Course guides
280650 - 280650 - Automatic Regulation and Control

Unit in charge: Barcelona School of Nautical Studies
Teaching unit: 707 - ESAII - Department of Automatic Control.
Degree: BACHELOR’S DEGREE IN MARINE TECHNOLOGIES (Syllabus 2010). (Compulsory subject).
Academic year: 2020  ECTS Credits: 6.0  Languages: Catalan, Spanish

LECTURER
Coordinating lecturer: SERGIO ROMERO LAFUENTE
Others: Primer quadrimestre:
    ROSA M. FERNANDEZ CANTI - DT, GTM
    SERGIO ROMERO LAFUENTE - DT, GTM

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>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>20,0</td>
<td>13.33</td>
</tr>
<tr>
<td>Guided activities</td>
<td>5,0</td>
<td>3.33</td>
</tr>
<tr>
<td>Type</td>
<td>Hours</td>
<td>Percentage</td>
</tr>
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<td>-------------------------</td>
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</tr>
<tr>
<td>Hours small group</td>
<td>15,0</td>
<td>10.00</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>20,0</td>
<td>13.33</td>
</tr>
</tbody>
</table>

**Total learning time:** 150 h

## CONTENTS

### Introduction to automatic

**Description:**
Objective and scope of the subject. Feedback systems. Examples of dynamic systems in a ship.

**Related activities:**
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.

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.

**Full-or-part-time:** 1h 30m  
Theory classes: 1h 30m

### System modeling

**Description:**

**Full-or-part-time:** 13h 45m  
Theory classes: 3h 30m  
Practical classes: 2h  
Self study : 8h 15m

### Time response

**Description:**
Impulse and step responses of first and second order systems. Stationary error of feedback systems.

**Full-or-part-time:** 22h 30m  
Theory classes: 6h  
Practical classes: 3h  
Self study : 13h 30m

### System stability

**Description:**

**Full-or-part-time:** 9h 15m  
Theory classes: 2h  
Practical classes: 2h  
Self study : 5h 15m
Design of PID controllers

**Description:**

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

Root locus technique

**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.

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

Frequency response

**Description:**

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

Stability in the frequency domain

**Description:**
Nyquist criterion. Gain and phase margins.

**Full-or-part-time:** 13h 45m
Theory classes: 3h 30m
Practical classes: 2h
Self study: 8h 15m
**GRADING SYSTEM**

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

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

- **Nfinal**: Final result
- **Npf**: Final exam qualification
- **Nac**: Continuous evaluation
- **Nel**: 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.

**EXAMINATION RULES.**

- 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:**

**RESOURCES**

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