Materials technology

Academic Year: (2024 / 2025) **Review date: 12-03-2024**

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

Coordinating teacher: MARTINEZ CISNEROS, CYNTHIA SUSANA

Type: Electives ECTS Credits : 6.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Materials Science and Engineering

SKILLS AND LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG4. Solve mathematical, physical, chemical, biological and technological problems that may arise within the framework of the applications of quantum technologies, nanotechnology, biology, micro- and nano-electronics and photonics in various fields of engineering.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CG7. Undertake further specialized studies, both in physics and in the various branches of engineering.
CE9. Understand and handle the fundamentals of materials science, technology and chemistry, as well as the relationship between microstructure, synthesis or processing and the properties of materials.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA4. To be able to successfully manage themselves in the complex situations that might arise in their

academic or professional fields of study and that might require the development of novel approaches or solutions.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

OBJECTIVES

In general, the student must develop skills and master the knowledge associated to the manufacture of components for specific applications.
Specifically, the student must acquire the knowledge and skills associated to materials technology. This implies: 1) to acquire the knowledge of the fundamentals of science, technology and chemistry of materials and 2) to understand the relationship among microstructure, synthesis and/or processing and the properties of the materials.

Furthermore, during the course, other skills will be promoted:

- Ability to analyze and solve complex problems, encouraging skills for searching, understanding and identifying the most relevant information and analyzing and interpreting results obtained to reach a final decision.
- Ability to correlate multidisciplinary knowledge to solve technological problems.

Acquisition of knowledge and skills to apply materials engineering in the achievement of components for specific applications.

In more detail:

- Ability to select the proper material for a specific application.
- Ability to select a forming process for a particular material, considering size, shape, properties and final application.
- Knowledge of the different joining processes, excluding mechanical fastening methods, understanding the chemical and/or metallurgical processes involved.
- Knowledge of failure possibilities linked to in-service behavior, providing the capability to determine the cause of failure.
- Knowledge of inspection and testing methods.

DESCRIPTION OF CONTENTS: PROGRAMME

Block I: Introduction to Materials Technology

1. Introduction to the subject

Block II: Engineering alloys

2. Ferrous alloys
- Low-alloy steels
- High-alloy steels
- Stainless steels
- Tool steels
- Cast irons (white iron, gray iron, malleable iron, ductile iron)

3. Non-ferrous alloys
- Aluminum Alloys
- Titanium Alloys
- Copper alloys (brass, bronzes)

Block III: Forming of materials

4. Fundamentals of forming by casting
- Solidification
- Formation of the ingot structure
- Defects

5. Casting techniques

- Permanent mold processes
- Non-permanent mold processes
- Influence of the casting process on microstructure and properties of materials
- Continuous casting

6. Fundamentals of forming by plastic deformation
- Factors affecting plastic deformation
- Effects of plastic deformation
- Strain hardening
- Cold working
- Recrystallization annealing
- Hot working
- Warm / Isothermal deformation
- Superplasticity

7. Deformation Techniques
- Rolling
- Forging
- Extrusion
- Drawing

8. Powder Technology
- Manufacturing, processing and properties of powders
- Forming techniques
- Sintering

9. Processing of ceramics
- Processing for ceramic powders (cold/hot isostatic pressing, slip casting, tape casting, extrusion).
- Thermal treatments (drying, firing)
- Monocrystals
- Preparation of thin films (PVD, CVD)

10. Processing of polymers
- Basic principles polymers processing
- Polymer forming processes
- Additives
- Plastics recycling

11. Processing of polymer matrix composites (PMC)
- Fiber-reinforced composite materials
- Open mold processes
- Closed mold processes

Block IV: Failure of materials

12. Fracture
- Fracture types
- Principles of fracture mechanics
- Impact fracture testing: brittle-ductile transition
- Problems on fracture

13. Fatigue
- Cyclic stresses
- The S-N curve
- Crack initiation and propagation
- Fatigue in components without crack
- Fatigue in components with crack
- Factors that affect fatigue life
- Problems on fatigue

14. Creep
- Concept of creep
- Creep test: creep curves

- Data extrapolation methods: Larson-Miller parameter
- Mechanisms of creep
- Problems on creep

15. Friction and wear
- Tribology
- Friction: adhesion theory
- Wear: types and mechanisms
- Friction and wear tests
- Lubrication

16. Corrosion of metals
- General concepts of corrosion
- Dry corrosion (mechanism, protective oxides, affected sectors)
- Electrochemical corrosion (thermodynamics and mechanism, factors that produce a corrosion cell)
- Types of corrosion
- Protection against corrosion

Block V: Joining techniques

17. Welding
- Welding metallurgy
- Defects in welding
- Welding techniques

18. Adhesives
- Basic concepts of adhesives
- Classification of adhesives
- Formation of the adhesive bond
- Mechanical behavior of the adhesive bond
- Degradation of the adhesive bond

Block VI: Surface treatments and coating

19. Surface treatments and coatings
- Surface preparation and cleaning
- Surface treatments that do not modify composition (flame hardening, induction hardening, laser hardening)
- Surface treatments that modify composition (nitriding, carburizing, carbonitriding).
- Coatings (galvanized, electrodeposition, organic coatings, thermal spray)

Block VII: Non-destructive testing (NDT)

20. Non-destructive testing (NDT)
- Introduction and classification
- Visual inspection
- Penetrating liquids
- Magnetic particles
- Induction currents: eddy currents
- Radiography and scintigraphy
- Ultrasounds

LEARNING ACTIVITIES AND METHODOLOGY

Master classes, reduced-group classes, individual tutorship and personal work of the student; focused on acquiring theoretical knowledge.
Laboratory sessions, classes focused on solving problems, individual tutorships and personal work of the student; oriented to the acquisition of practical skills related to the program of the subject.

Note: For the 2020/2021 academic year, teaching will be bimodal 50% (synchronous online teaching in big or aggregate groups, face-to-face teaching in small groups).

ASSESSMENT SYSTEM

% end-of-term-examination:	55
% of continuous assessment (assigments, laboratory, practicals…):	45

The assessment consists of a final test (55% of the final mark) and a continuous evaluation system (45%). For the continuous evaluation to be considered, it is required to obtain a minimum of 4/10 in the final exam.

The continuous assessment consists of:

(i) Three individual tests, with a 30% weight
(ii) Laboratory: execution of four practices. The final laboratory mark will consist of solving a questionnaire or test at the beginning of each one, to check the student's knowledge, and a final report. Final laboratory weight: 10%.
(iii) Synchronous tests performed during master classes (5%).

The assistance to the 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 ENTER THE LABORATORY IF HE/SHE HAS NOT ANSWERED THE TESTS. THE NON-ASSISTANCE TO THE LABORATORY WITHOUT JUSTIFIED CAUSE IMPLIES SUSPENDING THE CONTINUOUS EVALUATION.
Laboratories take place during march and April, according to the corresponding ongoing academic calendar.

BASIC BIBLIOGRAPHY

- M.F. Ashby, Engineering materials., Elsevier, , 2006

- S. Kalpakjian, Manufacturing engineering and technology., Pearson Education, , 2014

- W.D. Callister, Jr., Materials Science and Engineering: an introduction. , Ed. John Wiley & Sons, , 2003

- W.F. Smith, Foundations of materials science and engineering., McGraw-Hill Higher Education, 2010