UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
MASTER'S DEGREE (MSC)	AEROSPACE ENGINEERING
SUBJECT	AEROSPACE PROPULSION
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50350-Ingegneria aerospaziale ed astronautica
CODE	22205
SCIENTIFIC SECTOR(S)	ING-IND/07
HEAD PROFESSOR(S)	LOMBARDO GIUSEPPE Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	12
INDIVIDUAL STUDY (Hrs)	192
COURSE ACTIVITY (Hrs)	108
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**LOMBARDO GIUSEPPE** Tuesday 9:00 13:00 M010

DOCENTE: Prof. GIUSEPPE LOMBARDO

PREREQUISITES	Knowledge of thermodynamics, aerodynamics and gas dynamics. Specifically: real gases, analysis of thermodynamic cycles, normal and oblique shock waves, Fanno flow, Rayleigh flow, boundary layers, compressible and thermal boundary layers.
LEARNING OUTCOMES	Knowledge and understanding: Knowledge and understanding of the technologies used for the preliminary study and the development of aircraft and spacecraft propulsion systems. Knowledge and understanding of the elements influencing the design and the performance of the engine/motor. Knowledge and understanding of aerospace propulsion problems and solutions and elements for a detailed design of the engine/motor. Knowledge and understanding of the space flight maneuvers and the propulsion systems required for their realization. The student will be able to analyse the engine performance with reference to the physical and chemical phenomena that influence the engine behavior. Capacity to apply knowledge and understanding: Capacity to apply performance prediction methods and analysis of aircraft and spacecraft engines/motors and their components. Capacity to analyze transients, automatic controls, capacity to evaluate noise and pollutant emissions. Making judgments: Ability to assess the real behavior and performance of aircraft and spacecraft engines/motors and their components. The student will have the ability to find best solutions in engine/motor design. Communication: Communication ability by means of technical reports of aircraft or spacecraft engines/motor analysis . The student will have the ability to communicate and interact in a multidisciplinary team with other aircraft or spacecraft specialists. Lifelong learning skills: The knowledge acquired will allow the understanding of scientific publications and may allow the admission to courses at doctoral level or the access to research centers in the aerospace propulsion field.
ASSESSMENT METHODS	Examination of the individual classroom practice assigned during the course drawn up as technical report and oral examination. The oral exam consists of in-depth analysis questions in the areas of the discipline. The examination of the classroom practice presented as technical report and the oral exam will be aimed at assessment of: 1) Acquired knowledge; 2) Processing skills; 3) Exposure capacity. Acquired knowledge: The ability to critically and quantitatively describe the different components of an aircraft engine and a rocket engine/motor will be verified as well as the ability to illustrate and implement the iterative process with which the project of the three types of engines is defined; Processing capacity. Will be verified: 1) The ability to establish connections between the course contents and to grasp the implications of the design choices on the aircraft and the rocket engine/ motor, both intended as complex systems; 2) The degree of mastery of the topics of the course through specific questions formulated in order to stimulate an autonomous critical elaboration by the student, beyond the classroom practices developed during the course. Exposure capacity: the mastery of the technical language necessary to describe the components of an aircraft engine and a rocket engine/motor, their interactions and the processes involved in the design of the three types of engines will be verified. Grade in thirtieths - from 18/30 to 30/30 and possible lode. The formulation of the final grade is based on the outcome of the examination of the individual classroom practice presented and the outcome of the oral exam.. The maximum score will be obtained when the student demonstrates that he has acquired the ability to describe, with accurate and articulated technical language, the different elements of the aircraft engines and rocket engines/ motors, their systems and the interactions between them, using analytical tools developed during the course and demonstrating autonomous and original processing skills in relation to the questions posed during the exam. An intermediate score will be obtained when the student, although mastering subjects and language, shows little capacity for autonomous and original development. The evaluation will be minimal if the student demonstrates sufficient knowledge of the course topics, exhibits them with poorly articulated technical language and demonstrates little autonomous processing capacity in relation to the questions asked.
EDUCATIONAL OBJECTIVES	The student will transfer the principles of thermodynamics and gas dynamics to aerospace propulsion.

	He will recognise the relevance of jet propulsion in the science, commercial and defence sectors. He will learn the solutions and techniques involved in aerospace propulsion, some architecture details, some specific technologies, the forecasting performance methods involved in the design and analysis of aircraft and spacecraft engines and motors. He will have knowledge and skills that will allow him to analyze the design concepts of aircraft and spacecraft engines and motors.
TEACHING METHODS	Lectures, classroom practice
SUGGESTED BIBLIOGRAPHY	Jack L. Kerrebroch, “Aircraft Engines and Gas Turbines”, The MIT Press, Cambridge Massachusetts. ISBN-13: 978-0262534031. ISBN-10: 0262534037. George P. Sutton, Oscar Biblarz, “Rocket Propulsion Elements”, John Wiley & Sons. ISBN: 978-1-118-75365-1. Ronald D. Flack, "Fundamentals of Jet Propulsion with Applications", Cambridge Aerospace Series. ISBN: 9780521154178

SYLLABUS

Hrs	Frontal teaching
1	Course Introduction
1	Aircraft Engines
2	Space Launch Vehicles, Spacecrafts and Missiles Rocket Engines and Motors
2	The Ramjet
1	The Turbojet
1	The Afterburner Turbojet
3	The Turbofan
3	The Afterburner Turbofan
2	The Turboprop
2	Subsonic and Supersonic Inlets
1	Aviation Fuels and Green Fuels
2	Aircraft Engine Combustors and Afterburners
2	Aircraft Engine Nozzles
4	Aircraft Engine Compressors and Fans
3	Aircraft Engine Turbines
2	Aircraft Engine Controls
1	Electric and Hybrid Aircraft Propulsion
1	EASA certifications and regulations on aircraft engines
3	Space missions, space propulsion, requirements from astrodynamics.
3	Rocket Motor and Rocket Engine Fundamentals
3	Rocket Nozzles
6	The Solid Propellant Rocket Motor
2	Solid Propellants, Solid Propellant Combustion
2	Combustion Stability in Solid Propellant Rocket Motors
6	The Liquid Propellant Rocket Engine
2	Liquid Propellant Rocket EngineTurbopumps
2	Liquid Propellants, Liquid Propellant Combustion
2	Combustion Stability in Liquid Propellant Rocket Engines
3	Rocket Motor and Rocket Engine Controls

Hrs	Practice
2	The Ramjet
4	The Turbofan
3	The turbofan with afterburner
2	Subsonic and Supersonic Inlets
4	Compressors and Fans
3	Turbines
8	Solid Propellant Rocket Motors
8	Liquid Propellant Rocket Engines
6	Combustion and Combustion Stability in Solid Propellant Rocket Motors and Liquid Propellant Rocket Engines