Course guide
280684 - 280684 - Automatic Control Systems and Computer Networks on Board

Last modified: 17/10/2024

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). (Optional subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: FRANCISCO JAVIER AYMERICH MARTINEZ

Others: Segon quadrimestre:
FRANCISCO JAVIER AYMERICH MARTINEZ - GTDT
ROSA M. FERNANDEZ CANTI - GTDT
JOVÉ BUENO, MARC - GTDT
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DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

STCW:
ETO.1. A-III/6-1. Function: Electrical, electronic and control engineering at the operational level
ETO.2. A-III/6-1.1 Monitor the operation of electrical, electronic and control systems
ETO.3. A-III/6-KUP 1.1.6 Knowledge of: Fundamentals of automation, automatic control systems and technology
ETO.4. A-III/6-KUP 1.1.7 Knowledge of: Instrumentation, alarm and monitoring systems
ETO.5. A-III/6-1.5 Operate computers and computer networks on ships
ETO.6. A-III/6-KUP 1.5.1.1 Understanding of: .1 main features of data processing
ETO.7. A-III/6-KUP 1.5.1.2 Understanding of: .2 construction and use of computer networks on ships
ETO.8. A-III/6-KUP 1.5.1.3 Understanding of: .3 bridge-based, engine-roombased and commercial computer use
ETO.9. A-III/6- 2. Function: Maintenance and repair at the operational level
ETO.10. A-III/6-2.1 Maintenance and repair of electrical and electronic equipment
ETO.11. A-III/6-CCS 2.1.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices
ETO.12. A-III/6-CCS 2.1.5.4 Function and performance tests of the following equipment and their configuration: .4 The interpretation of electrical and electronic diagrams

TEACHING METHODOLOGY

· Receive, understand and synthesize knowledge.
· Set up and solve problems.
· Analyze results.
· Perform work in a team and individually.
· Perform laboratoty practices

LEARNING OBJECTIVES OF THE SUBJECT

For the computer part, the aim of the subject is the introduction to the concepts of computer networks and application of these concepts to their implementation in ships.
Sensor and instrument connectivity in these networks.
The student must be able to analyze the characteristics of a communications network and interpret how to integrate the different devices of the ship in these networks.
On the automation side, the aim of the course is to introduce the student to the role of the computer as a control element.
The student will be introduced to controller tuning techniques, PLC programming through ladder and structured language. You will be able to set up a network of PLCs.
The student will also be able to explain what a SCADA monitoring system is and program screens along with alarms and histories.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	15,0	10.00
Guided activities	5,0	3.33
Self study	90,0	60.00
Hours large group	30,0	20.00
Hours small group	10,0	6.67

Total learning time: 150 h

CONTENTS

Introduction

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

Full-or-part-time: 2h
Theory classes: 2h

1. Communication networks

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. Aplication 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

Related competencies :
A36-1.5.1a. A-III/6-KUP 1.5.1.1 Understanding of: .1 main features of data processing
A36-1.5.1b. A-III/6-KUP 1.5.1.2 Understanding of: .2 construction and use of computer networks on ships
A36-1.5.1c. A-III/6-KUP 1.5.1.3 Understanding of: .3 bridge-based, engine-roombased and commercial computer use

Full-or-part-time: 40h
Theory classes: 8h
Practical classes: 4h
Laboratory classes: 2h
Guided activities: 1h
Self study : 25h

2. Programmable logic controller

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

Related competencies :
A36-2.1.5b. A-III/6-CCS 2.1.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices
A36-2.1.5d. A-III/6-CCS 2.1.5.4 Function and performance tests of the following equipment and their configuration: .4 The interpretation of electrical and electronic diagrams

Full-or-part-time: 35h
Theory classes: 6h
Practical classes: 4h
Laboratory classes: 4h
Guided activities: 1h
Self study : 20h

3. Digital controller dessign

Description:
1. Introduction. Controller design
1.1 Feedback
1.2 Specifications of control systems
1.3 PID regulator. Ziegler-Nichols tuning
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

Related competencies :
A36-2.1.5b. A-III/6-CCS 2.1.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices
A36-1.1.6. A-III/6-KUP 1.1.6 Knowledge of: Fundamentals of automation, automatic control systems and technology

Full-or-part-time: 40h
Theory classes: 8h
Practical classes: 4h
Laboratory classes: 2h
Guided activities: 1h
Self study : 25h

4. Fieldbus and SCADA

Description:
1. Introduction. Levels of control
2. Sequential control PLCs.
3. Distributed control networks of PLCs.
4 Supervised control through SCADA systems
4.1 WinCC: Screens, alarms, history, runtime
5. Control systems in the nautical environment.
5.1. Examples in marine applications: Electro-hydraulic and electro-pneumatic control systems, viscosity and fuel temperature control, ...
6. Programming in TIA Portal: binary operations, counters, timers, analog inputs and outputs, modular programming, system instructions

Related competencies :
A36-2.1.5b. A-III/6-CCS 2.1.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices
A36-1.1.7. A-III/6-KUP 1.1.7 Knowledge of: Instrumentation, alarm and monitoring systems
A36-2.1.5d. A-III/6-CCS 2.1.5.4 Function and performance tests of the following equipment and their configuration: .4 The interpretation of electrical and electronic diagrams
A36-1.5.1c. A-III/6-KUP 1.5.1.3 Understanding of: .3 bridge-based, engine-roombased and commercial computer use

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

GRADING SYSTEM

The final score is the sum of the following partial grades:
Nfinal = 0,15·Npf(INF) + 0,15·Nac(INF) + 0,1·Nad (INF) + 0,1·NeL (INF) + 0,1·Nad (AUT) + 0,1·NeL (AUT) + 0,3·Npf(AUT)

(INF) refers to the computer and (AUT) as part of the automatic

Nfinal: final.
NPF: final exam grade.
Nac: continuous assessment.
NeL: grade teaching laboratory (lab, computer lab).
Nad: 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 oportunity to do a reexamination test that consists of a global exam of the subject.

Method of demonstrating competence: passing the internship in the laboratory
Competence assessment criteria: correct configuration of equipment and networks according to the manuals, error-free operation

EXAMINATION RULES.

· 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:
- Abad Domingo, Alfredo. Redes de área local. Madrid: McGraw-Hill, 2005. ISBN 844819974X.
- Thornton, Tim. Computers on board. Londres: Adlard Coles Nautical, 2007. ISBN 9780713683547.
- Phillips, C.; Nagle, H. Troy. Sistemas de control digital : análisis y diseño. 2a ed. Barcelona: Gustavo Gili, 1993. ISBN 8425213355.
- Kuo, Benjamin C. Sistemas de control digital. México: Compañía Editorial Continental, 1997. ISBN 9682612926.
- Ortiz, Sergio; Espinosa, José Manuel. Sistemas secuenciales programables. Barcelona: Marcombo Formación, 2014. ISBN 9788426721044.
- Peciña Belmonte, Luis. Programación de Autómatas Siemens S7-300 y S7-1500. Barcelona: Marcombo Formación, 2017. ISBN 9788426724595.
- Creus Solé, Antonio. Neumática e Hidráulica. 2a ed.. Barcelona: Marcombo, 2010. ISBN 9788426716774.

Complementary:
- Stallings, William. Comunicaciones y redes de computadores. 7a ed. Madrid: Pearson Educación, 2004. ISBN 8420541109.
- Levine, William S. The control handbook. 2nd ed. Florida: CRC Press, 2010. ISBN 9781420073669.
- International Maritime Organization. Electro-technical officer. IMO model course 7.08. London: IMO, 2014. ISBN 9789280115802.

RESOURCES

Other resources:
Matlab/Simulink
Siemens Totally Integrated Automation Portal (TIA Portal)
Process simulator Siemens SIMIT