820225 - TCME - Circuit Theory and Electrical Machines

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2017
Degree: BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish

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 solving exercises outside the classroom so that the student can assess the degree of understanding of the subject.
- 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.

<table>
<thead>
<tr>
<th>Study load</th>
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<tbody>
<tr>
<td><strong>Total learning time:</strong> 150h</td>
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<tr>
<td>Hours large group:</td>
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<td>Hours medium group:</td>
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<tr>
<td>Hours small group:</td>
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<tr>
<td>Guided activities:</td>
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<tr>
<td>Self study:</td>
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# Content

<table>
<thead>
<tr>
<th>Unit 01: Circuit analysis techniques.</th>
<th>Learning time: 17h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td><img src="image" alt="Image" /></td>
</tr>
<tr>
<td>Basics concepts: voltage, current, resistance, conductance, Ohm's law, power and energy.</td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Basics elements on electrical circuits: voltage sources, current, resistors.</td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Basic analysis techniques: Laws of Kirchhoff, equivalent circuits, voltage divider and current analysis of branches, loops and knots. Examples of application in electrical engineering.</td>
<td>Self study : 9h</td>
</tr>
<tr>
<td>Interconnection between loads and generators: loading effects theorem and maximum power transfer.</td>
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<tr>
<td>Controlled sources (VCVS, CCVS, VCCS and CCCS) and analysis.</td>
<td></td>
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<tr>
<td>Controlled source applications in modeling operational amplifiers and transistors: practical examples.</td>
<td></td>
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<tr>
<td>Important parameters of amplifier stages based on op.amp. and transistors: input impedance, output impedance, gain, bandwidth, etc.</td>
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<tr>
<td>Waveform generators.</td>
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<tr>
<th>Unit 02: First and second order circuits.</th>
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<td><strong>Learning time: 19h</strong></td>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>This section covers:</td>
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<tr>
<td>RC and RL circuits.</td>
<td>This section covers:</td>
</tr>
<tr>
<td>First-order circuits step response.</td>
<td>The series and parallel RLC circuit.</td>
</tr>
<tr>
<td>Initial and final conditions.</td>
<td>Second order circuit step response.</td>
</tr>
<tr>
<td>First-order circuit response to exponential and sinusoidal inputs.</td>
<td><img src="image" alt="Image" /></td>
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</tbody>
</table>

**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.
### Unit 03: Sinusoidal steady-state response. Phasors.

**Description:**
- Sinusoidal 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.

**Learning time:**
- Theory classes: 3h
- Laboratory classes: 0h
- 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.

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

**Specific objectives:**
<table>
<thead>
<tr>
<th>Unit 05: Frequency response.</th>
<th>Learning time: 17h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> Bode Diagrams.</td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>First-order low-pass and high-pass responses.</td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Bandpass and bandstop responses.</td>
<td>Self study: 9h</td>
</tr>
<tr>
<td>Others frequency responses in RLC circuits.</td>
<td></td>
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<tr>
<td>Bode diagrams from poles and zeros.</td>
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<tr>
<td>Frequency response and step response.</td>
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<tr>
<td>Overview of Fourier analysis.</td>
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<tr>
<td>Fourier coefficients.</td>
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<tr>
<td>Waveform symmetries.</td>
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<tr>
<td>Circuit analysis using the Fourier series.</td>
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<tr>
<td>Fourier Transforms.</td>
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<tr>
<td>Circuit analysis using Fourier transforms.</td>
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**Specific objectives:**

<table>
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<tr>
<th>Unit 06: AC power systems.</th>
<th>Learning time: 7h 30m</th>
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<tbody>
<tr>
<td><strong>Description:</strong> Study of powers: average power, reactive power and complex power.</td>
<td>Theory classes: 3h</td>
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<tr>
<td>Single-phase power circuits analysis in sinusoidal steady-state.</td>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td>Three-phase power circuits analysis in sinusoidal steady-state.</td>
<td>Self study: 4h 30m</td>
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</tbody>
</table>
# Unit 07: Basic principles of electrical machines

**Learning time:** 17h  
Theory classes: 6h  
Laboratory classes: 2h  
Self study: 9h

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

**Related activities:**

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# Unit 08: AC electrical machines and others machines

**Learning time:** 24h 30m  
Theory classes: 9h  
Laboratory classes: 2h  
Self study: 13h 30m

**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.
Qualification system

The evaluation system consists on the following ratings with the partial weights:

- A Partial Test: 35%.
- A Final test: 35%.
- Laboratory: 10%.
- Monitoring exercises: 10%
- Competences: 10%

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:

\[
Nota_Curs = \text{Prova_Parcial} \times 0.35 + \text{Prova_Final} \times 0.35 + \text{Lab} \times 0.1 + \text{Ex} \times 0.1 + \text{Comp} \times 0.1
\]

A Reassessment Test, as written test of all course content, is contemplated for students whose course grade is suspended (Nota_Curs < 5.0). The date of the test is also established by academic organization.

The final grade (Nota_Curs) will be:

\[
Nota_Curs = \text{Prova_Reeval} \times 0.7 + \text{Lab} \times 0.1 + \text{Ex} \times 0.1 + \text{Comp} \times 0.1
\]
Bibliography

Basic:


Complementary:


Others resources:

Hyperlink

Apunts

Course notes