UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
BACHELOR'S DEGREE (BSC)	ENERGY ENGINEERING AND RENEWABLE ENERGIES
INTEGRATED COURSE	PRINCIPLES OF CHEMISTRY FOR TECHNOLOGIES - INTEGRATED COURSE
CODE	20465
MODULES	Yes
NUMBER OF MODULES	2
SCIENTIFIC SECTOR(S)	CHIM/07, ING-IND/22
HEAD PROFESSOR(S)	GARCIA LOPEZ ELISA ISABEL — Professore Associato — Univ. di PALERMO
OTHER PROFESSOR(S)	GARCIA LOPEZ ELISA ISABEL — Professore Associato — Univ. di PALERMO GULINO EMMANUEL FORTUNATO — Ricercatore a tempo determinato — Univ. di PALERMO
CREDITS	12
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**GARCIA LOPEZ ELISA ISABEL** Friday 10:00 13:00 Stanza S06P1004. Primo piano. Edificio 6. **GULINO EMMANUEL FORTUNATO** Monday 15:00 18:00 Viale Delle Scienze Edificio 6, Piano 3°, Studio 3015 Tuesday 15:00 18:00 Viale Delle Scienze Edificio 6, Piano 3°, Studio 3015

DOCENTE: Prof.ssa ELISA ISABEL GARCIA LOPEZ

PREREQUISITES	Basic concepts on calculus and trigonometry
LEARNING OUTCOMES	Knowledge of issues concerning the structure of matter and the principles that regulate its chemical-physical transformations (phase transformations, chemical reactions, etc ..). In particular, the student will be able to understand the basic principles of atomic structure and chemical bonding. The student will also able to evaluate the influence of the operating parameters (such as temperature and pressure) on chemical reactions. These abilities will be verified by the written and oral examinations. -Applying knowledge and understanding: Ability to independently evaluate both the validity and the accuracy limits of of the structure of matter models and the principles of thermodynamics and kinetics of chemical reactions. These abilities will be verified by the written and oral examinations. Making judgments The student will have acquired the capacity to independently assess both the validity and the approximate models limits of the matter structure, as well as the use of the thermodynamics principles and the kinetics of chemical reactions. This ability will be verified by the written and oral examinations. -Communication skills: Ability to communicate and express issues concerning the fundamental aspects of the discipline (atomic structure, thermodynamics and kinetics chemical reactions). This ability will be verified by the written and oral examinations. -Learning ability: The student will learn the basic aspects of the structure of matter and of the chemical reactions. This knowledge will contribute to the student formation in the phenomenological disciplines (physical and chemical) and it will allow him to continue his engineering studies with greater autonomy and discernment. This ability will be verified by the written and oral examinations.
ASSESSMENT METHODS	Two exams: a first written test lasting two hours consisting in at least 10 theoretical and numerical questions which require a short answer. This text will been evaluated on the basis of thirtieths. Students who get a vote in the writing test not lower than eighteen/thirtieths will be admitted to the oral exam. The exam will be not passed if the student will show a not acceptable knowledge of the topics. The oral exam will consist of an interview, based on the written test, in order to check that the student possess the skills and disciplinary knowledge in all of the main topics described in the program. The oral questions could have also an open nature and hence the answers could be discursive. The final assessment will be formulated taking into account both the written exam and the interview. The final assessment is on a 30 basis according to the following criteria: 30-30+: excellent knowledge of the topics, excellent language and vocabulary, good analytical capability, the student is able to apply knowledge to solve the proposed problems 26-29: Good management of the topics, nice language and vocabulary, the student is able to apply knowledge to solve the proposed problems 24-25: basic knowledge of the topics, fair language and vocabulary, limited capability to apply autonomously knowledge to solve the proposed problems 21-23: the student does not show full management of the main topics while possessing the knowledge, satisfactorily language and vocabulary, poor capability to apply autonomously the acquired knowledge 18-20: minimal basic knowledge of the main topics and of the technical language and vocabulary, poor or no capability to apply autonomously the acquired knowledge.
TEACHING METHODS	Lectures and classroom exercises

MODULE
TECHNOLOGY OF MATERIALS

Prof. EMMANUEL FORTUNATO GULINO

SUGGESTED BIBLIOGRAPHY	
W. F. Smith, J. Hashemi. "SCIENZA E TECNOLOGIA DEI MATERIALI". McGraw-Hill. 4 edizione. ISBN: 9788838667657	
AMBIT	10657-Attività formative affini o integrative
INDIVIDUAL STUDY (Hrs)	48
COURSE ACTIVITY (Hrs)	27
EDUCATIONAL OBJECTIVES OF THE MODULE	
The goal is to learn the fundamental principles of chemistry, highlighting the importance of methodological criteria that can be useful for the continuation of engineering studies.	

SYLLABUS

Hrs	Frontal teaching
1	INTRODUCTION TO MATERIALS SCIENCE AND TECHNOLOGY (Introduction to materials: metals, polymers, and ceramics. Comparison of properties. Criteria for selection.)
3	CRYSTALLINE AND AMORPHOUS STRUCTURE OF MATERIALS (Crystal systems and Bravais lattices. Main metallic crystal structures. Coordination number. Atomic packing and density. Positions of atoms, directions, and planes in cubic elementary cells. Polymorphism.)
2	SOLIDIFICATION AND CRYSTALLINE IMPERFECTIONS (Solidification of metals. Metallic solid solutions. Crystal defects.)
3	PHASE DIAGRAMS (State diagrams. Phase transformations. Microstructures. Isomorphous binary systems. Eutectic systems and other systems. Examples of metallic alloys.)
4	STEELS AND CAST IRONS (Iron-Carbon phase diagram. TTT and CCT diagrams. Heat and thermochemical treatments: quenching, annealing, carburization. Classification of steels and cast irons. Production of steels and cast irons.)
4	MECHANICAL PROPERTIES (Tensile test, compression test, bending test, impact test, hardness, fatigue behavior.)
6	POLYMERS (Introduction and characteristics. Solid state, glass transition, and crystalline state. Processing methods, extrusion, and injection molding. Industrial polymers and applications.)

Hrs	Practice
4	METALS (calculation of theoretical density, determination of Miller indices, phase diagrams, and phase analysis) - MECHANICAL PROPERTIES (stress-strain diagram, calculation of resilience).

MODULE
CHEMISTRY FOR ENGINEERING

Prof.ssa ELISA ISABEL GARCIA LOPEZ

SUGGESTED BIBLIOGRAPHY

Testo principale in italiano:
“Elementi di chimica” L. Palmisano, G. Marcì, A. Costantini, EDISES, 2° Edizione Agosto 2020. ISBN: 8836230237

Main text in English:
“Chemistry: The Molecular Nature of Matter and Change” By M. Silberberg and P. Amateis. McGraw-Hill. 9th Edition 2021. ISBN10: 1260240215; ISBN13: 9781260240214

Testi di approfondimento e consultazione:
G. Chinnici, "Il sogno di Democrito. L’atomo dall’antichità alla meccanica quantistica" Ed. Hoepli (ISBN: 8820397951)
P.W. Atkins, "Le regole del gioco. Come la termodinamica fa funzionare l'universo" Ed. Zanichelli (ISBN: 8808061450)
F. Selleri, "Le forme dell'energia. La luce e il calore. Da E=mc² all'energia nucleare" Ed. Dedalo (ISBN: 8822062361)
D. Zanobetti, "Energia Nucleare. Un Dossier Completo" Ed. Esculapio (ISBN: 9788893852364)

AMBIT	50293-Fisica e chimica
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81

EDUCATIONAL OBJECTIVES OF THE MODULE

The aim is the learning of the fundamental principles of chemistry, highlighting the importance of the methodological criteria that may be useful for the continuation of engineering studies.

SYLLABUS

Hrs	Frontal teaching
4	Elements, compounds, mixtures, molecules, ions. The concept of mole. Chemical reactions and stoichiometry
1	Thermodynamic system, state functions and equations of state; definition of phase, homogeneous and heterogeneous systems
1	Concentration units in homogeneous systems: molarity, normality, molality, mole fraction, percentage by weight and by volume.
4	Atomic models for the hydrogen atom. Introduction to wave mechanics. Schroedinger equation. Atomic orbitals for the hydrogen atom and for polyelectronic systems. Quantic numbers. Configuration of the elements and the periodic table. Periodic properties: ionization energy, electron affinity
2	Nuclear chemistry. Characteristics of the nucleus: nuclear stability and instability. Radioactivity. Natural disintegration rate. Energy characteristics of the nucleus. Energy of fission and nuclear fusion. Applications of radioactive isotopes. Measurement of radioactivity.
5	Chemical bond. Ionic bond. Covalent bond (homopolar and heteropolar). Sigma and greek pi bonds . Electronegativity. Molecular geometry and hybrid orbitals. Dative bond. Intermolecular bonds. Hydrogen bonding. Metallic bonding. Metals, insulators and semiconductors.
2	Oxidation number. Oxidation-reduction reactions. Combustion
3	Gaseous systems. Ideal gas: equation of state. Elements of kinetic theory of gases, distribution of the molecular rate. Real gases: equation of Van der Waals. Andrews diagrams
2	Solid state – Amorphous solids and crystalline solids. Solid structure and properties. Unit cell. Packaging. Bravais cells. Types of crystalline solids: ionic, molecular, metallic, macromolecular
2	Vapour-liquid equilibrium: the vapor pressure of a liquid. Boiling of a liquid. Phase diagrams for systems of one component.
4	Two-component systems. Colligative properties. Raoult's Law. Cryoscopy and ebullioscopy. Osmosis and osmotic pressure. Phase changes in two-component systems. Vapor-liquid equilibria. Azeotropes. solid-liquid equilibria. Eutectic.
4	Types of solutions: solubility and saturated solutions. Solubility of gases in liquids: Henry's law. Properties of solutions: Raoult's law. boiling point increase, cryoscopic decreasing and osmotic pressure. Phase diagrams for two-component systems. Distillation. Azeotrope. Eutectic.
3	Thermodynamics: System, state and state function. Forms of energy and their equivalence. 1st Principle. Enthalpy. Hess's Law. 2nd Principle. Entropy. Free energy. Spontaneity criteria. Gibbs law. Application of thermodynamic functions. 3rd Law of Thermodynamics
2	Chemical kinetics: homogeneous reactions. Reaction rate, reaction order, reaction mechanism Influence of temperature on the reaction rate; Arrhenius Law. Catalysts
2	Chemical equilibrium. Equilibrium constant for reactions in ideal homogeneous systems. The principle of Chatelier. Equilibrium constant for heterogeneous reactions
4	Aqueous solution equilibrium: acids and bases. Definition of acid and basic by Arrhenius, Bronsted-Lowry and Lewis. Calculation of pH for solutions of strong and weak acids and bases . Hydrolysis of salts. Buffer solutions. Product solubility.

3	Electrochemistry. Batteries, galvanic half cells, standard reduction potentials and policies to determine the force oxidation or reduction of a redox couple. Nernst law. Electrolysis and Faraday's laws.
3	Periodic table of elements, description of groups. Hydrides. basic oxides, acid and amphoteric surfactants. inorganic acids Most common. Salts. Introduction to organic chemistry. Nomenclature of: the hydrocarbons (alkanes, alkenes, alkynes and aromatic), alcohols, aldehydes and ketones, carboxylic acids, amines.

Hrs	Practice
5	Problems on Stoichiometry
4	Numerical applications: Redox reactions and combustion
3	Chemical bond. Lewis Molecular structures
2	Numeric applications of colligative properties
2	Applications on thermodinamics for chemistry
3	Chemical equilibrium: Features of a chemical reaction equilibrium. Mass law. Equilibrium constants. Shifting of the equilibrium. Dependence of the equilibrium constant on temperature. van't Hoff law. heterogeneous equilibria. Mobile balance principle or the Chatelier.
7	Ionic equilibrium: weak and strong electrolytes, degree of dissociation. Effect of dissociation on the colligative properties: the van't Hoff law. Ionization of water. pH and pOH of solutions of acids, bases and buffer solutions monoprotic weak solutions of acids and bases. Polybasic acids. Buffer solutions. Acid-base balance in the saline solutions. Solubility equilibria: solubility equilibrium constant
4	Electrochemistry. Redox reactions, half-elements and their representation, batteries. Normal Potential reduction table. Nernst equation. Galvanic concentration cells. Electrolysis. Faraday's laws. overvoltage