UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2022/2023
BACHELOR'S DEGREE (BSC)	ENERGY ENGINEERING AND RENEWABLE ENERGIES
SUBJECT	TECHNICAL PHYSICS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50299-Ingegneria energetica
CODE	03318
SCIENTIFIC SECTOR(S)	ING-IND/10
HEAD PROFESSOR(S)	MORALE MASSIMO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**MORALE MASSIMO** Tuesday 11:00 12:00 Dipartimento di Ingegneria Ed. 9, piano primo, Studio 1010 (su appuntamento e previa conferma), anche tramite portale Teams (via chat / e-mail massimo.morale@unipa.it o massimo.morale@community.unipa.it).

DOCENTE: Prof. MASSIMO MORALE

PREREQUISITES	Basic knowledge of: Mathematical Analysis, Linear Algebra, Analytic Geometry, Classical Mechanics, Electromagnetism, Chemistry and Applied Chemistry, Technical Drawing
LEARNING OUTCOMES	Knowledge and understanding The student, at the end of the course, will have knowledge of basic topics related to Heat Transfer, Fluid Mechanics, Thermodynamics and Psychrometry. The written and / or oral exam is the verification tool. Applying knowledge and understanding The student will be able to implement the concepts learned during the course to some real problems, both in design and verify. The written and / or oral exam is the verification tool. Making judgments The student will be able to recognize and classify the physical phenomena studied for their correct management in working situation. The written and / or oral exam is the verification tool. Communication skills The student will acquire the ability to communicate and express the concepts inherent in the discipline. It will be able to hold conversations and prepare basic documents related to the Heat Transfer, Fluid Mechanics, Thermodynamics and Psychrometry. The written and / or oral exam is the verification tool. Learning ability The student will have learned the basics that will enable him to continue his engineering studies relating to the discipline with greater profit. The written and / or oral exam is the verification tool.
ASSESSMENT METHODS	The assessment is done by an ongoing evaluation and a final exam consisting of a written test and / or an oral examination on the following areas: Thermodynamics, Heat Transfer, Psychrometry, Fluid Mechanics The written tests consist: 1) in a questionnaire with 15 multiple choices or numerical answer questions, 2) in the commented resolution of 2 or 3 numeric or theoretical exercises (duration max 3 h). The oral exam consists of maximum 3 open questions (duration 0.75 h max). Purpose of the tests is to verify the acquired knowledge and the ability to critique, processing and communication. The final vote is out of thirty, eventually cum laude. A) Excellent (30-30 cum laude): Excellent knowledge of teaching contents; students should show high analytical and synthetic capabilities and should be able to apply their knowledge to solve highly complex problems. B) Very good (27-29): Very good knowledge of the teaching contents and excellent language control; students should show analytical and synthetic skills and be able to apply their knowledge to solve problems of medium and, in some cases, even higher complexity. C) Good (24- 26): Good knowledge of teaching contents and good language control; the students should be able to apply their knowledge to solve problems of medium complexity D) Satisfactory (19-23): Average knowledge of the teaching contents, in some cases limited to the main topic; acceptable ability to use the specific discipline language and independently apply the acquired knowledge. E) Sufficient (18): Minimum teaching content knowledge, often limited to the main topic; modest ability to use the subject specific language and independently apply the acquired knowledge. F) Fail (less than 18): Lack of an acceptable knowledge of the main teaching content knowledge. Very little or no ability to use the specific subject language and apply independently the acquired knowledge.
EDUCATIONAL OBJECTIVES	The Course has the aim to give basics for the applications in: Fluid Mechanics, Thermodynamics, Heat transfer, and Psychrometrics. In addition to the study of the theory, the Course wants to give the acquisition of a useful skill with the most common and simple calculation techniques. It is recommended to add exercises based with the help of the recommended texts.
TEACHING METHODS	Teaching is scheduled in theoretical lectures and practical exercises. The exercises are numerical examples solved in the classroom by the teacher and / or students under the guidance of professor. The examples are on the theoretical concepts introduced in class and they are related to typical energy applications both civil and industrial, also related to the environmental aspects.
SUGGESTED BIBLIOGRAPHY	Testi di utile consultazione/Useful books (Disponibili anche in Biblioteca-Availables also in Library) 0. Dispense fornite dal Docente/Booklets 1. Giuseppe Rodonò, Ruggero Volpes: “Fisica tecnica: Vol. 1 Trasmissione del

	calore. Moto dei fluidi", Aracne editrice, Roma, 2011, ISBN-13: 978-8854843608; 2. Giuseppe Rodonò, Ruggero Volpes: "Fisica tecnica: Vol. 2: Termodinamica", Aracne editrice, Roma, 2011, ISBN-13: 978-8854844728; 3. Yunus A. Çengel, Afshin J. Ghajar: "Heat and Mass Transfer: Fundamentals and Applications" 6th Ed., Kindle Edition, McGraw-Hill Higher Education, ISBN-13: 978-0073398198; 4. "Dati per la Fisica Tecnica", a cura di Giuseppe Rodonò e Ruggero Volpes, Università degli Studi di Palermo, Dipartimento di Energetica, Palermo, 2000 (disponibile sul portale del Corso); 5. Gino Parolini, Andrea Del Monaco, Donato Maria Fontana: "Fondamenti di fisica tecnica", UTET, Torino, 1983, ISBN-13 : 978-8802036960 6. G. Cesini, G. Latini, F. Polonara: "Fisica tecnica", CittàStudi Edizioni, 2017, ISBN-13 : 978-8825174038 7. Frank Kreith, "Principi di trasmissione del calore", (curr. Alfano G.; Naso V.), Liguori Editore, Napoli, 1975, ISBN-13978-8820703561: : 8. Stefano Bergero, Paolo Cavalletti, Anna Chiari: "Problemi di Fisica Tecnica: 100 esercizi svolti e ragionati", Dario Flaccovio, Palermo, 2014, ISBN: 978-8857902791 9. Giustina Casagrande, Ettore Lanzarone, Luca D. Marocco, "Esercizi di fisica tecnica", Pitagora, 2020, ISBN-13: 978-8837112158

SYLLABUS

Hrs	Frontal teaching
10	Course overview APPLIED THERMODYNAMICS Definition of variables and basic concepts: system and thermodynamic state; equilibrium, processes and transformations. Balance equation of an extensive property. Pressure, density and temperature. State equation, phase transformations in single-component systems and the ideal gas equation, liquid-vapor system properties, specific heat.
10	Fundamental transformations. Energy, heat and work, the work of the external and internal forces. Friction work in fluids. The first law of thermodynamics: formulation, internal energy, enthalpy. Energy balance. The second law of thermodynamics: thermal devices, general formulation, entropy, reversibility and irreversibility. Clausius inequality, Gibbs equations, Maxwell's relations.
8	Energy conversion systems. Ideal Carnot cycle. Carnot's theorem. Thermodynamic temperature. Direct and reverse cycles. Vapour and Gas power cycles. Reverse vapour compression cycles. Heat pumps.
2	PSYCHROMETRICS Ideal gas mixtures. Psychrometric properties, charts and transformations. Humidity measures, AHU, HVAC plants.
8	HEAT TRANSFER Introduction to the thermal transport modes: conduction, convection, and radiation. Thermal conduction: Fourier's postulate and law, thermal conductivity. One-dimensional, steady state conduction with and without thermal energy generation. The plane wall, radial systems. Transient conduction. Numerical methods.
4	Convection: fluid properties. Laminar and turbulent flow. Velocity and thermal boundary layers. Newton's law of cooling. Free and forced convection: internal and external flows. Dimensionless parameters and theirs meaning. Summary of convection relationships. Boiling and condensation.
5	Thermal Radiation. Fundamentals definitions. Absorptivity, reflectivity, transmissivity. The black body. Grey surfaces. Emissivity. View factors, emittance, radiative exchange between black and grey surfaces. The electrical circuit analogy for radiation among grey surfaces.
5	Complex Heat Transfer: combined convection and radiation. Heat transfer with extended surfaces, temperature distribution, rate of heat transfer, and fin efficiency. Heat Exchangers, double pipe heat exchanger, temperature distribution, logarithmic mean temperature difference method and effectiveness-NTU method. Thermo-technical measures,
2	FLUID MECHANICS Static Fluids, pressure measurements, hydrostatic forces, Bernoulli equation and its applications, compressible fluids, internal and external flows, head losses.

Hrs	Practice
27	Exercises on the Course topics