Universidad del País Vasco Euskal Herriko Unibertsitatea

**COURSE GUIDE** 2025/26

**Faculty** 363 - Faculty of Engineering - Bilbao **Cycle** .

**Degree** GMECAN30 - Bachelor`s Degree in Mechanical Engineering **Year** First year

## COURSE

27675 - Chemical Fundamentals of Engineering **Credits, ECTS:** 9

## COURSE DESCRIPTION

Chemical Fundamentals of Engineering is an undergraduate core module for 1st year of Bachelor of Science (BSc) in Industrial Engineering for different engineering programmes: Electrical, Mechanical, Electronics. It is a 9-ECTS module and it is a full year module. It is taught by the Department of Chemical Engineering and Environment.
This study guide is intended to provide students with a general view of the module, of its learning outcomes, syllabus, teaching methods, etc.
The aim of this module is, on the one hand, to provide students with those foundation principles of Chemistry that are relevant to Engineering. On the other hand, the module focuses on developing the required skills to apply those principles.

The contents of this module are designed to introduce and enhance students' understanding and application of chemistry principles that underlie the structure and properties of matter, as well as the physical and chemical changes that it can undergo. Additionally, students will be encouraged to engage in the development of learning strategies for the subsequent modules, such as Material Sciences of 2nd year and Environmental Technology of 4th year. These modules are common to all BSc programmes.
There are no prerequisites to follow the module. It is recommended that students have completed the Chemistry module during Secondary Education and that they possess basic knowledge of organic and inorganic chemistry nomenclature and magnitudes and units common to Physics and Chemistry.

## COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

SKILLS

CB4. Students are able to convey information, ideas, problems and solutions to both specialized and non-specialized audiences
C3. Knowledge of basic and technology subjects to enable students to learn new methods and theories, instilling in them the considerable versatility required to adapt to new situations
C4. Ability to resolve problems through initiative, decision-making, creativity, critical reasoning and convey knowledge, skills and abilities in the field of Industrial Engineering
C12. To adopt a responsible attitude, an organised approach to work and a willingness to learn considering the challenge posed by the need for lifelong training
C13. To apply the specific strategies of scientific methodology: analyse the situation and its issues both qualitatively and quantitatively. Propose hypotheses and solutions using the specific models of Industrial Engineering
C14. To work efficiently in a team integrating capabilities and knowledge for adopting decisions within the field of Industrial Engineering
FB4. Ability to understand and apply the basic knowledge principles of general chemistry, organic and inorganic chemistry and its applications in engineering

LEARNING OUTCOMES

Skills CB4, C3 and C4

o Communicates knowledge, procedures, skills and results effectively, using adequate terminology of Engineering and Chemistry
o Has acquired knowledge and learning strategies for further professional qualification

Skills C12, C13 and C14

o Applies the strategies of the scientific method to solve problems related to the properties and the behaviour of matter in different applications. Analyses the problem within the theoretical framework required, makes decisions showing initiative and creativity, and chooses the appropriate equations and models to solve problems
o Works effectively in a team during laboratory classes, integrating skills, knowledge and organizational skills for decision-making
o Adopts a responsible attitude, an organised approach to work and a willingness to learn

Skill FB4

o Demonstrates knowledge of the essential principles and theories of the structure of matter to gain understanding of properties and performance of materials
o Demonstrates a clear understanding of the underlying principles of the physical and chemical processes that chemical

substances undergo, and thus, be able to determine the consequences of these processes in different applications

## Theoretical and Practical Contents

SYLLABUS
Unit 1. Introduction: The aim of this introduction unit is to explain how Chemistry relates to other sciences. The terminology, vocabulary and basic principles that describe the behaviour of matter and energy are introduced.
Unit 2. Electronic structure of atoms: The composition of atoms (fundamental particles) is studied, with a particular emphasis on the distribution of electrons on the atomic levels (quantum mechanical model), since many chemical properties of the elements can be determined based upon the electron configuration.
Unit 3. Periodic table: Elements are classified according to their periodic chemical properties, highlighting the concepts of ionization energy, electron affinity and electronegativity. Additionally, the ionic and covalent valences are justified based upon their position in the Periodic Table.
Unit 4. Chemical bond: The study of the chemical bond will help understand the bonds that hold together atoms in molecules and ions in ionic compounds. The three main types of chemical bonding are studied (ionic, covalent and metallic) and their properties are discussed.
Unit 5. Intermolecular forces. Aggregation states of matter: The weakest forces that exist between molecules and between ions and molecules (intermolecular forces) are described and the resulting properties. The structure of the three aggregation states of matter will be analysed (solid, liquid and gas) and some of their common and most important properties. The key types of crystal structure will be studied.
Unit 6. Phase diagrams: Phase changes or transitions between gases, liquids and solids will be studied based upon phase diagrams.
Unit 7. Mixtures and solutions. Properties of solutions. Properties of colloids ad emulsions: The different types of dispersed systems will be introduced. Actual solutions, the magnitudes and the laws governing them will be studied more in-depth. Then, the colligative properties of solutions and their most important applications will be discussed. Colloids and their technical applications will be studied.
Unit 8. Thermochemistry. Combustion: In this unit, the thermodynamic magnitudes and functions will be studied, as well as the relationship between them. Particular attention will be paid to combustion processes.
Unit 9. Acids, bases and salts: Acid and base definitions, pH scale and relationship between the acids´ strength and the molecular structure will be studied. The quantitative study of the ionization of acids and bases in water will be addressed.
Unit 10. Electrochemistry. Corrosion: Electron transfer reactions in aqueous solutions (redox reactions) will be studied, as well as the conversion processes between chemical energy and electrical energy. Metal corrosion process, its causes and corrosion protection will be discussed.
Unit 11. Industrial inorganic chemistry: The synthesis, properties and applications of the key inorganic compounds (from an industrial point of view) will be studied.
Unit 12. Organic chemistry. Polymers: The goal of this unit is to provide students with an introduction to foundational concepts of organic chemistry: its definition and understanding of its distinguishing features that rely on the specific structure of organic molecules. The main organic functional groups and their properties will be studied. In addition, general properties of organic polymers will be analysed.

LABORATORY EXPERIMENTS: The laboratory sessions complement the lectures and take place in semester two.
- PL0. Introduction to laboratory
- PL1. Stoichiometry
- PL2. Dissolutions and colligative properties.
- PL3. Calorimetry
- PL4. Neutralization titration.
- PL5. Electrochemistry

## TEACHING METHODS

The following modes of teaching will be used: Lectures, Seminars and Laboratory Practicals.

* Skills C3, C4, C12, C13 and FB4 will be developed during lectures, and one of the key aspects of the learning process, that is, the "guided independent study" will be encouraged. To this purpose, students will be given different assignments and their skills will be monitored.
* During the Laboratory Practicals and Seminars, the focus will be placed on the development of skills CB4, C12 and C14, applying a more active teaching method where the student-teacher interaction becomes the central aspect. To this end, students will take part in different group activities, both in the Seminars and in the Laboratory.

- Attendance at Seminars and Labs will be monitored and a minimum attendance of 80% will be required for satisfactory completion of continuous assessment.

"If the health situation avoids the development of any teaching or evaluation activity, a non-presential alternative will be

used and the students will be promptly informed."

## TYPES OF TEACHING

| Types of teaching | M | S | GA | GL | GO | GCL | TA | TI | GCA |
|---|---|---|---|---|---|---|---|---|---|
| Hours of face-to-face teaching | 60 | 14 | | 16 | | | | | |
| Horas de Actividad No Presencial del Alumno/a | 80 | 35 | | 20 | | | | | |

**Legend:**
M: Lecture-based
S: Seminar
GA: Applied classroom-based groups
GL: Applied laboratory-based groups
GO: Applied computer-based groups
GCL: Applied clinical-based groups
TA: Workshop
TI: Industrial workshop
GCA: Applied fieldwork groups

## Evaluation methods

- Continuous evaluation
- End-of-course evaluation

## Evaluation tools and percentages of final mark

- Written test, open questions 70%
- Written exams = 70%

Laboratory practicals (15%) and teacher suggested assignments (15%) 30%

## ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

Continuous assessment

-First term exam held during the official period of January exams: it is a written exam that will consist of extended response questions and problems: 30%
If a student passes this exam, the mark will be carried forward to the reassessment exam in the extraordinary examination period (included). Students that fail this exam will have to resit for first term material in the ordinary examination period of May.

- Exam held during the official exam period in May: it is a written exam that will consist of extended response questions and problems:

a) In the case of students that got a pass for the first term exam held during January official exam period: they will take the written exam of the second term of the subject: 40 % (35% related to lectures and 5% related to laboratory coursework).

b) In the case of students that did not pass the first term exam held during January official exam period: they will take the written exam of the whole subject: 70% (65% related to lectures and 5% related to laboratory coursework)

- Laboratory practicals and teacher suggested assignments: assessment tests, lab experiments, lab report writing, individual practical lab exam, team work and oral presentations: 30%

The overall grade of the module will be obtained by the sum of the marks obtained previously but for that it is necessary to pass the exam held during the official period and the part corresponding to the laboratory work. If the exam is not passed, the assigned mark will be the one obtained in that exam.

Final assessment

Students following article 8.3 of the Regulation Guidelines on Assessment of students in the UPV/EHU will be able to sit a final exam.

"Regardless of the assessment mode followed, students have the right to be assessed by a final exam. In that case, students should submit a written form of withdrawal from the continuous assessment mode to the teacher responsible of the module within the first 18 weeks of the course start date (for full academic year modules), according to the academic calendar of the corresponding faculty/school"

Final assesment consists in a written exam held during the official exam period in May and it consists of extended response questions and problems (80%) and a specific test that consists of a laboratory practical exam and the preparation and presentation of an inorganic chemistry topic: 20%

Failure to attend an examination will not count as an assessment attempt and it will be marked as No attendance.

"If the health situation avoids the development of any teaching or evaluation activity, a non-presential alternative will be used and the students will be promptly informed."

## EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

Students that fail to pass the module in the ordinary sitting, irrespective of the assessment method followed, will be able to resit a final exam. This final exam is held during the official exam period in June and consists of a written exam with extended response questions and problems: 80% and a specific test that consists of a laboratory practical exam and the preparation and presentation of an inorganic chemistry topic: 20%

Students that followed the continuous assessment in the ordinary sitting could choose, when taking the exam, whether they want to carry forward the marks of the coursework (lab practicals and assignments) or not. If the coursework mark is carried forward, the resit mark will be based on 70% examination. If the coursework mark is not carried forward, the resit mark will be based on the exams described in the previous paragraph.

Failure to attend the resit written examination will not count as an assessment attempt and it will be marked as "No attendance".

"If the health situation avoids the development of any teaching or evaluation activity, a non-presential alternative will be used and the students will be promptly informed."

## MANDATORY MATERIALS

Compulsory materials
- Chemistry Laboratory manual
- Problems and solved exercises of the module units
- Lab coat (cotton)
- Safety glasses

## BIBLIOGRAPHY

### Basic bibliography

- Chang R., Goldsby K. Chemistry. McGraw Hill. New York, 12th Ed, 2016
- Petrucci R. H., Harwood W.S. General Chemistry: Principles and Modern applications. Pearson Canada, 2011
- Reboiras M.D. Problemas Resueltos de Química. La Ciencia Básica. S.A.Ed. Paraninfo. Madrid, 2007

### Detailed bibliography

- Caselles M.J., Gómez M.R. Química Aplicada a la Ingeniería. UNED. Madrid, 2007
- Smith W.F. Foundations of Materials Science and Engineering. Mc. Graw-Hill, 2014
- Shackelford J.F. Material Science for Engineers. Prentice-Hall, 2005

### Journals

### Web sites of interest

- eGela

## OBSERVATIONS