Course guide
280640 - 280640 - Applied Thermodynamics and Thermotechnics

Last modified: 27/05/2025

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

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

LECTURER

Coordinating lecturer: SERGIO IVÁN VELASQUEZ CORREA

Others: Primer quadrimestre:
SERGIO IVÁN VELASQUEZ CORREA - GTM
RAFAEL PACHECO BLAZQUEZ - DT, GESTN, MUENO

PRIOR SKILLS

It is necessary for the student to have a fluent mathematical domain (solving equations, systems of equations, total derivatives, partial derivatives, definite integrals, indefinite integrals and ordinary differential equations)

REQUIREMENTS

Mathematics principles I
Physics
Chemistry

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
GTM.18. Knowledge of applied thermodynamics and heat transfer.
GESTN.CE14. Applied knowledge of thermodynamics and heat transfer.

Transversal:
TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

STCW:
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 1.1.2 Basic knowledge of heat transmission, mechanics and hydromechanics

TEACHING METHODOLOGY

-A large part of the teaching methodology followed is of lectures in which the theory is developed.
-Other important part of the teaching methodology used is the case study. Problems arise which are analyzed, reflected and resolved. Students are invited to participate in these classes as it facilitates the learning of the whole classroom.
-The students are proposed to solve exercises and problems, in order to be able to apply the theory of the subject. This is the first step in developing problem-based learning.
- The students will be provided with tables and thermodynamic tools for the interactive resolution of the problems exposed in class

LEARNING OBJECTIVES OF THE SUBJECT

· To acquire knowledge of applied thermodynamics and be able to perform thermodynamic calculations and apply them to the materials that require it.
· To know the basics of heat transmission.
· To apply with solvency the concepts of heat transmission in the materials that require it.
· To study with books and articles in English and write a report or technical work in English.
· To provide the student with the ability to analyze the behaviour of basic power and cooling cycles.

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

1. Heat Transfer

Description:
Definition and mechanisms. Energy conservation principle

Full-or-part-time: 6h
Practical classes: 2h
Self study : 4h

2. Conducción

Description:
The driving term. Heat diffusion equation. One-dimensional conduction in steady state. The flat wall. Radial systems. Extended surfaces. Fins Two-dimensional conduction in steady state. Presentation of the analytical method. Resolution by the numerical method. Driving in a transitory state. Resolution of the explicit method with differences. Resolution with the implicit method with finite differences.

Full-or-part-time: 29h
Theory classes: 5h
Practical classes: 7h
Self study : 17h

3. Convección

Description:
Introduction to convection. Boundary layer. Laminar and turbulent flow. Equations for heat transfer by convection in the thermal boundary layer. Evaporative cooling. External flow. Internal flow. Free convection.

Full-or-part-time: 3h
Theory classes: 1h
Self study : 2h

4, Radiación

Description:
Fundamental concepts. Blackbody radiation. Real surfaces. Surface emissivity. Absorption, reflection and transmission. Relationship between emissivity and absorptivity. Environmental radiation. Radiation exchange between surfaces: Form factors. Radiation exchange between gray and diffuse surfaces in an enclosure.

Full-or-part-time: 18h
Theory classes: 4h
Guided activities: 4h
Self study : 10h

5. Heat Exchangers

Description:
A heat exchanger is a device for transferring heat energy from a fluid or substance at higher temperature to one of lower. The purpose of these devices is to prepare a substance or quantity of matter for various purposes, entrance to a process, an environment conditioning, heat removal systems that should remain at a constant temperature, evaporate or condense substances, etc.

Full-or-part-time: 10h
Theory classes: 1h
Guided activities: 2h
Self study : 7h

6. Conceptos básicos de Termodinamica

Description:
Introduction and definitions. Energy. Energy transfer. First Law of thermodynamics. Energy balance. Energy balance in cycles.

Full-or-part-time: 4h
Theory classes: 1h
Self study : 3h

7. Propiedades de las sustancias puras

Description:
Pure substances. Thermodynamic state. The p-v-T relationship. Entropy. Calculation of thermodynamic properties. Ideal gas equation of state.

Full-or-part-time: 3h
Theory classes: 1h
Self study : 2h

8. Análisis de energía en sistemas cerrados

Description:
Mobile border work. Energy balance for closed systems. Specific heat. Internal energy, enthalpy and specific heats of ideal gases. Internal energy, enthalpy and specific heats of solids and liquids.

Full-or-part-time: 10h
Theory classes: 1h
Guided activities: 2h
Self study : 7h

9. Análisis de masa y energía en volúmenes de control

Description:
Conservation of mass. Flow and energy work of a fluid in motion. Energy analysis in stable flow systems. Steady flow devices. Analysis of non-steady flow processes.

Full-or-part-time: 14h
Theory classes: 2h
Guided activities: 4h
Self study : 8h

10. Segunda ley de la Termodinámica

Description:
Introduction to the second law. Thermal energy deposits. Thermal machines. Refrigerators and heat pumps. Equivalence between the Kelvin-Planck statement and the Clausius statement. Perpetual motion machines. Reversible and irreversible processes. The Carnot cycle. Carnot principles. Carnot's heat engine. The Carnot refrigerator and the heat pump.

Full-or-part-time: 19h
Theory classes: 3h
Guided activities: 5h
Self study : 11h

11. Entropy

Description:
Entropy The principle of increasing entropy. Isentropic processes. Property diagrams involving entropy. What is entropy. TdS relationships. Entropy change in liquids and solids. Change of entropy in ideal gases. Reversible steady flow work. Minimization of compressor work. Isentropic efficiency of steady flow devices. Entropy balance.

Full-or-part-time: 20h
Theory classes: 4h
Guided activities: 5h
Self study : 11h

12. Power cycles

Description:
Power cycles are cycles which convert some heat input into a mechanical work output. Thermodynamic power cycles are the basis for the operation of heat engines, which supply most of the world's electric power and run the vast majority of motor vehicles. Power cycles can be organized into two categories: real cycles and ideal cycles. Cycles encountered in real world devices (real cycles) are difficult to analyze because of the presence of complicating effects (friction). Some cycles to be studied are:
Carnot
Rankine
Refrigeration
Stirling
Brayton
Diesel
Otto

Full-or-part-time: 12h
Theory classes: 1h
Guided activities: 3h
Self study : 8h

GRADING SYSTEM

The final grade of the subject is the result from summing the partial evaluations as follows:
Nfinal = 0,5 Npf + 0,3 Npp+ 0,2 Nac
Nfinal: Final grade
Npf: Final exam grade
Npp: Partial exam grade
Nac: Continuous evaluation process (quizes, homeworks, etc.)

The minimum mark of the exams must be 3.5 to be able to pass the subject

EXAMINATION RULES.

· The works required by the teacher must be delivered on the date indicated. All works delivered outside the indicated date will not be evaluated.
· It will be considered not presented to the student or student who does not attend the evaluable tests.
· All those works or partial tests not performed will be valued with a zero

BIBLIOGRAPHY

Basic:
- Incropera, Frank Paul; DeWitt, David P. Fundamentos de transferencia de calor. 4a ed. México: Prentice Hall, 1999. ISBN 9701701704.
- Kreith, Frank; Bohn, Merk S. Principios de Transferencia de calor. 6a ed. Madrid: International Thomson, 2002. ISBN 8497320611.
- Moran, Michael J. ; Shapiro, Howard N. Fundamentos de Termodinámica técnica. 2a ed. Barcelona: Reverté, 2004. ISBN 8429143130.
- Salla Tarragó, Josep M. [et. al.]. Termodinámica aplicada. Barcelona: UPC, 1994. ISBN 8476533802.
- Segura Clavell, José. Termodinámica técnica. Barcelona: Reverté, 1988. ISBN 8429143521.
- Montes Pita, María José. Teoría y problemas de transmisión de calor [on line]. Madrid: UNED Universidad Nacional de Educación a Distancia, [2015] [Consultation: 01/09/2022]. Available on: https://lectura-unebook-es.recursos.biblioteca.upc.edu/viewer/9788436270785. ISBN 9788436270785.
- 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.
- Çengel, Yunus A. [i altres]. Transferencia de calor y masa : fundamentos y aplicaciones [on line]. Sexta edición. México: McGraw-Hill, [2020] [Consultation: 01/09/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=10213. ISBN 9781456280048.
- Çengel, Yunus A; Boles, Michael A; Kanoglu, Mehmet; Navarro Salas, Rodolfo. Termodinámica [on line]. Novena edición. México, D.F.: McGraw-Hill, [2019] [Consultation: 01/09/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5808940. ISBN 9781456269166.

Complementary:
- Illa i Alibés, Josep; Cuchí Oterino, J. C. Problemes de Termotècnia. Vic: Eumo, 1990. ISBN 8476025580.
- Agüera Soriano, José. Termodinámica lógica y motores térmicos. Madrid: Ciencia 3, 1999. ISBN 8486204984.
- Electro-technical officer. IMO model course 7.08. London: International Maritime Organization, 2014. ISBN 9789280115802.

RESOURCES

Other resources:
NIST Chemistry WebBook
NIST Standard Reference Database Number 69
National Institute of Standards and Technology (NIST)
Thermophysical Properties of Fluid Systems
Access Link: https://webbook.nist.gov/chemistry/fluid/