INSTITUTO POLITÉCNICO DE BRAGANÇA

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| Course Unit | Option I - Applied Physics for Engineering | | | Field of study | Physics | | |
| Master in | Renewable Energy and Energetic Efficiency | | | School | School of Technology and Management | | |
| Academic Year | 2011/2012 | Year of study | 1 | Level | 2-1 | ECTS credits | 6.0 |
| Type | Semestral | Semester | 1 | Code | 6793-475-1101-02-11 | | |

| Workload (hours) | 162 | Contact hours | T - | TP 60 | PL - | TC - | S - | E - | OT - | O - |
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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): José Alexandre de Carvalho Gonçalves, Simão Pedro de Almeida Pinho

## Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Recognize the importance of thermodynamics in the design, development and operation of processes, pursuing an efficient use of energy.
2. Apply thermodynamic laws to obtain energy efficiency use in processes.
3. Explain the operation and performance of gas and vapor cycles for energy production.
4. Analyse, interpret and apply experimental information, as well as equations of state, to solve mass and energy balances, and describe thermodynamically a pure substance.
5. know the basic concepts of circuit analysis: Ohm's Law, Kirchoffs laws, voltage and current divisors, superposition theorem, Thévenin and Norton's Theorems.
6. Identify and know the basic principles of typical electronic devices commonly used in analogue electronic systems.
7. Identify, understand and project the functional blocks of a measurement system.

## Prerequisites

Before the course unit the learner is expected to be able to:
1. Apply mathematics, particularly differential and integral calculus.
2. Use of informatic tools such as MATLAB or MS Excel.

## Course contents

Fundamental Concepts. Thermodynamic Properties of Pure Substances. First Law of Thermodynamics. Second Law of Thermodynamics. Exergetic Analysis. Gas, Power and Combined Power Cycles. Basic concepts of circuit analysis and analogue electronics. Functional blocks of a measurement system.

## Course contents (extended version)

1. Fundamental Concepts
   - Dimensions and units. System and surroundings.
   - Temperature scale, force, pressure and volume. Thermodynamics and energy.
2. Thermodynamic Properties of Pure Substances
   - Phases of a pure substance. Phase changes. Property diagrams and tables.
   - The ideal gas equation. Compressibility factor and equations of state.
3. First Law of Thermodynamics
   - Heat and mechanical forms of work. 1st law of thermodynamics: closed and steady-flow processes.
   - Internal energy, enthalpy and specific heats.
4. Second Law of Thermodynamics
   - Thermal energy reservoirs. Energy conversion efficiencies.
   - Reversible and irreversible processes. Carnot engine. Entropy. Second law of thermodynamics.
   - Isentropic efficiencies of steady-flow devices. Entropy balance.
5. Exergetic Analysis
   - Reversible work and irreversibility. Exergy changes and transfer.
   - Closed systems and control volumes exergy balance.
6. Gas, Vapor and Combined Power Cycles
   - Otto, Diesel, Brayton and Rankine cycles. Cogeneration. Combined gas-vapor power cycles.
7. Circuit analysis
   - Concept of electric charge, electric current
   - Joule effect.
   - Conductor resistance.
   - Concepts of voltage and electric power.
   - Ohm and Kirchoff laws.
   - Current and voltage sources.
   - Direct current circuit analysis.
   - . Superposition Theorem.
   - Thévenin and Norton theorems.
   - Voltage and current divisors.
8. Analogue electronics
   - Operational amplifiers: Ideal and non ideal characteristics.
   - Diodes: Limitative circuits, Zener's diodes and their applications.
   - Filters: Analysis and implementation.

## Recommended reading


1. S. Sieniutycz e A. De Vos, Thermodynamics of Energy Conversion and Transport, 1st Edition, Springer-Verlag, 2000.
2. Y. A. Çengel e M. A. Boles, Thermodynamics: An Engineering Approach, 3rd Edition, McGraw-Hill, 1998.
3. R. A. Bartkpwiak, "Electric circuit analysis", Wiley, 1985.
4. S. Franco, "Design with operational amplifiers and analog integrated circuits", McGraw Hill, 1997.
5. R. Pallas-Areny, J. G. Webster, "Sensors and signal conditioning", John Wiley & Sons, 1993.


## Teaching and learning methods

Theoretical analysis of fundamental tools and concepts for the compreension, application and calculations in the thermodynamics area. Presentation of practical examples and model exercices. Problem solving and critical analysis of the results. Evaluation of homework. Development of application projects.

## Assessment methods

- Alternative 1 - (Regular, Student Worker) (Final, Supplementary, Special)
  - Practical Work - 30%
  - Final Written Exam - 70%

## Language of instruction

Portuguese, with additional English support for foreign students.

## Electronic validation

| José Alexandre de Carvalho Gonçalves, Simão Pedro de Almeida Pinho | Maria Filomena Filipe Barreiro | Fernando Jorge Coutinho Monteiro | Paulo Jorge Pinto Leitão | Luís Manuel Frolen Ribeiro | Albano Agostinho Gomes Alves |
|---|---|---|---|---|---|
| 28-09-2011 | 28-09-2011 | 30-09-2011 | 03-10-2011 | 24-10-2011 | 01-11-2011 |