Universitat de Lleida

DEGREE CURRICULUM

THERMAL ENGINEERING I

Coordination: CABEZA FABRA, LUISA FERNANDA

Academic year 2019-20

Subject's general information

Subject name	THERMAL ENGINEERING I
Code	102111
Semester	1st Q(SEMESTER) CONTINUED EVALUATION
Typology	

Degree	Course	Character	Modality
Master's Degree in Industrial Engineering	1	COMPLEMENTARY TRAINING	Attendance-based
Bachelor's Degree in Automation and Industrial Electronic Engineering	2	COMPULSORY	Attendance-based
Bachelor's Degree in Mechanical Engineering	2	COMPULSORY	Attendance-based
Not informed	2	COMPULSORY	Attendance-based
Bachelor's Degree in Energy and Sustainability 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	0.4	2.6	3
Number of groups	6	3	3

Coordination	CABEZA FABRA, LUISA FERNANDA
Department	COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING
Teaching load distribution between lectures and independent student work	40% attendance-based 60% student work
Important information on data processing	Consult this link for more information.
Language	Catalan 90% English 10%
Office and hour of attention	Request by e-mail

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CABEZA FABRA, LUISA FERNANDA	luisaf.cabeza@udl.cat	2	
CASTELLÀ ROCA, JOAN	joan.castella@udl.cat	6,6	
DE GRACIA CUESTA, ÁLVARO	alvaro.degracia@udl.cat	4,2	
ZSEMBINSZKI , GABRIEL SEBASTIAN	gabriel.zsembinszki@udl.cat	6,4	

Subject's extra information

Compulsory subject to the three degrees that gives a good introduction to heat transfer.

Continued work is recommended throughout the semester in order to achieve the objectives of the course, and frequently visit the Virtual Campus space associated with the subject. As for messages, we recommend using personal emails of each teacher instead of using only messaging of Virtual Campus.

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

- Blue 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

- Acquire basic knowledge on the different heat transfer mechanisms

- Deepen the study of heat transfer by conduction

- Deepen the study of heat transfer by convection

- Deepen the study of heat transfer by radiation

- Gain knowledge of the theoretical methods for the analysis of heat exchangers

- Use the knowledge of heat transfer and fluid mechanics to solve problems of heat transfer

- Argue and analyze the results obtained in heat transfer problems

- Experimentally study heat transfer by convection and radiation

- Gain knowledge of the use of specific software for solving heat transfer problems

Competences

Transversal competences

- **EPS1**. Ability to resolve problems and elaborate and defend arguments inside their field of study.
- **EPS2**. Ability to gather and interpret relevant data in their field of study, and to emit judgements that include a reflection on relevant themes of a social, scientific or ethical nature.
- **EPS7**. Ability to work under pressure and/or in situations where there is a lack of information.

Specific competences

- **GEM7**. Knowledge of applied thermodynamics and heat transmission, and of the basic principles and their application to the solution of engineering problems.
- **GEM8**. Knowledge of the basic principles of fluid mechanics and their application to the solution of problems in the field of engineering. Calculation of pipelines, channels and systems of fluids.

Subject contents

1.Basic concepts

- 1.1. Introduction to thermodynamics
- 1.2. Introduction to heat transfer
- 1.3. Heat transfer mechanisms
- 1.4. Simultaneous heat transfer mechanisms
- 1.5. Problems on basic concepts of heat transfer

2.Steady heat conduction

- 2.1. Steady heat conduction in plane walls
- 2.2. Thermal contact resistance
- 2.3. Generalized thermal resistance networks
- 2.4. Heat conduction in cylinders and spheres
- 2.5. Critical radius of insulation
- 2.6. Heat transfer from finned surfaces
- 2.7. Heat transfer in common configurations
- 2.8. Problems on steady heat conduction

3.Transient heat conduction

- 3.1. Lumped system analysis
- 3.2. Transient heat conduction in large plane walls, long cylinders, and spheres
- 3.3. Transient heat conduction in semi-infinite solids
- 3.4. Transient heat conduction in multidimensional systems
- 3.5. Problems on transient heat conduction

4.Forced convection

- 4.1. Physical mechanism of forced convection
- 4.2. Velocity boundary layer
- 4.3. Thermal boundary layer
- 4.4. Flow over flat plates
- 4.5. Flow across cylinders and spheres
- 4.6. Flow in tubes
- 4.7. Problems on forced convection

5.Natural convection

- 5.1. Physical mechanism of natural convection

5.2. Natural convection over surfaces

5.3. Natural convection inside enclosures

5.4. Natural convection from finned surfaces

5.5. Combined natural and forced convection

5.6. Problems on natural convection

6.Radiation

6.1. Introduction

6.2. Thermal radiation

6.3. Blackbody radiation

6.4. Radiation properties

6.5. Atmospheric and solar radiation

6.6. The view factor

6.7. Problems on radiation heat transfer

7.Heat exchangers

7.1. Types of heat exchangers

7.2. The overall heat transfer coefficient

7.3. Analysis of heat exchangers

7.4. The log mean temperature difference method

7.5. The effectiveness-NTU method

7.6. Problems on heat exchangers

Methodology

- Master classes, in which the theoretical concepts of each topic are introduced, illustrating them with examples and exercises.
- Classes of exercises, in which exercises of gradual difficulty will be resolved to consolidate the concepts and notions developed in the theory classes.
- Laboratory practices in small groups

Development plan

To see the temporal planning of the subject, see the file uploaded to the resources section of the Virtual Campus.

Evaluation

- **First partial exam**

It consists of an individual written exam, in which the contents developed in class during weeks 1 to 8 will be assessed. This activity contributes a 30% to the total grade of the subject. The grade of the first partial exam must be equal to or higher than 3 to be able to calculate the average in the month of January.

- **Second partial exam**

It consists of an individual written exam, in which the contents developed in class during weeks 10 to 15 will be assessed. This activity contributes a 50% to the total grade of the subject. The grade of the second partial exam must be equal to or higher than 3 to be able to calculate the average in the month of January.

- **Laboratory practices**

Two sessions of laboratory practices will be performed, which are mandatory, and the corresponding report made in small groups will be evaluated. This activity contributes a 20% to the total grade of the subject. The grade of each of the two practices must be equal to or higher than 4 to be able to calculate the average in the month of January.

- **Calculation average grade in January**

In the month of January, the average will be made when the student meets the previous requirements (grade higher than or equal to 3 in partial exams, and higher than or equal to 4 in laboratory practices). *The subject is approved with a minimum average grade of 5.*

- **Recovery**

In case that the subject has not been approved in January, it must be recovered. In the recovery, the average will be made only in case that all grades are higher than or equal to 4, therefore it is only necessary to recover:

- Partial exams with a grade less than 4.

- Laboratory practices with a grade less than 4.

In the month of February the average will be made when the student meets the previous requirements (grade higher than or equal to 4 in partial exams and in laboratory practices). *The subject is approved with a minimum average grade of 5.*

Bibliography

Basic bibliography:

· Y. A. Çengel, “Heat Transfer. A practical approach”, McGrawHill, 1998. ISBN: 0-07-011505-2.

Complementary bibliography:

· F. P. Incropera, D. P. De Witt,“Fundamentos de transferencia de calor”, Prentice Hall Hispanoamericana, 1999.ISBN: 970-17-0170-4.

· J. P. Holman, “Transferencia de calor”, McGrawHill, 1998. ISBN: 84-481-2040-X.

· F. Kreith, M. S. Bohn,“Principios de transferencia de calor”, Paraninfo Thompson, 2001. ISBN:970-686-063-0.

· J. M. Marín, C. Monné,“Transferencia de calor”, Kronos, 1998. ISBN: 84-88502-72-9.

· J. Illa, J. C. Cuchí “Problemes de termotècnia”, Eumo, 1991. ISBN: 84-7602-558-0.