Course guide
280660 - 280660 - Electric Propulsion and Power Electronics

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).
Academic year: 2023 ECTS Credits: 4.5 Languages: Catalan, Spanish

LECTURER
Coordinating lecturer: PAU CASALS TORRENS
Others: Primer quadrimestre:
PAU CASALS TORRENS - GTM

REQUIREMENTS
Subjet 280641

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
GTM.CE28. Knowledge of the fundamentals of power electronics and its application to board.
GTM.CE27. Knowledge of electric propulsion systems and their operation and maintenance.
GTM.CE30. Ability to design and manage energy optimization systems applied to marine installations.

Transversal:
URI N2. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.
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-KUP 2.1.1.2 Basic configuration and operation principles of the following electrical, electronic and control equipment: .2 electronic equipment: .a) characteristics of basic electronic circuit elements, .b) flowchart for automatic and control systems, .c) functions, characteristics and features of control systems for machinery items, including main propulsion plant operation control and steam boiler automatic controls
ME.5. A-III/1-2.2 Maintenance and repair of electrical and electronic equipment
ME.6. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage
ME.7. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment
ME.8. A-III/1-KUP 2.2.5.1 Function and performance tests of the following equipment and their configuration: .1 monitoring systems
ME.9. A-III/1-KUP 2.2.5.2 Function and performance tests of the following equipment and their configuration: .2 automatic control devices
ME.10. A-III/1-KUP 2.2.5.3 Function and performance tests of the following equipment and their configuration: .3 protective devices
ME.11. 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 1.1.4 Knowledge of Fundamentals of electronics and power electronics
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- 1.3 Operate generators and distribution systems
ETO.7. A-III/6-KUP 1.3.1 Coupling, load sharing and changing over generators
ETO.8. A-III/6-KUP 1.3.2 Coupling and breaking connection between switchboards and distribution
ETO.9. A-III/6-1.4 Operate and maintain power systems in excess of 1,000 volts
ETO.10. A-III/6-KUP 1.4.3 Theoretical knowledge: Electrical propulsion of the ships, electrical motors and control systems

TEACHING METHODOLOGY
Real applications analysis.
Application of theoretical knowledge to the laboratory practices.
Attitude and skills development for power plants operation.
Case studies and articles on the subject.
Perform work individually.

LEARNING OBJECTIVES OF THE SUBJECT
· Understanding the basics of electrical machines.
· Understand the schemes and connections of different types of machines and applications.
· Understand the regulation systems of V, f, P, Q in synchronous generators in island and parallel.
· Understand the regulation and control systems of electrical motors.
· Having the ability to do calculations and solve problems of electrical machines, using the corresponding equivalent circuits.

Moreover, one objective of this course is to provide knowledge, understanding and proficiency of skills STCW A-III/1:
1. Having knowledge about the operation of electrical distribution systems, generation plant, generators and their synchronization, and motors starting associated control circuits.
2. Understand the use of measuring equipment and electrical testing for locating common faults and maintenance and repair.
3. Having the basic knowledge for the maintenance of electrical machines and their control systems. Use and safe operation of electrical equipment.

Competencies required and defined in Section A-III/1 (Minimum requirements for certification of officers in charge of the watch in unattended machinery or service engineers designated camera unattended machinery (propulsion power of 750 kW or more) of the International Convention on Standards of Training, Certification and Watchkeeping for seafarers.

This competence are assessed according to the section "evaluation" of this record.
STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>35.0</td>
<td>31.11</td>
</tr>
<tr>
<td>Hours small group</td>
<td>10.0</td>
<td>8.89</td>
</tr>
<tr>
<td>Self study</td>
<td>67.5</td>
<td>60.00</td>
</tr>
</tbody>
</table>

Total learning time: **112.5 h**

CONTENTS

1. **DC machine**

Description: Having knowledge about the operation of electrical distribution systems, generation plant, generators, motors and starter. Construction and operational systems and DC electrical equipment on board properties. Having the basic knowledge for the maintenance of electrical machines and their control systems.

Related competencies:
- A36-1.1.4. A-III/6-KUP 1.1.4 Knowledge of Fundamentals of electronics and power electronics
- 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
- A31-2.2.3. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage
- A31-2.2.4. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment
- A36-1.1.8. A-III/6-KUP 1.1.8 Knowledge of: Electrical drives

Full-or-part-time: **3h**
- Theory classes: 2h
- Laboratory classes: 1h

2. **Synchronous machine**

Description: Having knowledge about the operation of electrical distribution systems, generation plant, generators and their synchronization, associated control circuits. Operational and construction in the AC electrical systems and equipment onboard features. Having the basic knowledge for the maintenance of electrical machines and their control systems.

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
- A31-2.2.3. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage
- A31-2.2.4. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment
- A36-1.1.8. A-III/6-KUP 1.1.8 Knowledge of: Electrical drives

Full-or-part-time: **9h**
- Theory classes: 6h
- Laboratory classes: 3h
3. Asynchronous machine

**Description:**
Having knowledge about the operation of electrical distribution systems, motors and starters, associated control circuits. Operational and construction in the AC electrical systems and equipment onboard features. Having the basic knowledge for the maintenance of electrical machines and their control systems.

**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
- A31-2.2.3. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage
- A31-2.2.4. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment
- A36-1.1.8. A-III/6-KUP 1.1.8 Knowledge of: Electrical drives

**Full-or-part-time:** 6h
- Theory classes: 4h
- Laboratory classes: 2h

4. Start systems

**Description:**
Having knowledge about the operation of electrical distribution systems, motors and starters, associated control circuits. Operational and construction in the AC electrical systems and equipment onboard features. Having the basic knowledge for the maintenance of electrical machines and their control systems.

**Related competencies:**
- A36-1.4.3. A-III/6-KUP 1.4.3 Theoretical knowledge: Electrical propulsion of the ships, electrical motors and control systems
- A36-1.1.5. A-III/6-KUP 1.1.5 Knowledge of: Electrical power distribution boards and electrical 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
- A31-2.2.6. A-III/1-KUP 2.2.6 The interpretation of electrical and simple electronic diagrams
- A31-2.2.3. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage
- A31-2.2.4. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment
- A31-2.1.1b. A-III/1-KUP 2.1.1.2 Basic configuration and operation principles of the following electrical, electronic and control equipment: 2. electronic equipment: a) characteristics of basic electronic circuit elements, b) flowchart for automatic and control systems, c) functions, characteristics and features of control systems for machinery items, including main propulsion plant operation control and steam boiler automatic controls
- A36-1.3.2. A-III/6-KUP 1.3.2 Coupling and breaking connection between switchboards and distribution
- A36-1.3.1. A-III/6-KUP 1.3.1 Coupling, load sharing and changing over generators

**Full-or-part-time:** 3h
- Theory classes: 2h
- Laboratory classes: 1h
5. Electrical Equipment

Description:
Automation, static converters, Protection, Measuring Equipment.

Having knowledge about the operation of electrical distribution systems, generation plant, generators and their synchronization, motors and starting associated control circuits.

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
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
A31-2.2.2.3. A-III/1-KUP 2.2.3 Detection of electric malfunction, location of faults and measures to prevent damage
A31-2.2.2.4. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment
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
A31-2.1.1b. A-III/1-KUP 2.1.1.2 Basic configuration and operation principles of the following electrical, electronic and control equipment: .2 electronic equipment: .a) characteristics of basic electronic circuit elements, .b) flowchart for automatic and control systems, .c) functions, characteristics and features of control systems for machinery items, including main propulsion plant operation control and steam boiler automatic controls
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: 3h
Theory classes: 2h
Laboratory classes: 1h

6. Energy balance

Description:
Having knowledge about the operation of electrical distribution systems, power plant.

Related competencies:
A31-2.1.1b. A-III/1-KUP 2.1.1.2 Basic configuration and operation principles of the following electrical, electronic and control equipment: .2 electronic equipment: .a) characteristics of basic electronic circuit elements, .b) flowchart for automatic and control systems, .c) functions, characteristics and features of control systems for machinery items, including main propulsion plant operation control and steam boiler automatic controls
A36-1.3.2. A-III/6-KUP 1.3.2 Coupling and breaking connection between switchboards and distribution
A36-1.3.1. A-III/6-KUP 1.3.1 Coupling, load sharing and changing over generators

Full-or-part-time: 2h
Theory classes: 2h
7. Harmonic and transient

Description:
Having knowledge about the operation of electrical distribution systems, generation plant, generators and their synchronization, and start motors.

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: .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
A36-1.3.2. A-III/6-KUP 1.3.2 Coupling and breaking connection between switchboards and distribution
A36-1.3.1. A-III/6-KUP 1.3.1 Coupling, load sharing and changing over generators

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

8. Faults and troubleshooting

Description:
Understand the use of measuring equipment and electrical testing for locating common faults, power failures and maintenance and repair. Safety requirements for work on electrical systems on board. Use and safe operation of electrical equipment. Having the basic knowledge for the maintenance of electrical machines and their control systems.

Related competencies:
A31-2.2.6. A-III/1-KUP 2.2.6 The interpretation of electrical and simple electronic diagrams
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
A31-2.2.4. A-III/1-KUP 2.2.4 Construction and operation of electrical testing and measuring equipment
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
A31-2.2.5a. 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: 4h
Theory classes: 2h
Laboratory classes: 2h

ACTIVITIES

Laboratory Practices

Description:
Practice 5. Reviews and equipment for locating faults in electrical machines.

Full-or-part-time: 10h
Laboratory classes: 10h
GRADING SYSTEM

During the course there will be continuous evaluations, according to the following percentages:

Continuous evaluations 20% (Lab. practices, Lab. exams, Works, Expositions)
Partial Exam 40%
Final Exam 40%

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

EXAMINATION RULES.

Attendance and completion of the hands-on labs, is a compulsory requirement.

BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Other resources:
Notes and technical articles contributed by teachers in ATENEA