

Course guide 240IEN32 - 240IEN32 - Climate Control and Refrigeration

Last modified: 14/06/2023

Unit in charge: Teaching unit:	Barcelona School of Industrial Engineering 724 - MMT - Department of Heat Engines.		
Degree:	MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).		
Academic year: 2023	ECTS Credits: 4.5	Languages: Catalan	

LECTURER

Coordinating lecturer:	Ruiz Mansilla, Rafael
Others:	Ribé Torijano, Òscar Ruiz Mansilla, Rafael

REQUIREMENTS

Thermodynamics, Thermotechnics, Fluid Mechanics

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CEEENE3. Design and value equipment and cooling and refrigeration systems.

TEACHING METHODOLOGY

A.- The presentations in class must be very participatory, conveniently mixing the new theoretical concepts with their practical application with examples and illustrative exercises:

1.- The classes combine theory and problems, inviting students to actively participate in them, in case analysis and technical decision making.

2.- As the subject progresses in each subject, the percentage of time devoted to theoretical exposition and practical exercises becomes smaller.

3.- The difficulty of the exercises performed will be progressive

B.- Students will have to carry out different non-contact activities scheduled chronologically throughout the course

- 1.- Study of the documentation provided on each topic
- 2.- The work continued throughout the course with the proposal and collection of problems is encouraged.

3.- Resolution of the exercises proposed in the Digital Campus on the subject that is being treated in class (weekly frequency)

LEARNING OBJECTIVES OF THE SUBJECT

Objective:

Achieving basic criteria for the calculation and design of equipment, systems and installación sin the fields of refrigeration and air conditioning, taking both technical and energy efficiency criteria.

Purpose:

- Estimate the different thermal needs in cold chambers, tunnels and buildings.
- Take decisions on the choice of air conditioning or refrigeration system according to the needs and type of installation.
- Ability to apply criteria in the calculation, sizing and selection of the main components of equipments.
- Ability to size and balance distribution networks suited to meet the thermal demands.
- Become familiar with the technology of the fundamental elements of the installations.



STUDY LOAD

Туре	Hours	Percentage
Hours small group	13,5	12.00
Self study	72,0	64.00
Hours large group	27,0	24.00

Total learning time: 112.5 h

CONTENTS

INTRODUCCIÓN

Description:

Aim and scope of the subject

Presentation, content and regulations of the subject. Industrial application areas: food, comfort, etc. Simple vapor compression cycle. Refrigerants. Cycle theory. P-h diagram. COP. Examples.

Real vapor compression cycle

Pressure drop, overheating and supercooling in the pipes. Compression process efficiencies: Volumetric, mechanical, electrical and isoentròpic. Examples of applications in cycles of industrial air conditioning and refrigeration

Refrigeration compressors

Classification criteria. Study of the curves of a real compressor. Practical determination of performances.

Full-or-part-time: 7h

Theory classes: 7h

REFRIGERATION

Description:

Multi-stage Cycles

Need and interest multi-stage cycles for low temperatures. Double step, partial and total injection. Boosters cycle. Cascade cycles. Examples of calculation

Psycrometrics

The psycrometric diagram for moist air. Study of variables. Simple processes: heating, cooling, humidification, drying, mixing, etc. Examples of calculation

Cold storage

Calculation of thermal needs in cold storage (fresh and frozen) and tunnels. Terms involved. Examples of calculation of chambers and tunnels

R&C elements and attached devices in cooling cycles Thermostatic expansión systems. Capillaries. Solenoid valve, valve, by-step hot gases.

Full-or-part-time: 10h

Theory classes: 10h



HEAT EXCHANGERS IN REFRIGERATION AND AIR CONDITIONING

Description:

Cooling coils

Type. Enthalpic potential. Heat and mass transfer. Calculation of the surface of a coil. Removed moisture . Real stare curve. Partially dry coil. Operation of commercial coils from the manufacturer catalog.

Evaporators.

Classification. Dry expansion and flooded evaporators . Tubular or plate evaporators. Calculation of an evaporator. Thermal difference to consider. Selecting from a catalog.

Condensers.

Thermal power of a condenser. Classification. Condensers for water and air. Effective thermal difference in condensers. Fouling. Coefficient of condensation. Design of a condenser.

Cooling towers and evaporative condensers

Transfer of heat to the atmosphere. Type. Analysis of a counterflow RT. Weather conditions out of a TR. Crossflow cooling tower. Condenser and evaporative coolers. Capacity and selection of a TR (tables).

Full-or-part-time: 10h

Theory classes: 10h

AIR CONDITIONING

Description:

Thermal loads sheet

Terms of the thermal requirements of heating or cooling. Sensible and latent loads. The sensible heat factor. Internal loads, ventilation and total. Examples of calculation of thermal requirements

Air conditioning equipment and systems Compact. Split. Water, air , refrigerant and mixed systems. Zoning.

Heat Pumps. Energy savings in air conditioning

Handling Air Units Description, features and operation. Handling psychrometric chart. Calculation of airflow in ventilation outlet or through the room air conditioner

Distribution Systems Distribution through air ducts. Criteria for the design. Calculation methods: constant friction and static recovery. Example calculations duct outlet and return. Distribution by piped water. Monotububular and bitubular systems. Examples of calculation of piped water.

Regulation and control in air conditioning

Full-or-part-time: 13h 30m Theory classes: 13h 30m



GRADING SYSTEM

The student's grade will be:

N_FINAL = 0.35 NE_CLIM + 0.35 NE_REFR + 0.2 NE_AC + 0.1 N_LLI

NE_CLIM: Air conditioning exam note (usually on the date of the exam)
NE_REFR: Refrigeration exam note (usually on end date)
NE_AC: average mark of the different tests of continuous assessment that will be done without prior notice in class throughout the course (between 6 and 8)
N_LLI: Note of the exercises delivered during the course at Atenea
N_FINAL: Final note

REVALUATION: The grade on the revaluation exam will replace the final grade

EXAMINATION RULES.

Partial and final exams (air conditioning and refrigeration) will consist of short questions and some problems.

The exercises of continuous evaluation will realize to indication of the profesorado during the same development of the classes, without previous warning in any moment along the course.

During the short questions no material will be allowed to be consulted, while for the resolution of the problems it will be possible to use a calculator and a single A4 sheet (two sides) or original handwritten form with the text or formulas that the student considers appropriate (it is necessary that the notes are taken because occasionally for the accomplishment of some problem it could be allowed to consult additional material which would be communicated at the same time of the test).

BIBLIOGRAPHY

Basic:

- Ruiz, Rafael. Procesos de tratamiento de aire en climatización. Psicrometría [on line]. Barcelona: L'autor, 2022 [Consultation: 14/06/2023]. Available on: <u>https://upcommons.upc.edu/handle/2117/373852</u>.

- Ruiz, Rafael. Refrigeración [on line]. Barcelona: L'autor, 2022 [Consultation: 14/06/2023]. Available on: https://upcommons.upc.edu/handle/2117/375902.

- American Society of Heating, Refrigerating and Air-Conditioning Engineers. ASHRAE handbook. Fundamentals. 2013. Atlanta: American Society of Heating, Refrigerating and air-Conditioning Engineers, 2013. ISBN 1523-7222.

- American Society of Heating, Refrigerating and air-Conditioning Engineers. The ASHRAE handbook. I-P and SI ed. Atlanta, GA: American Society of Heating, Refrigerating and air-Conditioning Engineers, 2013-. ISBN 9781936504473.

- American Society of Heating, Refrigerating and Air-Conditioning Engineers. ASHRAE handbook. Refrigeration. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2012. ISBN 9781936504732.

Complementary:

- Pizzetti, Carlo. Acondicionamiento del aire y refrigeración : [teoría y cálculo de las instalaciones]. 2ª ed, traducida de la 3ª ed. italiana. Madrid: Bellisco, 1991. ISBN 8485198492.

- Stoecker, W. F. Industrial refrigeration handbook. New York [etc.]: McGraw-Hill, cop. 1998. ISBN 007061623X.