Universidad Carlos III de Madrid
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COURSE: AEROSPACE MATERIALS I (251 - 15333)		
DEGREE: BACHELOR IN AEROSPACE ENGINEERING	**YEAR: 2**	**TERM: 1ST**

WEEKLY PLANNING

WEEK	SESSION	DESCRIPTION	GROUPS (mark X)		SPECIAL ROOM FOR SESSION (Computer class room, audio-visual class room)	WEEKLY PROGRAMMING FOR STUDENT		
			ONLINE SYNCHRONOUS LECTURES (Blackboard Collaborate	SEMINARS		DESCRIPTION	CLASS HOURS	HOMEWORK HOURS (Max. 7h week)
1	1	**PRESENTATION OF THE COURSE. TOPIC 1. BONDING IN SOLIDS**		X		Introduction to the course. Course structure and evaluation. Bonding in solids. Relationship between bonding, structure, and materials properties.	1.6	3
2	2	**TOPIC 2. STRUCTURE OF MATERIALS I**	X			Crystalline systems and some definitions. Important metallic structures. Atomic positions. Directions in the crystalline cells. Planes in the crystalline cells.	1.6	7
2	3	**TOPIC 2. STRUCTURE OF MATERIALS II**		X		Calculation of the atomic density. Crystalline defects. Solid solutions. Polymorphism and Allotropy. Amorphous Materials.	1.6	
3	4	**TOPIC 3. DIFFUSION IN SOLIDS. MASS TRANSPORT**	X			Definition of diffusion. Diffusion mechanisms. Fick's diffusion laws. Diffusivity. Industrial applications: examples	1.6	5
3	5	**PROBLEMS ON TOPICS 2 AND 3**		X		Resolution of Problems.	1.6	
4	6	**TOPIC 4. PHASE DIAGRAMS I**	X			Basic concepts: Component, phase, micro constituent. One component phase diagrams. Binary isomorphous phase diagrams.	1.6	7

						Gibbs Phase Rule. Tie line and lever rule. Non equilibrium solidification. Binary eutectic systems.		
4	7	**TOPIC 4. PHASE DIAGRAMS II**		X		Precipitation in solid state. Invariant reactions. Intermetallic components. Congruent and incongruent melting.	1.6	
5	8	**TOPIC 4. PHASE DIAGRAMS III**	X			Fe-C System. Equilibrium transformations in the metastable Fe-C system. Eutectoid steels. Pearlitic transformations. Hypoeutectoid and hypereutectoid steels. Influence of alloy elements in metastable Fe-C.	1.6	7
5	9	**TOPIC 4. PHASE DIAGRAMS IV**		X		**TEST 1** Ceramic phase diagrams. Ternary phase diagrams. Ternary phase diagrams in metallic alloys and ceramics.	1.6	
6	10	**PROBLEMS ON TOPIC 4**	X			Resolution of PROBLEMS.	1.6	3
7	11	**TOPIC 5. MECHANICAL PROPERTIES I**	X			Basic Concepts. Uniaxial Tension Test. Stress-strain Curve: Elastic Zone and Plastic Zone. Slip Systems Stress-strain Curve: Calculations. Ductility concepts. True Stress-strain Curves.	1.6	7
7	12	**TOPIC 5. MECHANICAL PROPERTIES II**		X		Strengthening Mechanisms. Hardness.	1.6	
8	13	**TOPIC 6. ELECTRICAL PROPERTIES**	X			Classic Model. Classification. Diagrams of Energy-Bands. Conducting materials. Metallic conductors. Ceramic conductors. Semiconducting materials. Intrinsic. Extrinsic. Insulating materials.	1.6	7
8	14	**PROBLEMS ON TOPICS 5 AND 6**		X		Resolution of PROBLEMS	1.6	
9	15	**TOPIC 8 CERAMIC MATERIALS I**	X			Introduction. Structure of Ceramic materials. Glasses. Mechanical properties of Ceramic materials.	1.6	7
9	16	**TOPIC 8 CERAMIC MATERIALS II**		X		Processing of Ceramic materials. Applications.	1.6	
10	17	**TOPIC 7. MAGNETIC AND THERMAL PROPERTIES**	X			MAGNETIC PROPERTIES. General concepts. 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	1.6	5
10	18	**PROBLEMS ON TOPICS 7 AND 8**		X		**TEST 2** Resolution of PROBLEMS.	1.6	
11	19	**TOPIC 9 POLYMERS I**	X	X		Introduction. General overview. Historical development. Chemical structure of polymers. Nomenclature. Size and shape of polymers. Molecular weight and its distribution. Solid state of polymers. Crystalline polymers. Thermal transitions. Mechanical properties of polymers Viscoelasticity.	1.6	7

11	20	**TOPIC 9 POLYMERS II**		X		Processing and applications of polymeric materials.	1.6	
12	21	**TOPIC 10 COMPOSITES I**	X			Concept of composite materials. Constituents of composite materials. Classification. Why polymers are used in Composite Materials? Reinforcements. Particles. Composite materials reinforced with large particles. Fibres and prepregs. Mechanical properties of different reinforcement materials.	1.6	7
12	22	**TOPIC 10 COMPOSITES II**		X		Polymer matrix in Composite materials. Thermoset and Thermoplastic matrices. Epoxy matrix. Epoxy/amine network formation. Additives used to modify resin properties. Thermoplastic matrices. The interface region. Mean elastic properties of composites. Direction relative to a composite with an uniformly dispersed aggregate.	1.6	
13	23	**TOPIC 10 COMPOSITES III**	X			Fabrication Processes. Composite materials and Aerospace Construction Certification requirements for composites structures.	1.6	5
13	24	**PROBLEMS ON TOPICS 8, 9, AND 10**		X		Resolution of PROBLEMS.	1.6	
14	25	**TOPIC 11. ADHESIVES**	X			Mechanisms of Adhesion. Modes of failure. Types of adhesives. Processing and design considerations. Testing methods and degradation mechanisms of adhesives.	1.6	4
15	26	**TEST 3**	X			**TEST 3**	1.6	
						Subtotal 1	**41.6**	**81**
			Total 1 *(Hours of class plus student homework hours between weeks 1-15)*				**122.6**	
15		Tutorials, handing in, etc					5	
16		Assessments					3	21
17								
18								
						Subtotal 2	**3**	**26**
			Total 2 *(Hours of class plus student homework hours between weeks 15-18)*				**29**	

		LABORATORY SESSION I: CRYSTALLINE STRUCTURES			Lab. 1.0.A02	Closed packed and non-compact crystalline structures. X-ray diffraction pattern	1.6	2

		LABORATORY SESSION II: COMPOSITE MATERIALS			Composite materials and their application in designing of engineering structures.	1.6	2
		LABORATORY SESSION III: TENSILE TEST			Strength and elongation of materials.	1.6	2
		LABORATORY SESSION IV: IDENTIFICATION OF POLYMERS			Identification of different type of polymers used industrially.	1.6	2
					Subtotal 3	**6.4**	**8**
			Total 3 *(Hours of laboratory class plus student homework hours)*			**14.4**	
TOTAL *(Total 1 + Total 2 + Total 3. Maximum 180 hours)*						**166**	

Description of the b to be carried out with an indication that the competencies are specified; detail of the strategy to follow for each practice; periodic time of asynchronous dedication of the students (video, questionnaire, scripts), time of presence of the students, whether it will be sequential or not, etc ...; Collective tutorials: platform and dates; Evaluation criteria, etc.

Laboratory SESSIONS	Contents	Methods	Online Asynchronous (1h)	Presential on-site in the laboratory (3,4h)	Nº of work posts	Data Treatment (1h)	Collective Tutorials (Blackboard Collaborate, after each lab session) (1h)	Competencies	Evaluation Criteria
CRYSTALLINE STRUCTURES	Stacking of planes to form the main structures in metals: BCC, FCC and HCP. Search for interstitial positions. Determination of metals by X-ray diffraction. Study of Bragg's law.	**On-site presential 60%** (Laboratory practice) and **40% online** (Asynchronous theoretical explanation, synchronous online tutoring and asynchronous practical work by the student)	Explanation of the theory for the laboratory session. Explanation of the experimental method to be used, as well as the specific security measures of the lab session.	Completion of the lab session as it comes in scripts.	8	Determination of metal from diffractogram with the help of tables with the diffraction patterns of possible metals.	Yes, via Blackboard Collaborate, after the lab session	Yes	Test before the laboratory session (Aula Global). Report handed in through Aula Global (Homework)

COMPOSITE MATERIALS	Processing of composite materials from pre-peg, with different fiber orientations. Carrying out Charpy test on manufactured composite materials	**On-site presential 60%** (Laboratory practice) and **40% online** (Asynchronous theoretical explanation, synchronous online tutoring and asynchronous practical work by the student)	Explanation of the theory for the laboratory session. Explanation of the experimental method to be used, as well as the specific security measures of the lab session.	Completion of the lab session as it comes in scripts.	8	Determination of the properties of the manufactured composite materials (density, modulus of elasticity, etc.) from the properties of the matrix and the reinforcement. Relationship of the toughness values obtained in the Charpy test with the orientation of the fibers in the composite material.	Yes, via Blackboard Collaborate, after the lab session	Yes	Test before the laboratory session (Aula Global). Report handed in through Aula Global (Homework)
TENSILE TEST	Perform standard tensile tests on different materials (PTFE, PE, Al, Composite Material) to determine important aspects of their mechanical properties	**On-site presential 60%** (Laboratory practice) and **40% online** (Asynchronous theoretical explanation, synchronous online tutoring and asynchronous practical work by the student)	Explanation of the theory for the laboratory session. Explanation of the experimental method to be used, as well as the specific security measures of the lab session.	Completion of the lab session as it comes in scripts.	8	Determine the mechanical properties (elastic limit, modulus of elasticity, tensile strength, fracture deformation, resilience) of the tested materials from the stress-strain curves. Relate the mechanical properties with the structure and characteristics of each material.	Yes, via Blackboard Collaborate, after the lab session	Yes	Test before the laboratory session (Aula Global). Report handed in through Aula Global (Homework)
IDENTIFICATION OF POLYMERS	Determination of polymers by study of behavior at T, Belstein test, chip study, density. Polymer classification: thermoset, thermoplastic, elastomer.	**On-site presential 60%** (Laboratory practice) and **40% online** (Asynchronous theoretical explanation, synchronous online tutoring and asynchronous practical work by the student)	Explanation of the theory for the laboratory session. Explanation of the experimental method to be used, as well as the specific security measures of the lab session.	Completion of the lab session as it comes in scripts.	8	Relationship between the mechanical, thermal and physical properties studied with the classification of polymers.	Yes, via Blackboard Collaborate, after the lab session	Yes	Test before the laboratory session (Aula Global). Report handed in through Aula Global (Homework)