Universitat de Lleida

DEGREE CURRICULUM

THERMAL ENGINEERING II

Coordination: MARTORELL BOADA, INGRID

Academic year 2022-23

THERMAL ENGINEERING II 2022-23

Subject's general information

Subject name	THERMAL ENGINEERING II
Code	102301
Semester	1st Q(SEMESTER) CONTINUED EVALUATION
Typology	

Degree	Course	Character	Modality
Bachelor's Degree in Energy and Sustainability Engineering	3	COMPULSORY	Attendance-based
Bachelor's Degree in Mechanical Engineering	3	COMPULSORY	Attendance-based
Double bachelor's degree: Degree in Mechanical Engineering and Degree in Energy and Sustainability Engineering	3	COMPULSORY	Attendance-based

Course number of credits (ECTS)	6
Type of activity, credits, and groups	

Activity type	PRALAB	PRAULA	TEORIA
Number of credits	0.4	2.6	3
Number of groups	6	2	1

Coordination	MARTORELL BOADA, INGRID
Department	COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING
Teaching load distribution between lectures and independent student work	Classes will be in the classroom It is considered that the work done in classroom represents 40 % of the total work of the student. 60 h lectures (40%) 90 h autonomous work (60%)
Important information on data processing	Consult this link for more information.
Language	Catalan 100%

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
ERAS VILA, JOSEP ANTONI	josep.eras@udl.cat	,8	
MARTORELL BOADA, INGRID	ingrid.martorell@udl.cat	8,8	
MEDRANO MARTORELL, MARCO	marc.medrano@udl.cat	1	

Subject's extra information

Thermal Engineering II is a compulsory subject taught in third course during the first semester in the GEM and GEES.

This course requires continuous work throughout the semester in order to achieve the goals. It is recommended to visit frequently the Virtual Campus, where course information is announced. We recommend using direct mail instead of the teacher's personal email in the Messaging Virtual Campus.

The course is a journey through the different principles of thermodynamics and refrigeration and power cycles are also covered.

It is **COMPULSORY** that the students bring the following elements of individual protection (EPI) to the practices at the laboratory.

- Blue or white laboratory gown from UdL (unisex)
- Protection glasses
- Mechanical protection gloves

They can be purchased through the shop Údels of the UdL:

C/ Jaume II, 67 baixos
Centre the Cultures i Cooperació Transfronterera

http://www.publicacions.udl.cat/

The use of other elements of protection (for example caps, masks, gloves of chemical or electrical risk, etc.) will depend on the type of practice to be done. In that case, the teacher will inform of the necessity of specific EPI.

Not bringing the EPI's described or not fulfilling the norms of general security that are detailed below imply that the student can not access to the laboratories or have to go out of them. The no realisation of the practices for this reason imply the **consequences in the evaluation** of the subject that are described in this course guide.

GENERAL NORMS OF SECURITY IN LABORATORY PRACTICES

- Keep the place of realisation of the practices clean and tidy. The table of work has to be free from backpacks, folders, coats…
- No short trousers or short skirts are allowed in the laboratory.
- Closed and covered footwear is compulsory in the laboratory.
- Long hair needs to be tied.
- Keep the laboratoy gown laced in order to be protected from spills of chemicals.
- Bangles, pendants or wide sleeves are not allowed as they can be trapped.
- Avoid the use of contact lenses, since the effect of the chemical products is much bigger if they enter between the contact lense and the cornea. Protection over-glasses can be purchased.
- No food or drink is allowed in the laboratory.
- It is forbidden to smoke in the laboratories.
- Wash your hands whenever you have contact with a chemical product and before going out of the laboratory.
- Follow the instructions of the teacher and of the laboratory technicians and ask for any doubt on security.

For further information, you can check the following document of the *Servei de Prevenció de Riscos Laborals de la UdL*: http://www.sprl.udl.cat/alumnes/index.html

Learning objectives

• Obtain the necessary data of physical properties of fluids in tables and diagrams with solvency.
• Be able to numerically solve the problems of thermodynamics.
• Be able to argue the results with critical thinking
• Be able to critically analyze and synthesize concepts learned in the course
• Learn the theoretical and practical knowledge of thermal energy.
• Understand the basic principles of power and cooling cycles.

Competences

- **CB2.** That students know how to apply their knowledge to their work or vocation in a professional way 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.
- **CB3.** That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant issues of a social, scientific or ethical nature.
- **CB5.** That the students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.
- **CG2.** Understand and master the basic concepts of the general laws of mechanics, thermodynamics, fields and waves, and electromagnetism and their application to solve engineering problems.
- **CG7.** To have knowledge in applied thermodynamics and heat transfer, basic principles, and its applicationin solving engineering problems.
- **CG8.** Have knowledge of the basic principles of fluid mechanics and their application to problem solving in the field of engineering and know how to calculate pipes, channels and fluid systems..
- **CT2.** Master a foreign language, especially English.
- **CT5**.To acquire essential notions of scientific thinking.
- **EPS1**. Capacity to solve problems and prepare and defence arguments inside the area of studies.
- **EPS6**. Capacity of analysis and synthesis.
- **GEM21**. Applied knowledge of thermal engineering.
- **GEM24/CE3**. To applied knowledge of the fundamentals of fluid-mechanical systems and machines.

Subject contents

1. Properties of pure substances

1.1. Pure substances

1.2. Phases of a pure substance

1.3. Change processes do a pure substance

1.4. Property diagrams for phase change processes

1.5. Property tables

1.6. Ideal gas equation of state

1.7. The compressibility factor - a measure of the deviation from ideal gas

1.8. Specific heat

1.9. Internal energy, enthalpy and specific heat of ideal gases

1.10. Internal energy, enthalpy and specific heat of solids and liquids

1.11. Problem properties pure substances

2. First law of thermodynamics

2.1. The first principle of thermodynamics

2.2. Energy balance for closed systems

2.3. Energy balance for steady state systems

2.4. Some stationary equipment engineering

2.5. Energy balance for non-steady state processes

2.6. Problems first principle of thermodynamics

3. Second law of thermodynamics

3.1. Introduction to the second law of thermodynamics

3.2. Thermal energy storage

3.3. Heat engines

3.4. Efficiencies in energy conversion

3.5. Refrigerators and heat pumps

3.6. The Carnot cycle

3.7. The Carnot heat engine

3.8. The refrigerator and heat pump Carnot

3.9. Problems of the second law of thermodynamics

4. Entropy

4.1. Entropy

4.2. The principle of entropy increase

4.3. Entropy change of pure substances

4.4. Isentropic processes

4.5. Entropy change of liquids and solids

4.6. Entropy change of ideal gases

4.7. Isentropic efficiency of steady state devices

4.8. Balance of entropy

4.9. Problems entropy

5. Gas power cycles

5.1. Cosideracions basic analysis of power cycles

5.2. Carnot cycle and its value engineering

5.3. Standard air assumptions

5.4. Reciprocal motor

5.5. The Otto cycle: the ideal cycle for spark-ignition engines

5.6. Diesel Cycle: The Ideal Cycle for Compression-ignition engines

5.7. Stirling and Ericsson cycles

5.8. Brayton cycle: the ideal cycle for gas turbines

5.9. Problems cycle gas power

6. Steam power cycles and combined cycles

6.1. Carnot cycle steam

6.2. The Rankine cycle: the ideal cycle steam power cycles

6.3. Deviations of actual vapor power cycles ideals

Methodology

The methodology used combines inquiry-based learning and flipped learning. The methodology of the course will be divided into:

1.-Flipped learning activities completed by students prior to class.

2.-Theory and practice sessions: doubts and misconceptions discussion found in the flipped learning activities: introduction of new concepts and hands-on activities.

3.-Problems sessions where teacher will present some examples but basically students will play an active role in the learning process.

3.-Practical laboratory sessions.

Development plan

Week	Methodology	Topic	Lecture Hours	Autonomous work hours
1-2	Lecture. Resolution of problems	Subject presentation and 1. Properties of pure substances, .	6	9
2-4	Lecture. Resolution of problems	2. First law of thermodynamics	8	12
4-6	Lecture. Resolution of problems.	3. Second law of thermodynamics	8	12
6-8	Lecture. Resolution of problems.	4. Entropy	10	15
9		Evaluation. Written test.		
10-12	Lecture. Resolution of problems.	5. Gas power cycles	12	18
13-15	Lecture. Resolution of problems. Lab practices	6. Steam power cycles and combined cycles	12	18
16-19		Evaluation. Written Test. Recovery		

Evaluation

EVALUATION ACTIVITY 1: FIRST PARTIAL

–30%

–Score ≥ 3 to average with the other scores of the course

EVALUATION ACTIVITY 2: SECOND PARTIAL

–30%

–Score ≥ 3 to average with the other scores of the course.

EVALUATION ACTIVITY 3: LAB ACTIVITIES- In group activities or individually.

–20%

–iN GROUP

EVALUATION ACTIVITY 4: Problems and activities in class- during the course, in groups

–20%

Bibliography

Recommended references

- Yunus A. Çengel, Michael A. Boles "Thermodynamics, an engineering approach", International Edition, Eight Edition, Mc Graw Hill, ISBN: 978-0-07-339817-4.
- Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey. “Fundamentals of Engineering Thermodynamics”, 7th Edition, ISBN-10: 0470917687
- Michael Horsley, “Engineering Thermodynamics”,Springer, ISBN-10: 0412445204.
- Antonio Saggion, Rossella Faraldo, Mattero Puerno. "Thermodynamics. Fundamentals Principles and Applications", Springer, 2019, ISBN: 978-3030269753.