Course guide
280650 - 280650 - Automatic Regulation and Control

Last modified: 27/05/2025

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: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: SERGIO ROMERO LAFUENTE

Others: Primer quadrimestre:
SERGIO ROMERO LAFUENTE - DT, GTM

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
GTM.CE9. Knowledge, use and application of automation and control methods applicable to the ship and offshore installations.

STCW:
ME.1. A-III/1-1. Function: Marine engineering at the operational level
ME.2. A-III/1-1.4 Operate main and auxiliary machinery and associated control systems
ME.3. A-III/1-KUP 1.4.1.8 Basic construction and operation principles of machinery systems, including: .8 automatic control systems
ME.4. A-III/1-2. Function: Electrical, electronic and control engineering at the operational level
ME.5. A-III/1-2.1 Operate electrical, electronic and control systems
ME.6. A-III/1-KUP 2.1.1.3 Basic configuration and operation principles of the following electrical, electronic and control equipment: .3 control systems: .a) various automàtic control methodologies and characteristics .b) Proportional–Integral– Derivative (PID) control characteristics and associated system devices for process control
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

TEACHING METHODOLOGY

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

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 machinary systems.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Self study	90,0	60.00
Hours small group	30,0	20.00

Total learning time: 150 h

CONTENTS

1. 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

2. System modeling

Description:
Transfer function of linear systems. Canonical gain, poles and zeros. Block diagrams. Block algebra.

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

3. 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

4. System stability

Description:
Definition of stability. Necessary and sufficient condition. Routh criterion.

Full-or-part-time: 9h 15m
Theory classes: 2h
Practical classes: 2h
Self study : 5h 15m

5. Design of PID controllers

Description:
PID controllers. Basic control actions. Effect of the actions of the P, I and D controls. Design of PID controllers.

Related competencies :
A31-1.4.0. A-III/1-1.4 Operate main and auxiliary machinery and associated control systems
A31-2.1.0. A-III/1-2.1 Operate electrical, electronic and control systems
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: 31h 45m
Theory classes: 4h
Practical classes: 3h 30m
Laboratory classes: 4h
Guided activities: 9h
Self study : 11h 15m

6. Root locus technique

Description:
Controller design from the root locus tecnique

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 acquiered 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 th 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

7. Frequency response

Description:
Gain and phase. Bode diagram. Frequency response of the canonical elements. Bode diagram of a general system. Polar diagram.

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

8. 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:
Nfinal: 0.45 Npf + 0.4 Nac + 0.15 Nel

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 wil be denoted as "NOT TAKEN".

BIBLIOGRAPHY

Basic:
- Ogata, Katsuhiko. Ingeniería de control moderna [on line]. 5a ed. Madrid: Pearson Educación, 2010 [Consultation: 01/09/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1259. ISBN 9788483226605.
- Phillips, C; Nagle, H. Troy. Sistemas de control digital : análisis y diseño. 2a ed. Barcelona: Gustavo Gili, 1993. ISBN 8425213355.

Complementary:
- Dorf, Richard C. Sistemas automáticos de control: teoría y pràctica. Bogotá: Fondo educativo interamericano, 1977.
- Kuo, Benjamin C. Sistemas de control digital. México: Compañia Editorial Continental, 1997. ISBN 9682612926.
- Balcells Sendra, J.; Romeral Martínez, J.L. Autómatas programables. Barcelona: Marcombo, 1997. ISBN 8426710891.

- Chief Engineer Officer and Second Engineer Officer : IMO model course 7.02. London: International Maritime Organization, 2014. ISBN 9789280115826.
- International Maritime Organization. Electro-technical officer. IMO model course 7.08. London: IMO, 2014. ISBN 9789280115802.

RESOURCES

Other resources:
Notes of theory and problems of the subject (Digital Campus Atenea)
Matlab/Simulink