UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2018/2019
BACHELOR'S DEGREE (BSC)	CIVIL AND BUIDING ENGINEERING
INTEGRATED COURSE	TECHNICAL PHYSICS
CODE	03318
MODULES	Yes
NUMBER OF MODULES	2
SCIENTIFIC SECTOR(S)	ING-IND/09, ING-IND/11
HEAD PROFESSOR(S)	LA GENNUSA MARIA Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	LA GENNUSA MARIA Professore Associato Univ. di PALERMO
CREDITS	9
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	3
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**LA GENNUSA MARIA** Thursday 12:00 14:00 Dipartimento di Ingegneria, Edificio 9, Studio 2009, secondo piano. Friday 10:00 12:00 Dipartimento di Ingegneria, Edificio 9, Studio 2009, secondo piano.

DOCENTE: Prof.ssa MARIA LA GENNUSA

PREREQUISITES	Basic knowledge of mathematical analysis. Basic knowledge of linear algebra. Classical mechanics. State of matter. Units of measurement.
LEARNING OUTCOMES	KNOWLEDGE AND COMPREHENSION ABILITIES The course will provide all of the knowledge and methods needed to address the issues more recurrent in the engineering design concerning the problems of thermodynamics, heat transfer and power systems with a particular attention to the environmental sustainability. The knowledge will concern: - Thermal exchange phenomena in all its forms (conduction, convection, radiation and mixed); - The fluid mechanics; - Thermodynamics' laws and its practical applications (different forms of energy, Thermodynamics' laws on energy conversion, energy balance for closed and open systems, properties of pure substances, vapour power systems and gas power systems, thermal comfort in confined spaces, air-conditioning processes). ABILITY TO APPLY KNOWLEDGE AND COMPREHENSION The student will be able to: - Identify more suitable analysis methods to address thermodynamics' problems, heat transfer and engineering plant; - Acquire the dynamics of energy use and energy transformation processes; - Set up and properly deal with the problems concerning to heat transfer; - Evaluate of the suitable air-conditioning processes in order to achieve a correct indoor thermal comfort; - Know the fundamental thermodynamic properties; - Assess the energy cost associated with the production of mechanical / electrical work from traditional or renewable energy sources; - Evaluate the energy cost associated with the energy transfer between systems by heat and mass transport. JUDGEMENT AUTONOMY At the end of the course, students will have acquired the ability to single out the most appropriate solutions for each specific question in the field of thermodynamics and heat transfer, evaluating the effectiveness of different solutions. In detail, students will be able to: - Compare processes for the production of work and energy and to assess its efficiency; - Evaluate the efficiency of thermodynamic cycles and to compare different energy use systems with thermodynamic considerations; - Estimate the effectiveness of different solutions for improving energy efficiency of components and systems through a proper identification and computation of involved heat exchanges; - Act independently to address problems associated with the use of energy in buildings, including the correct use of energy sources, thanks to the knowledge of integrated methods of analysis. COMMUNICATION ABILITIES The student will have acquire the ability to: - Communicate and express issues concerning the themes of the course; - Support conversations on thermodynamics and heat transfer, and to highlight problems related to thermal and thermo-hygrometric interactions among occupants, confined spaces and external environment; - Offer practical solutions. The delivery modes of the course and the final tests of evaluation are strongly aimed at enhancing the communication capacity of the student towards external consumer, both institutional and private. LEARNING ABILITIES Thanks to the acquired knowledge, the student will be able to deepen his own knowledge through a literature search or by subsequent university courses. The learning of new methods of analysis to address energy and environmental issues, will allow the student continuing his engineering studies with greater autonomy and discernment. EDUCATIONAL OBJECTIVES The aim of the course is to provide the fundamentals that allow the student to address the most frequent problems related to thermodynamics, heat transfer and engineering plant in the design practice. In detail: - the heat transfer (conduction, convection, radiation and mixed); - the principles of thermodynamics; - the properties of pure substances;

	- the operation of the direct and inverse cycles; - the psychrometry. The course also puts the emphasis on design methods and environmental quality control methods of the confined spaces. It also presents an overview of energy technologies, both in civil and industrial sectors, which use of renewable sources.
ASSESSMENT METHODS	The assessment of learning will be carried out through a written test and an oral examination. EVALUATION CRITERIA OF LEARNING Evaluation criteria include an assessment of knowledge and skills of the individual student. The final evaluation aims at appraising whether the student possesses a good knowledge and comprehension of the topics acquired during the course, and whether he/she has acquired the ability to apply theoretical concepts to practical situations. Knowledge and competence are assessed through a written test and an oral examination. In detail, the written test consists of 3-4 numerical exercises with the aim of verifying the capacity of the student of facing the qualitative and quantitative problems of thermodynamics and heat transfer. The exercises will be chosen among some topics: Thermodynamics, heat transfer, psychometric applications and fluids mechanics. For written test is expected from 3-4 hours. The oral examination is aimed to evaluate the student's ability to use the acquired knowledge for solving problems as well as to express in a technical correct language. The oral examination will consist of at least four questions related to the topics dealt with during the course: a question on Thermodynamics, one on psychometric applications and HVAC systems, one on heat transfer and one on photometry and lighting. Student will be evaluated on the basis of three key criteria: (1) accuracy of the written test; (2) adequacy of oral answers; (3) student's ability to present to the examiner the topics of the program in a successful way. The student will have to solve the largest number of written questions and answer at least four oral questions on all of the topics described in the list below (see "Programma dell'insegnamento"). The lowest evaluation grade will be achieved if the student proves his/her knowledge and comprehension of the main subjects, at least within a general framework, and can apply that knowledge. The evaluation range is comprised between 18/30 and 30/30. In detail, the final assessment, properly graded, will be formulated on the basis of the following conditions: a) sufficient knowledge of the topics and theories; sufficient awareness and autonomy in the application of theories to solve problems; sufficient expressive capacity, rework and multidisciplinary connection (18-21 rating); b) Fairly good knowledge of the topics and theories; fairly good awareness and autonomy in the application of theories to solve problems; discrete expressive capacity, rework and multidisciplinary connection (22-25 rating); c) Good knowledge of the topics and theories; good awareness and autonomy in the application of theories to solve problems; good expression, reworking and multidisciplinary connection (26-28 rating); d) Excellent knowledge of topics and theories; excellent level of awareness and autonomy in the application of theories to solve problems; excellent expressive capacity, rework and multidisciplinary connection (29-30 cum laude rating).
TEACHING METHODS	Teaching methods consist in theoretical lectures and exercises, aimed at applying the learned knowledge through numerical exercises. The exercises will cover applications of the theoretical knowledge to the solution of real problems, with particular attention to energy/environmental implications of the solutions developed. Moreover, the classroom exercises aim to simulate the final written test.

MODULE MODULE I *Prof.ssa MARIA LA GENNUSA*	
SUGGESTED BIBLIOGRAPHY	
• Çengel Y. A, Termodinamica e Trasmissione del Calore, McGraw Hill. Per approfondire gli argomenti trattati durante il corso, si consiglia inoltre di consultare i seguenti testi: • Rodono' G., Volpes R., Fisica Tecnica Vol. 1 Trasmissione del calore, moto dei fluidi. Aracne 2011. • Rodono' G., Volpes R., Fisica Tecnica Vol. 2 Termodinamica. Aracne 2011. • Cocchi A., Elementi di termofisica generale ed applicata, Progetto Leonardo, Bologna. • G. Moncada Lo Giudice, L. De Santoli. Progettazione di impianti tecnici. Casa Editrice Ambrosiana.	
AMBIT	50282-Ingegneria della sicurezza e protezione civile, ambientale e del territorio
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
EDUCATIONAL OBJECTIVES OF THE MODULE	
The aim of course is to provide the basic knowledges that allow the student to address the most frequent problems in the design practice concerning thermodynamics and heat transfer. The knowledge will concern: - Thermodynamics' laws of thermodynamic systems both closed and volume control; - Properties of pure substances; - Thermal exchange phenomena in all its forms (conduction, convection, radiation and mixed thermal changes).	

SYLLABUS

Hrs	Frontal teaching
1	Course overview. Introduction on energy, environment and building sector.
1	Applied physics. Definition of heat, energy, power and relative unit of measurement.
2	Introduction to thermodynamics: Terminology - Thermodynamic systems - Property or macroscopic coordinates - Thermodynamic state - Thermodynamic equilibrium - Quasistatic and reversible processes - Irreversible processes - Gibbs phase rule.
4	Thermodynamics of closed system: The first law of thermodynamics - Equivalence between heat and work - Experience of Joule - Internal energy - Enthalpy.
4	Thermodynamics of closed system: The second law of thermodynamics - The statements of Kelvin and Clausius - Reversibility - Dissipative effects - Heat engines - Thermodynamic efficiency - The Carnot principle - The thermodynamics temperature scale - Entropy - Exergy as work potential of energy.
2	Thermodynamics of the control volume: Mass balance and mechanical energy balance - First and second law of thermodynamics for control volumes - Mass balance and total energy for steady-flow processes - Some steady-flow engineering devices: heat exchangers, turbines and compressors, pumps, expanders, nozzles and diffusers, pipes and so on.) - Energy and available work - Irreversibility - The quality of energy - Exergy.
3	Properties of pure substance: Chemically and physically homogeneous substances - The T-v diagram - The P-v diagram - The P-T diagram - The P-v-T Surface - Entropy diagram (TS) - Enthalpy diagram (HS) - The pressure-enthalpy diagram (PH) - The Temperature-enthalpy diagram (TH) - Two-phase mixtures of a pure substance - Thermodynamic properties of liquid, saturated vapor and superheated vapor - Ideal gas - The ideal-gas equation of state - Property and thermodynamic processes of ideal gases.
2	Thermodinamic properties of real gases - van der Waals equation of state and other equation of state.
3	Gas mixtures: Ideal gas mixtures - The Dalton and Amagat Models- Gas-vapor mixture- Elements of psychrometry - Mixtures of air and water vapor - Specific and relative humidity of air - Degree of Saturation - Dew-point temperature - Adiabatic saturation and wet-bulb temperature - Mollier Diagram and the Psychrometric Chart.
4	Conduction: Heat conduction equation - Fourier law - Steady heat transfer and Transient heat transfer - Heat conduction equation in a large plane wall, in a long cylinder, in a sphere - Multilayer plane walls - Global exchange thermal coefficient for plane, cylindrical and spherical geometry.
2	Heat transfer by convection: Physical mechanism on convection - Classification of fluid flows - Thermal boundary layer - Laminar and turbulent flows - Nusselt, Prandtl and Grashof Numbers - Heat and momentum transfer in turbulent flow - Derivation of differential convection equations - Forced, natural and mixed convection - Dimensional Analysis.
2	Radiation Heat Transfer: Thermal radiation - Radiative properties: Emissivity, Absorptivity, Reflectivity, and Transmissivity - Black body - Radiation laws: Stefan-Boltzmann's Law - Plank's law- Wien's law- Lambert's Law - Gray bodies and real bodies - Kirchhoff's Law.
2	Simultaneous presence of different types of thermal exchange - Overall heat transfer coefficient - The mass transfer and the Glaser method - The Glaser's Diagram.

Hrs	Practice
22	Classroom exercises covering all the topics treated during the frontal lessons.

MODULE
MODULE II

Prof.ssa MARIA LA GENNUSA

SUGGESTED BIBLIOGRAPHY	
• Çengel Y. A, Termodinamica e Trasmissione del Calore, McGraw Hill. Per approfondire gli argomenti trattati durante il corso, si consiglia inoltre di consultare i seguenti testi: • G. Moncada Lo Giudice, L. De Santoli. Progettazione di impianti tecnici. Casa Editrice Ambrosiana. • Moncada Lo Giudice G., De Lieto Vollaro A., Illuminotecnica, Masson, Roma. • Rodono' G., Volpes R., Fisica Tecnica Vol. 1 Trasmissione del calore, moto dei fluidi. Aracne 2011. • Rodono' G., Volpes R., Fisica Tecnica Vol. 2 Termodinamica. Aracne 2011. • Cocchi A., Elementi di termofisica generale ed applicata, Progetto Leonardo, Bologna.	
AMBIT	10653-Attività formative affini o integrative
INDIVIDUAL STUDY (Hrs)	48
COURSE ACTIVITY (Hrs)	27
EDUCATIONAL OBJECTIVES OF THE MODULE	
The aim of course is to provide the basic knowledges that allow the student to address the most frequent problems in the design practice concerning thermodynamics, heat transfer and lightning. The knowledge will concern: - fluid mechanics; - properties and transformations of humid air mixtures for air-conditioned processes; - vapor and combined vapor cycles, refrigeration cycles and heat pump, gas power cycles; - photometry and lighting. The course also focuses on design methods and environmental quality control methods of confined spaces. It also presents an overview of energy technologies, both in civil and industrial sectors, make use of renewable sources.	

SYLLABUS

Hrs	Frontal teaching
3	Fluid dynamics: Physical aspects of the fluid flow- Laminar and turbulent flow - Viscosity - Dynamic boundary layer - Thermal boundary layer - Fundamental equations of isothermal flow.
6	Properties and processes of gas-vapor mixture - Human comfort - Air-conditioning processes.
5	Vapor and Combined Vapor Cycles: the Carnot Vapor Cycle - The ideal Rankine Cycle - The ideal Reheat Ranking Cycle - Refrigeration cycles and Heat Pump. Gas Power Cycles: Otto Cycle - Diesel Cycle - Joule Cycle - Stirling and Ericsson Cycle. Brayton Cycle.
2	Photometry and lighting.

Hrs	Practice
11	Classroom exercises covering all the topics treated during the frontal lessons.