UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2021/2022
BACHELOR'S DEGREE (BSC)	BUILDING ENGINEERING, INNOVATION AND RETROFITTING
SUBJECT	CHEMISTRY AND TECHNOLOGY OF MATERIALS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50108-Edilizia e ambiente
CODE	16742
SCIENTIFIC SECTOR(S)	ING-IND/22
HEAD PROFESSOR(S)	FIORE VINCENZO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	147
COURSE ACTIVITY (Hrs)	78
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	TECHNOLOGY OF MATERIALS - Corso: INGEGNERIA CIVILE TECHNOLOGY OF MATERIALS - Corso: CIVIL ENGINEERING
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**FIORE VINCENZO** Tuesday 09:00 11:00 Viale delle Scienze, Edificio 6, terzo piano, stanza 3012 Thursday 09:00 11:00 Team "Didattica telematica Prof. Fiore" codice: opuh3tj

DOCENTE: Prof. VINCENZO FIORE

PREREQUISITES	Basic knowledge of mathematics: command of the concepts concerning mathematical calculation, proportions, first and second degree equations, graphic representation of elementary functions, solution of algebraic equations, slope of a curve and derivative. Basic knowledge of physics: command of the fundamental laws of Newtonian mechanics, basic concepts of electrostatics, electromagnetism, electromagnetic waves and optics.
LEARNING OUTCOMES	Knowledge and understanding At the end of the course, the student will acquire the basic knowledge of the structure of matter and will be able to comprehend the principles governing its chemical-physical transformations and the energy variations that accompany them. In particular, he will have acquired the basic knowledge about: atoms and atomic structure; chemical bond theory; phase equilibria; aggregation states; Chemical equilibria; thermodynamic functions; nomenclature of inorganic compounds and colligative properties. Moreover, the student will acquire the basic knowledge of the main classes of engineering materials used in construction sector, thus becoming able to comprehend the correlation between chemical composition, structure and properties of materials. Finally, the student will acquire the knowledge of the basic principles of chemistry and materials technology and the use of specific languages. Applying knowledge and understanding Logical reasoning ability and aptitude to tackle problems scientifically rigorously; Structure-property relationships for the materials; Ability to correlate the structure of matter with its properties; Capacity in solving problems regarding combustion, molecular, ionic and acid-base equilibrium; Ability to understand the transformations of the matter according to chemical reactions; Ability to choose the most suitable materials for the production of a device considering its characteristics and the final application; Methods of detection and characterization of materials on the basis of their properties; Ability to understand the structure-property relationships for materials used in construction sector; Ability to connect the studied topics with real issues. Capacity in solving problems regarding the main water treatments and mix-design of concrete; Ability to apply the knowledge in the design and manufacturing of building works. Making judgements Autonomy in the application of the basic concepts of chemistry and in the resolution of problems regarding chemical reactions and aqueous solutions; Autonomy in the full understanding both of properties and of manufacturing methods concerning materials useful for the construction sector; Ability to assess water quality by choosing the most suitable treatments as function of application. Communication skills The student will be able to communicate with competence and properties of language about the problems relating to the matter structure and its transformations in order to better understand the behavior of the materials. Learning skills The student will be able to deal independently the study of problems concerning all aspects presented during the course. Ability to deal independently with issues related to water treatment, choice of materials, their characterization and optimization of transformation methods. At the end of the course, the student will be able to understand the main aspects concerning chemistry and technology of materials related with materials useful for the construction sector, thus acquiring the ability to correlate the knowledge achieved during the course with the technological aspects addressed in successive teachings.
ASSESSMENT METHODS	Learning of the contents presented during the course will be evaluated using two tests: one written and one oral. The written examination, which tends to verify the skills and the knowledge relating to the disciplinary scope of the course, will be composed of six clear and uniquely interpretable numerical questions, that meet constraints that make them comparable with the predetermined correction criteria. It will be considered the logic followed by the student in the resolution of the questions; the correctness of the procedure identified for the solution of the question; the accuracy of the final result; the adequacy of the numerical found result; the ability to understand the results obtained; the use of an adequate

	language. Numerical questions presented in the written examination will cover the following topics: stoichiometry, ideal gas laws, colligative properties of solutions, pH of aqueous solutions, solubility, water hardness, mix–design of concrete, elastic properties of composite materials, mechanical response of materials, phase diagrams. The maximum expected duration of the written examination is three hours. The total score of the written tests will be expressed in thirtieths and will result from the sum of the scores given to each question depending on its complete resolution, partial or no resolution. A minimum score of 15/30 is needed in order to access to the oral examination. The oral examination consists of an interview to ascertain the possession of the skills and the knowledge provided by the course, the computing capacity and un adequate display capacity. The candidate will have to answer at least to three topics concerning the program, with reference to the recommended texts. The assessment is expressed in thirtieths. These examinations aim to evaluate some basic competences and problem solving capability of the student. Furthermore, the competences and the knowledge learnt during the course will be assessed. The stimuli, well defined, clear and univocally interpretable allow formulating the answer in full autonomy. Moreover, they are structured in order to allow the comparability. The questions will verify: acquired knowledge; elaboration capability; talking capability; ability to build autonomous connections not bound to the referring textbooks; capability to produce autonomous evaluations inherent the course topics; capability to understand the applications connected with the discipline areas; capability to connect the discipline topics with the referring professional and technological context. The final evaluation will be expressed in thirtieths and will be the average of the written and oral examinations. The threshold of sufficiency will be achieved when the student shows the knowledge and understanding of the topics at least in the general guidelines and has minimum application competencies in order to solve concrete cases; He must also have exhibiting and arguing skills that will enable it to pass its knowledge to the examiner. Below this threshold, the examination will be insufficient. The more, instead, the student is able to interact with the examiner with his arguments and exhibit skills, and the more his knowledge and application skills go in. Assessment - Grade: excellent; Mark: 30 – 30 with distinction; Learning outcome: Excellent knowledge of the topics and very good language skills. Good analytical skills. The student is able to use the knowledge he/she has acquired to solve problems. - Grade: very good; Mark: 26-29; Learning outcome: Good grasp of the topics. Sound language skills. The student is able to use the knowledge he/she has acquired to solve problems. - Grade: good; Mark: 24-25; Learning outcome: Basic knowledge of the main topics. Fair language skills with limited ability to independently use the knowledge acquired to solve problems. - Grade: satisfatory; Mark: 21-23; Learning outcome: The student lacks a firm grasp but has some knowledge of the main topics. Satisfactory language skills. Low ability to independently use the knowledge acquired. - Grade: sufficient; Mark: 18-20; Learning outcome: Minimum basic knowledge of the main topics and technical language. Very low ability to independently use the knowledge acquired. - Grade: fail; Learning outcome: The student does not have an acceptable knowledge of the topics.
EDUCATIONAL OBJECTIVES	At the end of the course, the student will be able to address and solve application problems related to various topics covered during the course, will have acquired the ability to correlate the various topics and will have learned to critically analyze the results obtained also recognizing their validity. Moreover, the student will be able to understand how the knowledge of some basic concepts of chemistry, material science and technology is the basis of almost all technologies and how they can be used in the performance of their profession. An important example concerns the graduated in building engineering that could be involved, in the course of its professional activity, in the preparation and study of materials used in the field of building construction. The student will be able to correlate the properties of the main materials currently used in the building field to their structure and to apply such knowledge in design, construction, innovation and retrofitting of building engineering works and for the design, management and maintenance constructions of ordinary complexity.
TEACHING METHODS	Lectures and numerical exercises carried out in the classroom and eventually at

	the distance.
SUGGESTED BIBLIOGRAPHY	P. W. Atkins, L. Jones, L. Laverman - "Fondamenti di chimica generale", II Edizione, ISBN 978-88-086-7012-0, Zanichelli. P. Silvestroni - "Fondamenti di chimica", XI Edizione, ISBN 978-88-089-2053-4, Zanichelli. W. F. Smith, J. Hashemi - "Scienza e Tecnologia dei Materiali", IV Edizione, ISBN 978-88-386-6765-7, MacGraw–Hill. W.D. Callister, D.G. Rethwisch - "Materiali per l'Ingegneria Civile ed Industriale", ISBN 978-88-7959-880-4, Edises. M. Lucco Borlera, C. Brisi. - "Tecnologia dei materiali e chimica applicata", ISBN 978-88-8218-020-4, Levrotto & Bella.

SYLLABUS

Hrs	Frontal teaching
2	INTRODUCTION TO THE COURSE (elements, compounds, atom and molecule, atomic number, mass number, atomic mass, molecular mass and mass formula, Avogadro constant, mole, molar mass, number of oxidation, formulas and nomenclature of the main classes of inorganic compounds)
2	CHEMICAL REACTIONS (classification and balance of chemical reactions, Reactions in aqueous solution, stoichiometric calculations)
2	CHEMICAL AND PHYSICAL BOND (ionic bond, Nonpolar and polar covalent bonds, electronegativity, dative bond, hybridization of atomic orbitals, hydrogen bonding, dipole interactions, Van der Waals forces, metallic bond)
2	STATES OF MATTER (solids, liquids and gas)
2	THERMODYNAMICS (Thermodynamic aspects of chemical transformations: internal energy, enthalpy, entropy, free energy. conditions of equilibrium, criteria of spontaneity for a transformation)
1	CHEMICAL BALANCE (homogeneous and heterogeneous equilibria. G° of the reaction and the equilibrium constant (Kc, Kp). shifting balance: Le Chatelier's principle, effects of temperature, pressure and the change in the equilibrium concentrations)
1	SOLUTIONS (Types of solutions and mechanisms of solubilization of the solutes. concentration of solutions, mass%, mole fraction, molarity,% by volume, molarity and normality, Raoult's Law, colligative properties)
2	HETEROGENEOUS EQUILIBRIA IN AQUEOUS SOLUTION (Ionic product of water, pH, strength of acids and bases (Ka, Kb), Polybasic acids and bases, hydrolysis, buffer solutions, heterogeneous equilibria in aqueous solution: solubility product)
4	WATER (Introduction, properties, features and analysis of water. sedimentation, coagulation, flocculation, filtration, aeration and degassing, water hardness and softening treatments, lime and soda softening, cation-exchange softening. demineralisation by ion-exchange. other treatments)
1	MECHANICAL CHARACTERIZATION OF MATERIALS (Tensile test, compression test, bending test, impact test, hardness, fatigue behavior)
5	METALS (Metals structure, Bravais lattices, defects and solid solutions, number of coordination, atomic packing factor and density, crystallization)
3	PHASE DIAGRAMS (Phase diagrams of two component system, transformations, microstructures. eutectic systems and other systems)
4	STEEL, CAST IRON AND NON-FERROUS ALLOYS (Classification of steels, production of steel and cast iron, thermal and thermochemical treatments: hardening, annealing, carburization of steel. Iron-Carbon diagram. TTT and CTT diagrams)
5	CERAMIC AND GLASSES (Structure, amorphous and crystalline phases, viscosity, processing methods, main classes of commercial glass, thermal and thermochemical treatments)
3	POLYMERS (Main properties and structure, thermoset and thermoplastic polymers, processing methods of thermoplastics, curing process of thermoset, industrial polymers and related applications)
1	COMPOSITES (Characteristics and applications, laminates and sandwich structures, main fibers, manufacturing methods)
2	BINDERS (Air binders: lime and gypsum. Hydraulic binders. Portland cement: production, setting and hardening, properties' end. Other cements as alternative to Portland one: pozzolanic cement and concrete blast furnace)

Hrs	Practice
2	Tutorials on molecular mass and mass formula, mole, number of oxidation, formulas and nomenclature of the main classes of inorganic compounds
2	Tutorials on chemical reactions
3	Tutorials on chemical balances
5	Tutorials on aqueous solutions, calculation of pH of solutions of strong acids, strong bases, weak acids, weak bases. hydrolysis, the pH calculation of aqueous solutions of salts. buffer solutions., solubility
6	Tutorials on calculation of water hardness, lime and soda softening, cation-exchange softening, Stokes' law
3	Tutorials on mechanical characterization of materials
3	Tutorials on metals structure , calculation of theoretical density, determination of the Miller indices and atomic packing factor

Hrs	Practice
4	Tutorials on Iron-Carbon diagram
3	Micromechanics prediction of the elastic properties of unidirectional composite materials along their principal directions
5	Tutorials on Portland cement and mix-design of concrete