240251 - Electrotechnics and Electrical Machines

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2018
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>Total learning time: 150h</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></td>
<td>150h</td>
<td>0h</td>
<td>50h</td>
<td>10h</td>
<td>0h</td>
<td>90h</td>
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<td>33.33%</td>
<td>6.67%</td>
<td>0.00%</td>
<td>60.00%</td>
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</table>
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## Content

<table>
<thead>
<tr>
<th>DC Circuits</th>
<th>Learning time: 17h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> Electric current and potential difference</td>
<td></td>
</tr>
<tr>
<td>Resistance of a conductor, Ohm's Law</td>
<td></td>
</tr>
<tr>
<td>Conventions signs in accordance with IEC</td>
<td></td>
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<tr>
<td>Kirchhoff's Laws</td>
<td></td>
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<tr>
<td>Resistance association</td>
<td></td>
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<tr>
<td>Charging and discharging of capacitors and inductors</td>
<td></td>
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<tr>
<td>Power and energy</td>
<td></td>
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<tr>
<td>Measuring devices</td>
<td></td>
</tr>
<tr>
<td><strong>Related activities:</strong> Problem solving and videos</td>
<td></td>
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<tr>
<td><strong>Specific objectives:</strong> Learn to correctly represent the current circuits</td>
<td></td>
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<tr>
<td>Know how to interpret and solve dc circuits</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>AC circuits</th>
<th>Learning time: 26h 40m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> Alternating current. Measurement of an alternating quantity</td>
<td></td>
</tr>
<tr>
<td>Behavior of resistors, inductors and capacitors</td>
<td></td>
</tr>
<tr>
<td>Generalization to more complicated circuits. Fassor associated with an alternating magnitude. Operations phasor</td>
<td></td>
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<tr>
<td>Resonance and reactive compensation</td>
<td></td>
</tr>
<tr>
<td>Power and energy</td>
<td></td>
</tr>
<tr>
<td>Measuring devices</td>
<td></td>
</tr>
<tr>
<td>Aparells de mesura</td>
<td></td>
</tr>
<tr>
<td><strong>Related activities:</strong> Problem solving, videos and practical</td>
<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong> Represent, solve and calculate AC circuits</td>
<td></td>
</tr>
</tbody>
</table>
### 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

**Learning time:** 14h 20m  
Theory classes: 7h 30m  
Self study: 6h 50m

**Description:**  
Definition and principle of operation  
Mechanical Loading: torque and speed  
Characteristic curves. Four-quadrant operation  
DC motors series excitation and separate excitation  
synchronous motors  
Induction motors

**Related activities:**  
Problems

**Specific objectives:**  
Understand the practical operation of electric motors  
Knowing how to find the operating point of an engine  
Can analyze the nameplate of a motor and calculate performance data from it

## Cable selection

**Learning time:** 9h 40m  
Theory classes: 4h 30m  
Self study: 5h 10m

**Description:**  
General, parts and materials involved Criteria  
Criterion of the maximum current  
Criterion of the maximum voltage drop  
Criterion of the maximum short-circuit current

**Related activities:**  
Problems

**Specific objectives:**  
Learn to determine the section must have a cable for an application  
Namely determining the voltage drop in the cable to be
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## Protection of electrical installations

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 24h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concepts and overcharge</td>
<td>Theory classes: 10h 30m</td>
</tr>
<tr>
<td>Calculation of short-circuit current</td>
<td>Self study: 13h 30m</td>
</tr>
<tr>
<td>Fuses, circuit breakers and overload relays</td>
<td></td>
</tr>
<tr>
<td>Effects of electrical current to the human body</td>
<td></td>
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<tr>
<td>Concept earth leakage</td>
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<tr>
<td>Direct and indirect contact</td>
<td></td>
</tr>
<tr>
<td>Reference Grounding and protection</td>
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<tr>
<td>Connection technology neutral</td>
<td></td>
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<tr>
<td>Switches and differential relays</td>
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</tbody>
</table>

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

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

## Industrial automation

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 22h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements of a system to automate</td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td>electromechanical automation</td>
<td>Laboratory classes: 10h</td>
</tr>
<tr>
<td>PLCs</td>
<td>Guided activities: 4h</td>
</tr>
<tr>
<td>Programming Languages</td>
<td>Self study: 5h 30m</td>
</tr>
<tr>
<td>Elements of supervision</td>
<td></td>
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</tbody>
</table>

### 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
## Planning of activities

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

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

| **PRACTICE PLCs** | **Hours:** 2h  
Laboratory classes: 2h |
<table>
<thead>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong> Learning to program PLCs</td>
<td></td>
</tr>
<tr>
<td><strong>Support materials:</strong> Script of practice and laboratory</td>
<td></td>
</tr>
<tr>
<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong> Evidence: The completion of the practice assembly.</td>
<td></td>
</tr>
</tbody>
</table>
| **Specific objectives:** Understand the operation of a PLC  
Learning automata programming in ladder diagram |
### PRACTICE LADDER DIAGRAM

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

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

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

**Descriptions of the assignments due and their relation to the assessment:**  
evidence:  
The preliminary design of the program

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

### PRACTICE Grafcet

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

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

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

**Descriptions of the assignments due and their relation to the assessment:**  
evidence:  
The preliminary design of the program

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

### PRACTICAL AUTOMATION OF A CHEMICAL PROCESS

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

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

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

**Descriptions of the assignments due and their relation to the assessment:**  
evidence:  
The preliminary design of the program

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

### 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

### 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

### 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.

### 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