240251 - Electrotechnics and Electrical Machines

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan

Teaching staff
Coordinator: Boix Aragonès, Oriol
Others: Boix Aragonès, Oriol
          Sudrià Andreu, Antoni

Opening hours
Timetable: To be decided with the students

Degree competences to which the subject contributes
Specific:
1. Knowledge and use of electric machines and circuit theory principles.

Teaching methodology
Exhibition in the Classes that combine theory and problems. The participatory development of the problems will be made in the form. There will also be laboratory practicals.

Learning objectives of the subject
At the end of the course, the student should be able to:
* Solve various types of electrical circuits in steady state; both DC and AC single and three phase symmetric.
* Know the different types of electrical machines and their basic characteristics and know how to select the most appropriate for an application.
* Apply criteria in the selection and sizing of the components of an electrical installation (cables, protections, etc..).
* Learn the basics of automation of industrial processes and know-how simple programs for programmable logic controllers.
## Study load

<table>
<thead>
<tr>
<th></th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total learning time:</td>
<td>150h</td>
<td>0h</td>
<td>50h</td>
<td>10h</td>
<td>90h</td>
</tr>
</tbody>
</table>

- Hours large group: 0h (0.00%)
- Hours medium group: 50h (33.33%)
- Hours small group: 10h (6.67%)
- Guided activities: 0h (0.00%)
- Self study: 90h (60.00%)
# 240251 - Electrotechnics and Electrical Machines

## Content

| **DC Circuits** | **Learning time:** 17h  
Theory classes: 4h 30m  
Self study : 12h 30m |
|-----------------|--------------------------------------------------|
| **Description:**  
Electric current and potential difference  
Resistance of a conductor. Ohm's Law  
Conventions signs in accordance with IEC  
Kirchhoff’s Laws  
Resistance association  
Charging and discharging of capacitors and inductors  
Power and energy  
Measuring devices  

**Related activities:**  
Problem solving and videos  

**Specific objectives:**  
Learn to correctly represent the current circuits  
Know how to interpret and solve dc circuits |

| **AC circuits** | **Learning time:** 26h 40m  
Theory classes: 6h  
Laboratory classes: 2h  
Self study : 18h 40m |
|-----------------|--------------------------------------------------|
| **Description:**  
Alternating current. Measurement of an alternating quantity  
Behavior of resistors, inductors and capacitors  
Generalization to more complicated circuits. Fassor associated with an alternating magnitude. Operations phasor  
Resonance and reactive compensation  
Power and energy  
Measuring devices  

**Related activities:**  
Problem solving, videos and practical  

**Specific objectives:**  
Represent, solve and calculate AC circuits |
## 3-phase systems

**Description:**
- Definition 3-phase system. Simple and compound tensions
- Piping loads
- Symmetrical and balanced systems with symmetrical load. Schematic phase-neutral equivalent
- Powers. Power Measurement
- The electromagnetic contactor. On-off circuit

**Related activities:**
- Problems, videos and practical

**Specific objectives:**
- Can analyze and solve three-phase circuits

**Learning time:** 31h 20m
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 23h 20m

## Transformers

**Description:**
- Description and working principle
- Ideal transformer
- Primary and secondary reduction
- Real transformers
- 3-phase transformers

**Related activities:**
- Problems

**Specific objectives:**
- Understand the operation of a transformer
- Know how to calculate transformer circuits
- Knowing how the presence of a transformer for short circuit

**Learning time:** 4h 30m
- Theory classes: 3h
- Self study: 1h 30m
### Electrical Machines

<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
<th><strong>Learning time:</strong> 14h 20m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition and principle of operation</td>
<td>Theory classes: 7h 30m</td>
</tr>
<tr>
<td>Mechanical Loading: torque and speed</td>
<td>Self study: 6h 50m</td>
</tr>
<tr>
<td>Characteristic curves. Four-quadrant operation</td>
<td></td>
</tr>
<tr>
<td>DC motors series excitation and separate excitation</td>
<td></td>
</tr>
<tr>
<td>Synchronous motors</td>
<td></td>
</tr>
<tr>
<td>Induction motors</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Related activities:</strong></th>
<th><strong>Specific objectives:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Problems</td>
<td>Understand the practical operation of electric motors</td>
</tr>
<tr>
<td></td>
<td>Knowing how to find the operating point of an engine</td>
</tr>
<tr>
<td></td>
<td>Can analyze the nameplate of a motor and calculate performance data from it</td>
</tr>
</tbody>
</table>

### Cable Selection

<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
<th><strong>Learning time:</strong> 9h 40m</th>
</tr>
</thead>
<tbody>
<tr>
<td>General, parts and materials involved Criteria</td>
<td>Theory classes: 4h 30m</td>
</tr>
<tr>
<td>Criterion of the maximum current</td>
<td>Self study: 5h 10m</td>
</tr>
<tr>
<td>Criterion of the maximum voltage drop</td>
<td></td>
</tr>
<tr>
<td>Criterion of the maximum short-circuit current</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Related activities:</strong></th>
<th><strong>Specific objectives:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Problems</td>
<td>Learn to determine the section must have a cable for an application</td>
</tr>
<tr>
<td></td>
<td>Namely determining the voltage drop in the cable to be</td>
</tr>
</tbody>
</table>
## Protection of electrical installations

**Description:**
- Concepts and overcharge
- Calculation of short-circuit current
- Fuses, circuit breakers and overload relays
- Effects of electrical current to the human body
- Concept earth leakage
- Direct and indirect contact
- Reference Grounding and protection
- Connection technology neutral
- Switches and differential relays

**Related activities:**
- Problem solving, videos and practical

**Specific objectives:**
- Know the elements that protect electrical installations and properties.

### Learning time: 24h
- Theory classes: 10h 30m
- Self study: 13h 30m

## industrial automation

**Description:**
- Elements of a system to automate
- Electromechanical automation
- PLCs
- Programming Languages
- Elements of supervision

**Related activities:**
- Practices

**Specific objectives:**
- Meet the automation, architecture and applications.
- Learn to do basic programming in PLC ladder diagram and grafcet
- Learn the basic operation of the monitor elements

### Learning time: 22h 30m
- Theory classes: 3h
- Laboratory classes: 10h
- Guided activities: 4h
- Self study: 5h 30m
### Planning of activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours:</th>
<th>Laboratory classes:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRACTICAL CIRCUIT switched</strong></td>
<td>2h</td>
<td>2h</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
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<td></td>
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<tr>
<td>Make the connection of a single-phase circuit of the household type</td>
<td></td>
<td></td>
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<tr>
<td><strong>Support materials:</strong></td>
<td></td>
<td></td>
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<tr>
<td>Script of practice and laboratory</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
<td></td>
<td></td>
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<tr>
<td>Evidence:</td>
<td></td>
<td></td>
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<tr>
<td>The completion of the practice assembly.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understand the operation and connection of a single-phase circuit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **PRACTICAL CIRCUIT START-STOP**            | 2h     | 2h                  |
| **Description:**                             |        |                     |
| Connection of an industrial three-phase circuit to start and stop a motor |        |                     |
| **Support materials:**                       |        |                     |
| Script of practice and laboratory            |        |                     |
| **Descriptions of the assignments due and their relation to the assessment:** |        |                     |
| Evidence:                                    |        |                     |
| The completion of the practice assembly.     |        |                     |
| **Specific objectives:**                     |        |                     |
| Understand the operation of a three-phase circuit |        |                     |
| Understanding how a simple electromechanical automation |        |                     |

| **PRACTICE PLCs**                            | 2h     | 2h                  |
| **Description:**                             |        |                     |
| Learning to program PLCs                    |        |                     |
| **Support materials:**                       |        |                     |
| Script of practice and laboratory            |        |                     |
| **Descriptions of the assignments due and their relation to the assessment:** |        |                     |
| Evidence:                                    |        |                     |
| The completion of the practice assembly.     |        |                     |
| **Specific objectives:**                     |        |                     |
| Understand the operation of a PLC           |        |                     |
| Learning automata programming in ladder diagram |        |                     |
### PRACTICE LADDER DIAGRAM

**Description:**
Prepare a program in ladder diagram for a particular automation and test in the PLC.

**Support materials:**
Script of practice and laboratory.

**Specific objectives:**
Understand how to program in ladder diagram.

**Hours:** 2h  
Laboratory classes: 2h

### PRACTICE Grafcet

**Description:**
Prepare for a program grafcet automation and test in the PLC.

**Support materials:**
Script of practice and laboratory.

**Specific objectives:**
Understanding the language and expertise grafcet simple programs with it.

**Hours:** 2h  
Laboratory classes: 2h

### PRACTICAL AUTOMATION OF A CHEMICAL PROCESS

**Description:**
Design the program to automate a simple process and program to the PLC.

**Support materials:**
Script of practice and laboratory.

**Specific objectives:**
Understand the operation of PLCs when working with real variables  
Meet the operation graphics.

**Hours:** 2h  
Laboratory classes: 2h

### PARTIAL EXAMINATION

**Hours:** 1h 15m  
Theory classes: 1h 15m
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**Description:**
Reviewing the first three issues of the course

**Support materials:**
Statement, Form and Calculator

**Descriptions of the assignments due and their relation to the assessment:**
examination

**Specific objectives:**
See if acquired knowledge are well

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### FINAL EXAMINATION

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 3h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review the content of the subject having a share of problems and an explanatory section on practices and away from the subject of the problems are not</td>
<td>Theory classes: 3h</td>
</tr>
</tbody>
</table>

**Support materials:**
Statement, Form and Calculator

**Descriptions of the assignments due and their relation to the assessment:**
examination

**Specific objectives:**
See if acquired knowledge are well

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**Qualification system**

The final mark will be the highest from the following expressions:

Nota f1 = 0.5* Mark of the final exam + 0.25* Mark of the Practices + 0.25* Mark of the partial exam

Nota f2 = 0.7* Mark of the Final Exam + 0.3* Mark of the Practices

The mark of the practices will be the average of the marks from each of the scheduled practices. The practices which have not been carried out will be punctuated with a zero.

If present at the examination of reassessment, the same expressions apply for the calculation of the ratings but replaces the final exam for the exam reevaluation.

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**Regulations for carrying out activities**

The exam or midterm and final exams will be conducted on the dates and times designated by the School.

The final exam (Like the reassessment exam) consists of a part in which concepts of theory and laboratory practices and wonder of problems. The share of problems, the student may use a calculator and sheet form.
Bibliography

**Others resources:**
NOTES AND VIDEOS OF THE SUBJECT TO BE ACCESSIBLE FROM DIGITAL CAMPUS