COURSE DESCRIPTION
AIR CONDITIONING PLANTS

SSD: FISICA TECNICA INDUSTRIALE (ING-IND/10)

DEGREE PROGRAMME: INGEGNERIA MECCANICA PER L'ENERGIA E L'AMBIENTE (M65)
ACADEMIC YEAR 2022/2023

COURSE DESCRIPTION

TEACHER: PALOMBO ADOLFO
PHONE: 081-7682299
EMAIL: adolfo.palombo@unina.it

GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: NOT APPLICABLE
MODULE: NOT APPLICABLE
CHANNEL: FG A-Z
YEAR OF THE DEGREE PROGRAMME: I
PERIOD IN WHICH THE COURSE IS DELIVERED: SEMESTER II
CFU: 9

REQUIRED PRELIMINARY COURSES

None.

PREREQUISITES

None.

LEARNING GOALS

The course, of crucial importance for engineers dealing with energy topics, aims at developing knowledge on the energy efficient design of the envelope-HVAC plant system (building, ship, train, vehicle, aircraft) also with the target of economic and environmental sustainability. Fundamentals on the envelope thermo-physics and on the HVAC systems are provided by highlighting the technical-application aspects with particular attention to energy efficiency.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must prove knowledge of the topics concerning: 1) the choice of the system according to the use of indoor spaces, the hygrothermal comfort of occupants and the energy and economic aspects concerning the envelope-HVAC plant system; 2) the calculation of system heating and cooling loads; 3) the energy needs and the energy class of the system according to current standard and rules for heating, cooling and domestic hot water production; 4) the design and tuning of the various components of the HVAC system (thermo-refrigeration unit, distribution network of heat transfer fluids, heat exchange terminals, control system, etc.) according to the regulations in force.

Applying knowledge and understanding

The student must be able to: 1) make the suitable choice of the HVAC system according to the selected indoor space use, the hygrothermal comfort of occupants and energy and economic issues of envelope-plant systems; 2) perform, also through the use of specific software, the calculation of the system heating and cooling loads; 3) assess, also through the use of specific software, the energy needs and the energy performance class of the system according to the standards and rules for heating, cooling and domestic hot water production in the current scenario and in those for possible system refurbishments; 4) carry out the design and tuning of the various components of the HVAC system (furnace/heat pump/chiller unit, distribution network of heat transfer fluids, heat exchange units, control system, etc.) according to standards and rules and through the use of specific software also with BIM (Building Information Modelling) approach.

COURSE CONTENT/SYLLABUS

*1. **MOIST AIR** [0.5 CFU] - Thermodynamic properties of humid air. Psychrometric charts. Elementary transformations of moist air. Applications.*

*2. **DESIGN CONSTRAINTS FOR HYGROTHERMAL COMFORT AND AIR QUALITY** [0.5 CFU] - Metabolism. Thermoregulation system. Evaluation of hygrothermal comfort. Indexes for the assessment of comfort. Natural and forced ventilation. Ventilation efficiency. Internal design conditions. Applications.*

*3. **HEATING LOAD** [1 CFU] - Assessment of the heating load. Thermal loads for transmission through the envelope. Thermal bridges. Corrections. Thermal loads for ventilation. Restart power. Overall thermal load. Applications.*

*4. **COOLING LOAD** [1 CFU] - Dynamism of phenomena. Sensitive and latent loads. Assessment of refrigeration loads by the Carrier method. Thermal load due to solar radiation through the glass. Thermal load for transmission through the glass. Thermal load for transmission through opaque structures - Sol-air temperature. Internal loads. Load for ventilation and air infiltration. Applications.*

*5. **HEATING SYSTEMS** [0.5 CFU] - Gas fired heater. Pumps. Distribution network: single-pipe, two-pipes, four-pipes. Expansion vessel. Safety devices. Two- and three-way valves. Operating features of the hydronic circuit. Applications.*

*6. **DESIGN OF THE WATER DISTRIBUTION NETWORK** [1 CFU] - Materials for pipes. Pressure drops in the distribution networks crossed by liquids. Calculation of distributed and concentrated pressure drops. Sizing of water distribution networks. Applications.*

*7. **UNITS FOR HEAT EXCHANGE** [0.5 CFU] - Analysis, sizing and tuning of radiators, fan coils, unit heaters, convectors and radiant panels. Applications.*
*8. **ENERGY EFFICIENCY** [1 CFU] - Definitions and reference parameters: degree day, use of buildings, period of operation of the heating system, ambient temperatures, average seasonal overall efficiency, regulation, energy requirement for building heating and cooling and for the production of domestic hot water. Duties and checks to be carried out. Procedures for energy diagnosis and certification. Design and construction solutions for the improvement of the envelope efficiency. Economic analysis. Applications.*
*9. **AIR CONDITIONING SYSTEMS** [1.5 CFU] - Classification of systems. Simple centralized systems: calculation of the handled air flow, partial load tuning. Centralized multi-zone systems. Mixed air-water systems: primary air, calculation of the cooling and thermal capacity of the local exchange units, primary air systems and fan coils. Double duct systems. Variable flow systems. Autonomous direct expansion systems. Heat recovery units: classification, efficiency of the recovery unit. Fans. Free cooling. Criteria for choosing the HVAC system. Applications.*
*10. **DESIGN OF THE AIR DISTRIBUTION NETWORK** [1 CFU] - Air distribution: air into the room, diffusers. Air intake. Calculation of distributed and concentrated pressure drops into channels. Pressure at the diffusers. Sizing of air channels. Applications.*
*11. **CHILLERS AND HEAT PUMPS** [0.5 CFU] - Steam compression units: generality on the thermodynamic cycle, thermal energy sources and sinks, steam compression machines electrically driven. Performance indexes. Components of refrigeration units / heat pumps. Latest generation refrigeration units / heat pumps. Market analysis. Applications.*

READINGS/BIBLIOGRAPHY

Teacher's notes.

TEACHING METHODS OF THE COURSE (OR MODULE)

Lectures, exercises (also through PCs for the design project development through the use of professional software) and supplementary seminars.

EXAMINATION/EVALUATION CRITERIA

a) Exam type

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

In case of a written exam, questions refer to

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

b) Evaluation pattern

The grade is achieved through the outcome of the written test, the quality of the design project and the answers provided by the student during the oral test. The final grade is carefully motivated to the student.