

## Course guide

# 280655 - 280655 - Internal Combustion Engines

Last modified: 27/05/2024

**Unit in charge:** Barcelona School of Nautical Studies  
**Teaching unit:** 742 - CEN - Department of Nautical Sciences and Engineering.

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

**Academic year:** 2024    **ECTS Credits:** 9.0    **Languages:** Spanish

### LECTURER

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**Coordinating lecturer:** MANUEL RODRIGUEZ CASTILLO

**Others:** Segon quadrimestre:  
MANUEL RODRIGUEZ CASTILLO - DT, GTM

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**  
GTM.CE30. Ability to design and manage energy optimization systems applied to marine installations.

**Transversal:**  
SCS N2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.

**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 1.4.1.1 Basic construction and operation principles of machinery systems, including: .1 marine diesel engine  
ME.4. A-III/1-KUP 1.4.1.9 Basic construction and operation principles of machinery systems, including: .9 fluid flow and characteristics of lubricating oil, fuel oil and cooling systems  
ME.5. A-III/1-KUP 1.4.2 Safety and emergency procedures for operation of propulsion plant machinery, including control systems  
ME.6. A-III/1-KUP 1.4.3.1 Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems: .1 main engine and associated auxiliaries  
ME.7. A-III/1-KUP 1.4.3.3 Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems: .3 auxiliary prime movers and associated systems  
ME.8. A-III/1-KUP 1.4.3.4 Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems: .4 other auxiliaries, including refrigeration, airconditioning and ventilation systems  
ME.9. A-III/1-3. Function: Maintenance and repair at the operational level  
ME.10. A-III/1-3.2 Maintenance and repair of shipboard machinery and equipment  
ME.11. A-III/1-KUP 3.2.1 Safety measures to be taken for repair and maintenance, including the safe isolation of shipboard machinery and equipment required before personnel are permitted to work on such machinery or equipment  
ME.12. A-III/1-KUP 3.2.2 Appropriate basic mechanical knowledge and skills  
ME.13. A-III/1-KUP 3.2.3 Maintenance and repair, such as dismantling, adjustment and reassembling of machinery and equipment  
ME.14. A-III/1-KUP 3.2.4 The use of appropriate specialized tools and measuring instruments  
ME.15. A-III/1-KUP 3.2.6 Interpretation of machinery drawings and handbooks  
ME.16. A-III/1-KUP 3.2.7 The interpretation of piping, hydraulic and pneumatic diagrams

### TEACHING METHODOLOGY

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Acquire, understand and synthesize knowledge.  
And solve problems.  
Prepare technical reports.  
Adopt solutions in practical cases.

## LEARNING OBJECTIVES OF THE SUBJECT

Understanding of the theoretical and practical operation of internal combustion engines.

Knowledge of the various types and their facilities on board.

Knowledge of the calculation of powers, jobs, performances, consumption, etc.

Know the concept of life cycle of a product and apply it to the development of products and services in the field of marine engineering, using the appropriate legislation and legislation.

On the other hand, one of the objectives of this subject is to give knowledge, understanding and aptitude of the competences of Annex III/1 of the STCW:

4. Operate the main and auxiliary machine and the corresponding control systems.

4.1 Basic principles of construction and operation of machinery systems, including:

.1 marine diesel engine

.9 fluid flow and characteristics of lubricating oil, fuel oil and cooling systems

4.2 Safety and emergency procedures for the operation of propulsion plant machinery, including control systems

4.3 Preparation, operation, fault detection and necessary measures to avoid damage to the elements of the machinery and systems of control:

.1 main engine and associated auxiliaries

.3 auxiliary primary engines and associated systems

9. Maintenance and repair of equipment and equipment on board

9.1 Safety measures to be taken for repair and maintenance, including the safe isolation of machinery and equipment from a the team requires equipment before the staff is ready to work on such equipment or equipment

9.2 Basic knowledge and basic skills

9.3 Maintenance and repair, such as disassembly, adjustment and assembly of equipment and equipment

9.4 The use of special tools and measuring instruments

9.5 Characteristics of design and selection of materials in the construction of equipment

9.6 Interpretation of drawings of machinery and manuals

9.7 The interpretation of pipelines, hydraulic and pneumatic diagrams

This knowledge is necessary in accordance with STCW Code A-III/1 and it's developed according to OFFICER IN CHARGE OF AN ENGINEERING WATCH (Model course 7.04) (2014 Edition)

## STUDY LOAD

Type	Hours	Percentage
Hours large group	90,0	40.00
Self study	135,0	60.00

**Total learning time:** 225 h

## CONTENTS

### Application and classification of internal combustion engines (MCI).

#### Description:

Study on the different applications of internal combustion engines and ranking.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

#### Fundamental concepts and general definitions of MCI.

**Description:**

Schematic and nomenclature of the reciprocating engine. The engine ignition. The compression ignition engine. Differences between MECh and MEC. Working fluid.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

#### Thermal cycles.

**Description:**

Analysis of a cycle and performance. Theoretical cycle and actual cycle. Theoretical Otto cycle. Theoretical Diesel cycle. Sabathé mixed cycle. Comparison cycles. Medium pressure cycle.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

#### Engine operating cycles two and four times.

**Description:**

Indicated cycle and mean pressure indicated. Differences between actual and theoretical cycles. Study diagram indicated. Pressure diagram.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

#### Organizational study of the engine.

**Description:**

Major Organs of the engines. Cylinders. Cylinder heads. Caucus. Pistons and segments. Biela. Crankshaft. Distribution mechanism. Valves. Subsidiary bodies. Construction characteristics.

**Specific objectives:**

4. Operate the main and auxiliary machine and the corresponding control systems.

4.1 Basic principles of construction and operation of machinery systems, including:

.1 marine diesel engine

.9 fluid flow and characteristics of lubricating oil, fuel oil and cooling systems

4.2 Safety and emergency procedures for the operation of propulsion plant machinery, including control systems

4.3 Preparation, operation, fault detection and necessary measures to avoid damage to the elements of the machinery and systems of control:

.1 main engine and associated auxiliaries

.3 auxiliary primary engines and associated systems

**Full-or-part-time:** 15h

Theory classes: 6h

Laboratory classes: 3h

Self study : 6h

### Calculation of powers, yields and consumptions.

**Description:**

Indicated power. Effective power. Power absorbed by passive resistance. Mean effective pressure. Yields.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

### Engine performance and factors that influence it.

**Description:**

Characteristic curves. Influence on the opening times of the valves. Loss of power. Specific consumption cash. Relationship between power and atmospheric conditions. Variables affecting engine performance.

**Specific objectives:**

9. Maintenance and repair of equipment and equipment on board

9.1 Safety measures to be taken for repair and maintenance, including the safe isolation of machinery and equipment from a the team requires equipment before the staff is ready to work on such equipment or equipment

9.2 Basic knowledge and basic skills

9.3 Maintenance and repair, such as disassembly, adjustment and assembly of equipment and equipment

9.4 The use of special tools and measuring instruments

9.5 Characteristics of design and selection of materials in the construction of equipment

9.6 Interpretation of drawings of machinery and manuals

9.7 The interpretation of pipelines, hydraulic and pneumatic diagrams

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

### Combustion and Fuels.

**Description:**

General. The fuel components. Power antiknock fuel. Additives. Properties of fuels. Marine Fuels.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

### Lubrication.

**Description:**

Lubricants. Functions of lubrication. Lubrication Systems. Characteristics of motor oil. Properties. Classification.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

### Forming the mixture.

**Description:**

Injection. Injection systems and elements.

The process combustion. Variables influencing ignition delay. Combustors. Direct and indirect injection. Functions of the injection system. Injection systems. Fuel metering.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

### Refrigeration.

**Description:**

Refrigerants. Systems and cooling elements.

Refrigeración. Cálculo function of the amount of heat extracted. Cooling systems. Forced circulation. Thermosyphon circulation. Cooling regulation.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

### Scavenging

**Description:**

General concepts. Scavenging systems. Cross scavenging . Uniflow scavenging. Tangential scanveiging. Back Scavenging.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

### Motor starting.

**Description:**

Systems and startup items. Reversible motors.

Engine starting systems. Electric start. Pneumatic starter. Distributor boot.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

### Supercharger.

**Description:**

Supercharging systems and components.

Supercharging systems. Types of compressors. Turbochargers. Multistage supercharging. EGR valve. Wastegate valve. Regulation.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h



### Rotary engines.

**Description:**

Wankel engine. Quasiturbine. Radmax. Ripalda. Round Engine. Application of rotary engines.

**Full-or-part-time:** 15h

Theory classes: 6h

Self study : 9h

## GRADING SYSTEM

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The final score is the sum of the following partial grades:

$$N_{\text{final}} = 0.7 N_{\text{pf}} + 0.3 N_{\text{elt}}$$

$N_{\text{final}}$ : final grade.

$N_{\text{pf}}$ : final test score.

$N_{\text{elt}}$ : scores of teaching and laboratory work.

The final test consists of a part with issues related to the learning objectives of the course in terms of knowledge or understanding concepts, and a set of application exercises.

The rating of teaching and laboratory work will consist of technical reports delivery practices and / or jobs.

A final test will be conducted reassessment students who meet the requirements established by the regulations of the center, which will consist of a single test in which all of the matter that will be assessed during the course.

## EXAMINATION RULES.

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If you have not done laboratory activities, work or evaluation, is considered not scored.

It is considered not submitted when not perform any tests.

## BIBLIOGRAPHY

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### Basic:

- Giacosa, Dante. Motores endotérmicos : motores de encendido por chispa: a carburación y a inyección, motores de encendido por compresión Diesel, lentos y rápidos, motores rotativos - turbinas de gas: teoría, construcción, pruebas. 3a ed. Barcelona: Omega, 1988. ISBN 8428208484.
- Payri González, Francisco; Desantes Fernández, José María. Motores de combustión interna alternativos. Valencia: Editorial UPV, 2011. ISBN 9788483637050.
- Cabronero Mesas, Daniel. Motores de combustión interna. 3a ed. corregida. Barcelona: L'autor, 2003. ISBN 8460449114.
- Woodyard, Doug (ed.). Pounder's marine diesel engines and gas turbines [on line]. 9th ed. Oxford [etc.]: Elsevier Butterworth Heinemann, 2009 [Consultation: 01/09/2022]. Available on: <https://www.sciencedirect-com.recursos.biblioteca.upc.edu/book/9780750689847/pounders-marine-diesel-engines-and-gas-turbines>. ISBN 9780750689847.
- Álvarez Flórez, Jesús A.; Callejón i Agramunt, Ismael; Forns Farrús, Sergi. Motores de combustión interna [on line]. Madrid: UNED Universidad Nacional de Educación a Distancia, [2005] [Consultation: 01/09/2022]. Available on: <https://lectura-unebook-es.recursos.biblioteca.upc.edu/viewer/9788436270860>. ISBN 9788436270860 .
- Rovira de Antonio, Antonio; Muñoz Domínguez, Marta. Máquinas y motores térmicos : introducción a los motores alternativos y a las turbomáquinas térmicas [on line]. Madrid: UNED Universidad Nacional de Educación a Distancia, [2016] [Consultation: 01/09/2022]. Available on: <https://lectura-unebook-es.recursos.biblioteca.upc.edu/viewer/9788436271034>. ISBN 9788436271034.
- Muñoz Domínguez, Marta; Rovira De Antonio, Antonio José. Máquinas térmicas [on line]. Madrid: UNED Universidad Nacional de Educación a Distancia, [2014] [Consultation: 01/09/2022]. Available on: <https://lectura-unebook-es.recursos.biblioteca.upc.edu/viewer/9788436268867>. ISBN 9788436268867.
- Gupta, Aman; Sharma, Shubham; Narayan, Sunny. Combustion engines : an introduction to their design, performance, and selection [on line]. Hoboken, NJ: John Wiley & Sons, [2016] [Consultation: 30/05/2022]. Available on: <https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/9781119284543>. ISBN 9781119284543.
- Nwaoha, Chikezie; Holloway, Michael D; Onyewuenyi, Oliver A. Process plant equipment : operation, control, and reliability [on line]. Hoboken, New Jersey: John Wiley & Sons, Inc, [2012] [Consultation: 01/09/2022]. Available on: <https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/9781118162569>. ISBN 9781118162569.

### Complementary:

- Carreras Planells, Ramón [et al.]. Motores de combustión interna : fundamentos. 2a ed. Barcelona: Edicions UPC, 1994. ISBN 8476534019.
- Heywood, John B. Internal combustion engine fundamentals. New York: McGraw-Hill, 1988. ISBN 007028637X.
- Kates, Edgar J. Motores diesel y de gas de alta compresión. Barcelona: Reverté, 1982. ISBN 842914837X.
- Lichty, Lester C. Procesos de los motores de combustión. Madrid: Ediciones del Castillo, 1970.
- Obert, Edward Frederic. Motores de combustión interna: análisis y aplicaciones. México: CECSA, 1966.
- Taylor, Charles Fayette. The Internal combustion engine in theory and practice, 2 vols. Massachusetts: MIT Press, 1985. ISBN 0262700263.
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- González Calleja, David. Motores térmicos y sus sistemas auxiliares. 2ª ed. Madrid: Paraninfo, [2015]. ISBN 9788428335546.
- The Motor ship. London: A.P.Chalkler, [1920]-.
- Ingeniería naval : revista editada por la Asociación de Ingenieros Navales de España. Madrid: Asociación de Ingenieros Navales de España, [1929]-.
- Marine propulsion & auxiliary machinery : the journal of ships' engineering systems. Einfeld: Riviera Maritime Media, 2003-.
- Karim, Ghazi A. Dual-Fuel diesel engines. Boca Raton, FL: CRC Press, 2021. ISBN 9780367783587.

## RESOURCES

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### Other resources:

Man Energy solutions [en línea] [Consulta: 28 juny 2021]. Disponible a: <<https://www.man-es.com>> /> Wärtsilä [en línea][Consulta: 28 juny 2021]. Disponible a: <<https://www.wartsila.com>></https:>