Thermal system design

Academic Year: (2023 / 2024) **Review date: 25/04/2023 11:46:22**

Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: SANCHEZ GONZALEZ, ALBERTO

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Thermal Engineering (Thermodynamics)
Heat Transfer
Engineering Fluidmechanics

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA3. Engineering Design: To be able to design industrial products that comply with the required specifications, collaborating with professionals in related technologies within multidisciplinary teams.
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.
RA6. Transversal Skills: To have the necessary skills for the practice of engineering in today's society.

OBJECTIVES

This course is devoted to the design of HVAC systems to produce heat and cold in buildings and industry.
At the end of the course, students will be able to:
- Know the principles of heating and cooling equipment for buildings and industry.
- Apply the knowledge to the sizing of thermal systems, using established methods.
- Use software applicat6ions for building energy simulation and thermal systems.
- Design HVAC (Heating, Ventilation and Air Conditioning) systems and buildings to minimize energy consumption.
- Consult and comply with current regulations and standards in thermal systems and energy in buildings.
- Develop research and HVAC projects, using reliable sources of information.
- Size and select the equipment, according to criteria of efficiency, security, quality, cost, environmental awareness.
- Communicate effectively projects and researches in HVAC systems, working both individually and in group.
- Understand the relationship between buildings, energy consumption and environmental impact.
- Collaborate with associated professionals within multidisciplinary teams.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Refrigeration and Heat Generation

Vapor compression cycle. Refrigerants and environmental impact. Coefficient of performance (COP). Components: compressor, condenser, evaporator. Two-stage compression. Auxiliary equipment. Heat pumps. Low-temperature geothermal energy. Boilers and furnaces: natural gas, fuel-oil, biomass, electric. District heating. Combined heat and power (CHP).
Integration of renewable energy systems. Solar cooling (absorption machine). Evaporative cooling.

2. Energy in Buildings

Building energy use, environmental impact and sustainability. Energy sources, primary/final energy, CO2 emissions.
Regulations and standards. Código Técnico de la Edificación, documento básico de Ahorro de Energía (CTE HE). European energy performance of buildings directive (EPBD), energy certification of new and existing buildings, energy label, nearly zero energy buildings (nZEB). Reglamento de instalaciones térmicas en los edificios (RITE). Energy audit.

3. Thermal Loads

Outdoor design conditions, climatic zones, typical meteorological year (TMY). Indoor comfort conditions, air quality, ventilation (CTE-HS3). Hygrometry, psychrometric chart.
Heat transfer through building envelope. Materials, thermal insulation, and constructions. Overal heat transfer coefficient, U-value.
Passive heating and cooling, bioclimatic design. Fenestrations, glazings, shadings, solar heat gains.
Heating and cooling loads. Internal loads. Sensible and latent heat. Selection of equipment.

4. HVAC Systems

Applications in buildings, industry, and transport.
Heating, ventilating, air conditioning and refrigeration systems (HVAC). Service hot water (SHW). Thermal storage.
Transport and distribution of energy. Centralized vs. decentralized systems, zoning. Terminal elements. Air-and-water systems, fan-coils. All-water systems: pumps, pipes, radiators, radiant panels. All-air systems: air handling unit (AHU), fans, ducts, diffusors. Sizing.

LEARNING ACTIVITIES AND METHODOLOGY

The learning methodology includes:
- Magistral lectures, in which the course contents are presented.
- Problems¿ lectures, in which examples are solved.
- Workshops, where students work on their individual projects.
- Four lab sessions, where students learn practical aspects and the use of computer tools:
  1. Simulation of energy demand: compliance with CTE HE1.
  2. Calculation of thermal loads, according to CTE HE2 (RITE).
  3. Sizing of air ducts.
  4. Building energy performance certificate (label): compliance with CTE HE0.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

As a very applied course, continuous assessment represents 100% of the final grade, based on:
- Individual project (50%), distributed in 4 partial assignments. Each student develops a building energy project, where the knowledge gained during the course, including the use of software tools (lab sessions), is applied.
- Two mid-term exams (40%), in which is assessed the ability to solve practical problems of HVAC systems, as well as the assimilation of concepts.
- A work in group (10%), which is shown in class.

In the event of course fail by continuous evaluation, the exams/assignments not passed will be reassessed in the ordinary call.

BASIC BIBLIOGRAPHY

- A.L. Miranda Manual de aire acondicionado Carrier, Marcombo, 2017

- Ana María Díez et al. Manual práctico de climatización en edificios, Paraninfo, 2018

- Enrique Torrella Alcaraz Manual de climatización, A. Madrid Vicente, 2005

- Fco Javier Rey Martínez, Eloy Velasco Bombas de calor y energías renovables en los edificios, Paraninfo, 2005

- Francisco Javier Rey Martínez, Eloy Velasco, Javier María Rey Hernández Eficiencia energética de los edificios. Certificación energética, Paraninfo, 2018

- José Manuel Pinazo Ojer Fundamentos de climatización, ATECYR, 2019

ADDITIONAL BIBLIOGRAPHY

- null ASHRAE Fundamentals (SI Edition), ASHRAE.

- Doug Oughton, Steve Hodkinson. Faber & Kell's Heating & Air-conditioning of Buildings, Elsevier, 2008

- F.C. McQuiston, J.D. Parker, J.D. Spitler. Heating, Ventilating, and Air Conditioning: Analysis and Design, John Wiley & Sons, 2005

- G.F. Hundy, A.R. Trott, T.C. Welch. Refrigeration and Air-Conditioning, Elsevier, 2008

- Paul Tymkow Building Services Design for Energy Efficient Buildings, Routledge, 2013

- Robert McDowall. Fundamentals of HVAC Systems, Elsevier, 2007

- T.A. Reddy, J.F. Kreider, P.S. Curtiss, A. Rabl. Heating and Cooling of Buildings: Design for Efficiency, Taylor & Francis, 2010

- W.T. Grondzik. Air-conditioning System Design Manual, ASHRAE, 2007

BASIC ELECTRONIC RESOURCES

- European Union. . Directive on the Energy Performance of Buildings EPBD 2010: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0031&from=EN

- MINETUR. . Reglamento de Instalaciones Térmicas en los Edificios RITE: http://www.minetur.gob.es/energia/desarrollo/EficienciaEnergetica/RITE/Paginas/InstalacionesTermicas.aspx

- Ministerio de Vivienda. . Código Técnico de la Edificación: http://www.codigotecnico.org