Gómez Expósito, Antonio; Olivera Ortiz de Urbina, José Antonio. Problemas resueltos de teoría de circuitos. 2ª ed. Madrid: Editorial Paraninfo, 1994. ISBN 8428317860.
- Nasar, Syed A. 3000 solved problems in electric circuits. New York: McGraw-Hill, cop. 1988. ISBN 9780070459366.
- Chapman, Stephen J. Máquinas eléctricas. 4ª ed. México [etc.]: McGraw-Hill, cop. 2005. ISBN 9701049470.
- Alabern, X.; Humet Coderch, Lluís; Iglesias i Méndez, Serafín. Problemes de circuits elèctrics resolts i comentats. Vic: Eumo, DL 1992. ISBN 8476025629.
- Irwin, J. David. Análisis básico de circuitos en ingeniería. 6ª ed. México [etc.]: Limusa Wiley, cop. 2003. ISBN 9681862953.

RESOURCES

Hyperlink:
- Apunts. Course notes