30017 - Thermal Engineering

Información del Plan Docente

Academic Year	2018/19
Subject	30017 - Thermal Engineering
Faculty / School	110 - Escuela de Ingeniería y Arquitectura
Degree	436 - Bachelor's Degree in Industrial Engineering Technology
ECTS	6.0
Year	2
Semester	Second 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 learning process is based on the following activities:

1. Lectures, given to the entire group, in which the lecturer will explain the main concepts and procedures and will solve application problems, representative of realistic cases for the future professional practice. The participation of students, both to answer questions during the theoretical explanations as to contribute to the resolution of the exercises, will be sought. In parallel, the student must study and do exercises at home for better utilization of classes.

2. Practices of computer simulation and laboratory are distributed throughout the semester and whose assessment will contribute to the final grade. The will be performed in groups of two or three students. In advance, the outline of each

practice will be distributed in Moodle. It includes a questionnaire which must be previously solved and delivered at the beginning of the session. Autonomous learning and teamwork is enhanced with this activity.

3. Tutored work individually or in small groups (ideally couples): using a software tool, students analyze and solve realistic case studies, with the advice of the teacher. Autonomous learning and teamwork is enhanced with this activity.

4. Personal work: Proposing exercises, questions and additional problems, the student is encouraged to study the matter and applying it to the resolution of the exercises. This activity is essential for the learning process and to pass the evaluation tests.

5. Academic Tutorials: The lecturer provides the student certain procedures for approach and resolving doubts. The use of these tutorials is highly recommended to ensure an adequate progress in learning.

4.2.Learning tasks

The program offered to the student to achieve the expected results includes the following activities:

Lectures: will be developed throughout the semester, including solving problems through 3 hours per week on schedule assigned by the center. It is, therefore, an in-person activity. Attendance is not compulsory but highly recommended. The schedule of the subject is shown in the "Program" section.

Practical sessions: 5 sessions of 2.5 h, including laboratory sessions and problem-solving sessions with computer, are planned. The student will dedicate the order of 1 h to the preparation of practice and to complete the previous questionnaire. In the laboratory sessions the student checks a given physical phenomenon and obtains experimental results which should be contrasted with the theory. At computer sessions, the student solves certain problems by numerical and graphical tools that allow treatment systems from a broader perspective.

The practices must be carried out by the student where the lecturer will encourage their participation and ability to make decisions.

Expected practices

1. Multidimensional and transient conduction. Finite difference method

2. External forced convection. Empirical estimate of convection coefficient

3. Analysis of a heat exchanger

4. Combustion: mass and energy balances. Boiler efficiency

5. Absorption refrigeration cycle. Using EES

Tutored works: Throughout the semester, in coordination with lectures and to be a complement of practices, several realistic case studies will be solved in small groups with the help of the lecturer, requiring an estimated dedication of 20 h. Materials and schedules will be posted in Moodle.

Study and personal work: This is the main part of the course, requiring about 60 hours of autonomous work, necessary for the study of theory, problem solving and preparation of the final exam.

Academic tutorials: The lecturer will publish on the website of the EINA a schedule to attend to the students in an orderly manner throughout the semester.

Final exam: EINA will plan dates of the two calls, June and September, and will publish it on the website of the EINA.

The course includes 6.0 ECTS organized according to:

- Lectures (1.8 ECTS): 45 hours.

- Laboratory sessions (0.6 ECTS): 15 hours.

- Guided assignments (0.8 ECTS): 20 hours.

- Autonomous work (2.8 ECTS): 70 hours.

- Tutorials

4.3.Syllabus

The specific program will be organized by the lecturer at the beginning of the course according to the student profile. It will cover the objectives from both theoretical and practical point of view of the following topics:

Lesson 1: Fundamentals of heat transfer. Relationship with Engineering Thermodynamics. Basic laws: conduction, convection, radiation

Lesson 2: Fundamentals of heat conduction. Fourier law. Conductivity and thermal diffusivity. Heat diffusion equation. Boundary and initial conditions.

Lesson 3. One-dimensional, steady-state conduction. Basic geometries. Thermal resistance model. Conduction with thermal energy generation. Heat transfer for extended surfaces (fins).

Lesson 4: Multidimensional, steady-state conduction. Analytical approach. Numerical methods in 2-D and 3-D. Finite difference method.

Lesson 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).

Lesson 6: Fundamentals of convection. Mathematical approach. Boundary layers. Dimensional analysis. Analogies in transport phenomena.

Lesson 7. External forced convection. Convection heat transfer coefficient. Using correlations in basic geometries: flat plate, cylinder, sphere, tube bank.

Lesson 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.

Lesson 9. Free convection. Phenomenology and physical equations. Laminar free convection on a vertical surface. Empirical correlations.

Lesson 10. Boiling and condensation.

Lesson 11: Heat Exchangers. Types and description. Thermal profiles. Analysis of heat exchangers. Log Mean Temperature Difference method. Ε-NTU Method.

Lesson 12: Radiation. Main characteristics of radiation. Types of radiation. Fundamental concepts. The black body. environmental radiation. The view factor. Radiation exchange between surfaces.

Lesson 13: Combustion. Fuels and characterization. Thermochemistry of combustion: material and energy balances. Adiabatic flame temperature. Absolute entropy and the third Law of Thernodynamics.

Lesson 14: Introduction to Thermal Systems. Work Production: reciprocating internal combustion engines, thermal turbomachinery. Heat production: boilers. Cold production: refrigeration by compression and absorption, heat pump.

4.4.Course planning and calendar

Lectures and practice sessions are planned by the EINA. Timetables are available on the website.

Lecturer will inform about the timetable of tutoring at the beginning of the semester.

The other activities will be planned according to the teaching assignment and according to the number of students enrolled. They will be announced in advance in class and through Moodle.

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).

For further details concerning the timetable, classroom and further information regarding this course, please refer to the Escuela de Ingeniería y Arquitectura de la Universidad de Zaragoza (EINA), website, https://eina.unizar.es/ .

4.5.Bibliography and recommended resources