UNIVERSITÀ DEGLI STUDI DI PALERMO

SCHOOL	POLYTECHNIC SCHOOL
ACADEMIC YEAR	2016/2017
SECOND CYCLE (7TH LEVEL) COURSE	AEROSPACE ENGINEERING
SUBJECT	CORROSION AND PROTECTION OF AEROSPACE MATERIALS
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	20907-Attività formative affini o integrative
CODE	18053
SCIENTIFIC SECTOR(S)	ING-IND/23
HEAD PROFESSOR(S)	SANTAMARIA MONICA Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
YEAR	1
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**SANTAMARIA MONICA** Monday 13:00 14:00 Studio personale Edificio 6 secondo piano previa conferma per e-mail Wednesday 12:30 14:00 Studio personale Edificio 6 secondo piano previa conferma per e-mail Friday 12:30 14:00 Studio personale Edificio 6 secondo piano previa conferma per e-mail

DOCENTE: Prof.ssa MONICA SANTAMARIA

TEACHING METHODS	Frontal lectures, Laboratory and Demonstration Sessions, Laboratory Practice Sessions
ASSESSMENT METHODS	Oral exam and discussion on a case study selected by the student. To earn the minimum score, student must know the fundamental aspects of the course. Higher score will be attributed according to the student ability in applying knowledge and skills learned in this course to practical and technical problems, and according to what extent students are aware of the steps they go through in solving problems and how well they can explain their problem-solving steps.
LEARNING OUTCOMES	Knowledge and understanding At the end of the course student is expected to have a deep understanding of the mechanism of corrosion processes and on their nature as a function of the environmental physico-chemical conditions. Student will be aware on the synergistic effect of stress and corrosion in materials degradation and failure. He/she is expected to know the corrosion protection methods and strategies and to isolate the critical issues responsible of material degradation. Student will learn about corrosion protection and prevention in the aerospace industry, necessary for correct aircraft design and maintenance Applying knowledge and understanding Student is expected to know corrosion mechanism and morphology of the metallic material indifferent environments. Thanks to this fundamental knowledge he/she will be able to understand causes of the corrosion processes with a special focus on the phenomena involving metals and alloys usually employed in the aerospace industry, being able to select the most appropriate material according to the environmental conditions. Making judments Staring from knowledge of the theoretical aspects of the corrosion processes as well as from the laboratory experiences the student is expected to be able to match the right material with the environment where the latter is supposed to work, and he/she will regulate the maintenance of aircraft, in order to ensure safe and correct functioning during flight. Communication Student is expected to be able to work autonomously and collaborate with other team members involved in the same project (design and/or maintenance). Learning skills Following a deep understanding of the theoretical aspects and a after laboratory experience, student is expected t be able to seek advice from technical regulations, technical manuals, scientific literature updating frequently his/her knowledge.
EDUCATIONAL OBJECTIVES	The aim of the course is to provide basic concepts of corrosion processes and the tools for a correct selection of the materials, of the protection and prevention methods to control and limit the damages and failure in aerospace industry.
PREREQUISITES	General and Inorganic Chemistry, basic electricity with an emphasis on Ohms Law
SUGGESTED BIBLIOGRAPHY	Pietro Pedeferri, Corrosione dei e protezione dei materiali metallici. Vol. I e Vol. II, polipress, 2007, Milano Italia. Corrosion Control in the Aerospace Industry, Edited by Samuel Benavides, US Coast Guard, USA, 2009. Lectures notes and powerpoint presentations.

SYLLABUS

Hrs	Frontal teaching
4	Introduction. General aspects of corrosion processes. Mechanical and physic-chemical properties of materials. Direct and indirect corrosion damages.
5	Wet and dry corrosion. Electrochemical nechanism of corrosion. Corrosion reactions: anodic and cathodic half cell reactions. Farday's law. Thermodynamics of corrosion. Standard potential, Nerst Equation and Poribaix diagrams.
5	Kinetic of corrosion. Cathodic and anodic overvoltage.Charge transfer and mass transfer control. Passivation conditions. Evan's diagrams. Influence of Metal on corrosion processes.
8	Corrosion attack morphology: generalized corrosion, galvanic coupling, pitting corrosion, crevice corrosion, interference corrosion, selective dissolution, intergranular corrosion, turbulence corrosion, erosion corrosion, impingement corrosion, stress corrosion cracking, fatigue corrosion, hydrogen embrittlement, microbial corrosion. CO2 and H2S induced corrosion.
5	Al alloys. Effects of corrosion of structural integrity of aircrafts. Effect of corrosion processes on mechanical properties of Al light alloys. Impact of corrosion damages and cost in the aerospace industry.

SYLLABUS

Hrs	Frontal teaching
4	Monitoring, evaluation and prevention of corrosion processes: non destructive techniques for corrosion evaluation in the aerospace industry. Modeling of corrosion processes, of stress corrosion and fatigue corrosion of structure for aerospace applications.
7	Protection against corrosion: coatings and surface treatments. Anodizing of aluminium and magnesium alloys. Inhibitors and inhibitors embedded coatings. Primer. Conversion coatings and chromate free conversion coatings. Influence of microstructure on corrosion resistance of Al alloys. Corrosion resistance of welded region: postwelding treatments. Coating removal.
2	Corrosion tests: corrosion rate estimate in laboratory and in real systems (Salt Spray Test, Adhesion test, etc).
2	Design and selection of material: data base consulting, smart systems and regulations. Economic evaluation and reliability assessment (Life Cycle Cost, Decision analysis)

Hrs	Practice
2	Pourbaix diagrams from thermodynamics data and their use in corrosion studies.
2	Experimental determination of corrosion potential and corrosion rate. Polarization resistance measurement d.c. and a.c. methods.Corrosion protection and prevention: noble materials, passive films, coating, cathodic protection, inhibitors.
2	Inspection techniques on structure and non destructive techniques. Analysis of corrosion damaged materials. Monitoring of on going corrosion processes.
2	Cathodic protection: potential and current density for cathodic protection. Coatings. Laboratory test on cathodic protection, coatings fabrication and characterization by ex eletrochemical and structural techniques).
2	Anodizing of Al ad Mg alloys. Test of corrosion resistance of anodic oxides on Al alloys and Mg alloys. Corrosion resistance tests on Ti and Ti alloys, and on carbion and stainless steel.
2	Corrosion products identification by X-ray diffraction and Raman Spectroscopy. Analysis of the attack morphology by scanning eletron microscopy.