280684 - Automatic Control Systems and Computer Networks on Board

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 Optional)
BACHELOR'S DEGREE IN MARINE TECHNOLOGIES/BACHELOR'S DEGREE IN NAVAL SYSTEMS AND TECHNOLOGY ENGINEERING (Syllabus 2016). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: FRANCISCO JAVIER AYMERICH MARTINEZ
Others: Segon quadrimestre:
FRANCISCO JAVIER AYMERICH MARTINEZ - 1
ROSA M. FERNANDEZ CANTI - 1

Teaching methodology
- Receive, understand and synthesize knowledge.
- Set up and solve problems.
- Analyze results.
- Perform work in a team and individually.

Learning objectives of the subject
Introduction to the concepts of networks and application of these concepts to be implemented on ships. Sensors connectivity in these networks. Students must be able to analyze the characteristics of a communication network to integrate and interpret how the various devices ship in these networks.
For the automatic part of the objective of the course is to introduce students to the role of the computer as an element of control. It will introduce students to linear control techniques and new approaches to the design of control systems.
This course will evaluate the following STCW competences:
A-III/6 - 1. Monitor the operation of electrical, electronic and control systems, including the KUP A-III/6 - 1.3 knowledge of electro-technology and electrical machines theory, fundamentals of electronics and power electronics, electrical power distribution boards and electrical equipment, fundamentals of automation, automatic control systems and technology
A-III/6 - 2. Monitor the operation of automatic control systems of propulsion and auxiliary machinery, including the KUP A-III/6 - 2.1 Preparation of control systems of propulsion and auxiliary machinery for operation
A-III/6 - 5. Operate computers and computer networks on ships, including the KUP A-III/6 - 5.1 Understanding of 1. main features of data processing, 2. construction and use of computer networks on ships, 3. bridge-based, engine-room-based and commercial computer use.
### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>30h</th>
<th>20.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>15h</td>
<td>10.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>10h</td>
<td>6.67%</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>5h</td>
<td>3.33%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Learning time: 2h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
</tbody>
</table>

**Description:**
Course overview. Motivation: implementation of digital control systems (using PLC) and the need for communication between intelligent devices (using communication networks). Examples.

<table>
<thead>
<tr>
<th>Communication networks (A-III/ 6 - 5.1)</th>
<th>Learning time: 40h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 8h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study: 25h</td>
</tr>
</tbody>
</table>

**Description:**
1. Introduction
1.1. Purpose and scope
1.2. Introduction to different types of networks. examples
2. Communication Networks
2.1. Introduction
2.2 Implementation of networks. TCP / IP networks.
2.3. Interconnection between networks.
2.4. Application to the interconnection of network equipment on the ship
3. Communication Networks. Standards
3.1. Standard Profibus
3.2 Standard Profinet
3.3. Standard NMEA 0183
3.4. Standard NMEA 2000
4. Application of network concepts on the ship
4.1 Interconnection of equipment on the boat
4.2 Introduction to monitoring equipment on the ship. Sensors. Information visualization
4.3 Examples of integration
### Programmable logic controller (A-III/6 - 2.1)

- **Description:**
  1. Introduction: Automation
  1.1. Circuits and logics of contacts
  1.2. Industrial instrumentation and standards of representation
  2. Architecture of a PLC
  2.1. External architecture of a PLC
  2.2. Internal architecture of a PLC
  2.3. Input and output interfaces for PLCs
  3. Programming a PLC
  3.1. Programming languages (ladder, instruction list)
  3.2. Step 7 programming on TIA Portal
  4. Application of PLCs to control naval machines

- **Learning time:** 35h
  - Theory classes: 6h
  - Practical classes: 4h
  - Laboratory classes: 4h
  - Guided activities: 1h
  - Self study: 20h

### Digital controller design (A-III/6 - 1.3, A-III/6 - 2.1)

- **Description:**
  1. Introduction. Controller design
  1.1 Feedback
  1.2 Specifications of control systems
  1.3 PID
  2. Signals and systems in discrete time
  2.1 Z Transform
  2.2 Response Time and frequency
  2.3 Discretization Methods
  2.4 Analysis of stability and behavior
  2.5 Design of digital controllers: deadbeat and Dahlin

- **Learning time:** 40h
  - Theory classes: 8h
  - Practical classes: 4h
  - Laboratory classes: 2h
  - Guided activities: 1h
  - Self study: 25h
Fieldbus and SCADA (A-III/6 - 1.3, A-III/6 - 2.1, A-III/6 - 5.1)

Learning time: 33h
- Theory classes: 6h
- Practical classes: 3h
- Laboratory classes: 3h
- Guided activities: 2h
- Self study: 20h

Description:
1. Introduction. Levels of control
2. Sequential control PLCs.
3. Distributed control networks of PLCs.
4. Supervised control through SCADA systems
5. Control systems in the marine environment.
5.1. Examples marine applications: electro-hydraulic control systems and electro-pneumatic control of viscosity and temperature of the fuel.

Qualification system

The final score is the sum of the following partial grades:
\[ N_{\text{final}} = 0.15 \cdot N_{\text{PF (INF)}} + 0.15 \cdot N_{\text{AC (INF)}} + 0.2 \cdot N_{\text{Ad}} + 0.2 \cdot N_{\text{EL (INF)}} + 0.3 \cdot N_{\text{PF (AUT)}} \]

(\text{INF}) refers to the computer and (\text{AUT}) as part of the automatic

\( N_{\text{final}} \): final.
\( N_{\text{PF}} \): final exam grade.
\( N_{\text{AC}} \): continuous assessment.
\( N_{\text{EL}} \): grade teaching laboratory (lab, computer lab).
\( N_{\text{Ad}} \): qualification of directed activities.

The final exam consists of a questions about concepts associated with learning objectives of the course in terms of knowledge and understanding, and a set of application exercises.

Continuous assessment is a partial test in different activities during the course.
The rating is the average degree in the laboratory of lab activities.

Reexamination: Students with a final qualification between 3.0 and 4.9 have the opportunity to do a reexamination test that consists of a global exam of the subject.

Regulations for carrying out activities

- If any of the activities or laboratory continuous assessment are not done will be considered as not rated.
- Students who do not submit to the final exam, do not submit to any activity of continuous assessment, do not submit any lab activity, or do not submit any directed activity included as "not taken" in the subject.
Bibliography

Basic:


Complementary: