COURSE SYLLABUS 2018-2019

SUBJECT DATASHEET

Course information	
Name	Energy Engineering
Code	DIM-IND-523
Degree	Master on Industrial Engineering
Year	First
Semester	Second (Spring)
ECTS credits	7.5
Type	Compulsory
Department	Mechanical Engineering
Area	Energy
Coordinator	José Ignacio Linares Hurtado

Instructor information	
Instructor	
Name	Luis López Álvarez
Department	Mechanical Engineering
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Lab Instructors	
Nombre	Luis López Álvarez
Nombre	Bienvenido Martínez Pantoja
Nombre	Leopoldo Prieto Fernández
Nombre	José Rafael Rubio Caldera

SPECIFIC SUBJECT DATASHEET

Subject contextualization

Contribution to the professional profile of the Title

In the professional profile of the Masters in Industrial Engineering this subject aims to equip students with the basic knowledge to understand both energy sources and systems to convert them into power, heating and cooling and to assess the technical and economic feasibility of energy systems.

After completing the course students will be able to discuss energy policy scenarios with technical criteria to evaluate energy systems using exergy techniques, analyzing the behavior of energy systems working at off-design point, knowing and proposing improvements in power plants of all types and determine the strengths and weaknesses of the different energy sources, both from production and from logistics and processing. In short, the knowledge acquired in this course will provide students with the technical criteria to contribute to the energy debate seeking sustainability in a holistic sense (economic, social and environmental).

In addition, this course has a mixed theoretical and practical sense, so that the theoretical components are added the practical aimed at solving numerical issues where the concepts studied will be exercised, as well as conducting laboratory practice where they face real systems to scale.

Pre requirements

There are not any prerequisites needed to study the subject. However, as the subject is inserted in an engineering syllabus, it is supported on concepts previously seen in other subjects:

Thermodynamics

- **Energy and mass balances**

Heat transfer

- **Heat exchangers**

Sustainable Development and Engineering

- **Renewable resources**

THEME SEGMENT AND CONTENTS

Contents – Theme segments

THEME 1: Systems

Unit 1: INTRODUCTION

1.1 Energy, classifications and types. Energy sources.
1.2 Macro-energy units.
1.3 Environmental implications of power generation.
1.4 Social and geostrategical aspects of energy sources.
1.5 Assessment of scenarios and energy policies.
1.6 Assessment of economic feasibility of energy projects.

Unit 3: EXERGY ANALYSIS

3.1 Introduction.
3.2 Exergy analysis in power and refrigeration cycles.
3.3 Exergy analysis in control volumes.
3.4 Exergy efficiency.

Unit 9: ENERGY SYSTEMS MODELING

9.1 Introduction.
9.2 Heat exchangers and ducts.
9.3 Volumetric machines.
9.4 Turbomachines.
9.5 Systems integration.

THEME 2: Energy sources

Unit 2: COMBUSTION

2.1 Introduction.
2.2 Combustion reactions.
2.3 Mass balance.
2.4 Energy balance.

Unit 7: NUCLEAR ENERGY

7.1 Introduction
7.2 Nuclear reactions.
7.3 Systems and components of a nuclear reactor.

7.4 Nuclear fuel cycle. **7.5** Nuclear wastes. **7.6** Ionozing radiations. **7.7** Nuclear fusion. **7.8** Nuclear power plants: types and Generations **7.9** Current nuclear power plants: Generation II and III **7.10** Forthcoming nuclear power plants: Generation III+, IV and fusion
Unit 8: FOSSIL FUELS
8.1 Introduction **8.2** Oil and derivatives production and distribution. **8.3** Natural gas production and distribution. **8.4** Coal production and distribution. **8.5** Non-conventional hydrocarbons production. **8.6** CO_2 storage.
Unit 10: HYDROGEN AS ENERGY CARRIER
10.1 Introduction **10.2** Hydrogen generation. **10.3** Hydrogen storage. **10.4** Hydrogen direct combustion. **10.5** Fuel cells.
THEME 3: Energy conversion
Unit 4: FOSSIL FUEL POWER PLANTS
4.1 Introduction. **4.2** Coal power plants (steam cycle). **4.3** Combined cycle power plants. **4.4** Repowering of coal power plants. **4.5** Clean combustion in power plants. **4.6** CO_2 capture.
Unit 5: REFRIGERATION CYCLES AND HEAT PUMPS
5.1 Introduction. **5.2** Low temperature chillers. **5.3** Advanced heat pumps. **5.4** Non-conventional chillers. **5.5** Absorption chillers.
Unit 6: ADVANCED POWER PLANTS
6.1 Introduction. **6.2** Combined heat and power. **6.3** Organic Rankine cycles. **6.4** Supercritical CO2 cycles. **6.5** Other power plants. **6.6** Electric generation from renewable sources **6.7** Massive energy storage.

Competences – Learning Outcomes
Competences
Basic Competences
CB2. Knowing how to apply and integrate their knowledge, understanding these, its scientific basis and troubleshooting capabilities in new and imprecisely defined environments, including multidisciplinary contexts both researchers and highly skilled professionals. CB7. Being able to take responsibility for their own professional development and specialization in one or more fields of study.
General Competences
CG1. To have appropriate knowledge about the scientific and technological aspects of: mathematical, analytical and numerical methods in engineering, electrical engineering, power engineering, chemical engineering, mechanical engineering, continuum mechanics, industrial electronics, automation, manufacturing, materials, quantitative methods management, industrial computing, planning, infrastructure, and so on. CG2. To project, to calculate and to design products, processes, facilities and plants.
Competences of the Industrial Technologies Module
CMT5. Knowledge and capabilities for the design and analysis of thermal machines and engines, hydraulic machines and industrial heating and cooling facilities. CMT6. Knowledge and capabilities to understand, analyze, operate and manage the different energy sources.
Competences of the Facilities, plants and complementary constructions Module
CMI4. Knowledge and skills to plan and design electrical and fluid facilities, lighting, air conditioning and ventilation, energy saving and efficiency, acoustics, communications, automation and smart buildings and security installations.
Learning outcomes
At the end of the course students should be able to: LO1. To calculate the energy and mass balance of a combustion. LO2. To know the capture and storage CO2 capture. LO3. To analyse energy systems to identify enhancement efficiency opportunities. LO4. To achieve the performances of complex energy systems so at its design point as off-design point. LO5. To design and analyse thermal and hydraulic circuits so for fluids transport as for power transmission and devices driving.

LO6. To know and analyse advanced systems of electricity generation. LO7. To calculate the mass and energy balance of chilling devices based on different technologies. LO8. To know the current technology challenges of fossil fuels. LO9. To understand the electricity generation technology from nuclear energy. LO10. TO calculate the performance of renewable energy installations. LO11. To know the hydrogen energy technologies analysing their performances.

TEACHING METHODOLOGY

Subject methodological aspects	
In-class methodology: Activities	**Competences**
1. **Lectures.** The lecturer will explain basic concepts for every unit showing the more important aspects. Special attention to be paid with equations and how to use. Examples will be presented, discussed and solved to complete the understanding. **(46 hours)**.	**CG1,CMT5, CMT6, CMI4**
2. **In-class case discussion and problem solving.** Students will discuss the cases and problems proposed by the teacher. Cases will be open challenges that can be analyzed and solved by the use of the concepts already presented in class. **(16 hours)**.	**CB2, CB7, CG2**
3. **Team Work presentations**. The students, split in small teams, will expose in class a work about topics related with the subject. The topics will be able proposed by the lecturer or by the students with the approval by the former. **(5 hours).**	**CB2, CB7, CG2**
4. **Lab sessions.** The students, split in small teams, will do lab sessions with different devices and simulation software in order to apply the acquired knowledge in the lectures to actual energy facilities. **(8 hours).**	**CB2, CB7, CG2**
Distance Methodology: Activities	**Competences**
1. **Self-learning on the concepts presented in class**. The student must make a personal work back to the lectures to understand and internalize the knowledge provided in the subject. It will be used for that the material presented on slides and notes (additional texts) on the subject **(60 hours).**	**CB2, CB7, CG2**
2. **Cases study.** The student will analyze the resolution of the	

problems in class conducted primarily by the lecturer, and then turn to face the problems proposed (no solved) in class, whose solution will be available later, asking questions in the tutoring sessions. This activity shall also apply to previous years solved exams available for students in Moodle. **(50 hours).**	**CB2, CB7, CG2**
3. Lab sessions. After the in-lab session a report will be written following a guide provided by the instructor. **(16 hours).**	**CB2, CB7, CG2**
4. Team Works. Once the topic has been assigned the students, divided in small teams, will perform the information searching and the developing of the work and the presentation. The work will be controlled by partial deliveries at established milestones. **(24 hours).**	**CB2, CB7, CG2**

ASSESSMENT AND SCORING CRITERIA

Assessment activities	Criteria	Weight
<u>Exams performing:</u> • Mid term exam • End of term exam	- Concepts understanding. - Use of concepts to solve real cases. - Problem solving solution analysis and results interpretation. - Presentation and written communication.	**70%**
<u>Continuous assessment:</u> • Team work	- Information searching. - Knowledge application to critical assessing technical information. - Oral and written expression.	**15%**
• Lab sessions	- Technical writing. - Results exposition. - Analysis of results according to acquired knowledge in the subject.	**15%**

Scoring
The score for the **ordinary summon** will be obtained by: • 70% comes from the exams. End of term exam score will weight 50% in the overall score of the subject while the score in the mid term exam will weight 20%. • 15% comes from team work. • 15% comes from the lab sessions reports. If the previous weighted average results higher than 5 the subject score will be such average; in the opposite case the score will be the minimum between such average and the end of term exam score. **Extraordinary summon** • 20% from the score obtained in continuous evaluation (team work and lab reports). • 80% from the extraordinary summon exam. If the previous weighted average results higher than 5 the subject score will be such average; in the opposite case the score will be the minimum between such average and the extraordinary summon exam score. **Rules** Attendance (see latter) and work team and lab reports performing is a necessary condition to pass the subject in both summons. Neither programmable calculators nor formulae summary, books and notes are not allowed in the final exam of the ordinary summon and in the exam of the extraordinary summon a formulae summary covering economic parameters (unit 1) and cogeneration indexes (unit 6) will be included. A sample of such summary can be found in past exams available in Moodle. Attendance: The absence of more than 15% of the total amount of classes can entail to fail the ordinary summon.

WORKING SCHEDULE

In-class and distance activities	Do date	Delivery date
• Self-learning of concepts presented in class (slides and additional text if any)	After session	
• Problem solving	After the end of the unit	
• Mid term and end of term exam	Week 8 and ordinary summon period	

• Mid term exam preparation	At least weeks 7 and 8	
• End of term exam preparation	At least weeks 13, 14 and 15	
• Lab sessions	Weeks 11, 12, 13 and 14	
• Lab sessions reports performing		Weeks 12, 13, 14 and 15
• Team work performing	Weeks 3 to 15	M1: week 7 M2: week 11 M3: week 13 to 15
• Team work presentation	Weeks 13 to 15	

STUDENT SCHEDULE SUMMARY (HOURS)			
LIVE			
Lectures	Team work	Case discussion	Lab Sessions
46	5	16	8
DISTANCE			
Team wokr	Self-work on cases	Lab report	
24	110	16	
		ECTS:	7,5 (225 hours)

BIBLIOGRAPHY AND RESOURCES

Basic bibliography

Notes and Slides

- Slides of every unit (available at Moodle).
- Additional texts of nearly all the units (available at Moodle).
- Solved problems (available at Moodle).
- Solved exams (available at Moodle).

Additional Bibliography

Text books

- E. Cassedy and P. Grossman, Introduction to Energy: Resources, Technology and Society. Cambridge University Press, 1998
- R.W. Haywood, Analysis of Engineering Cycles, 4th Edition. Pergamon Press, 1991.