



Universitat de Lleida

DEGREE CURRICULUM
**THERMODYNAMICS AND HEAT
TRANSMISSION**

Coordination: CANTERO GÓMEZ, M. ROSA

Academic year 2018-19

Subject's general information

Subject name	THERMODYNAMICS AND HEAT TRANSMISSION			
Code	102331			
Semester	1st Q(SEMESTER) CONTINUED EVALUATION			
Typology	Degree	Course	Character	Modality
	Not informed	2	COMPULSORY	Attendance-based
	Bachelor's degree in Industrial Organisation and Logistics Engineering	2	COMPULSORY	Attendance-based
Course number of credits (ECTS)	6			
Type of activity, credits, and groups	Activity type	PRALAB	PRAULA	TEORIA
	Number of credits	1	2	3
	Number of groups	3	2	2
Coordination	CANTERO GÓMEZ, M. ROSA			
Department	COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING			
Teaching load distribution between lectures and independent student work	60 h lectures (40 %) 90 h Autonomous work (60 %)			
Important information on data processing	Consult this link for more information.			
Language	Catalan			
Distribution of credits	3 theoretical credits 3 practical credits			

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CANTERO GÓMEZ, M. ROSA	rosa.cantero@udl.cat	13	

Subject's extra information

Compulsory subject taught during the first semester of the second year of the Degree in Chemical Engineering and the Degree in Engineering in Industrial Organization and Logistics.

Continuous work is required throughout the semester in order to achieve the objectives of this subject. It is highly recommended that students visit the Virtual Campus associated with the subject on a frequent basis and that they communicate with the professor via their personal email address directly instead of using the Virtual Campus messaging system only.

Learning objectives

- Capacity to understand thermodynamics and its principles.
- Capacity to understand the different mechanisms of heat transmission.
- Capacity to understand the power and refrigeration cycles.
- Capacity to understand the concepts of psychrometry.
- Capacity to critically analyze and synthesize the knowledge acquired.
- Capacity to obtain data of fluid properties from tables and diagrams with solvency.
- Capacity to use the knowledge acquired to solve engineering problems related to thermodynamics and heat transmission.
- Capacity to reason and analyze the results obtained from the problems worked on, thus deepening critical thinking.

Competences

Basic competences

- **B01.** That students have demonstrated to possess and understand knowledge in an area of study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply knowledge coming from the vanguard of his/her field of study.
- **B02.** That students know how to apply their knowledge to their work or vocation in a professional manner and possess the skills that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.
- **B04.** That students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.

General competences

- **CG3.** To synthesize basic and technological subjects, which enable them to learn new methods and theories, and provide them with versatility to adapt to new situations.
- **CG4.** To solve problems with initiative, make decisions, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Chemical Engineering.
- **CG6.** To implement specifications, regulations and mandatory rules.
- **CG10.** To work in a multilingual and multidisciplinary environment.

Specific competences

- **CE2.** To conceptualize and command the fundamental concepts about the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application to solve problems in engineering.
- **CE7.** To conceptualize applied thermodynamics and heat transmission. To recognize the basic principles and their application to solving engineering problems.

Transversal competences

- **CT1.** To develop a proper understanding and oral and written expression of Catalan and Spanish.
- **CT3.** To implement new technologies and technologies of information and communication.
- **CT5.** To apply essential notions of scientific thinking.

Subject contents

1. Properties of gases

- 1.1. PVT behavior of ideal gases
- 1.2. Ideal gas mixtures
- 1.3. Non-ideal behavior of gases
- 1.4. The Virial equation of state
- 1.5. Condensation of gases
- 1.6. Critical point
- 1.7. Van der Waals equation of state
- 1.8. Law of corresponding states

2. Phase equilibrium

- 2.1. Phase rule
- 2.2. Diagrams P-T: one-component phase equilibrium
- 2.3. Clausius-Clapeyron equation

3. Work and heat

- 3.1. Work
 - 3.1.1. Expansion or compression work
 - 3.1.2. Other forms of work
- 3.2. Heat transfer
 - 3.2.1. Conduction
 - 3.2.2. Convection
 - 3.2.3. Radiation

4. First law of thermodynamics

- 4.1. First law of thermodynamics
- 4.2. Enthalpy
- 4.3. Specific heat
- 4.4. Calculation of magnitudes included in the first law of thermodynamics

5. Second and third laws of thermodynamics

- 5.1. Heat engines, heat pumps and refrigerators
- 5.2. Enunciates of the second law of thermodynamics
- 5.3. Carnot machine
- 5.4. Carnot efficiency
- 5.5 Entropy
- 5.6. Entropy change for an ideal gas
- 5.7. Entropy change for vapors, solids and liquids
- 5.8. The inequality of Clausius
- 5.9. Entropy change for an irreversible process
- 5.10. Entropy and third law of thermodynamics

6. Vapor power and refrigeration cycles

- 6.1. Rankine cycle
- 6.2. Rankine cycle efficiency
- 6.3. Reheat cycle
- 6.4. Regenerative cycles
- 6.5. Losses on power cycle efficiency
- 6.6. Vapor refrigeration cycle
- 6.7. Heat pump

7. Gas power and refrigeration cycles

- 7.1. Air standard cycle
- 7.2. Otto cycle
- 7.3. Diesel cycle
- 7.4. Brayton cycle
- 7.5. Regenerative Brayton cycle
- 7.6. Gas refrigeration cycle

8. Psychrometry

- 8.1. Mixture of water vapor and dry air
- 8.2. Adiabatic saturation
- 8.3. Wet bulb temperature
- 8.4. Psychrometric diagram
- 8.5. Air conditioning processes

Methodology

- Lectures in which the theoretical concepts of each topic are introduced, illustrating them with examples.
- Problem-solving sessions in which students take an active part in their learning process working in small groups or individually.
- Work of a practical case in small groups.

Development plan

Week	Methodology	Contents	Lecture hours	Autonomous work hours
1-2	Lecture. Problem solving.	Presentation subject. 1. Properties of gases.	6	9
2-3	Lecture. Problem solving.	2. Phase equilibrium	4	6
3-5	Lecture. Problem solving.	3. Work and heat. Presentation case study.	9	13
5-7	Lecture. Problem solving.	4. First law of thermodynamics	6	10
7-8	Lecture. Problem solving. Practical case.	5. Second and third laws of thermodynamics. Work practical case.	7	12
9		Evaluation. Written test.		
10-12	Lecture. Problem solving. Practical case.	6. Vapor power and refrigeration cycles. Work practical case.	9	15
12-14	Lecture. Problem solving. Practical case.	7. Gas power and refrigeration cycles. Work practical case.	9	15
14-15	Lecture. Problem solving. Practical case.	8. Psychrometry. Work practical case.	6	10

16-19		Evaluation. Written test. Referral exam.		
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Evaluation

- **Assessment activity 1 (AA1):** Midterm exam, units 1-5 (20% of the final qualification).
- **Assessment activity 2 (AA2):** Final exam, units 1-8 (50% of the final qualification).
- **Assessment activity 3:** Individual controls of the problems worked on in group and active participation in the work sessions (15% of the final qualification).
- **Assessment activity 4:** Work in the practical case (15% of the final qualification).

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Referral exam: Units 1-8. Allows students to obtain up to 70% of the final grade (equivalent to AA1 + AA2).

Bibliography

- Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey. "Fundamentals of Engineering Thermodynamics", 7th Edition, Wiley, 2010. ISBN-10: 0470917687.
- Potter, Merle C., Scott, Elaine P., Termodinámica. Thomson, 2006. ISBN: 9789706865656.
- Yunus A. Çengel, Michael A. Boles, "Thermodynamics, an engineering approach", 4th Edition, McGraw-Hill, 2001. ISBN: 0-07-238332-1.
- Y. A. Çengel, "Heat Transfer. A practical approach", McGraw-Hill, 1998. ISBN: 0-07-011505-2.