Course guides
820225 - TCME - Circuit Theory and Electrical Machines

Last modified: 03/03/2020

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

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

Academic year: 2019 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: ALFONSO CONESA ROCA

Others: Primer quadrimestre:
ALFONSO CONESA ROCA - T11, T12, T13, T14

Segon quadrimestre:
ALFONSO CONESA ROCA - M21, M22, M23, M24, M25, M26

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

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 electrical machines.
Transformers and magnetically coupled circuits: mutual inductance.
Transformers: characteristics, mathematical analysis and applications.
DC machine: fundamentals, characteristics, mathematical analysis and applications.
Different excitation systems on machine DC.

Related activities:

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

Unit 08: AC electrical machines and others machines.

Description:
Rotating magnetic fields.
AC asynchronous machine: fundamentals, characteristics, mathematical analysis and applications.
Torque-speed characteristic, power and performance.
Connection of three-phase motors.
Operation of the single-phase motor.
Special machines in Electronics and Automation Engineering: stepper motors, PMSM, servomotors, etc.
Introduction to control: linear control, PWM control pulse control, etc.

Full-or-part-time: 24h 30m
Theory classes: 9h
Laboratory classes: 2h
Self study : 13h 30m

GRADING SYSTEM

The evaluation system consists on the following ratings with the partial weights:
- A Partial Test: 40%.
- A Final test: 40%.
- Laboratory: 15%.
- Competences: 5%

The partial test is a written test conducted in mid-course schedule.
The final test is performed when the clases are finished. The date is setup by academic organization.
The course grade (Nota_Curs) is obtained with the above weights:
Nota_Curs = Prova_Parcial*0.40 + Prova_Final*0.40 + Lab*0.15 + Comp*0.05

A Reassessment Test, as written test of all course content, is contemplated for students whose course grade is suspended (Nota_Curs
The final grade (Nota_Curs) will be:
Nota_Curs = Prova_Reeval*0.80 + Lab*0.15 + Comp*0.05

BIBLIOGRAPHY

Basic:
- Ulaby, Fawwaz T; Maharbiz, Michel M. Circuits. [Allendale, New Jersey]: National Technology and Science Press, cop. 2009. ISBN 9781934891193.
- 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.
- Fraile Mora, Jesús; Fraile Ardanuy, Jesús. Problemas de máquinas eléctricas. Madrid [etc.]: McGraw-Hill, cop. 2005. ISBN 8448142403.
- 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. 7ª ed. México D.F. [etc.]: McGraw Hill, cop. 2007. ISBN 9789701061077.
- Dorf, Richard C.; Svoboda, James A. Circuitos eléctricos : introducción al análisis y diseño. 3ª ed. México: Alfaomega, cop. 2000. ISBN 9701505174.
- 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.
- Irwin, J. David. Análisis básico de circuitos en ingeniería. 6ª ed. México [etc.]: Limusa Wiley, cop. 2003. ISBN 9681862953.
- 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.

RESOURCES

Hyperlink:
- Apunts. Course notes