Course guide
280686 - 280686 - Maintenance and Repair of Equipment and Electronic Systems

Last modified: 27/05/2025

Unit in charge: Barcelona School of Nautical Studies
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: BACHELOR'S DEGREE IN MARINE TECHNOLOGIES (Syllabus 2010). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: JOSEP MARIA TORRENTS DOLZ

Others: Segon quadrimestre:
JOSEP MARIA TORRENTS DOLZ - GTDT

PRIOR SKILLS

Electric current, electrical voltage, power and energy, their relation within electrical circuits and the use of their units in the SI. Basic circuit analysis (Kirchoff and Ohm laws). Numbering bases (binary, octal and hexadecimal). Knowledge of electronic instrumentation.

REQUIREMENTS

280647 Naval Electronics

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

STCW:
ETO.1. A-III/6- 2. Function: Maintenance and repair at the operational level
ETO.2. A-III/6-2.1 Maintenance and repair of electrical and electronic equipment
ETO.3. 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
ETO.4. A-III/6-2.2 Maintenance and repair of automation and control systems of main propulsion and auxiliary machinery
ETO.5. A-III/6-CCS 2.2.4 Safety and emergency procedures: Test, detect faults and maintain and restore electrical and electronic control equipment to operating condition
ETO.6. A-III/6-2.4 Maintenance and repair of electrical, electronic and control
ETO.7. A-III/6-CCS 2.4.2 Safety and emergency procedures: Safe isolation of equipment and associated systems required before personnel are permitted to work on such plant or equipment
ETO.8. A-III/6-CCS 2.4.3 Safety and emergency procedures: Practical knowledge for the testing, maintenance, fault finding and repair

TEACHING METHODOLOGY

Various methodologies are combined:
Lecture class,
Problem class,
Videos and presentations discussed in class.
Laboratory and field practices.
Repair by welding of electronic circuits

LEARNING OBJECTIVES OF THE SUBJECT

Measurement theory and instrumentation. Electronic tools.
Security procedures. Security for people, facilities and equipment.
Electronic systems. Typology. Measuring chain in an electronic system.
Concepts and types of maintenance, location and repair of faults in electronic circuits and systems. Troubleshooting.
Electromagnetic compatibility within circuits and between equipment.
Selection and use of tools and measuring instruments
Assembly, disassembly of equipment in accordance with the manuals
Fault detection and interpretation
Interpretation of plans and diagrams

STUDY LOAD

Type	Hours	Percentage
Hours large group	60,0	40.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Topic 0 Subject presentation. Analog electronics and digital electronics review (physical, logical and architectural level)

Description:
Revise basic electronic concepts for the development of the subject, circuit analysis, combinational and sequential logic, digital system identification.

Full-or-part-time: 4h
Theory classes: 2h
Practical classes: 2h

Topic 1 Theory of the measure and instrumentation

Description:
Establish concepts of measurement and measurement uncertainty in electronic equipment. GUM guide and examples, type A and B measurements. In the laboratory, measure with different instruments and compare specifications. DMM, Oscilloscope, Function Generator, Power Supply. Advanced instrumentation. Maintenance orientation and fault location.

Related activities:
Establish concepts of measurement and measurement uncertainty in electronic equipment. GUM guide and examples, type A and B measurements. In the laboratory, measure with different instruments and compare specifications. DMM, Oscilloscope, Function Generator, Power Supply. Advanced instrumentation. Maintenance orientation and fault location.

Related competencies :
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: 22h
Theory classes: 4h
Practical classes: 2h
Guided activities: 2h
Self study : 14h

Topic 2 Introduction to the programming language G

Description:
Visit Campus Nord Laboratories (canceled). Introduce programming and instrument control. Practice in FNB computer laboratories. National Instruments tutorials (LabVIEW). Simple control programs, e.g. for a DMM. Repetitive measures and to assess uncertainties.

Full-or-part-time: 18h
Practical classes: 2h
Laboratory classes: 2h
Guided activities: 2h
Self study : 12h

Topic 3 Electrical safety for people, facilities, equipment and circuits

Description:
Be aware of electrical safety and usual preventive measures. Grounding and shielding. Analysis of the circuits involved and electrical risks for both people and equipment. Describe electrical safety elements (earth, magnetothermal, differential). Measure grid interference (50 Hz).

Related competencies :
A36-2.4.4. A-III/6-CCS 2.4.3 Safety and emergency procedures: Practical knowledge for the testing, maintenance, fault finding and repair

Full-or-part-time: 18h
Theory classes: 2h
Laboratory classes: 2h
Guided activities: 2h
Self study : 12h

Topic 4 Electronic systems. Measuring chain in an electronic system

Description:
Identify the basic building blocks in a measurement system: Sensor, conditioning, acquisition and processing, actuator. Sn-Pb welding. Load cell. Temperature measurement system (with NTC). Extensometric gauge as sensor. Sensors for measuring physical variables (temperature, pressure, humidity, force, torque, flow, concentration ...). Study of different signal conditioning circuits from a sensor from the point of view of the electrical variable provided by the sensor: Resistance, Capacitance, Inductance, Voltage, Current, Time/Frequency (RCLVIT). Wheatstone Bridge. S&H, acquisition and processing. Data acquisition systems (ADC): Flash, successive approaches, double ramp. Advantages and disadvantages. Meaning of SMRR in a double ramp converter.

Related competencies :
A36-2.4.3. A-III/6-CCS 2.4.2 Safety and emergency procedures: Safe isolation of equipment and associated systems required before personnel are permitted to work on such plant or equipment
A36-2.2.4. A-III/6-CCS 2.2.4 Safety and emergency procedures: Test, detect faults and maintain and restore electrical and electronic control equipment to operating condition

Full-or-part-time: 22h
Theory classes: 4h
Practical classes: 4h
Guided activities: 4h
Self study : 10h

Topic 5 Concepts and types of maintenance, advantages and disadvantages

Description:
Understand the different types of maintenance. Preventive (based on: 1) time of use, 2) early detection, 3) risk assessment, 4) condition or degradation (condition), 5) prediction (IoT, AI)) o Corrective (delayed or in an emergency). Economic costs associated with each type of maintenance. Vibration analysis. HBM.

Full-or-part-time: 16h
Theory classes: 2h
Practical classes: 2h
Guided activities: 4h
Self study : 8h

Topic 6 Location and repair of faults in electronic circuits and systems

Description:
Study the procedure and logical considerations for locating faults in an electronic circuit or system. Study the tools to locate faults in electrical and electronic systems.

Related competencies :
A36-2.4.3. A-III/6-CCS 2.4.2 Safety and emergency procedures: Safe isolation of equipment and associated systems required before personnel are permitted to work on such plant or equipment
A36-2.2.4. A-III/6-CCS 2.2.4 Safety and emergency procedures: Test, detect faults and maintain and restore electrical and electronic control equipment to operating condition
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
A36-2.4.4. A-III/6-CCS 2.4.3 Safety and emergency procedures: Practical knowledge for the testing, maintenance, fault finding and repair

Full-or-part-time: 26h
Theory classes: 2h
Practical classes: 6h
Laboratory classes: 10h
Guided activities: 4h
Self study : 4h

Topic 7 Dedicated electronic instruments and others. Multifunction calibrator. RCL analyzer. Thermographic camera

Description:
Study multifunction calibrator as an integrated equipment of other equipment. Theory equipment with pseudo-bridges, Kelvin clamps. Use of "singular" instruments to locate faults. Uncertainty analysis of alternative measures. Thermographic camera. Study the physical principle on which thermographic cameras are based (black (gray) body radiation). Properties of materials at infrared frequencies. Measuring errors with infrared camera (e.g. blur of optics, thermal noise, influence of glasses, (reflections), of the adjustment parameters in the calibration).

Related competencies :
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
A36-2.4.4. A-III/6-CCS 2.4.3 Safety and emergency procedures: Practical knowledge for the testing, maintenance, fault finding and repair

Full-or-part-time: 20h
Theory classes: 4h
Laboratory classes: 4h
Guided activities: 8h
Self study : 4h

Topic 8 Electromagnetic compatibility within circuits and between equipment

Description:
Describe simple cases of electromagnetic interference problems and how to mitigate them. Review of the previous topics.

Related competencies :
A36-2.2.4. A-III/6-CCS 2.2.4 Safety and emergency procedures: Test, detect faults and maintain and restore electrical and electronic control equipment to operating condition

Full-or-part-time: 4h
Theory classes: 2h
Laboratory classes: 1h 59m
Guided activities: 0h 01m

ACTIVITIES

Access to the laboratory on the first day

Description:
Regulations for the use of the Electronics Laboratory

Sign the risk prevention sheet before entering the laboratory on the first day. Read and prepare practice and previous study and / or material before entering the laboratory. The assistant, always present during the lab session, assigns desk to each student enrolled in the group that performs the lab session. Coats and bags are not naughty or dangerous (e.g. tripped). No smoking or eating or drinking in the laboratory. Not on the balcony either. When finished, we clean and tidy the place. Tools and instruments are used only for the purpose of the lab session. It is forbidden to disarm them, if any damage is detected, please inform to the assistant.

Working in the laboratory presents health risks. Before starting, it is necessary to understand the General Standards of Safety and Hygiene in Laboratories prepared by the Occupational Risk Prevention Service of the UPC:
https://www.upc.edu/prevencio/ca/seguretat-higiene/arxius/safety-hygiene-regulations/shr-001-general-safety-hygiene-regulations-laboratories.pdf
In addition, it is necessary to understand additional risks when working with electricity or welding. Working with electricity:
https://www.upc.edu/prevencio/ca/seguretat-higiene/arxius/safety-hygiene-regulations/shr-504-electrical-work-the-5-basic-rules.pdf
https://www.upc.edu/prevencio/ca/seguretat-higiene/arxius/safety-hygiene-regulations/shr-505-electrical-work-the-5-additional-rules.pdf
Solder with tin wire:
https://www.upc.edu/prevencio/ca/seguretat-higiene/arxius/safety-hygiene-regulations/shr-218-soldering.pdf

Final comment: Reverse-polarized capacitors (electrolytic, or polarized) tend to explode within minutes. Always double-check their polarity before connecting them.

Delivery:
Signed document.

Full-or-part-time: 0h 20m
Laboratory classes: 0h 20m

Lab sessions

Description:
Three quarters of MRESE's assistance time at FNB is spent in the laboratory. In the laboratory, electrical variables are generated to excite and characterize equipment electrically. Physical variables are measured through sensors or electrical variables directly with the measuring instruments. Practical cases of problems with electrical variable measurements and strategies for their solution are presented. Breakdowns are caused to systems and devices and procedures are established for locating the breakdowns and how to fix them.

Material:
Instruments, connection and measurement cables, rapid prototyping board, passive and active components and sensors of physical variables (both electrical, dimensional, environmental and flow) and their conditioning.

Full-or-part-time: 44h 40m
Laboratory classes: 44h 40m

GRADING SYSTEM

To pass, students must pass an exam and the correct resolution of exercises (theoretical and/or practical and in the lab). The final grade is the weighted average of 30% of the exam and 70% of the exercises.

Competency assessment criteria: laboratory-approved training

EXAMINATION RULES.

The exam is individual; only pen (not pencil) and scientific calculator (not programmable) allowed. Cell phone is not allowed.

BIBLIOGRAPHY

Basic:
- Geier, Michael. How to diagnose and fix everything electronic. 2a. Nova York: McGraw-Hill, 2016. ISBN 9780071848299.
- Regulations for the electrical and electronic equipment of ships with recommended practice for their implementation. 6th ed. London: The Institution of Electrical Engineers, 1990. ISBN 0863412173.
- Manley, Pat. Essential boat electrics. Hoboken: John Wiley & Sons, 2006. ISBN 9781904475170.
- Calder, Nigel. Boatowner's mechanical and electrical manual : how to maintain, repair, and improve your boat's essential systems. 3rd ed. Londres: Adlard Coles Nautical, 2005. ISBN 9780713672268.
- Payne, John C. The Marine electrical and electronics bible. 2nd. London: Adlard Coles Nautical, 2000. ISBN 0713657243.
- Closas Torrente, Lluís; Closas Gómez, Pau. Manteniment i reparació dels sistemes electrònics d'un vaixell. Nautical Union, 2017.
- Wolf, Stanley. Guide to electronic measurements and laboratory practice. 2nd. ed. Englewood Cliffs, NJ: Prentice-Hall, 1983. ISBN 0133696529.
- Tomal, Daniel R; Agajanian, Aram S. Electronic troubleshooting. Fourth edition. New York: Mc Graw Hill Education, [2014]. ISBN 9780071819909.
- Geier, Michael. How to diagnose and fix everything electronic [on line]. 2nd ed. New York: McGraw-Hill, 2016 [Consultation: 02/07/2024]. Available on: https://www-accessengineeringlibrary-com.recursos.biblioteca.upc.edu/content/book/9780071848299?implicit-login=true. ISBN 9780071848305.

Complementary:
- Pallàs Areny, Ramon. Adquisición y distribución de señales. Barcelona: Marcombo, 1993. ISBN 8426709184.
- Adler, U. (ed.). Automotive electric/electronic system. 3rd ed. Stuttgart: Bosch, 1999. ISBN 0768005086.
- Pallàs Areny, Ramon; Webster, John G. Sensors and Signal Conditioning [on line]. 2nd ed. New York [etc.]: John Wiley & Sons, cop. 2001 [Consultation: 01/09/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=4747125. ISBN 9781118585931.
- Lenk, John D. Circuit troubleshooting handbook. New York: McGraw-Hill, 1999. ISBN 0070381860.

- Richards, Steve. Electronics, navigational aids and radio theory for electrotechnical officers. 2nd edition. Dublin: Bloomsbury Publishing, 2023. ISBN 9781472975287.