Aerospace Materials I

Academic Year: (2021 / 2022) **Review date: 23-12-2021**

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

Coordinating teacher: TSIPAS , SOPHIA ALEXANDRA

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Chemical basis of Engineering

OBJECTIVES

Students will acquire the following abilities:
- Basic knowledge on materials science and engineering: bonding in solids, structure of materials, diffusion in solids, mass transport, phase diagrams.
- Properties of polymers, ceramics and composites: mechanical properties, electrical, magnetic and thermal properties.
- Introduction to polymers, ceramics, and composites and its use and performance in aerospace.
- Processing and Applications

In addition the following abilities will be acquired:
- To solve complex problems.
- To look for, to understand, and to differentiate the relevant information to be able to take a decision.
- To use multidisciplinary knowledge to solve a problem.
- To work in groups and distribute work to face up to complex problems.

Students who successfully complete this course will be able to present a collaborative attitude that will enable them to get from other people information, skills, and knowledge necessary to manufacture components for specific applications.

DESCRIPTION OF CONTENTS: PROGRAMME

-Introduction to to Materials Science & Eng. Classification of materials. Properties. Evolution of main aerospace materials. Materials requirements in structures and engines.
-Bonding in solids. Relationship between bonding, structure and properties of materials
-Crystalline systems and some definitions. Atomic positions. Directions and planes in the crystalline cells.
-Crystalline defects. Solid solutions. Polymorphism and Allotropy. Amorphous Materials
-Diffusion mechanisms. Fick¿s diffusion laws. Industrial applications examples
-Phase Diagrams: Component, phase, micro constituent. Unary or one component phase diagrams. Binary isomorphous phase diagrams. Gibbs Phase Rule. Tie line and lever rule. Non equilibrium solidification. Binary eutectic systems.
-Precipitation in solid state. Invariant reactions. Intermetallic components. Congruent and incongruent melting
-Fe-C System. Equilibrium transformations in the metastable Fe-C system. Eutectoid steels. Pearlitic transformations. Hypoeutectoid steels. Hypereutectoid steels. Influence of alloy elements in metastable Fe-C
-Ceramic phase diagrams. Ternary phase diagrams. Ternary phase diagrams in metallic alloys. Ternary phase diagrams in ceramics
- Mechanical properties: Uniaxial Tension Test. Stress-strain Curve: Elastic Zone. Plastic Zone. Slip Systems Ductility concepts. True Stress-strain Curves
- Strengthening Mechanisms. Hardness
-Electrical Properties: Classification. Diagrams of Energy-Bands. Conducting materials. Metallic conductors .Ceramic conductors. Semiconducting materials. Intrinsic. Extrinsic. Insulating materials
- MAGNETIC PROPERTIES. Origin of the magnetic behaviour of materials. Types of magnetism. ferromagnetic, ferrimagnetic; paramagnetic; diamagnetic; anti-ferromagnetic. Magnetic domains. Hysteresis cycles. Types of materials according to their hysteresis cycles. Factors affecting the hysteresis cycle. Applications. THERMAL PROPERTIES
-Ceramic materials . Structure of Ceramic Materials. Glasses. Mechanical Properties of Ceramic

Materials
Processing of ceramic materials. Applications
-Polymeric materials: Chemical structure of polymers. Molecular weight and its distribution. Solid state of polymers. Crystalline polymers. Thermal transitions. Mechanical properties of polymers Viscoelasticity
Processing and practical applications of polymeric materials
-Concept of composite materials. Constituents of composite materials. Classification. Reinforcements. Particles. Composite materials reinforced with large particles. Fibres and prepregs. Mechanical properties of different reinforcement materials
-Polymer matrix in Composite Materials. Thermoset and thermoplastic matrices. Additives . Mean elastic properties of composites. Fabrication Processes. Composite materials and in Aerospace
- Mechanisms of Adhesion. Modes of failure. Types of adhesives. Processing and design considerations.

LEARNING ACTIVITIES AND METHODOLOGY

-The course will consist of Master Classes where the theory of the topics will be presented and Tutorial Classes where applications and examples will be emphasized and problems exercises will be solved.
- There will be optional tutorial sessions for the students.
- There will be practical laboratory work of compulsory assistance. The laboratory sessions will result in the acquisition of practical abilities related to the content of the course.
- All the teaching material (lecture notes, handouts, exercises and problems, laboratory manual and additional material) will be distributed to the students through Aula Global.
IMPORTANT:
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.

ASSESSMENT SYSTEM

Continuous evaluation will consist of two parts:
(i) Mid-term tests to be solved individually during classes, or other activities that will count 30% of the total mark.
(ii) Laboratory practices, that will be assessed with a questionnaire that will be handed in at the end of each laboratory session, and that will count 10% of the total mark.
Percentage of continuous evaluation assessment (exercises, tests, laboratory): 40
-The final examination will count 60% of the total mark of the lecture course.
Help sessions and tutorial classes will be held prior to the final exam.
Percentage of end-of-term-examination: 60%
The minimum mark for the end-of-term exam is at least 4 out of 10.
Final mark must be at least 5.

The final mark is obtained in the following way:
LABORATORY SESSIONS (10%)
10% Laboratory Reports Assessment of the methodology and realization of the laboratory session as well as the written report.
CONTINOUS EVALUATION (30%)
30% Exercises and problems performed during class. Assesments during the course.
FINAL EXAM (60%)
60% Final Exam. It will contain problems and questions from the whole lecture course.

Minimum mark for end-of-term examination: 4 out of 10.

In order to pass the lecture course the final mark must be at least 5.

IMPORTANT:
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.

MINIMUM MARKS
- The assessment tests, the exercises, and problems handed in do not have a minimum mark in order to pass the lecture course.
- Attendance to the laboratory sessions is mandatory. Failure to hand in the laboratory reports will

result in no marking for the laboratory session.
- Attendance to assessment tests or submission of the exercises is not compulsory. However, failure to attend the test or submit the exercises will result in a mark of 0 in the corresponding exercise or test.
- The minimum mark for the end-of-term-exam is 4 out of 10. In order to pass the lecture course the final mark must be at least 5.

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

BASIC BIBLIOGRAPHY

- ASHBY MF Engineering materials: an introduction to their properties and applications, Pergamon Press, 1981
- ASKELAND DR. Essentials of materials science and engineering, 2nd ed Ed. Cengage Learning, 2010
- Adrian P. Mouritz Introduction to Aerospace Materials, Woodhead Publishing, 2012
- CALLISTER WD. Materials science and engineering: an introduction , 2nd ed John Wiley & Sons, 2003.
- MANGONON PL. The principles of materials selection for engineering design , Ed. Prentice Hall,, 1999
- SHACKELFORD JF. Introducción a la Ciencia de Materiales para ingenieros, 4th ed. Pearson Prentice-Hall, 2005
- SMITH WF Fundations of Materials Science and Engineering, McGraw-Hill, 2011
- Van Vlack L.H. Elements of Materials Science and Engineering, Ed Addison Wesley Co. , 1989