Degree course	Architecture
Course code	1000672
Lecturer	Marina Mistretta
Course name	Building Physics and Building Energy Systems
Disciplinary area	Industrial Engineering
Disciplinary field of science	ING-IND/11
University credits - ECTS	6
Teaching hours	60
Course year	Second
Semester	First

Synthetic description and specific course objectives

Building physics and energy systems is a formative class, aiming at the learning of the physics fundamentals regarding indoor environments applications, and at giving students the necessary knowledge in the topics of energy efficient building design, in compliance with the regulations in force and the energy and environmental requirements of the building sector. The main learning objectives of the class are connected to: 1) fundamental laws of thermodynamics, regarding mass and energy balances for open and closed systems, aiming at describing significant applications regarding the behaviour of the building-thermal plant system; 2) applied physics laws critical understanding, in order for the students to develop the ability to solve conceptual problems, 3) typical applications of the thermo-physics of the building focused on the thermal behaviour of the building envelope layers through the study of the steady-state heat transfer laws, 4) indoor environment control in terms of thermo-hygrometric comfort, according to the regulations in force.

Course entry requirements

No requirement

Course programme

The formative tasks of Building physics and energy systems class are to provide the students with the following topics:

Thermodynamics

Recurring unit of measurement conversion. Relevant and universal physical constants. Common values of the thermo-physical properties of matter. Unit of measurement of the derived physical matter properties. Thermodynamics systems: open and closed systems. Thermodynamics properties and measurements methods: temperature, pressure and volume. Energy, energy transfer and general energy analysis. Energy typologies, energy transfer as heat and work, internal energy, kinetic and potential energy. First law of Thermodynamics applied to closed systems: Enthalpy. Energy and environment: climatic change and greenhouse gases. Pure substance properties. Phase changes. Ideal gas law. Energy analysis of closed systems: mass and energy balances.

Psychometrics

Absolute humidity and relative humidity, dew temperature and dry bulb temperature. Psychometric chart. Psychometric processes in air handling procedures.

Heat transfer

Thermal conduction in steady state conditions. Conduction heat flow in a plane wall. Thermal conductivity. Steady state general conduction law for a plain wall. Thermal resistances. Thermal conductance. Thermal conduction in series and parallel layers. Convection. Thermal convection law. Convection thermal resistance. Convection coefficient. Heat transfer between walls and air. Heat transfer: radiation. Monochromatic emission. Global emission. Monochromatic emission intensity. Global emission intensity. Hemispheric emission. The black body and the Planck law. Specific emissivity. Gray body. Kirchoff law. Shape factor. Calculation of the thermal heat flux transferred through a multi-layer wall.

Thermo-hygrometric verifications in buildings: internal and superficial condensation. Partial vapour pressure and dew pressure. Vapour resistance. Glaser method.
Thermal-hygrometric comfort
Energy balance of the human body. Microclimate. Thermal-hygrometric comfort indicators. Local discomfort conditions.
Lighting engineering
Fundamentals of lightings. Photometric properties. Daylighting. Artificial light. General criteria of design.

Expected results

Knowledge in the topics of energy efficient building design, in compliance with the regulations in force and the energy and environmental requirements of the building sector, in order to understand the thermal behavior of the buildings.
Acquisition of a general methodology for the solution of the problems related to the thermal closed and open thermodynamic systems, the psychometric processes in air handling procedures, the heat transfer in the building envelopes in steady state conditions.

Course structure and teaching

Lectures *(hours/year in lecture theatre): 20*
Practical class *(hours/year in lecture theatre): 40*
Practical / Workshops *(hours/year in lecture theatre):*

Student's independent work

Excercises

Testing and exams

Student will be assessed by means of intermediate tests and a final test (both written and oral, separately).
The intermediate tests will aim at verifying the acquisition of the theoretical and practical concepts studied during the course until then. If students pass the tests with positive results, they will be exonerated from the written final test.
The final test will be characterized by a written test and an oral one, which will be done in different days. Students which will pass the intermediate tests or the final written test can access to the oral test.
The questions that form the oral exam will cover both theoretical issues, the solution of simple problems treated during the classroom exercises and, finally, the discussion of possible application works developed during the year.
With regards to the students who get not suitable results or retire during the test, the teacher will evaluate whether they will be able to attend the test in the same session or at the next session.

Suggested reading materials

1) Yunus Çengel "Termodinamica e Trasmissione del Calore" McGraw-Hill. Fourth Edition (In Italian language).
2) Guida AICARR: QUALITA' GLOBALE DELL'AMBIENTE INTERNO Collana Tecnica - Coordinatori: Francesca Romana d'Ambrosio Alfano, Luca Alberto Piterà, 2014 (In Italian language).