COURSE DESCRIPTION
ENVIRONMENTAL TECHNICAL PHYSICS

SSD: FISICA TECNICA AMBIENTALE (ING-IND/11)

DEGREE PROGRAMME: ARCHITETTURA (N14)
ACADEMIC YEAR 2022/2023

COURSE DESCRIPTION

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GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: NOT APPLICABLE
MODULE: NOT APPLICABLE
CHANNEL: 01 Cognome A - Z
YEAR OF THE DEGREE PROGRAMME: III
PERIOD IN WHICH THE COURSE IS DELIVERED: SEMESTER II
CFU: 8

REQUIRED PRELIMINARY COURSES

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PREREQUISITES

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LEARNING GOALS

Students will be able to:

- *Carrying out calculations and assessments dealing with energetic interactions between systems.*
- *Carrying out quantitative assessments through the main parameters involved in the environmental control analysis.*
- *Understanding the physical laws which describe heat exchange mechanisms, specifically dealing with solar thermal radiation, necessary for passive systems and renewable energy sources analyses.*

- *Assessing the building envelope's thermal and physical characteristics for the calculation of heat exchange rates between indoor and outdoor and for the hygrothermal analysis of building envelopes.*

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

Students must demonstrate knowledge and understanding of the energetic interactions among the indoor environment, the building envelope and the outdoor environment, also considering specific contextual conditions.
Students must show familiarity with the main physical parameters describing the environmental comfort conditions.

Applying knowledge and understanding

Students will demonstrate to be able to verify and size simple elements of the building envelope for limiting heating losses and for solar radiation control;
furthermore, they must show their ability to evaluate the correctness of possible design proposals, considering their impact on the building's energetic behaviour.
Finally, they must show awareness in applying calculation models.

COURSE CONTENT/SYLLABUS

A. Units and Physics hints (0.3 ECTS): Review of the main physical quantities (displacement, speed, acceleration, force, energy, power, pressure, density, temperature, mass and specific volume). Unit of measure. Measurement uncertainty. Systematic and accidental errors. Direct and indirect measurements. Fundamental quantities. Measurement Systems. The International System. Multiple and submultiples. Measurement conversions. Numerical exercises. (Ref. App. A Lecture notes)

B. Basic concepts and definitions (0.3 ECTS): System and environment. Mass control and volume control systems. Thermodynamic equilibrium. Properties, thermodynamic state. Internal and external properties. Total, specific, extensive and intensive quantities. Thermodynamic state, transformations. State postulate. Pure substance, phase, compressible simple system. Equations of state. The ideal gas. Numerical problems. (Ref. Chap. 1, Lecture notes)

C. Mass and energy analysis for mass control systems (1 ECTS): Energy, work and heat. Balance equation. Mass balance. Piston cylinder system. Volume variation work. Energy balance. Internal energy. Specific heat. Thermal capacity. Numerical problems (Ref. Chap. 2 Lecture notes)

D. Calculation of thermodynamic properties (0.4 ECTS): Incompressible liquid. Solid. Ideal gas. p,T chart. Saturated vapour. Subcooled liquid. Superheated steam. Determination of the phase. Linear interpolation. Numerical problems. (Ref. App. A Lecture notes)

E. Mass and energy analysis for volume control systems (1.5 ECTS): Local equilibrium hypothesis. One-dimensional flow. Steady-state conditions. Control volume. Mass balance. Mass flow rate. Volumetric flow rate. Energy balance. Pulse work. Enthalpy. Thermal and mechanical energy transfer rates. Numerical problems. (Ref. Chap. 3 Lecture notes)

F. Moist Air (1.5 ECTS): Definitions. Thermometric properties: dry bulb, wet bulb, adiabatic-saturation, and dew temperatures. Specific enthalpy. Specific volume. Specific humidity. Relative humidity. Humidity ratio. Psychometric chart. Transformations of moist air: simple heating, simple cooling, cooling with dehumidification. Adiabatic humidification. Adiabatic mixing. Numerical problems. (Ref. Chap. 4a and 4b Moist air - Lecture notes)

G. Introduction to heat transfer and conduction (0.5 ECTS): Heat exchange mechanisms. Conduction, convection and radiation. Thermal flow. Fourier's law. Undefined flat sheet: temperature trend, thermal flow and power, conductance and thermal resistance. Series and parallel mechanisms. Numerical problems. (Ref. Chap. 5, App. B, Lecture notes)

H. Heat transfer by combined mechanisms (0.5 ECTS): examples of combined mechanisms. Calculation of the heat transfer rate by combined mechanisms. Convective, radiative and overall heat transfer coefficients. Air gaps. Thermal transmittance. Numerical problems. (Ref. Chap. 6, App. C, Lecture notes)

I. Hygrothermal analysis of the building envelope (1 ECTS): surface and interstitial condensation. Simplified procedure for the hygrothermal analysis of building envelopes. Corrective actions for a wall affected by condensation phenomena. Thermo-hygrometric analysis of the floors. Notes on the ISO 13788 Standard. Numerical problems. (Ref. Chap 7 Lecture notes

J. Thermal radiation (1 ECTS): Wave, speed, frequency, period and wavelength. Quantum of energy. Electromagnetic fields and frequencies. Total and monochromatic radiative quantities: emissive power, irradiation and radiosity. Monochromatic and total absorption, reflection and transmission coefficients. Black body. Laws of radiation for the black body: Planck, Stefan-Boltzmann, Wien. Total and monochromatic emissivity. Gray body. The angle factor. Energy balance in the evaluation of the radiative heat exchange. Greenhouse effect. Numerical problems. (Ref. Chap. 8 Lecture notes)

READINGS/BIBLIOGRAPHY

Teaching material, as lecture notes, booklets, tables and diagrams will be provided by the teacher. To deepen the themes about moist air, heat exchange through the building envelope and hygrothermal analysis, the book "L. Bellia, P. Mazzei, F. Minichiello, D. Palma: ARIA UMIDA –Climatizzazione ed involucro edilizio. Liguori Editore", is suggested.

TEACHING METHODS OF THE COURSE (OR MODULE)

The course consists of theorical lectures and numerical exercises sessions. Teaching material will be available online and spreadsheets will be used.

Teachers will conduct lectures according to the following planning:

a) 50% frontal teaching dealing with theorical topics (4 ECTS)

b) 50% exercise sessions during which the learned theorical concepts will be applied (4 ECTS).

EXAMINATION/EVALUATION CRITERIA

a) Exam type

☐ Written

- [x] Oral
- [ ] Project discussion
- [ ] Other

In case of a written exam, questions refer to

- [ ] Multiple choice answers
- [ ] Open answers
- [ ] Numerical exercises

b) Evaluation pattern

The exam consists of an interview during which the student is required to apply his/her expected competence by solving numerical exercises and to demonstrate his/her acquired knowledge by answering questions and discussing on the program arguments.