Energy in Buildings

Academic Year: (2019 / 2020) **Review date: 20-04-2020**

Department assigned to the subject: Department of Electrical Engineering, Department of Thermal and Fluids

Coordinating teacher: SANCHEZ GONZALEZ, ALBERTO

Type: Electives ECTS Credits : 6.0

Year : 4 Semester : 2

STUDENTS ARE EXPECTED TO HAVE COMPLETED

Thermal Engineering
Fluid Transport and Hydraulic Machinery
Solar Energy

COMPETENCES AND SKILLS THAT WILL BE ACQUIRED AND LEARNING RESULTS.

At the end of the course the students will be able to:

1. Know and understand the technological principles of HVAC, lighting and renewable energy systems in buildings.
2. Be aware of the wider multidisciplinary context of energy engineering and buildings.
3. Apply their knowledge to the sizing of thermal and electrical systems in buildings.
4. Use computer software for building energy simulation.
5. Design buildings and systems to minimize the consumption of energy.
6. Search and apply valid codes and standards for energy in buildings.
7. Size and select thermal and electrical equipment for buidings.
8. Develop and show an energy project applied to buildings.
9. Undestand the relationship between buildings, energy consumption and environmental impact.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Energy Consumption in Buildings

Building energy use, environmental impact and sustainability. Energy sources, primary/final energy, CO2 emissions. European energy performance of buildings directive (EPBD), certification of new and existing buildings, energy rating/labeling, nearly zero energy buildings (nZEB), energy audit. Energy codes for buildings, Código técnico de la edificación - Ahorro de energía (CTE-HE), ASHRAE standard 90.1.

2. Heating and Cooling Loads

Outdoor design conditions, climatic zones, typical meteorological year (TMY). Indoor comfort conditions, air quality, ventilation (CTE-HS3). Heat transfer through building envelope, insulating materials, U-value. Glazings, shadings, solar heat gains (SHGC). Passive heating and cooling, bioclimatic design. Internal loads, latent heat, psychrometric chart. Building energy simulation tools.

3. Refrigeration and Heat Generation

Vapor compression cycle, refrigerant charts, coefficient of performance (COP). Compressor, condenser, evaporator. Electric heat pumps. Electric heaters. Natural gas and fuel-oil boilers. Service water heating (SWH).

Renewable energy systems: low-temperature geothermal energy, solar thermal (CTE-HE4), solar cooling, biomass. Thermal energy storage (TES), district heating and cooling (DHC), combined heat and power (CHP). Integration in buildings.

4. HVAC Systems

Heating, ventilating, and air conditioning (HVAC), decentralized vs. centralized systems, zoning. Direct expansion systems. Air-and-water systems, fan-coils. All-water systems: pumps, pipes, radiators, radiant panels. All-air systems: air handling unit (AHU), fans, ducts, diffusors.

5. Lighting systems.

Main types of lamps. Parameters of visual comfort. Luminaries and lighting systems. Regulation of lighting (regulation 0-10 V, DSI regulation, regulation DALI).

6. Photovoltaic Systems

Types of photovoltaic cells. Installation configuration (panels, wiring, protections and investor). Resource assessment, integration into the building.

7. Power factor compensation.

Concept of power factor compensation. Estimation of consumption of reactive power. Capacitor banks and its regulation.

LEARNING ACTIVITIES AND METHODOLOGY

The learning methodology includes:

1. Lectures in which the course contents are presented.
2. Workshops, usually held in a computer room, where each student works on their projects.

ASSESSMENT SYSTEM

Continuous assessment based on the delivery of a final project.
At the end of the course, students present their projects.
Each student will be assigned a building case study, in which the student will apply the knowledge gained during the course.

To check the progress, there will be scheduled several assignments:

1. Building model and annual energy demand (compliance with building codes).
2. Heating and cooling loads.
3. HVAC equipment selection.
4. Lighting system design.
5. Lighting control systems associated with the system proposed.
6. Incorporation of a photovoltaic system on the building.

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

BASIC BIBLIOGRAPHY

- ASHRAE. ASHRAE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings, ASHRAE, 2016
- Anna Yudina. Lumitecture: Illuminating Interiors for Designers and Architects , Thames & Hudson, 2016
- Harry Box. Set Lighting Technician's Handbook: Film Lighting Equipment, Practice, and Electrical Distribution , Elsevier Inc., 2010
- Michael Boxwell. Solar Electricity Handbook: A Simple Practical Guide to Solar Energy - Designing and Installing Photovoltaic Solar Electric Systems, Greenstream Publishing , 2014
- Paul Tymkow. Building Services Design for Energy Efficient Buildings, Routledge, 2013
- T.A. Reddy, J.F. Kreider, P.S. Curtiss, A. Rabl. Heating and Cooling of Buildings: Design for Efficiency, Taylor & Francis, 2010

ADDITIONAL BIBLIOGRAPHY

- ASHRAE Fundamentals (SI Edition), ASHRAE.
- 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
- Robert McDowall Fundamentals of HVAC Systems, Elsevier, 2007
- W.P. Jones Air Conditioning Engineering, Elsevier, 2001
- 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/FR/TXT/PDF/?uri=CELEX:32010L0031&from=EN