Universidad Zaragoza

Year : 2019/20

60804 - Energy Technology

Syllabus Information

Academic Year: 2019/20
Subject: 60804 - Energy Technology
Faculty / School: 110 -

Degree: 532 - Master's in Industrial Engineering

ECTS: 4.5
Year: 1
Semester: 532-First semester o Second semester
107-First semester
Subject Type: Compulsory
Module: ---

1.General information

1.1.Aims of the course

1.2.Context and importance of this course in the degree

1.3.Recommendations to take this course

2.Learning goals

2.1.Competences

2.2.Learning goals

2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The methodology followed in this course is oriented towards achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as lectures, computer lab sessions, case studies, and assignments.

4.2.Learning tasks

The course includes the following learning tasks:

- **Lectures** (30 hours). Whole group two-hour sessions. Presentation of the main theoretical contents (section 5.3.) such as technological questions and legal and environmental issues.
- **Computer lab sessions** (12.5 hours). 5 sessions of 2.5 hours each where students solve complex problems in groups using the computer.
- **Group work**. Calculation and technical reports done in computer lab sessions that must be submitted to the professor in the due date.

4.3.Syllabus

The course will address the following topics:

1. Introduction: Energy resources. Thermodynamic properties and energy balances in engineering systems. Second principle of thermodynamics. Primary and final energy. Earth energy balance. Quantification of fossil resources. Proved reserves. Ratios reserves / consumption. Production peaks
2. Fossil fuels. Coal, oil and liquid fuels. Natural Gas and PLG. Interchangeability of fuel gases
3. Renewable energy sources and technolgies. Solar energy (low temperature, concentrated solar energy and PV). Wind energy. Biomass.
4. Steam power plants. Types of power plants. Steam generator. Steam cycle. Cooling cycle. Balance of plant. Flue gas cleaning systems: DeNox, DeSOx systems.
5. Combined cycle power plants.
6. Energy systems in industry. Heat exchangers networks. Cogeneration.

4.4.Course planning and calendar

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the EINA website (http://eina.unizar.es/intraneteina/index.php?r=calendarioExtN/index_oficial)

4.5.Bibliography and recommended resources

1. Energía y sistemas energéticos en general

- T. D. Eastop, D. R. Croft, 1990. *Energy Efficiency for Engineers and Technologists*. Longman
- A. P. Fraas, 1982. *Engineering Evaluation of Energy Systems*. McGraw-Hill
- A. W. Culp, 1991. *Principles of Energy Conversion*. McGraw-Hill
- R. C. Dorf, 1978. *Energy, Resources and Policy*. Addison-Wesley

2. Combustibles fósiles: carbón, petróleo, gas

- I. Arauzo, 1999. *Fuentes de Energía*. Máquinas y Motores Térmicos, Universidad de Zaragoza
- K. S. Deffeyes, 2001. *Hubbert's Peak. The Impending World Oil Shortage*. Princenton University Press

3. Fuentes y tecnologías renovables (solar, eólica, biomasa)

- G. Boyle (Ed.), 2004. *Renewable Energy. Power for a Sustainable Future. Second Edition*. Oxford University Press
- J. Duffie, W. Beckham, 1991. *Solar Engineering of Thermal Processes*. John Wiley & Sons
- J. Cheng (Ed.), 2010. *Biomass to Renewable Energy Processes*. CRC Press
- S. van Loo, J. Koppejan, 2008. *The Handbook of Biomass Combustion and Co-firing*. Earthscan
- J. F. Manwell, J. G. McGowan, A. L. Rogers, 2009. *Wind Energy Explained*. John Wiley and Sons
- C. Julian Chen, 2011. *Physics of Solar Energy*. John Wiley and Sons
- M. Romero-Álvarez, E. Zarza, 2007. ?Concentrating Solar Thermal Power?, en *Handbook of Energy Efficiency and Renewable Energy*, Cap. 21, Taylor and Francis

4. Ciclos de potencia de vapor

- M. M. El-Wakil, 1984. *Power Plant Technology*. McGraw-Hill
- S. Kakaç (Ed.), 1991. *Boilers, Evaporators, and Condensers*. John Wiley & Sons
- W. K. Li, A. P. Priddy, 1985. *Power Plant System Design*. John Wiley & Sons
- The Babcock & Wilcox Company, 1978. *Steam. Its generation and use*. 39th *Edition*. Cuadragésima edición: S. C. Stultz & J. B. Kitto (Eds.), 1992, Babcock & Wilcox
- G. R. Fryling, (Ed.), 1967. *Combustion Engineering. A Reference Book on Fuel Burning and Steam Generation. Revised Edition*. Combustion Engineering, Inc. Tercera edición: J. G. Singer (Ed.), 1981. *Combustion Fossil Power Systems. A Reference Book on Fuel Burning and Steam Generation*. Cuarta edición: Id., 1991
- O. Levenspiel, D. Kunii, 1991. *Fluidization Engineering*. Butterworth-Heinemann
- H. Spliethoff, 2010. *Power Generation from Solid Fuels*. Springer
- R. W. Haywood, 1991. *Analysis of Engineering Cycles. Power, Refrigerating and Gas Liquefaction Plant. Fourth Edition*. Pergamon Press
- C. Cortés, I. Arauzo, S. Espatolero, A. Gil, 2009. *Colección Tecnología Energética para la Generación Termoeléctrica. Centrales Térmicas de Carbón Pulverizado*. Prensas Universitarias de Zaragoza
- British Electricity International, 1992. *Modern Power Station Practice. Third Edition incorporating Modern Power*

System Practice. *Volume B. Boilers and Ancillary Plant*, *Volume C. Turbines, Generators and Associated Plant*. Pergamon Press
- E. B. Woodruff, H. B. Lammers, T. F. Lammers, 1984. *Steam Plant Operation. Fifth Edition*. McGraw-Hill

5. Turbinas de gas y ciclos combinados gas-vapor

- H. I. H. Saravanamuttoo, G. F. C. Rogers, H. Cohen, P. V. Straznicky, 2008. *Gas Turbine Theory. Sixth Edition*. Pearson:Prentice-Hall
- D. G. Wilson, T. Korakianitis, 1998. *The Design of High-Efficiency Turbomachinery and Gas Turbines. Second Edition*. Prentice-Hall
- R. Kehlhofer, B. Rukes, F. Hannemann, F. Stirnimann, 2009. *Combined Cycle Gas and Steam Turbine Power Plants*. PennWell
- J. H. Horlock, 1992. *Combined Power Plants*. *Including Combined Cycle Gas Turbine* (*CCGT*) *Plants*. Pergamon Press
- J. H. Horlock, 2003. *Advanced Gas Turbine Cycles*. Pergamon Press
- P. P. Walsh, P. Fletcher, 1998. *Gas Turbine Performance*. Blackwell Science:ASME

6. MACIs. Cogeneración y sistemas energéticos industriales

- J. B. Heywood, 1988. *Internal Combustion Engine Fundamentals*. McGraw-Hill
- J. H. Horlock, 1987. *Cogeneration. Combined Heat and Power* (*CHP*). *Thermodynamics and Economics*. Pergamon Press
- I. C. Kemp, 2000. *Pinch Analysis and Process Integration*. *Second Edition*. Elsevier