Last update: 06-05-2019

230462 - TERMO - Thermodynamics

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics
Academic year: 2019
Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Teaching unit Compulsory)
ECTS credits: 6 Teaching languages: Catalan

Teaching staff

Coordinator: LUIS CARLOS PARDO SOTO

Others: JOSE LUIS TAMARIT MUR

Degree competences to which the subject contributes

Specific:

1. Ability to solve problems in thermodynamics, heat transfer and fluid mechanics, in the fields of physics, aerodynamics, geophysics and engineering.

Generical:

3. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

Transversal:

1. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

Teaching methodology

There will be three theoretical and two practical weekly sessions. The theoretical lectures will be devoted to a careful presentation of the basic concepts and the main results which will be illustrated with some examples. The practical sessions will be devoted to the solution of a variety of exercises and problems.

Learning objectives of the subject

* Comprehension of basical principles in which thermodynamics is based
* Aplications of these concepts to the solving of practical problems
* Comprehensión of the link with other fields in physics and engineering

Study load

Total learning time: 150h	Hours large group:	65h	43.33%
	Self study:	85h	56.67%

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Content

1. Basic concepts

Learning time: 9h 11m

Theory classes: 2h 30m
Practical classes: 1h 36m
Self study : 5h 05m

Description:
Introduction thermodynamics. Thermodynamic system, variable thermodynamic equilibrium state, transformation thermodynamics. Zero principle and Temperature. Thermometers and empirical thermometric scales.

2. Monocomponent simple systems

Learning time: 19h 12m

Theory classes: 5h 50m
Practical classes: 3h 12m
Self study : 10h 10m

Description:
Simple Systems: Definition and Properties. PVT simple systems: thermal equation of state and thermal coefficients. Ideal Gas. Real gases and PVT surface . Vapor-liquid, solid-liquid and solid vapor equilibria. Triple point and critical point. Polymorphism. Thermal equation of state of real gas. Law of corresponding states. Compressibility factor.

3. Calorimetry and heat propagation

Learning time: 17h 13m

Theory classes: 4h 10m
Practical classes: 1h 36m
Self study : 11h 27m

Description:
Heat capacity. Specific heat. Heat transmission. Thermal conductivity. Fourier law. Thermal conductivity: one-dimensional and stationary. Dimensional transient conduction. Convection of heat. Thermal black body radiation. Stefan-Boltzmann law and Wien's law.

4. Firs law of thermodynamics

Learning time: 14h 22m

Theory classes: 4h 20m
Practical classes: 2h 24m
Self study : 7h 38m

Description:
Expansion work on simple systems PVT. Dissipative work. Conjugate variables and configuration work on other simple systems: work surface, working torque, electric and magnetic polarization work. First Principle of Thermodynamics. Internal energy. Enthalpy.

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5. First law of thermodynamics: energetic properties and aplications	Learning time: 13h 38m Theory classes: 3h 36m Practical classes: 2h 24m Self study : 7h 38m

Description:
Gay Lussac-Joule experiment. Energetic properties of ideal gas: Joule's law. Joule-Kelvin experiment. Energetic properties of real gas: Generalized Joule's law. Energetic properties of a simple PVT system. Transformations of an ideal gas thermodynamic.

6. Second law of thermodynamics: Heat engines	Learning time: 14h 22m Theory classes: 4h 20m Practical classes: 2h 24m Self study : 7h 38m

Description:
Heat engines, fridges and termobombes. Carnot cycle. Second Law of Thermodynamics: Statements of Clausius and Kelvin-Planck. Carnot's theorem. Examples of engines: Otto Cycle, Diesel Cycle.

7. Second law of thermodynamics: Entropy	Learning time: 11h 21m Theory classes: 3h Practical classes: 2h Self study : 6h 21m

Description:
Clausius theorem. Entropy. Entropy of an ideal gas. Entropy of a mixture of ideal gases. Entropic statement of Second Law of Thermodynamics. Heat and TS diagram. Principle of Carathéodory. Degradation of energy. Absolute scale of temperature. Entropy and disorder.

8. First and second law in open systems	Learning time: 18h 10m Theory classes: 4h 48m Practical classes: 3h 12m Self study : 10h 10m

Description:
Volume control. Principle of conservation of mass in a volume control. Principle of conservation of energy in a volume control. Energy equations in a volume control. Engineering applications in stationary regime. Balance of entropy in a volume control. Analysis entropic processes in stationary regime.

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9. Thermodynamic potentials	Learning time: 14h 21m Theory classes: 4h 19m Practical classes: 2h 24m Self study : 7h 38m

Description:
Thermodynamic potential in simple systems pvt. Maxwell relations. Equilibrium conditions. Equations TdS. Mayer relationships in simple PVT systems. Generalization of the Maxwell relations to other simple systems. Mayer generalized equation. Joule-Kelvin coefficient. General conditions of equilibrium. Fluctuations. Le Chatelier's principle.

10. Phase transition in monocomponent systems	Learning time: 13h 38m Theory classes: 3h 36m Practical classes: 2h 24m Self study : 7h 38m

Description:
Condition of phase equilibrium in simple PvTsystems. First-order phase transitions: Clausius-Clapeyron equation. Stable and metastable domains. Undercooled liquids and glass transition. Higher-order phase transitions: theories of Ehrenfest and Landau. Superconducting transition. Critical phenomena. Lambda transition in 4He. Liquid and solid helium. Ferromagnetic transition.

11. Absolut zero and third law of thermodynamics	Learning time: 4h 32m Theory classes: 1h 12m Practical classes: 0h 48m Self study : 2h 32m

Description:
Inaccessibility of absolute zero. Postulates of Nernst and Planck statement of the third law of thermodynamics. Thermodynamic properties near absolute zero. Summary of the principles of thermodynamics from an axiomatic point of view.

Qualification system

There will be a final exam (EF) and a partial exam (EP). The students' participation in practical sessions will be also taken into account (P). The final score will follow from max{EF, 0.65*EF + 0.30*EP + 0.05*P}

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Bibliography

Basic:

Ortega Girón, Manuel R.; Ibañez Mengual, José A. Lecciones de física: termología. 5a ed. Murcia: Diego Marin, 2003. ISBN 8484253341.

Aguilar Peris, José. Curso de termodinámica. Madrid: Alhambra, 2006. ISBN 8420513822.

Barrio Casado, María del [et al.]. Problemas resueltos de termodinámica. Madrid: Thomson, 2005. ISBN 8497323491.

Barrio, M. del [et al.]. Termodinámica básica: ejercicios [on line]. 2006. Barcelona: Edicions UPC, 2006 [Consultation: 10/03/2015]. Available on: <http://hdl.handle.net/2099.3/36828>. ISBN 9788483018712.

Complementary:

Sears, F.W.; Salinger, G.L. Termodinámica, teoría cinética y termodinámica estadística. 2a ed. Barcelona: Reverté, 2002. ISBN 978-8429141610.

Zemansky, Marc Waldo; Dittman, Richard H. Calor y termodinámica. 6a ed. Madrid: McGraw-Hill, 2009. ISBN 8485240855.

Çengel, Yunus A.; Boles, Michael A. Termodinámica. 7a ed. México: McGraw-Hill Interamerica-na, 2009. ISBN 9786071507433.