Course Unit	Applied Thermodynamics			Field of study	Energy		
Bachelor in	Renewable Energy Engineering			School	School of Technology and Management		
Academic Year	2021/2022	Year of study	2	Level	1-2	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9910-743-2205-00-21		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			-	30	30	-	-	-	-	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Manuel Luís Pires Clara

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. understand the importance of the second law in of thermodynamics in the characterization of the processes.
2. recognize the importance of entropy in the performance of the devices.
3. know characterize the different thermodynamic cycles of generating power identifying the conditions of application of each.
4. recognize the importance and knowing the effects of the changes and modifications in the cycles such as the reheat and regeneration.
5. identify the different thermodynamic refrigeration cycles and systems.

Prerequisites

Before the course unit the learner is expected to be able to:
1. Mastering of the basic knowledge of Mathematics Physics and Chemistry;
2. Apply the basic concepts of thermodynamics: units and thermodynamic properties;
3. Use the tables of the thermodynamic properties of pure substances and ideal gases;
4. Distinguish heat and work and apply the 1st law of thermodynamics to closed and open systems.

Course contents

Introduction (Brief Review of the Second Law and Entropy). Gas Power Cycles. Steam and Combined Power Cycles. Refrigeration Cycles.

Course contents (extended version)

1. The Second Law of Thermodynamics (Review)
   - Heat Engines, Refrigerators and Heat Pumps; Cycle, Heat Engine, Refrigerator and Carnot Principles.
2. Entropy (Review)
   - Entropy; Entropy Increase Principle; Entropy Change; Adiabatic Efficiencies.
3. Gas Power Cycles
   - Brayton Cycle with Ideal Regeneration, Cooling and Intermediate Reheat.
4. Steam and Combined Power Cycles
   - Rankine Cycle with Regeneration and Reheat; Cogeneration; Binary Cycles; Gas-Steam Combined Cycles.
5. Refrigeration Cycles
   - Ideal Vapor Compression Refrigeration Cycle; Absorption Refrigeration Systems.

Recommended reading

1. Y. Çengel, M. A. Boles and M. Kanolu, Thermodynamics: An Engineering Approach. Ninth edition. | New York, NY : McGraw-Hill Education, [2019]
2. M. J. Moran and H. N. Shapiro. Fundamentals of Engineering Thermodynamics. 8th ed. New York: John Wiley & Sons, 2014.
3. R. W. Haywood. Analysis of Engineering Cycles. Pergamon Press, 1991.

Teaching and learning methods

The unit will be taught using a combination of lectures such as: self guided learnig, pratice classes and laboratory assignments. A study guide and support material will be provided to the students.

Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final)
   - Intermediate Written Test - 30% (Initial Test.)
   - Intermediate Written Test - 35% (Intermediate Test.)
   - Intermediate Written Test - 35% (Final Test.)
2. Alternative 2 - (Regular, Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100%

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Manuel Luís Pires Clara	João Eduardo Pinto Castro Ribeiro	Ana Maria Alves Queiroz da Silva	Paulo Alexandre Vara Alves
03-03-2022	04-03-2022	04-03-2022	19-03-2022