UNIVERSITÀ DEGLI STUDI DI PALERMO

SCHOOL	POLYTECHNIC SCHOOL
ACADEMIC YEAR	2016/2017
SECOND CYCLE (7TH LEVEL) COURSE	AEROSPACE ENGINEERING
SUBJECT	AEROSPACE MATERIALS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50350-Ingegneria aerospaziale ed astronautica
CODE	04913
SCIENTIFIC SECTOR(S)	ING-IND/04
HEAD PROFESSOR(S)	MILAZZO ALBERTO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**MILAZZO ALBERTO** Tuesday 12:00 14:00 Ufficio del docente Thursday 12:00 14:00 Ufficio del docente

DOCENTE: Prof. ALBERTO MILAZZO

TEACHING METHODS	Lectures and exercises
ASSESSMENT METHODS	Oral exam with presentation of technical reports on the exercises. The examination is aimed at the verification of adequate knowledge of the methodological and operational aspects taught during the course and the ability to interpret and describe the problems related to the use of traditional and composite materials in aerospace structures, with reference to the aircraft airworthness . The exam consists of an oral test comprising two or three questions to the candidate, developed through a discussion and takes about twenty minutes. The candidate must submit for consideration the written reports of all the exercises carried out during the course and, as a rule, one of the exam questions deal with the deep discussion of the topics developed in the exercises. The marks are out of 30. Sufficiency is achieved if the student demonstrates knowledge and basic understanding of the topics and and he/she is able to present them with appropriate disciplinary lexicon. The assessment, to the honors with distinction, is modulated in relation to the capacity' of the student to demonstrate: • confidence and mastery of the subject • ability to make connections between topics and other disciplines • ability of application to complex problems • articulation of the subject presentation • mastery of technical language
LEARNING OUTCOMES	Knowledge and ability to understand: Knowledge of the behavior of traditional and advanced materials for aerospace structures; knowledge of standard methods of analysis, calculation and design of mechanical fatigue and fracture; ability to identify and understand the issues related to the use of materials on aerospace structures. Ability to apply knowledge and understanding: Ability to apply standard and advanced methods of analysis, calculation and structural design in the framework of fatigue and fracture mechanics problems for aerospace Making judgments: Being able to recognize problems of traditional and advanced materials failure, to identify the cause, to select and apply the analysis and design suitable approaches, thus determining the consequent steps for the problem solution. Communicative skills: Ability to communicate by means of technical reports the results of the analyses carried out and chosen solutions. The student will also have communicative skills for interaction within a team and with specialized technicians. Learning ability: The student will learn the basic principles of fatigue, fracture mechanics and then of the failure of materials (traditional and advanced) for aerospace structures. These principles will allow the study in deep of higher-level topics gained through the ability to access to and understanding of publications (journal papers and books).
EDUCATIONAL OBJECTIVES	The module provides the knowledge and skills that allow the analysis of structural integrity issues related to the use of traditional and advanced materials in aerospace constructions. The theoretical, experimental and numerical tools for the fatigue and fracture mechanics analysis of aerospace structures are provided, focusing on design and maintenance.
PREREQUISITES	Fundamentals of Structural Mechanics and Aerospace Structures
SUGGESTED BIBLIOGRAPHY	- R. M. Jones, “Mechanics of Composite Materials”, Taylor & Francis; 2nd edition , 1998. - T. L. Anderson, “Fracture Mechanics – Fundamentals and Applications”, CRC Press, 2nd edition, 1995 - Appunti e Dispense a cura del docente Ulteriori riferimenti - M.C.Y. Niu, “Composite Airframe Structures”, Hong Kong Conmilit Press Ltd., 1992. - D. Broek, “Elementary engineering fracture mechanics”, Noordhoff International Publishing , 1974.

SYLLABUS

Hrs	Frontal teaching
1	Aerospace materials: hystorical background, classification, aerospace applications, requirements and constraints
3	Fiber-reinforced composites: reinforcement mechanics , fiber and matrix properties, fibers and matrices employed.
2	Constitutive laws: anisotropy, orthotropy and isotropy
3	Micromechanics: physical and mechanical properties of composite materials, advanced models

SYLLABUS

Hrs	Frontal teaching
4	Macromechanics: composite material ply property, dependency on fiber direction, tayloring. Failure criteria.
5	Composite laminates: Classical Laminated Plate Theory; interlaminar stresses, enviromental effects, advanced models for multilayered structures
1	Bonded joints: stress state, delamination.
5	Fatigue: generalities and definitions, load cycle, fatigue failure charachteristics, S-N curves, Goodman and Haigh diagrams. Parameters influencing fatigue life: metallurgy, environment, geometry. Design guidelines. Load history. Cumulative damage laws.
1	Fracture Mechanics: history, objectives, microsciopic classification of fracture, parameters influencing fracture behaviour; examples of failures.
8	Linear Elastic Fracture Mechanics: stresses at crack tip; Griffith energy criterion, energy release rate, crack resistance, stable and unstable crack propagation, stress intensity factor, applications, relation between the stress intensity factor and the energy release rate, residual strength.
3	Elastoplastic Fracture Mechanics: Irwin correction, Dugdale approach, plastic zone shape, plane stress and plain strain, applicapbility of linear elastic fracture mechanics, J-integral, Crack Tip Opening Displacement.
2	Fatigue crack growth: fatigue crack growth, experimental laws for crack growth, residual life, application examples, parameters influencing crack growth , variable amplitude load cycle.
1	Fail-safe design, Non Destructive Inspection
2	Fracture Mechanics of stiffened panels: reduction and amplification of stresses in skin and stiffeners, rivets loads, resistance curves, crack growth rate, residual strength.
1	Background on fatigue and damage of fiber-reinforced composite materials. Background on fracture mechanics application to fiber reinforced composites

Hrs	Practice
3	Micromechanics: pysical and mechanical properties evaluation
2	Fiber-reinforced composite ply properties, dependency on fiber orientation.
4	Failure criteria for composite materials.
6	Composite laminates
3	Exercises and applications on fatigue
8	Exercises and applications on Fracture Mechanics: unstable crack propagation.
3	Exercises and applications on Fracture Mechanics: elastoplastic corrections.
4	Exercises and applications on Fracture Mechanics: crack growth under cyclic loads
3	Numerical applications: commercial codes