POLI ESCOLA SUPERIOR TECNOLOGIA GESTÃO TÉCNICO GUARDA	**SUBJECT DESCRIPTION**	**MODELO** PED.013.03

Course	**Mechanical and Industrial Informatics**					
Subject	**Thermodynamics and Thermal Machines**					
Academic year	2023/2024	*Curricular year*	2nd	*Study period*	1st semester	
Type of subject	Compulsory	*Student workload (H)*	Total: 162	Contact: 60	*ECTS*	6
Professor(s)	*PhD* Jorge Gregório					
☒ *Area/Group Coordinator* ☐ *Head of Department*	*PhD* Rui Pitarma					

PLANNED SUBJECT DESCRIPTION

1. LEARNING OBJECTIVES

Develop an intuitive understanding of the concepts and basic principles of thermodynamics.

Correctly identify the concepts and apply the basic principles of thermodynamics, as well as to use the correct methodology to solve problems involving thermodynamic properties.

In particular, Students will acquire skills to:

- Apply mass conservation, energy conservation and entropy enhancement principles;
- Apply mass, energy and entropy balances to thermodynamic processes and current equipment, namely thermal motors and refrigeration machines;
- Analyse the basic operation of a thermal motor in general and a thermoelectric plant specifically;
- Analyse the basic operation of a refrigerating machine in general and a vapour compression refrigerator in particular;
- Analyse and relate the characteristic parameters of internal combustion engines (ICE);
- Identify key environmental issues of ICE.

2. PROGRAMME

1 - Fundamental concepts and behavior of substances: systems, properties, Zero Law of Thermodynamics, pure substances, phase diagrams, tables and the perfect gas equation.

2 - Thermodynamics First Law: Heat, work, energy conservation principle, mass and energy balances.

3 - Thermodynamics Second Law: Irreversibilities, thermal machines, thermal cycles, entropy increase principle, entropy balances and isentropic yield.

4 - Thermal engine cycles: Carnot engine cycle, Rankine cycle and steam turbines, Brayton cycle and gas turbines, internal combustion engine (ICE) cycles.

5 - Refrigeration cycles: Brayton Carnot, vapor compression, cascade refrigeration cycle and absorption refrigeration systems.

6 - Internal combustion engines (ICE): Engine types, operation and comparison of two and four stroke, SI (Otto) and CI (Diesel) engines, design and operating parameters, analysis of characteristic curves and environmental impact.

3. COHERENCE BETWEEN PROGRAMME AND OBJECTIVES

The programme contents aim to provide students with knowledge about Thermodynamics and Thermal Machines in order to integrate them in the world of work in the area of thermodynamics and thermal transformations. In particular, the contents aim to prepare students to become aware of the need to know how to do in the instrumental and operational areas. The outlined programme will also allow students to be able to develop their activity autonomously and productively applying the concepts learned, in companies / organizations.

Throughout the curricular unit, whenever possible, emphasis is given to the environmental and energy problems that will be relevant to environmental sustainability.

4. MAIN BIBLIOGRAPHY

Mandatory

[1] Cengel, Yunus A. and Boles, Michael A.; (2001). Termodinâmica, 3rd Edition, Portuguese edition, Mechanical Engineering Series, Lisbon. McGraw-Hill. [536.7 CEN].

[2] Moran, Michael J.; and Shapiro, Boettner, Daisie D., Bailey, Margaret B.; (2015). Princípios de Termodinâmica para engenharia, 7rd Ed, SI Version, New York. WILEY. [536.7 MOR].

[3] Haar, Lester, Gallagher John S. and Kell, George S.; (1984). NBS/NRC STEAM TABLES - Thermodynamic and transport properties and Computer Programs for Vapor and liquid States of Water in SI units, New York. Hemispher Publishing. [536.7 HAA].

[4] Giacosa, Dante; (1986). Motores endotérmicos, 3.ª Edicion, Madrid. Editorial Dossat.

[5] Heywood, John B.; (1988). Internal Combustion Fundamentals, New York. McGraw-Hill.

[7] Gregório, Jorge; (2022) Apontamentos e exercícios de Termodinâmica e Máquinas Térmicas, IPG, Guarda

Recommended

[8] Jones, J. B. and Hawkins G. A.; (1986). Engineering Thermodynamics, 2nd Edition, New York. WILEY. [536.7 JON].

[9] Sonntag, Richard E., Borgnakke, Claus; (2007). Introduction to Engineering Thermodynamics, 2nd Edition, New York. WILEY.

[10] Bosch, Robert, (2022) Automotive Handbook, 11th edition, John Wiley & Sons, Chichester.

5. TEACHING METHODOLOGIES (INCLUDING EVALUATION)

The programmed contents privilege the interconnection between the theoretical and practical components. The theoretical aspects presented by the expository, demonstrative and interrogative methods supported by the board or using slides presentation will be, whenever possible, explored in the laboratory environment.

During the semester students should carry out project group and laboratory work.

The aim is to encourage practical aspects so that learning develops towards future professional activities with group work and demonstrations. These practical works will always be presented in reports that will be evaluated.

Evaluation: written test (70%), practical work (30%).

Classification equal to or greater than 10 values in 20 values allows you to obtain syllabus approval

6. COHERENCE BETWEEN TEACHING METHODOLOGIES AND OBJECTIVES

The teaching methodologies used in theoretical and practical classes such as interactive exposition, dialogue, demonstrative, interrogative, case study and problem-solving methodology allow students to develop an intuitive understanding of the basic principles of thermodynamics. They also enable them correctly identify concepts and apply fundamental principles of thermodynamics, as well as use the correct methodology to solve problems involving energy and entropy mass balances. The methodologies used help to understand the basic operation of an engine and analyze from an energy point of view a thermoelectric power plant or a refrigeration machine and identify its main environmental impacts.

7. ATTENDANCE

Students must be present in all classes to make the course more interactive and interesting to reach the proposed objectives with greater efficiency.

8. CONTACTS AND OFFICE HOURS

Contacts of the coordinator of the subject area and the professor of the course

Coordinator of the subject area

Name: PhD Rui Pitarma

Email: rpitarma@ipg.pt

Professor of the course

Name: PhD Jorge Gregório

Email: jgregorio@ipg.pt

Telephone: 271 220 120 – ext: 1214

Office nº14

Telephone: 271 220 120 – ext:1205

Telephone: 963 000 921

Office nº5

Attendance hours: Monday: 09:00 to 11:00.

9. OTHERS

Other than attendance, students must be punctual in classes and avoid unnecessary interruptions.

DATE: 11 de setembro de 2023

SIGNATURES

Professor(s), Area/Group Coordinator or Head of Department signatures

Area/Group Coordinator

(*PhD Rui Pitarma*)

Professor

(*PhD Jorge Gregório*)