280650 - Automatic Regulation and Control

**Coordinating unit:** 280 - FNB - Barcelona School of Nautical Studies
**Teaching unit:** 707 - ESAII - Department of Automatic Control
**Academic year:** 2019
**Degree:** BACHELOR'S DEGREE IN MARINE TECHNOLOGIES (Syllabus 2010). (Teaching unit Compulsory) BACHELOR'S DEGREE IN MARINE TECHNOLOGIES/BACHELOR'S DEGREE IN NAVAL SYSTEMS AND TECHNOLOGY ENGINEERING (Syllabus 2016). (Teaching unit Compulsory)
**ECTS credits:** 6
**Teaching languages:** Catalan, Spanish

### Teaching staff

**Coordinator:** SERGIO ROMERO LAFUENTE
**Others:** Primer quadrimestre:
- ROSA M. FERNANDEZ CANTI - 1
- SERGIO ROMERO LAFUENTE - 1

### Degree competences to which the subject contributes

**Specific:**
1. Knowledge, use and application of automation and control methods applicable to the ship and offshore installations.

### Teaching methodology

- Receive, understand and synthesize knowledge
- Consider and solve problems
- Analyze results
- Perform work in a team and individually

### Learning objectives of the subject

Introduction to the basic concepts and tools of system analysis. Design of controllers to improve the performance specifications of the systems. Presentation of control systems within the naval field. The student must be able to perform the analysis and modification of the naval machinery systems.

On the other hand, one of the objectives of this subject is provide the knowledge, understanding and proficiency (KUP) of the following competencies: "OPERATE ELECTRICAL, ELECTRONIC AND CONTROL SYSTEMS", "MONITOR THE OPERATION OF ELECTRICAL, ELECTRONIC AND CONTROL SYSTEMS" AND "OPERATE COMPUTERS AND COMPUTER NETWORKS ON SHIPS". These competencies are required and defined in Section A-III/1 Mandatory minimum requirements for certification of officers in charge of an engineering watch in a manned engine-room or designated duty engineer in a periodically unmanned engine-room (propulsion power of 750 kW or more) of the Seafarers' Training, Certification and Watchkeeping (STCW) International Code. Students will acquire the following Knowledge, Understanding and Proficiency (KUP) detailed in STCW A-III-1 corresponding to the control systems: 6.3.a) various automatic control methodologies and characteristics (in the global subject); and 6.3.b) Proportional-Integral-Derivative (PID) control characteristics and associated system devices for process control (in topic 5).
## Study load

<table>
<thead>
<tr>
<th></th>
<th>hours</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time</strong></td>
<td>150h</td>
<td></td>
</tr>
<tr>
<td>Hours large group:</td>
<td>20h</td>
<td>13.33%</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>20h</td>
<td>13.33%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>5h</td>
<td>3.33%</td>
</tr>
<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</table>
# 280650 - Automatic Regulation and Control

## Content

<table>
<thead>
<tr>
<th>Introduction to automatic</th>
<th>Learning time: 1h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 1h 30m</td>
</tr>
<tr>
<td>Objective and scope of the subject. Feedback systems. Examples of dynamic systems in a ship.</td>
<td></td>
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<tr>
<td>Related activities:</td>
<td></td>
</tr>
<tr>
<td>Lab 1: Introduction and control system of the angular velocity of a DC motor. In this session the student has to: 1) Understand the system and the function of the different blocks of the plant; 2) Identify the model of the plant; 3) Evaluate the performance of different control systems in open and closed loop; and 4) Understand the effect of the different actions of proportional, integral and derivative controls.</td>
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<tr>
<td>Lab 2: Control system for the angular position of a DC motor. In this session the student has to: 1) Evaluate the performance of different systems in open and closed loop; and 2) Design a PID controller.</td>
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<table>
<thead>
<tr>
<th>System modeling</th>
<th>Learning time: 13h 45m</th>
</tr>
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<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 3h 30m</td>
</tr>
<tr>
<td>Transfer function of linear systems. Canonical gain, poles and zeros. Block diagrams. Block algebra.</td>
<td>Practical classes: 2h</td>
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<td></td>
<td>Self study: 8h 15m</td>
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<table>
<thead>
<tr>
<th>Time response</th>
<th>Learning time: 22h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Impulse and step responses of first and second order systems. Stationary error of feedback systems.</td>
<td>Practical classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study: 13h 30m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System stability</th>
<th>Learning time: 9h 15m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>Definition of stability. Necessary and sufficient condition. Routh criterion.</td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 5h 15m</td>
</tr>
</tbody>
</table>
### Design of PID controllers

**Learning time:** 31h 45m
- Theory classes: 4h
- Practical classes: 3h 30m
- Laboratory classes: 4h
- Guided activities: 9h
- Self study: 11h 15m

**Description:**

### Root locus technique

**Learning time:** 30h
- Theory classes: 4h
- Practical classes: 4h
- Laboratory classes: 4h
- Guided activities: 6h
- Self study: 12h

**Description:**
Controller design from the root locus technique

**Related activities:**
Lab 3: Design of PID controllers using Root Locus Technique in order to regulate the behavior of the velocity and angular position of a DC motor. The practice will be carried out using Simulink, a simulation environment, and different graphic representation tools included in the Matlab Control System Toolbox.

Lab 4: Control of position in a magnetic levitation model. The student will make use of the acquired knowledge to design the controller that allows to position a ball with magnetic levitation. This practice allows to approach the student to real control problems, shortening the distance between the theoretical knowledge and the real applications.

### Frequency response

**Learning time:** 27h 30m
- Theory classes: 7h
- Practical classes: 4h
- Self study: 16h 30m

**Description:**
The final mark is the partial sum of the following qualifications:

\[ N_{\text{final}} = 0.45 \times N_{pf} + 0.4 \times N_{ac} + 0.15 \times N_{el} \]

- **N\text{final}**: Final result
- **N\text{pf}**: Final exam qualification
- **N\text{ac}**: Continuous evaluation
- **N\text{el}**: Laboratory qualification

The final exam consists of questions on concepts associated with the learning objectives of the course, and a set of practice exercises. Continuous evaluation is the result of a partial test (with a weight of 20% of the final mark) and activities conducted during the year.

Reexamination: According to the rules of the FNB, a reexamination test consisting of a comprehensive review of the subject will be performed. This test reassessment is aimed to students with a final mark ranging between 3.0 and 4.9.

### Regulations for carrying out activities

- Students who do not submit the final test, or have not done any of the labs, or have not submitted any test of the continuous evaluation will be denoted as “NOT TAKEN”.

### Bibliography

**Basic:**

**Complementary:**

**Others resources:**
- Notes of theory and problems of the subject (Digital Campus Atenea)