



Course guide

280641 - 280641 - Electricity and Electrotechnics

Last modified: 18/10/2024

Unit in charge: Barcelona School of Nautical Studies
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: BACHELOR'S DEGREE IN MARINE TECHNOLOGIES (Syllabus 2010). (Compulsory subject).
BACHELOR'S DEGREE IN NAVAL SYSTEMS AND TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

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

LECTURER

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DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

GTM.CE7. Knowledge of circuit theory and electrical characteristics of marine machinery and capacity to implement the operation and operation of the ship of this knowledge.

GESTN.CE9. Knowledge of circuit theory and the characteristics of electrical machines and ability to perform calculations for systems involving these elements.

Transversal:

TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

STCW:

- ME.1. A-III/1-2. Function: Electrical, electronic and control engineering at the operational level
- ME.2. A-III/1-2.1 Operate electrical, electronic and control systems
- ME.3. A-III/1-KUP 2.1.1.1 Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment: .a) generator and distribution systems, .b) preparing, starting, paralleling and changing over generators, .c) electrical motors including starting methodologies,.d) highvoltage Installations, .e) sequential control circuits and associated system devices
- ME.4. A-III/1-2.2 Maintenance and repair of electrical and electronic equipment
- ME.5. A-III/1-KUP 2.2.1 Safety requirements for working on shipboard electrical systems, including the safe isolation of electrical equipment required before personnel are permitted to work on such equipment
- ME.6. A-III/1-KUP 2.2.2 Maintenance and repair of electrical System equipment, switchboards, electric motors, generator and DC electrical systems and equipment
- ME.7. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage
- ME.8. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment
- ME.9. A-III/1-KUP 2.2.5.1 Function and performance tests of the following equipment and their configuration: .1 monitoring systems
- ME.10. A-III/1-KUP 2.2.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices
- ME.11. A-III/1-KUP 2.2.5.3 Function and performance tests of the following equipment and their configuration: .3 protective devices
- ME.12. A-III/1-KUP 2.2.6 The interpretation of electrical and simple electronic diagrams
- 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 1.1.3 Knowledge of Electrotechnology and electrical machines theory
- ETO.4. A-III/6-KUP 1.1.5 Knowledge of: Electrical power distribution boards and electrical equipment
- ETO.5. A-III/6-KUP 1.1.8 Knowledge of: Electrical drives
- ETO.6. A-III/6-KUP 1.1.9 Knowledge of: Technology of electrical materials

TEACHING METHODOLOGY

- Receive, understand and synthesize knowledge.
- Define and solve problems.
- Develop critical thinking and reasoning and defend it both in oral and in writing.
- Perform work individually.

LEARNING OBJECTIVES OF THE SUBJECT

- Understand the circuit theory fundamentals.
- Introduction to different types of electric machines and applications.
- Introduction to electrical installations of the ship.
- Be able to compute and solve basic electrical circuits and use equivalent schemes of electrical machines for problem solving and troubleshooting.
- Understand electrical systems and be able to explain them through plans and instructions
- Select tools, measuring instruments and devices for testing. Interpret the results correctly
- Work in line with manuals and good practices

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Self study	90,0	60.00
Hours large group	45,0	30.00

Total learning time: 150 h

CONTENTS

1. Characteristics and laws of electrical circuits

Description:

Basic knowledge about electrical distribution systems, their components and protection devices:
Fundamentals: charge, current, voltage, power, energy. Passive elements: resistors, inductor coils and capacitors. Ohm's law. Kirchhoff's laws. Independent sources of voltage and current. Values averaged and RMS of waveforms.

Related competencies :

A31-2.1.1a. A-III/1-KUP 2.1.1.1 Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment: .a) generator and distribution systems, .b) preparing, starting, paralleling and changing over generators, .c) electrical motors including starting methodologies,.d) highvoltage Installations, .e) sequential control circuits and associated system devices

A31-2.2.6. A-III/1-KUP 2.2.6 The interpretation of electrical and simple electronic diagrams

A36-1.1.3. A-III/6-KUP 1.1.3 Knowledge of Electrotechnology and electrical machines theory

A36-1.1.9. A-III/6-KUP 1.1.9 Knowledge of: Technology of electrical materials

Full-or-part-time: 15h

Theory classes: 2h

Laboratory classes: 2h

Guided activities: 1h

Self study : 10h

2. Circuit analysis

Description:

Knowledge about electrical distribution systems, their components and protection devices. Learn about measure and test devices to detect failures and maintenance and repair operation.

Resistors in series and parallel. Voltage and current dividers. Measuring equipment. Thevenin and Norton theorems.

Transformation of sources. Method of nodes and loops.

Related competencies :

A31-2.2.3. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage

A31-2.2.1. A-III/1-KUP 2.2.1 Safety requirements for working on shipboard electrical systems, including the safe isolation of electrical equipment required before personnel are permitted to work on such equipment

A31-2.1.1a. A-III/1-KUP 2.1.1.1 Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment: .a) generator and distribution systems, .b) preparing, starting, paralleling and changing over generators, .c) electrical motors including starting methodologies,.d) highvoltage Installations, .e) sequential control circuits and associated system devices

A36-1.1.3. A-III/6-KUP 1.1.3 Knowledge of Electrotechnology and electrical machines theory

A36-1.1.5. A-III/6-KUP 1.1.5 Knowledge of: Electrical power distribution boards and electrical equipment

A36-1.1.8. A-III/6-KUP 1.1.8 Knowledge of: Electrical drives

A36-1.1.9. A-III/6-KUP 1.1.9 Knowledge of: Technology of electrical materials

Full-or-part-time: 16h

Theory classes: 2h

Laboratory classes: 2h

Guided activities: 2h

Self study : 10h

3. Dynamic elements

Description:

Capacitor: charging and discharging. Energy storage in capacitor. Capacitors in series and parallel. Coil Inductance: loading and unloading. Energy storage in inductance. Coils in series and parallel.

Related competencies :

A31-2.2.5b. A-III/1-KUP 2.2.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices

A31-2.2.5c. A-III/1-KUP 2.2.5.3 Function and performance tests of the following equipment and their configuration: .3 protective devices

A31-2.2.1. A-III/1-KUP 2.2.1 Safety requirements for working on shipboard electrical systems, including the safe isolation of electrical equipment required before personnel are permitted to work on such equipment

A31-2.1.1a. A-III/1-KUP 2.1.1.1 Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment: .a) generator and distribution systems, .b) preparing, starting, paralleling and changing over generators, .c) electrical motors including starting methodologies,.d) highvoltage Installations, .e) sequential control circuits and associated system devices

A36-1.1.3. A-III/6-KUP 1.1.3 Knowledge of Electrotechnology and electrical machines theory

A31-2.2.5a. A-III/1-KUP 2.2.5.1 Function and performance tests of the following equipment and their configuration: .1 monitoring systems

A36-1.1.5. A-III/6-KUP 1.1.5 Knowledge of: Electrical power distribution boards and electrical equipment

A36-1.1.9. A-III/6-KUP 1.1.9 Knowledge of: Technology of electrical materials

Full-or-part-time: 14h

Theory classes: 2h

Guided activities: 2h

Self study : 10h

4. AC circuits analysis

Description:

Knowledge about electrical distribution systems, their components and protection devices:

Properties of sinusoidal magnitudes. Phasors. Relationship of current-voltage phasors. Impedance and admittance. Application of methods and theorems for circuits solving and network theorems for steady state. Complex power. Power factor and compensation.

Related competencies :

A31-2.2.5b. A-III/1-KUP 2.2.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices

A31-2.2.5c. A-III/1-KUP 2.2.5.3 Function and performance tests of the following equipment and their configuration: .3 protective devices

A31-2.2.3. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage

A31-2.2.1. A-III/1-KUP 2.2.1 Safety requirements for working on shipboard electrical systems, including the safe isolation of electrical equipment required before personnel are permitted to work on such equipment

A31-2.1.1a. A-III/1-KUP 2.1.1.1 Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment: .a) generator and distribution systems, .b) preparing, starting, paralleling and changing over generators, .c) electrical motors including starting methodologies,.d) highvoltage Installations, .e) sequential control circuits and associated system devices

A36-1.1.3. A-III/6-KUP 1.1.3 Knowledge of Electrotechnology and electrical machines theory

A31-2.2.4. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment

A31-2.2.5a. A-III/1-KUP 2.2.5.1 Function and performance tests of the following equipment and their configuration: .1 monitoring systems

Full-or-part-time: 20h

Theory classes: 6h

Laboratory classes: 2h

Guided activities: 2h

Self study : 10h

5. Three-phase circuits

Description:

Knowledge about electrical distribution systems, their components and protection devices (these knowledge are necessary according to STCW code):

Three-phase generation systems, load connection star (Y) and delta (D), three-phase relationships, monophasic equivalences, star-delta transformation, balanced and unbalanced loads, power measurements.

Related competencies :

A31-2.2.5b. A-III/1-KUP 2.2.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices

A31-2.2.5c. A-III/1-KUP 2.2.5.3 Function and performance tests of the following equipment and their configuration: .3 protective devices

A31-2.2.3. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage

A31-2.2.1. A-III/1-KUP 2.2.1 Safety requirements for working on shipboard electrical systems, including the safe isolation of electrical equipment required before personnel are permitted to work on such equipment

A31-2.1.1a. A-III/1-KUP 2.1.1.1 Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment: .a) generator and distribution systems, .b) preparing, starting, paralleling and changing over generators, .c) electrical motors including starting methodologies, .d) highvoltage Installations, .e) sequential control circuits and associated system devices

A36-1.1.3. A-III/6-KUP 1.1.3 Knowledge of Electrotechnology and electrical machines theory

A31-2.2.4. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment

A31-2.2.5a. A-III/1-KUP 2.2.5.1 Function and performance tests of the following equipment and their configuration: .1 monitoring systems

A36-1.1.5. A-III/6-KUP 1.1.5 Knowledge of: Electrical power distribution boards and electrical equipment

A36-1.1.9. A-III/6-KUP 1.1.9 Knowledge of: Technology of electrical materials

Full-or-part-time: 20h

Theory classes: 6h

Laboratory classes: 3h

Guided activities: 1h

Self study : 10h

6. Electrical installations

Description:

Knowledge about electrical distribution systems, their components and protection devices (these knowledge are necessary according to STCW code):

Calculation of electrical installations. Shortcircuits.

Related competencies :

A31-2.2.5b. A-III/1-KUP 2.2.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices

A31-2.2.5c. A-III/1-KUP 2.2.5.3 Function and performance tests of the following equipment and their configuration: .3 protective devices

A31-2.2.3. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage

A31-2.2.1. A-III/1-KUP 2.2.1 Safety requirements for working on shipboard electrical systems, including the safe isolation of electrical equipment required before personnel are permitted to work on such equipment

A31-2.1.1a. A-III/1-KUP 2.1.1.1 Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment: .a) generator and distribution systems, .b) preparing, starting, paralleling and changing over generators, .c) electrical motors including starting methodologies,.d) highvoltage Installations, .e) sequential control circuits and associated system devices

A31-2.2.2. A-III/1-KUP 2.2.2 Maintenance and repair of electrical System equipment, switchboards, electric motors, generator and DC electrical systems and equipment

A31-2.2.4. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment

A31-2.2.5a. A-III/1-KUP 2.2.5.1 Function and performance tests of the following equipment and their configuration: .1 monitoring systems

A36-1.1.5. A-III/6-KUP 1.1.5 Knowledge of: Electrical power distribution boards and electrical equipment

Full-or-part-time: 14h

Theory classes: 3h

Guided activities: 1h

Self study : 10h

7. Protections

Description:

Knowledge about electrical distribution systems, their components and protection devices.

Electric current danger. Direct and indirect contact. Continuity defects and insulation defects. The differential switch. The breaker switch. Protection curves and coordination.

Related competencies :

A31-2.2.5b. A-III/1-KUP 2.2.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices

A31-2.2.5c. A-III/1-KUP 2.2.5.3 Function and performance tests of the following equipment and their configuration: .3 protective devices

A31-2.2.3. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage

A31-2.2.5a. A-III/1-KUP 2.2.5.1 Function and performance tests of the following equipment and their configuration: .1 monitoring systems

A36-1.1.5. A-III/6-KUP 1.1.5 Knowledge of: Electrical power distribution boards and electrical equipment

A36-1.1.9. A-III/6-KUP 1.1.9 Knowledge of: Technology of electrical materials

Full-or-part-time: 16h

Theory classes: 4h

Laboratory classes: 1h

Guided activities: 1h

Self study : 10h

8. Transformers

Description:

Knowledge about electrical distribution systems, their components and protection devices (these knowledge are necessary according to STCW code):

Operating principles. Equations of ideal transformer. Interpreting the data plate. Rating values. Equivalent circuits. Study of the transformer under load. Three-phase transformers.

Related competencies :

A31-2.2.1. A-III/1-KUP 2.2.1 Safety requirements for working on shipboard electrical systems, including the safe isolation of electrical equipment required before personnel are permitted to work on such equipment

A31-2.1.1a. A-III/1-KUP 2.1.1.1 Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment: .a) generator and distribution systems, .b) preparing, starting, paralleling and changing over generators, .c) electrical motors including starting methodologies,.d) highvoltage Installations, .e) sequential control circuits and associated system devices

A31-2.2.2. A-III/1-KUP 2.2.2 Maintenance and repair of electrical System equipment, switchboards, electric motors, generator and DC electrical systems and equipment

A36-1.1.3. A-III/6-KUP 1.1.3 Knowledge of Electrotechnology and electrical machines theory

A36-1.1.9. A-III/6-KUP 1.1.9 Knowledge of: Technology of electrical materials

Full-or-part-time: 19h

Theory classes: 6h

Laboratory classes: 2h

Guided activities: 1h

Self study : 10h

9. Electrical Machines

Description:

Knowledge about electrical distribution systems, their components and protection devices.

Introduction to different types: DC Machines, Synchronous Machine, Asynchronous Machine (Induction). Interpretation of data plate ratings.

DC Machines: Equivalent circuits, changing direction of rotation, variation of motor speed.

Related competencies :

A31-2.2.1. A-III/1-KUP 2.2.1 Safety requirements for working on shipboard electrical systems, including the safe isolation of electrical equipment required before personnel are permitted to work on such equipment

A31-2.1.1a. A-III/1-KUP 2.1.1.1 Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment: .a) generator and distribution systems, .b) preparing, starting, paralleling and changing over generators, .c) electrical motors including starting methodologies,.d) highvoltage Installations, .e) sequential control circuits and associated system devices

A31-2.2.2. A-III/1-KUP 2.2.2 Maintenance and repair of electrical System equipment, switchboards, electric motors, generator and DC electrical systems and equipment

A36-1.1.3. A-III/6-KUP 1.1.3 Knowledge of Electrotechnology and electrical machines theory

A36-1.1.5. A-III/6-KUP 1.1.5 Knowledge of: Electrical power distribution boards and electrical equipment

A36-1.1.8. A-III/6-KUP 1.1.8 Knowledge of: Electrical drives

Full-or-part-time: 16h

Theory classes: 4h

Laboratory classes: 1h

Guided activities: 1h

Self study : 10h

GRADING SYSTEM

The final mark is the sum of the following qualifications:

$$N_{\text{final}} = 0,4 N_{\text{pf}} + 0,4 N_{\text{ac}} + 0,2 N_{\text{eL}}$$

N_{final} : final mark.

N_{pf} : final test grade.

N_{ac} : continuous assessment grade.

N_{eL} : laboratory grade.

The final test includes the concepts associated with the learning objectives of the subject with respect to knowledge or understanding of application exercises. Continuous assessment is cumulative to different activities, both individual and group, with a training goal conducted during the year (in the classroom and outside it).

The rating of laboratory practices is the sum of the following three laboratory activities:

$$N_{\text{eL}} = 0,4 N_{\text{pfL}} + 0,4 N_{\text{acL}} + 0,2 N_{\text{pL}}$$

N_{pfL} : final lab grade.

N_{acL} : lab continuous assessment.

N_{pL} : attendance and lab participation grade.

Reevaluation: Test that includes the concepts and objectives set for the final test.

Demonstration criteria for STCW competence: approved training in the electricity laboratory

EXAMINATION RULES.

- Attendance and completion of the hands-on labs, is a compulsory requirement.
- If not done any of the lab activities or continuous assessment, the student will be considered as non-rated.
- Will be considered "not present" the one who has not been in the exam or have an overall grade of less than 0.5 points.
- Under no circumstances a student can have any support formular in the tests.

BIBLIOGRAPHY

Basic:

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- Hayt, William H.; Kemmerly, Jack E.; Durbin, Steven M. Análisis de circuitos en ingeniería [on line]. 9a ed. New York: McGraw-Hill, 2019 [Consultation: 30/05/2022]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5808946>. ISBN 9781456272289.
- Boix, Oriol [et al.]. Tecnología eléctrica. Barcelona: Ceysa, 2002. ISBN 9788496960343.
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Complementary:

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- Electro-technical officer. IMO model course 7.08. London: International Maritime Organization, 2014. ISBN 9789280115802.
- Sanjurjo Navarro, Rafael. Máquinas eléctricas : 51 problemas útiles [on line]. Edición estudiante (EEES). Madrid: García-Maroto Editores, [2019] [Consultation: 29/07/2024]. Available on : https://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8435. ISBN 9788417969073.
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RESOURCES

Other resources:

Course notes to ATENEA