Year : 2018/19

60818 - Thermic engineering

Syllabus Information

Academic Year:	2018/19
Subject:	60818 - Thermic engineering
Faculty / School:	110 -
Degree:	532 - Master's in Industrial Engineering
ECTS:	6.0
Year:	1
Semester:	First semester
Subject Type:	Optional
Module:	---

General information

Aims of the course

Context and importance of this course in the degree

Recommendations to take this course

Learning goals

Competences

Learning goals

Importance of learning goals

Assessment (1st and 2nd call)

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

Methodology, learning tasks, syllabus and resources

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**. Whole group sessions where the lecturer explains the main concepts and procedures of the course, solves application problems and representative cases for the future professional practice. The participation of

students, both when answering questions during the theoretical explanations and when solving problems, will be encouraged. In parallel, the student must study at home for a better use of the classes.
- **Computer lab sessions**. Small group sessions (2 or 3 students) of computer simulation and laboratory are distributed throughout the semester. Their assessment will contribute to the final grade. Task instructions will be available in advance on Moodle, which include a questionnaire to be previously solved and submitted at the beginning of the session. Autonomous learning and teamwork is enhanced with this activity.
- **Guided assignments**. It can be done individually or, ideally, in pairs, where students use a software tool to analyze and solve realistic case studies under the teacher's supervision. Autonomous learning and teamwork is enhanced with this activity.
- **Autonomous work** of the students. It consists on solving exercises, questions and additional problems, studying the course contents and applying them to the exercises. This activity is essential for the learning process and to pass the tests.
- **Tutorials**. Teacher's office hours for the students so solve doubts, review and discussing the course contents, etc. The use of these tutorials is highly recommended to ensure an adequate progress in learning.
- **Assessment**. A final exam of theory and practice with a maximum duration of 4 hours. Details are described in the "Assessment" section.

Learning tasks

The course includes the following learning tasks:

- **Lectures.** Theoretical explanations supported with problem-solving tasks in 3-hour sessions. Attendance is not compulsory but highly recommended. The contents of the course are detailed in the "Syllabus" section.
- **Practice sessions**. 5 sessions of 3 hours each, including laboratory sessions and problem-solving.
- **Guided assignments**. Throughout the semester, in coordination with lectures and to be a complement of practice sessions, several realistic case studies will be solved in small groups with the help of the lecturer.
- **Autonomous work and study** (60 hours). This is the main part of the course, necessary for the study of theory, problem-solving and preparation of the final exam.
- **Tutorials.** The lecturer will publish on the website of the EINA their office hours.
- **Final exam.** EINA will schedule the dates of the two calls, February and September, and will publish it on its website.

Syllabus

The course will address the following topics:

Lectures

1. Topic 1. Fundamentals of heat transfer. Relationship with Engineering Thermodynamics. Basic laws: conduction, convection, radiation.
2. Topic 2. Fundamentals of heat conduction. Fourier law. Conductivity and thermal diffusivity. Heat diffusion equation. Boundary and initial conditions.
3. Topic 3. One-dimensional, steady-state conduction. Basic geometries. Thermal resistance model. Conduction with thermal energy generation. Heat transfer for extended surfaces (fins).
4. Topic 4. Multidimensional, steady-state conduction. Analytical approach. Numerical methods in 2-D and 3-D. Finite difference method.
5. Topic 5. Transient Conduction. Lumped capacitance model. Overall thermal resistance and capacity of the system: time constant. One-dimensional and multidimensional problems. Numerical methods in transient systems (finite difference method).
6. Topic 6. Fundamentals of convection. Mathematical approach. Boundary layers. Dimensional analysis. Analogies in transport phenomena.
7. Topic 7. External forced convection. Convection heat transfer coefficient. Using correlations in basic geometries: flat plate, cylinder, sphere, tube bank.
8. Topic 8. Internal forced convection. Hydrodynamic and thermal considerations. Conditions of fully developed flow. Energy balance. Calculation of convective heat transfer coefficient in circular and non-circular tubes.
9. Topic 9. Free convection. Phenomenology and physical equations. Laminar free convection on a vertical surface. Empirical correlations.
10. Topic 10. Boiling and condensation.
11. Topic 11. Heat Exchangers. Types and description. Thermal profiles. Analysis of heat exchangers. Log Mean Temperature Difference method. Ε-NTU Method.
12. Topic 12. Radiation. Main characteristics of radiation. Types of radiation. Fundamental concepts. The black body. environmental radiation. The view factor. Radiation exchange between surfaces.
13. Topic 13. Psychrometry. Ideal gas mixtures. Properties of moist air. Psychrometric diagram. Material and energy

balances for systems moist air. Psychrometric processes.
14. Topic 14. Combustion. Fuels and characterization. Thermochemistry of combustion: material and energy balances. Adiabatic flame temperature. Absolute entropy and the third Law of Thernodynamics.
15. Topic 15. Introduction to Thermal Systems. Work Production: reciprocating internal combustion engines, thermal turbomachinery. Heat production: boilers. Cold production: refrigeration by compression and absorption, heat pump.

Practice sessions

1. Absorption refrigeration cycle. Using EES.
2. Psychrometry. Mass and energy balances in an evaporative cooler.
3. Descriptive reciprocating internal combustion engines.
4. Multidimensional and transient conduction. Finite difference method.
5. External forced convection. Empirical estimate of convection coefficient.
6. Analysis of a heat exchanger.
7. Combustion: mass and energy balances. Boiler efficiency.

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.

Bibliography and recommended resources

Resources
Feedback between the student and the teacher will be managed through Moodle. Here the lecturer will distribute course materials (notes, questions, problems, outlines, old exams, tables, etc.), make announcements and notifications to students, send and receive emails and make available to students the tools to carry on sending reports of learning activities.
In practical activities a software tool, Engineering Equation Solver, which will be available to students through Moodle, will be used. The complete manual can be downloaded from: http://www.fchart.com/ (ADD).
Bibliography

- Marín Herrero, José María. Transferencia de calor / Jose Ma. Marín y Carlos Monné . - 1a ed. Zaragoza : Kronos, 1998
- Incropera, Frank P.. Fundamentos de transferencia de calor / Frank P. Incropera, David P. DeWitt . - 4a ed. México : Prentice Hall, 1999
- Çengel, Yunus A.. Transferencia de calor y masa : un enfoque práctico / Yunus A. à?engel ; revisor técnico Sofía Faddeva . - 3ª ed. México D. F. : McGraw-Hill Interamericana, cop. 2007
- Mills, Anthony F.. Transferencia de calor / Anthony F. Mills ; versión en español de Sergio de Régules Ruiz-Funes ; con la colaboración técnica de Eduardo Muñoz Tomás y Víctor Hugo del Valle Muñoz Barcelona [etc.] : Irwin, D.L. 1995
- Bejan, Adrian. Heat transfer / Adrian Bejan . New York [etc.] : John Wiley and Sons, cop. 1993
- Muñoz Rodríguez, Mariano. Motores alternativos de combustión interna / Mariano Muñoz Rodríguez, Francisco Moreno Gómez, Jesús F. Morea Roy Zaragoza : Prensas Universitarias de Zaragoza, 1999
- Turbomáquinas térmicas / Mariano Muñoz Rodriguez, Francisco J. Collado Giménez, Francisco Moreno Gómez, Jesús F. Morea Roy . - 1a ed. Zaragoza : Prensas Universitarias, 1999
- Tester, J.W. Sustainable energy. Choosing among options / TESTER, J.W; DRAKE, E.M.; DRISCOLL, M.J.; GOLAY, M.W.; PETERS, W.A MIT Press.
- [Resolución de problemas y prácticas] - Gonzalez García, Juan M.. Problemas de transmisión de calor / Juan M. Gonzalez García, Rafael Calvo Ortega ; Colaboradores: Eduardo Muñoz Tomás, Antonio Mardomingo Gimeno, José Luis Elviro Peña . Madrid : Universidad Politécnica de Madrid, Escuela técnica superior de ingenieros industriales, Sección de publicaciones, 1989
- [Resolución de problemas y prácticas] - Pinazo Ojer, José Manuel. Transferencia de calor / J.M. Pinazo Ojer, E. Torrella Alcaraz . Valencia : Universidad Politécnica, Servicio de Publicaciones, D.L. 1988
- [Resolución de problemas y prácticas] - Muñoz Tomás, Eduardo. Una clase de problemas de transmisión del calor / Eduardo Muñoz Tomás, Carlos Corrochano Sánchez ; colaboradores, Luis Rebollo Medrano, Juan M. González García . [2a. ed.] Madrid : Bellisco, 1998
- [Resolución de problemas y prácticas] - The heat transfer problem solver / Research and Education Association ; M. Fogiel director . Piscataway, New Jersey : Research and Education Association, cop. 1984|g(1988)