Universitat de Lleida

DEGREE CURRICULUM

THERMOHYDRAULICS

Coordination: MARTORELL BOADA, INGRID

Academic year 2019-20

Subject's general information

Subject name	THERMOHYDRAULICS
Code	14534
Semester	2nd Q(SEMESTER) CONTINUED EVALUATION
Typology	Degree: Master's Degree in Industrial Engineering; Course: 1; Character: OPTIONAL; Modality: Attendance-based
Course number of credits (ECTS)	6
Type of activity, credits, and groups	Activity type: PRAULA / TEORIA; Number of credits: 3 / 3; Number of groups: 1 / 1
Coordination	MARTORELL BOADA, INGRID
Department	COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING
Teaching load distribution between lectures and independent student work	60 h lectures (40%) 90 h autonomous (60%)
Important information on data processing	Consult this link for more information.
Language	Catalan

Typology:

Degree	Course	Character	Modality
Master's Degree in Industrial Engineering	1	OPTIONAL	Attendance-based

Type of activity, credits, and groups:

Activity type	PRAULA	TEORIA
Number of credits	3	3
Number of groups	1	1

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
MARTORELL BOADA, INGRID	ingrid.martorell@udl.cat	3	
MEDRANO MARTORELL, MARCO	marc.medrano@udl.cat	3	

Subject's extra information

The present course is structured in two independent parts which will be developed in parallel during the semester. Part A corresponds to Thermodynamics and part B to Hydraulics. There are no prerequisites for the course, but the basics of differential and integral calculus, general physics and numerical calculus are necessary to follow it.

The course requires a continuous work throughout the semester. At the site of the Campus Virtual associated to the course relevant information will be uploaded regularly. To contact the professors it is recommended to use directly their personal e-mail instead of the Virtual Campus messaging service.

Learning objectives

GENERAL PURPOSE OF THE SUBJECT

To equip students with the knowledge and techniques , tools, skills and abilities needed to effectively develop professional activities related to engineering thermodynamics and hydraulics.

To accomplish with this overall objective specific objectives are:

- Transmit to specialists or not the knowledge acquired in the subject.
- Use the engineering tools to conceive, design , implement and provide solutions to projects.
- Demonstrate sufficient knowledge for this subject , both scientific and technological .
- To have ability to design and analyze thermal machines and engines and hydraulic machines and systems and industrial refrigeration heat .
- To have ability to solve complex problems related to thermodynamics.

Competences

Basic Competences according to Real decreto 861/2010 and Orden CIN/311/2009::

- CG6. To have suitable knowledge of the scientific and technological issues of: mathematical, analytical and numerical methods in engineering, electrical engineering, energetic engineering, chemical engineering, mechanical engineering, mechanics of continuous means, industrial electronics, automation, manufacture, material, quantitative methods of management, industrial computing, urbanism, infrastructures, etc.

General Competences according to Orden CIN/311/2009 and EPS criteria:

- CG3. Capacity to convey information, ideas, problems and solutions both to a specialised and no specialised public.
- CG4. Capacity to conceive, design and implement projects and/or provide new solutions, using the tools that the engineering offers.

Specific Competences according to Orden CIN/311/2009:

- CE5. Knowledge and capacity for the design and analysis of heat engines, hydraulic machines and installations of heat and industrial refrigeration.

Subject contents

Part A: THERMODYNAMICS

Theory program

Chapter 1. Properties of Pure Substances
1.1. Pure Substance
1.2. Phases of a Pure Substance
1.3. Phase-Change Processes of Pure Substances
1.4. Property Diagrams for Phase-Change Processes
1.5. Property Tables
1.6. The Ideal-Gas Equation of State
1.7. Compressibility Factor—A Measure of Deviation from Ideal-Gas Behavior
1.8. Specific Heats
1.9. Internal Energy, Enthalpy, and Specific Heats of Ideal Gases
1.10. Internal Energy, Enthalpy, and Specific Heat of Solids and Liquids

Chapter 2. The First Law of Thermodynamics
2.1. The First Law of Thermodynamics
2.2. Energy Analysis of Closed Systems
2.3. Energy Analysis of Steady-Flow Systems
2.4. Some Steady-Flow Engineering Devices
2.5. Energy Analysis of Unsteady-Flow Processes

Chapter 3. The Second Law of Thermodynamics
3.1. Introduction to the Second Law
3.2. Thermal Energy Reservoirs
3.3. Heat Engines
3.4. Thermal Efficiency
3.5. Refrigerators and Heat Pumps
3.6. The Carnot Cycle
3.7. The Reversed Carnot Cycle
3.8. The Carnot Refrigerator and Heat Pump

Chapter 4. Gas and Vapor Power Cycles
4.1. Basic Considerations in the Analysis of Power Cycles
4.2. The Carnot Cycle and Its Value in Engineering
4.3. Air-Standard Assumptions
4.4. An Overview of Reciprocating Engines
4.5. Otto Cycle: The Ideal Cycle for Spark-Ignition Engines
4.6. Diesel Cycle: The Ideal Cycle for Compression-Ignition Engines
4.7. The Carnot Vapor Cycle
4.8. Rankine Cycle: The Ideal Cycle for Vapor Power Cycles

Part B: HYDRAULICS

Theory program

Chapter 1. Hydraulics
1.1. Introduction
1.2. The basic equations
1.3. Head loss
1.4. Pump theory and characteristics

1.5. Series pipe flow
1.6. Parallel pipe flow, equivalent pipes
1.7. Three reservoir problem

Chapter 2. Economic criteria in the management of pumping systems

2.1 Similitude laws in pumps

2.2 Fitting the characteristic curves of pumps

2.3 Optimal working point of a pump

2.4 Optimal diameter of a pipe

2.5 Case study

Chapter 3. Introduction to pipe network analysis

3.1 Basic concepts

3.2 General equations governing the flow in a hydraulic network

3.3 Exponential formula for energy losses

3.4 Relation of the exponential formula to the Dary-Weissbach equation

3.5 The Q-eqs. method

3.6 The ?Q-eqs. method

3.7 The H-eqs. method

3.8 Introduction of pumps in the network

3.9 Case study

Chapter 4. Oleohydraulics
4.1. Introduction
4.2. The oleohydraulic circuit
4.3. The power elements: pumps
4.4. The regulation and control elements
4.5. The work elements: pistons and motors
4.6. Design of circuits

Methodology

The activities will be divided into: lectures, problem solving and case study.

- **Lectures:** In the lectures expose the contents of the subject orally by the teacher without the active participation of students.
- **Problem solving:** In problem solving sessions teachers present a complex issue that students should solve, whether working individually or in teams.
- **Case study:** The different approaches to analyze a complex problem, the adopted solution strategies and the form to present the achieved results are discussed. The students should present their own work within an established death line.

Development plan

Week	Methodology	Topic	Lecture hours	Autonomous work hours	Professor
1-8	Lecture Problems resolution Case study	Parts A and B Chapters 1-2	32	48	Ingrid Martorell Josep Illa
9	Written exam E1)	Chapters 1-2			
10-15	Lecture Problems resolution Case study	Parts A i B Chapters 3-4	24	36	Ingrid Martorell Josep Illa
16	Written exam E2)	Chapters 1-4			
17-19	Recovery (EJ)	Chapters 1-4			

Evaluation

Parts A and B will be evaluated separately based on the marks of the written exams (E1 and E2), the recovery exam (EJ) and the solved problems presented during the semester at an established date. The final mark (NF) will then be determined from the final marks of parts A and B (NA and NB) according to following criterion:

If NA >=3 and NB >=3:

NF=(NA+NB)/2.

If NA<3 or NB<3:

NF=min{4.0, (NA+NB)/2}.

Bibliography

Basic bibliography

-Yunus A. Çengel, Michael A. Boles "Thermodynamics, an engineering approach", International Edition, Fourth Edition, Mc Graw Hill, ISBN: 0-07-238332-1

-Bruce E. Larock, Roland W. Jeppson, "Hydraulics of pipelines systems". Ed. CRC Press. 2000 (ISBN:0-8493-1806-8)

-Renate Aheimer, Christine Löffler, Dieter Merkle, Georg Prede, Klaus Rupp, Dieter Scholz, Burkhard Schrader "Fundamentos de la hidráulica y electrohidráulica: Manual de estudio TP 501", Festo Didactic

Complementary bibliography

-J.Agüera Soriano, "Mecánica de fluidos incompresibles y turbomáquinas hidráulicas", 5ª ed., Editorial Ciencia3 S.A., 2002 (ISBN: 84-95391-01-05)

- Claudio Mataix, "Mecánica de fluidos y máquinas hidraulicas" , 2ª ed.,Ediciones del Castillo S.A., Madrid 1986 (ISBN: 84-219-0175-3)

Adaptations to the contents due to COVID-19

No changes in contents are made. Contents are the same that the ones presented in class at the beginning of the course,

Adaptations to the methodology due to COVID-19

Teaching methodology during this period combines the next tools:

- Detailed instructions of each session, using the ANUNCIS (ANNOUNCEMENTS) tool in Sakai.

- PowerPoint presentations in the RECURSOS (Resources) section in Sakai wit instructions or audios.

- Step by step problems resolution (powerpoints and audios).

- Videoconferences.

- Use of CTIVITATS tool (activities) in Sakai.

Adaptations to the development plan due to COVID-19

Termohidràulica sessions have been distributed as shown next:

a) THERMODYNAMICS

Date	Activity	Assignment	Evaluation activity
16 APRIL	Chapter 3: compression refrigeration		
23 APRIL	Chapter 4: theory and problems		
30 MAY	TEST ONLINE CHAPTER 3	Problem Chapter 2	1 i 2
7 MAY	Chapter 4: theory and problems	Problem Chapter 3	2
14 MAY	Chapter 4: theory and problems		
21 MAY	Chapter 4: summary and doubts	Problem Chapter 4	2
29 MAY	TEST ONLINE CHAPTER 4		1
10 JUNE	LAB REPORT	Report	3

b) HIDRAULICS

Date	Activity	Assignment	Activitat d'avaluació
22 APRIL	Chapter 7: Oleohydraulics, theory and problems	Example FluidSim	2
29 APRIL	Chapter 7: Oleohydraulics, theory and problems	Exercise 1	2
6 MAY	Chapter 7: Oleohydraulics, virtual activity	Exercise 2	2
13 MAY	Chapter 7: Oleohydraulics, summary and doubts		
20 MAY	Test online Chapter 7		1
10 JUNE	PRACT REPORT	Report	3

Adaptations to the evaluation due to COVID-19

Three evaluation activities for ther Thermodynamics part and three more for the Hydraulics part have been defines.Those three activities as well as their percentage are shown next:

- Evaluation activity 1: test (10 %)
  - Online exam via Sakai
  - Therory and problems
  - Individual evaluation
- Evaluation activity 2: problems (25 %)
  - Assigned problems with due dates
  - Individual evaluation
- Evaluation activity 3: lab report (15 %)
  - Written report in groups of 2
  - Group evaluation