Course guide
820737 - EEEURE - Energy Saving, Efficiency and Rational Use

Last modified: 21/01/2026

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 724 - MMT - Department of Heat Engines.

Degree: MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Compulsory subject).
MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2022). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Fernandez Francos, Xavier

Others:

Konuray, Ali Osman

PRIOR SKILLS

Knowledge in thermodynamics, heat transfer and fluid mechanics

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

Transversal:
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

TEACHING METHODOLOGY

The teaching methodology will combine different types of activities:
- Presential sessions in the classroom with theoretical content (introduction of basic concepts) and practical content (analysis and resolution of problems and case studies).
- Practical laboratory sessions for the experimental analysis of real systems introduced in classroom lectures where the analysis methodologies described in class will be developed in greater depth and related to more complex case studies.
Students will have different self-learning resources available:
- Lecture notes with detailed description of theoretical concepts developed and solved problems.
- Guides for laboratory sessions and for the use of software resources (EES, CoolProp).
Bibliographic resources (UPC library) and access to databases for the study of cases described in the scientific-technical literature.

LEARNING OBJECTIVES OF THE SUBJECT

The main goal is the learning and application of process analysis methodologies for the reduction of their energy use. In detail, these methodologies will involve:
(a) The analysis of the different energy flows involved in a certain process, corresponding to an economic activity (industrial, services) or residential sector, in relation to their demands and/or specifications.
(b) The identification of energy saving opportunities and improvement of the sustainability of the activity, based on the detection of critical energy waste points, the use of inefficient transformation systems, or excessive demand.
(c) The proposal of different solutions with technical feasibility,in order to reduce demand and energy consumption, and the possible integration of renewable energy sources.
(d) The evaluation of their economic viability, establishing priorities within the set of proposals and defining a substantiated set of recommendations.
These methodologies will be developed based on specific problems and case studies corresponding to different scenarios.
These learning objectives are summarized in this set of knowledge, skills and competences:
Knowledge:
K02.1 Interpret appropriate models for the study of relevant problems in the field of sustainable energy use.
Skills:
S03.1 Integrate knowledge from different areas of the energy field in the design and development of projects, systems and engineering solutions incorporating sustainability criteria.
S06.1 Understand advanced digital technologies, so that they can be applied with a critical perspective, in diverse contexts, in academic, professional, social or personal situations.
S08.1 Develop the ability to contribute to innovation in new or existing business institutions and organizations, through participation in creative projects and have the ability to apply skills and knowledge about entrepreneurship, organization and technological-based business development.
Competences:
C02.1 Apply appropriate methodologies for the design and implementation of projects in the field of production and management of energy from renewable sources.
C03.1 Manage the acquisition, structuring, analysis and visualization of data and information in the energy field, and critically assess the results of this management.
C07.1 Integrate the values of sustainability, understanding the complexity of systems, in order to undertake or promote actions that restore and maintain the health of ecosystems and improve justice, thus generating visions for sustainable futures.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours large group	45,0	36.00

Total learning time: 125 h

CONTENTS

0. Introduction

Description:
Types of energy. Energy consumption and energy intensity. Energy efficiency. Energy integration.

Full-or-part-time: 3h 30m
Theory classes: 1h 30m
Self study : 2h

1. Energy Audit

Description:
Concept of energy audit, regulations and stages. Energy management systems. Data collection and analysis . Investment, costs and scale factors. Energy and economic savings.

Related activities:
Classroom problems
Case studies

Related competencies :
CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

Full-or-part-time: 13h 30m
Theory classes: 1h 30m
Practical classes: 1h 30m
Guided activities: 1h 30m
Self study : 9h

2. Energy and exergy analysis of processes

Description:
Basic concepts of Thermodynamics. Mass, energy and entropy/exergy balances of processes. Analysis of practical cases using Engineering Equation Solver (EES) and CoolProp software.

Related activities:
Classroom problems.
Case studies

Related competencies :
CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

Full-or-part-time: 24h
Theory classes: 3h
Laboratory classes: 3h
Guided activities: 3h
Self study : 15h

3. Heat and cold production

Description:
Heat production by combustion. Thermodynamic analysis, energy efficiency and heat recovery in combustion processes.
Heat/cold production with heat pumps/refrigeration machines, absorption cycles.

Related activities:
Classroom problems.
Case studies.
Laboratory sessions.

Related competencies :
CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

Full-or-part-time: 32h
Theory classes: 4h
Practical classes: 5h
Guided activities: 3h
Self study : 20h

4. Cogeneration and polygeneration

Description:
Combined production of electrical power, heat and cold. Production and self-consumption. Energy integration.

Related activities:
Classroom problems.
Case studies.

Related competencies :
CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

Full-or-part-time: 18h
Theory classes: 3h
Practical classes: 1h 30m
Guided activities: 1h 30m
Self study : 12h

5. Heat recovery

Description:
Residual heat: internal recovery and revalorization. Heat exchange networks. Integration of production systems

Related activities:
Classroom problems.
Case studies.
Laboratory sessions.

Related competencies :
CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

Full-or-part-time: 29h
Theory classes: 3h
Practical classes: 4h 30m
Guided activities: 1h 30m
Self study : 20h

6. District heating and cooling

Description:
District heating and cooling, technological evolution and energy saving opportunities. Integration of renewable energies. Solid urban waste (SUW) revalorization.

Related activities:
Classroom problems.
Case studies.

Related competencies :
CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

Full-or-part-time: 15h
Theory classes: 1h 30m
Guided activities: 1h 30m
Self study : 12h

GRADING SYSTEM

Final grade will be determined from:
Gfinal=0.3*Gfe + 0.3*Gcp + 0.3*Gcs + 0.1*Glab
Gfinal: Final grade
Gfe: Final exam grade
Gcp: Classroom problem grade
Gcs: Case studies grade
Glab: Laboratory sessions grade
Students failing the subject will be allowed one retake exam. In that case, the final mark will be calculated as:
Gfinal=0,9*Gre+0,1*Glab
Where Gre is the grade obtained in the retake exam, which will take place on the date specified by the School. The retake exam will have the same characteristics as the final exam. Glab is the laboratory grade obtained in the previous period.
Students retaking the subject but who passed the laboratory evaluation may keep their previous laboratory grade (Glab) and therefore they do not need to do laboratory sessions again. In that case, they should communicate their intention to the coordinator of the subject.

EXAMINATION RULES.

The students will be allowed to bring calculator, lecture notes and tables to the final exam.

BIBLIOGRAPHY

Basic:
- Eastop, T. D; Croft, D. R. Energy efficiency : for engineers and technologists. Harlow, Essex, England : New York: Longman Scientific & Technical, 1990. ISBN 9780582031845.
- Moran, Michael J; Shapiro, Howard N. Fundamentos de termodinámica técnica . 2a ed. Barcelona [etc.] : Reverté, cop. 2004. ISBN 8429143130.
- Turton, Richard. Analysis, synthesis, and design of chemical processes . Fifth Edition. Boston : Prentice Hall, [2018]. ISBN 9780134177403.

Complementary:
- Querol, E.; Gonzalez-Regueral, B.; Perez-Benedito, J. L. Practical approach to exergy and thermoeconomic analyses of industrial processes [on line]. 1st ed. London: Springer London, 2013 [Consultation: 19/09/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-1-4471-4622-3. ISBN 9781283909181.
- Bejan, Adrian; Tsatsaronis, G; Moran, Michael J. Thermal design and optimization . New York : John Wiley & Sons, 1996. ISBN 0471584673.
- Sancho García, José; Miró Herrero, Rafael; Gallardo Bermell, Sergio. Gestión de la energía . Valencia : Universidad Politécnina de Valencia, Facultad de Administración y Dirección de Empresas., Departamento de Ingeniería Química y Nuclear, DL 2006. ISBN 8483630036.
- Ulrich, Gael D; Vasudevan, Palligarnai T. Chemical engineering process design and economics : a practical guide. 2nd ed. Durham, N.H. : Process, cop. 2004. ISBN 0970876823.
- Roosa, Stephen A; Doty, Steve; Turner, Wayne C. Energy management handbook . Ninth edition. Gistrup, Denmark : London ; New York, New York : River Publishers ; Routledge, [2020]. ISBN 9781003151364.
- Smith, Robin. Chemical process : design and integration. Second edition. Chichester, West Sussex, UK: John Wiley & Sons, 2016. ISBN 9781119990130.
- Institut Català d'Energia. Col·lecció Quadern Pràctic ICAEN [on line]. Available on: https://icaen.gencat.cat/ca/l_icaen/publicacions/quadern_practic/.
- Amidpour, Majid; Manesh, Mohammad Hasan Khoshgoftar. Cogeneration and polygeneration systems . London, England ; Cambridge, Massachusetts : Academic Press, [2021]. ISBN 9780128172490.
- Redondo Rivera, Óscar. Manual práctico de cálculos térmicos de edificios . Madrid : Tornapunta : Fundación Laboral de la Construcción, 2013. ISBN 9788415205692.