GUÍA DOCENTE
2020 - 2021

FICHA TÉCNICA DE LA ASIGNATURA

Datos de la asignatura

Nombre completo	Energy engineering
Código	DIM-MESEM-514
Título	Máster Universitario en Ingeniería Industrial por la Universidad Pontificia Comillas
Créditos	7,5 ECTS
Carácter	Obligatoria
Departamento / Área	Departamento de Ingeniería Mecánica

Datos del profesorado

DATOS ESPECÍFICOS DE LA ASIGNATURA

Contextualización de la asignatura

Aportación al perfil profesional de la titulación

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, 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.

Prerequisitos

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

Competencias - Objetivos

Competencias

GENERALES

BA02	Saber aplicar e integrar sus conocimientos, la comprensión de estos, su fundamentación científica y sus capacidades de resolución de problemas en entornos nuevos y definidos de forma imprecisa, incluyendo contextos de carácter multidisciplinar tanto investigadores como profesionales altamente especializados.
BA07	Ser capaces de asumir la responsabilidad de su propio desarrollo profesional y de su especialización en uno o más campos de estudio.
CG01	Tener conocimientos adecuados de los aspectos científicos y tecnológicos de: métodos matemáticos, analíticos y numéricos en la ingeniería, ingeniería eléctrica, ingeniería energética, ingeniería química, ingeniería mecánica, mecánica de medios continuos, electrónica industrial, automática, fabricación, materiales, métodos cuantitativos de gestión, informática industrial, urbanismo, infraestructuras, etc.
CG02	Proyectar, calcular y diseñar productos, procesos, instalaciones y plantas

ESPECÍFICAS

CMI04	Conocimiento y capacidades para el proyectar y diseñar instalaciones eléctricas y de fluidos, iluminación, climatización y ventilación, ahorro y eficiencia energética, acústica, comunicaciones, domótica y edificios inteligentes e instalaciones de seguridad
CMT01	Conocimiento y capacidad para el análisis y diseño de sistemas de generación, transporte y distribución de energía eléctrica
CMT05	Conocimientos y capacidades para el diseño y análisis de máquinas y motores térmicos, máquinas hidráulicas e instalaciones de calor y frío industrial
CMT06	Conocimientos y capacidades que permitan comprender, analizar, explotar y gestionar las distintas fuentes de energía

Resultados de Aprendizaje

RA01	Conocer el escenario energético actual (nacional e internacional) con sus retos a medio y largo plazo
RA02	Saber valorar económicamente un proyecto energético
RA03	Calcular el balance energético y másico de una combustión

RA04	Conocer las tecnologías de captura, transporte y almacenamiento de CO2
RA05	Obtener las prestaciones de sistemas energéticos complejos tanto en su punto nominal como en operación real
RA06	Conocer y analizar sistemas avanzados de producción de energía eléctrica
RA07	Calcular el balance másico y energético de equipos de refrigeración y climatización basados en diferentes tecnologías
RA08	Conocer los actuales retos tecnológicos de los combustibles fósiles
RA09	Comprender la tecnología de generación eléctrica a partir de energía nuclear
RA10	Calcular las prestaciones de instalaciones de energías renovables
RA11	Conocer las tecnologías de aprovechamiento energético del hidrógeno analizando sus prestaciones energéticas

BLOQUES TEMÁTICOS Y CONTENIDOS

Contenidos – Bloques Temáticos
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 8. ANALYSIS OF ENERGY SYSTEMS IN OFF-DESIGN WORKING
8.1 Introduction. 8.2 Heat exchangers and ducts. 8.3 Volumetric machines. 8.4 Turbomachines. 8.5 Systems integration.

ENERGY SOURCES

Unit 2. COMBUSTION

2.1 Introduction.

2.2 Combustion reactions.

2.3 Mass balance.

2.4 Energy balance.

Unit 6. NUCLEAR ENERGY

6.1 Introduction

6.2 Nuclear reactions.

6.3 Systems and components of a nuclear reactor.

6.4 Nuclear fuel cycle.

6.5 Nuclear wastes.

6.6 Ionozing radiations.

6.7 Nuclear fusion.

6.8 Nuclear power plants: types and Generations

6.9 Current nuclear power plants: Generation II and III

6.10 Forthcoming nuclear power plants: Generation III+, IV and fusion

Unit 7. FOSSIL FUELS

7.1 Introduction

7.2 Oil and derivatives production and distribution.

7.3 Natural gas production and distribution.

7.4 Coal production and distribution.

7.5 Non-conventional hydrocarbons production.

7.6 CO_2 storage.

Unit 9. HYDROGEN AND FUEL CELLS

9.1 Introduction

9.2 Hydrogen generation.

9.3 Hydrogen storage.

9.4 Hydrogen direct combustion.

9.5 Fuel cells.

ENERGY CONVERSION

Unit 3. FOSSIL FUEL POWER PLANTS

3.1 Introduction.

3.2 Coal power plants (steam cycle).

3.3 Combined cycle power plants.

3.4 Repowering of coal power plants.

3.5 Clean combustion in power plants.

3.6 CO_2 capture.

Unit 4. REFRIGERATION CYCLES AND HEAT PUMPS

4.1 Introduction.

4.2 Low temperature chillers.

4.3 Advanced heat pumps.

4.4 Non-conventional chillers.

4.5 Absorption chillers.

Unit 5. ADVANCED POWER PLANTS

5.1 Introduction.

5.2 Combined heat and power.

5.3 Organic Rankine cycles.

5.4 Supercritical CO2 cycles.

5.5 Other power plants.

5.6 Electric generation from renewable sources

5.7 Massive energy storage.

METODOLOGÍA DOCENTE

Aspectos metodológicos generales de la asignatura

Metodología Presencial: Actividades	
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. **(34 hours)**.	CG01, CMI04, CMT05, CMT06
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. **(23 hours)**.	BA02, BA07, CG02
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).**	BA02, BA07, CG02
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).**	BA02, BA07, CG02
Assessment. In the mid term students will individually perform a written exam no longer than 1.5 hours. Such exam will be solved in the next session (1 hour). At the end of the course an individual written exam will be performed. This exam will last 3 hours. **(5 hours).**	BA02, CG01, CMT05, CMT06
Metodología No presencial: Actividades	
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 **(45 hours).**	BA02, BA07, CG02
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. **(35 hours).**	BA02, BA07, CG02
Lab sessions. After the in-lab session a report will be written following a guide provided by the instructor. **(24 hours).**	BA02, BA07, CG02
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	BA02, BA07, CG02

milestones. **(20 hours).** **Exams preparation.** Students will prepare the exams based on the supplied material and the acquired knowledge. **(26 hours).**	BA02, CG01, CG02, CMT05, CMT06

RESUMEN HORAS DE TRABAJO DEL ALUMNO

HORAS PRESENCIALES				
Clase magistral y presentaciones generales	Resolución en clase de problemas prácticos	Trabajos	Prácticas de laboratorio	Evaluación
34.00	23.00	5.00	8.00	5.00
HORAS NO PRESENCIALES				
Estudio de los conceptos teóricos	Trabajo autónomo sobre los problemas	Prácticas de laboratorio	Trabajos	Preparación de exámenes
45.00	35.00	24.00	20.00	26.00
CRÉDITOS ECTS: 7,5 (225,00 horas)				

EVALUACIÓN Y CRITERIOS DE CALIFICACIÓN

Actividades de evaluación	Criterios de evaluación	Peso
• 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 %
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 %

Calificaciones

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.

Under requirement of the University, the exams might be done on-line, using the tools supplied by the University.

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.

Under requirement of the University, the exams might be done on-line, using the tools supplied by the University.

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.

PLAN DE TRABAJO Y CRONOGRAMA

Actividades	Fecha de realización	Fecha de entrega
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	

BIBLIOGRAFÍA Y RECURSOS

Bibliografía Básica

- 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).

Bibliografía Complementaria

- 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.