UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2021/2022
MASTER'S DEGREE (MSC)	ENERGETIC AND NUCLEAR ENGINEERING
SUBJECT	TECHNICAL PLANTS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50367-Ingegneria energetica e nucleare
CODE	03884
SCIENTIFIC SECTOR(S)	ING-IND/11
HEAD PROFESSOR(S)	PANNO DOMENICO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	1° 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	The course intends providing the knowledge necessary for the modern design, energy oriented and economically sustainable, of the HVAC systems for civil buildings.
LEARNING OUTCOMES	Knowledge and comprehension capability. The course aims to get the basic knowledge of the design of the heating, ventilation, and air conditioning systems in buildings. The check of the acquired knowledge will be made by means of a final exam in which the student will have to explain the topics of the course. Capability of applying knowledge and comprehension. The course permits to implement the knowledge and the methodological tools to operate with a specific expertise on the heating, ventilation, and air conditioning systems in buildings. Judgement autonomy. The course aims to achieve the integration of the knowledge resulting from the study of the other basic and professionalizing subjects of the graduation course in order to permit to analytically and autonomously manage the decision related to the design process. The student will be capable of selecting the most suitable design options considering the ethical and social consequences due to energy and economic decisions that do not obey the best rules prescribed by the acquired knowledge. Communication skills. The student will be able to communicate with competence and language skill about the physic laws related to the use of the thermal energy and the criterion for selecting an air conditioning system. Learning capability. The learning capability will be checked in the final exam in which the student will have to demonstrate the achieved awareness and
ASSESSMENT METHODS	The learning check will be made during a single oral exam in which the student will have to answer to at least four questions regarding the issues of the subject. The exam aims to assess: -the level of comprehension and knowledge of the topics of the subject; -the capability of applying the acquired knowledge to the solution of problems related to the subject, with competence, coherence, effectiveness and judgement autonomy. -the use of an accurate and suitable language in explaining the subject issues. The assessment is based on the following criterion: -Excellent, score 30-30 cum laude: the student has a very good knowledge of the topics, very good language skill, good analytical capability, and is able to use his knowledge to solve the submitted problems. -Very good, score 26-29: the student is quite confident about the topics, has a full language skill, and is able to use his knowledge to solve the submitted problems. -Good, score 24-25: the student has the basic knowledge of the main topics, a reasonable language skill, and shows a limited capability of applying his knowledge to solve the submitted problems. -Satisfactory, score 21-23: the student is not confident about the topics of the subject, even if he has a sufficient knowledge of them, he has a satisfactory language skill but he is scarcely able to autonomously apply the acquired knowledge. -Sufficient, score 18-20: the student has the minimal basic knowledge of the main topics and technical language of the subject and a very small capability of autonomously applying the acquired knowledge. -Insufficient less than 18: the student does not have a satisfactory knowledge of the topics of the subject.
EDUCATIONAL OBJECTIVES	The course aims to provide the knowledge necessary for the modern, energy oriented and economically sustainable design of the heating, ventilation, and air conditioning systems in buildings.
TEACHING METHODS	The course includes lectures and exercises.
SUGGESTED BIBLIOGRAPHY	C. Pizzetti “Condizionamento dell’aria e refrigerazione”, Masson Italia Editori - ISBN 9788840811659 A. Briganti “Manuale della climatizzazione”, Tecniche Nuove - ISBN-13 : 978-8848111331 A. Briganti “Il Condizionamento dell’aria”, Tecniche Nuove - ISBN-13 : 978-8848118835 Normativa tecnica UNI Materiale didattico messo a disposizione durante il corso

SYLLABUS

Hrs	Frontal teaching
1	Presentation of the course and teaching aids.

SYLLABUS

Hrs	Frontal teaching
3	Psychrometrics. Moist air. Saturation. Humidity definitions. Dew point temperature. Moist air enthalpy. Adiabatic saturation temperature. Wet bulb temperature. Temperature measurements. Humidity measurements. Psychrometric chart. ASHRAE chart. Main psychrometic processes.
3	Mentions of the environmental conditions for the comfort, the thermohygrometric comfort, the energy balance of the human body, the human body thermoregulation, the conditions for the thermohygrometric comfort, the prediction of the thermal comfort, the environmental indexes, the Fanger equation and the sensation indexes. Design environmental conditions.
7	Heating loads. Load calculations. Design temperatures. Thermal transmittance of outside elements. Thermal transmittance of simple windows. Thermal transmittance of double windows. Thermal transmittance of glass windows. Total heat loss of heated spaces. Outward heat losses. Heat loss toward non-heated spaces. Heat loss toward the ground. Heat losses toward or from heated spaces with different air temperatures. Intermittently heated spaces. Ventilation heat losses. Design heating load.
4	Air conditioning loads. Cooling load calculations. Solar heat gains thru windows. Heat gains thru walls. Internal loads. Air infiltrations.
14	HVAC system typologies. HVAC system classification. All-air systems. All-air systems for single thermal zone. Single duct systems for multiple thermal zones. Dual duct system. Dual conduit system. Air-water systems. Primary air fan-coil system. Primary air induction unit system. Radiator and radiant panel systems. Direct expansion systems. Criteria for selecting HVAC systems.
5	Air quality. Air pollutants. Indoor air quality. Air change mechanisms. Ventilation. Indoor air flows. Italian standards on ventilation. Air filtration. Air filter types. Selection of air filters.
5	Air conditioning processes. Air used to transfer energy. Air handling units. Mixing of airstreams. Simple heating and cooling. Air humidification. Air dehumidification. Internal loads compensation. All-air cooling. All-air heating.
5	Space air diffusion. Room air movement. Mixed-air systems. Outlet classification. Air diffusion system performance. Fully stratified systems. Partially mixed systems. Outlet types. Selection and location of exhaust inlets.
5	Air ducts. Bernoulli equation. Friction losses. Dynamic losses. Fan selection. Duct construction. Air duct design methods. Construction foresights. Duct thermal insulation.
9	Water piping. Piping materials. Bernoulli equation. Friction losses. Dynamic losses. Water pump selection. Water piping components. Expansion tank. Air venting. Piping installation. Piping thermal insulation.
8	Heating and cooling system equipment. Boilers. Chillers. Vapor-compression chillers. Absorption chillers. Heat pumps. Cooling towers and remote condensers. HVAC system schemes.
4	Automatic HVAC control systems. Types of control action. Sensors. Controllers. Controlled devices and actuators. Automatic control schemes.

Hrs	Practice
2	Air-handling unit design.
5	Air duct design.
1	Water piping design.