Thermal system design

Academic Year: (2022 / 2023) **Review date: 17-05-2022**

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

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

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.

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

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