UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2019/2020
MASTER'S DEGREE (MSC)	MECHANICAL ENGINEERING
SUBJECT	COOLING SYSTEMS
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	20933-Attività formative affini o integrative
CODE	07177
SCIENTIFIC SECTOR(S)	ING-IND/10
HEAD PROFESSOR(S)	PANNO DOMENICO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	COOLING SYSTEMS - Corso: INGEGNERIA ENERGETICA E NUCLEARE COOLING SYSTEMS - Corso: ENERGETIC AND NUCLEAR ENGINEERING
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**PANNO DOMENICO** Tuesday 09:30 10:30 Stanza T131 DEIM

DOCENTE: Prof. DOMENICO PANNO

PREREQUISITES	knowledge of applied physics.
LEARNING OUTCOMES	D.1: KNOWLEDGE AND UNDERSTANDING The course aims at the acquisition of knowledge of the operating techniques of refrigeration systems. The assessment of knowledge and understanding will be through a final examination during which the student will present the topics covered in the course and discuss the exercises performed. D.2: APPLYING KNOWLEDGE AND UNDERSTANDING The course allows the application of knowledge and the most appropriate methodological tools for the study of the different problems related to the operation of the refrigeration systems to intervene with specific expertise in the choice of operating systems of these techniques. To make more effective understanding of the theoretical, it will be carried out numerous exercises together with the course after which the student will be sent to the analytical formulation of these problems and be able to apply the techniques more established specialist for solutions. The evaluation of the knowledge and understanding gained by the student will be applied during the final exam, through the discussion of the exercises performed and / or the application of the methods described in the course. D.3: MAKING JUDGMENTS The course aims to achieve integration between the knowledge derived from the study of other disciplines, basic and vocational skills, included in the three-year degree course in Energy Engineering in order to allow you to manage, critically and independently, the related choices the complexity of refrigeration system. The acquisition of autonomy of judgment on the part of the student will be verified during the final exam, by illustration criticism of the choices and comparing these with other possible options. D.4: COMMUNICATION SKILLS The course allows to develop the ability to communicate clearly the reasons of operational choices made and their connection with the underlying theoretical knowledge. Such skills will be exercised during the hours of exercise, through exposure and discussion of the choices made by students. The acquisition of communication skills of the student will be verified during the final exam, including through the illustration of exercises performed. D.5: LEARNING SKILLS The course aims to develop the learning skills to help deal with the independent professional activity. This capacity will be developed urging the student to draw independently from theoretical sources and information, other than those proposed during the course, drawing on texts, regulations, laws, websites, scientific articles, etc. The ability to learn will be verified in the final examination during which the student will demonstrate the achieved awareness and critical capacity of analysis and synthesis of theoretical and applied aspects of the discipline studied.
ASSESSMENT METHODS	EXAMS OUTLINE Oral exam. The oral exam is a discussion with essay questions on the whole course programme; in particular, the student is asked to describe and comment the exercises developed during the course. Oral exam looks at: - knowledge and understanding of the course programme; applying such skills for problem solving within the course or related contexts; - correct use of language, clearness, fluency; concepts reinterpretation, critical faculties, and connection skills in disciplinary or interdisciplinary contexts. Marks are out of 30. Minimum mark is 18/30. ASSESSMENT CRITERIA For oral exam, marks are awarded considering to what extent the student has achieved the learning outcomes. The following scheme can be assumed for reference (see learning outcomes section, descriptors D.1-D.5). Best fit applies when learning outcomes are met at different levels. 28-30 / 30 with distinction D.1/D.2: full contents mastery; no errors; self-corrections/integrations of inaccuracies/omissions; correct and rigorous approach to problems; correct, complete and effective solutions; some originality evidence D.3/D.4/D.5: effective concepts reworking, coherent and autonomous approaches and judgments, disciplinary/interdisciplinary connections; very clear

	presentation, structured arguments, correct use of language. 24-27 D.1/D.2: good knowledge and understanding of course contents; few minor errors, partially fostered self-corrections or integrations; good approach to problems, essentially correct solutions; D.3/D.4/D.5: good coherence in linking concepts and approaching disciplinary or related subjects; good presentation, adequate use of language. 18-23 D.1/D.2: sufficient knowledge of contents; feasible approach to problems although with limited autonomy, acceptable solutions; errors or omissions not serious; D.3/D.4/D.5: sufficient concepts links within disciplinary contexts, although tentative and guided; basic presentation and use of language. below 18 (mark not awarded) D.1-D.5: learning outcomes are not sufficiently met.
EDUCATIONAL OBJECTIVES	The course aims to provide the basics and a methodology for the analysis of the main technologies of refrigeration plants. At the end of the course students will be able to describe the various technologies, to size plants, and choose the best technical solution for the proposed application.
TEACHING METHODS	Lectures and exercises. Teaching activities are organized to help the achievement learning outcomes (see learning outcomes section, descriptors D.1-D.5). The course contents are offered through lectures and guided exercises, emphasizing the applications and the synergy between the different topics (D.1). During the course, the contents are applied to problem solving issues, thus stimulating the development of the ability to apply the acquired knowledge and skills (D.2). During lectures (partly carried out through dialogues and interactions with students) and exercises, students are fostered to critically analyze the proposed issues; this helps the development of students analytical abilities and autonomous judgment (D.3). At the same time, the dialogue and interaction opportunities foster students to improve their skills of communication, argumentation and use of language (D.4). Finally, all course activities contribute to the development of learning skills, through knowledge reworking, links to real and interdisciplinary applications and stimulus in facing new problems autonomously (D.5).
SUGGESTED BIBLIOGRAPHY	1. U. Sellerio - Lezioni di Tecnica del Freddo. Edizione Sistema - Roma. 2. E. Bonaguri, D. Miari: Tecnica del Freddo - Hoepli - Milano. 3. R. J. Dossat: Principles of Refrigeration - Prentice Hall International Editions. 4. Dispense del docente

SYLLABUS

Hrs	Frontal teaching
3	Introduction to Refrigeration ; origin and evolution of the artificial production of cold.
3	Main areas of use and application of cold .
10	Thermodynamic cycles for cold production. Vapor compression chillers . Single stage Cycles and two stage Cycles . System solutions and comparison of the different types.
8	Refrigerants : properties , selection criteria and employment . Natural and synthetic refrigerants . Safety features and actions of refrigerants to the environment . Current legislation .
6	The components of refrigeration equipment : compressors , condensers , evaporators , throttling valve , auxiliary equipment .
3	Air cycle system; analysis of advantages and disadvantages compared to vapor compression systems .
8	The absorption systems. Chillers water - ammonia absorption. balances of energy and mass balances . Calculation of absorption machines . Absorption refrigeration machines H2O - LiBr.
2	Heat pump systems

Hrs	Practice
6	Thermodynamic refrigeration cycles ; absorption machines ; design of refrigeration equipment components

Hrs	Workshops
5	Measurement of the main operating parameters of a refrigeration system and EER computation.