Chemical basis of engineering

Academic Year: (2023 / 2024) **Review date: 16-05-2023**

Department assigned to the subject: Materials Science and Engineering and Chemical Engineering Department

Coordinating teacher: OLMOS DIAZ, DANIA

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 2

Branch of knowledge: Engineering and Architecture

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

High School Chemistry
Basic Maths and Physics

OBJECTIVES

To understand the basic principles of Chemistry: structure and properties of matter, thermochemistry and chemical equilibrium.
To understand the basic principles of Chemical Engineering: mass balances, chemical equilibrium and reaction rates.
To introduce the main inorganic and organic products and their production processes.
To explain the reactivity of the main inorganic and organic functional groups as well as their application in industrial synthesis.
To enable students to operate simple analytical equipment, to analyse and interpret their results.
General skills encouraged during the duration of the course:
-Ability to solve complex problems
-Ability to search for, understand and use relevant information in a decision-making process
-Ability to apply multidisciplinary knowledge for resolving a specific problem
-Ability to work in a group and distribute the workload in order to solve complex problems
General skills acquired by the student:
- Ability to obtain the necessary information, knowledge or understanding in order to develop solutions for specific applications

DESCRIPTION OF CONTENTS: PROGRAMME

Atoms, Molecules and Ions. Chemical bonding.
Thermochemistry and chemical equilibrium.
Chemical Equilibrium: Acid-Base and solubility equilibriums. Electrochemistry.
Chemical Kinetics
Applied Organic and Inorganic Chemistry
Basic operations in Chemical Engineering

Description
Topic 1. Atomic structure and periodic properties. Foundations of quantum theory. The periodic table. Periodic properties (Atomic radius. Ionic radius, ionization energy, electronic affinity, electronegativity).

Topic 2. Chemical Bond. Basic concepts. The ionic bond. The covalent bond. Repulsion model of the electronic pairs of the valence shell. Valence Bond Theory (Hybridization). Molecular Orbital Theory. Metallic Link. Intermolecular Forces.

Topic 3. States of matter. Gas Laws. Ideal gas equation. General properties of liquids. Solubility. Vapor pressure. Clausius equation. Equilibrium Phase diagrams (One or two components). Colligative properties of solutions.

Topic 4. Pressure-volume work. First Law of Thermodynamics. Enthalpy and chemical reactions. Hess's law. Heat capacity.
Exercises applied to thermochemical equations and the first law of thermodynamics. Second Law of Thermodynamics: Entropy and spontaneity, reversibility and chemical equilibrium. Entropy and the third law of thermodynamics. Spontaneity: Free energy.

Topic 5. Introduction to the concept of chemical equilibrium. Reversible reactions. Equilibrium

constants. Homogeneous and heterogeneous equilibria.
Free energy and chemical equilibrium. Factors that affect the chemical balance. Le Châtelier Principle. Effect of temperature on the equilibrium constant, K.

Topic 6. Basic Concepts. Acid-base theories. The AcidBase Properties of Water. The Self-Ionization of Water. pH Scale. The ionization constant.
Strength of Acids and Bases. Relationship between the ionization constants of acids and their conjugate bases. Polyprotic Acids AcidBase Properties of Salts. Hydrolysis. The Common-Ion Effect in Acid-Base Equilibria. Buffer solutions. Solubility. Solubility Equilibria. The Common Ion Effect.

Topic 7. Concept of oxidation and reduction. Types of electrochemical cells. Redox reactions. Calculation of electrochemical potentials. Spontaneous redox reactions. Effect of concentration on chemical potential. Faraday's Laws. Examples of electrochemical cells. Redox processes in aqueous medium. Corrosion cells. Cathodic protection and passivation.

Topic 8. Introduction to Organic Chemistry. Nomenclature. Hydrocarbons (aliphatic and aromatic). Physical properties of organic compounds. Isomerism. Organic Reactions.

Topic 9. (I) Introduction to Organic Chemistry. Nomenclature. Hydrocarbons (aliphatic and aromatic). Physical properties of organic compounds. Isomerism. Organic Reactions.

Topic 9 (II). Fossil fuels. Coal, natural gas and oil. Energy exploitation of fossil fuels. Combustion reactions. Stoichiometric and non-stoichiometric mixtures. Industrial exploitation of fossil fuels. Petrochemical and carbochemical industry. Other sources of energy. Exercises related to the topic.

Topic 10. Basic principles and concepts in Chemical Engineering. Classification of basic operations. Macroscopic balances. Mass balances. Basic operations. Mass transfer. Energy transfer. Mass and Energy Transfer operations. Momentum Transfer Operations.

LEARNING ACTIVITIES AND METHODOLOGY

Master classes, tutorial classes in small groups dedicated to resolving student questions and doubts, student presentations, individual tutorials, and individual work by the students; activities dedicated to acquisition of theoretical knowledge related to the lecture course (3 ECTS credits)
Laboratory practical sessions and classes in small groups dedicated to solving question sheets, individual tutorials and individual work by the student; activities dedicated to acquisition of practical skills related to the lecture course (3 ECTS credits)

ASSESSMENT SYSTEM

Continuous Evaluation (mínimo 40%):
- Tests and exercises will be done in class hours (30%, distance or face-to-face sessions). It is proposed to do 6 assessment exercises during the course. Participation and presentation on Projects (document + oral presentation).
- Attendance to practical sessions and assessed practical work paper (10%)
- Final Exam (60%). A minimum mark of 4.0 (out of 10) is required in this part to average with the continuous evaluation.

To pass the course a mark of 5.0 (out of 10) is required (60% Final exam + 40% Continuous evaluation).

The attendance to laboratory sessions is MANDATORY. The entrance to the laboratory is enabled once the student has watched the general security video and the specific video for chemistry/materials lab and answered both tests correctly. THE STUDENT CAN NOT ACCESS THE LABORATORY SESSIONS IF HE/SHE HAS NOT ANSWERED THE TESTS. THE NON-ASSISTANCE TO THE LABORATORY WITHOUT JUSTIFIED CAUSE IMPLIES FAILING THE CONTINUOUS EVALUATION.

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- K. HEINZ BÜCHNER, HANS-HEINRICH MORETTO, P. WODITSCH, Industrial Inorganic Chemistry, Wiley-VCH; 2000..
- K. WEISSERMEL, HANS-JÜRGEN ARPE, Industrial Organic Chemistry, 4th Edition, Wiley & Sons; 1997..
- P.W. ATKINS, L. JONES. Chemical Principles, W H Freeman & Co, 2001.

- R. CHANG. Chemistry,, McGraw-Hill Science, 2006..