AEROSPACE ENGINEERING (LM52)
(Brindisi - Università degli Studi)

Teaching AIRCRAFT POWERPLANT DESIGN AND MAINTENANCE C.I.

GenCod A005802
Owner professor Antonio Ficarella

Teaching in italian AIRCRAFT POWERPLANT DESIGN AND MAINTENANCE C.I.
SSD code ING-IND/09
Reference course AEROSPACE ENGINEERING
Course type Laurea Magistrale
Credits 9.0
Teaching hours Ore-Attivita-frontale: 81.0
For enrolled in 2019/2020
Taught in 2020/2021

Course year 2
Language INGLESE
Curriculum Percorso comune
Location Brindisi
Semester Primo-Semestre
Exam type Orale
Assessment
Course timetable https://easyroom.unisalento.it/Orario

BRIEF COURSE DESCRIPTION

REQUIREMENTS
Course Requirements
Knowledge of the operating principles of fluid machinery and fluid dynamics. Basic elements of design and technology of fluid machines. Knowledge of aircraft propulsion and the basic principles of flight mechanics.
COURSE AIMS

Aims of the course

(knowledge and understanding)
- Specialist knowledge of propulsion, advanced elements of mechanical design of aircraft engines.
- Knowledge of the internal fluid dynamics.
- Insights on design and technological features and performance of different types of engines.
- Insights into automatic controls and system design aimed at providing an integrated view of the aerospace product.
- Knowledge of advanced propulsion systems.
- Knowledge of specific technical terms in English.

(applying knowledge and understanding)
- Understanding of the main features of a project of the engine.
- Ability to perform sketches and preliminary dimensioning of the components of an aircraft engine.
- Ability to take action in the main stages the project of an aircraft engine.
- Advanced capabilities for the analysis of systems and control techniques.
- Ability to see the product in the form of system integrated complex.

(making judgements)
- Ability to analyze the mission requirements of the aircraft and to evaluate the necessary engine performance.
- Ability to understand the technological issues and system integration for the engine.
- Ability to understand the problems of research and development of an aircraft engine or of an aviation system.

(communication skills)
- Ability to communicate with experts in other fields of engineering for the integrated design of the engine.

(learning skills)
- Development of learning skills that enable to continue to study for the most part autonomously.
- Availability update the acquired knowledge.

TEACHING METHODOLOGY

Lectures; practical experiences in laboratories; homework (design project).

Laboratory
Engine performance Lab, Engine Monitoring Lab.
https://sites.google.com/site/greenenginelab2/home

Homework (desig project)
Software applications for the design of aircraft engines and systems. Application examples and design of aircraft engines and systems. Turbofan, turbofans with high bypass ratio, turboprop propeller design. Systems for Civil and military aircraft, helicopters, light aircraft. Fluid-dynamics numerical simulations applied to engines and systems design.
http://www.aircraftenginedesign.com/index.html (free software)
http://www.aircraftenginedesign.com/custom3.html
http://www.grc.nasa.gov/WWW/K-12/freesoftware_page.htm
http://www.cfdsupport.com/openfoam-for-windows.html
**Exam procedures**

The exam consists in the preparation of a Homework (design project) and an oral interview (even remotely carried out).

A design project related to aircraft engines or systems will be conducted. Homework assignments will be due at least one month before the examination. The deliverables are a written report (in digital format, with any files used for calculations and the relevant bibliography) and the discussion of the work. You must acknowledge all references (both literature and people) used; all the deliverables will be sent by email to the instructor at least 10 days before the oral examination. The oral examination consists of the discussion of the work of the year and a series of questions on the matters stated in the course program for the evaluation of acquired knowledge on the principles of operation of engines and aircraft systems, their performance and the principles of design and in general on the technologies of these systems.

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**OTHER USEFUL INFORMATION**

**OTHER REFERENCES**

- *PPSG Volume 1 - Piston Engines & Supercharging*, [http://shop.pilotwarehouse.co.uk/product222023catno0.html](http://shop.pilotwarehouse.co.uk/product222023catno0.html).

**INTERNET RESOURCES**

- [http://www.aircraftenginedesign.com/custom2.html](http://www.aircraftenginedesign.com/custom2.html)
FLUID MECHANICAL DESIGN OF AIRCRAFT ENGINE TURBOMACHINERY

Turbomachinery flow physics
Turbomachinery losses, Efficiencies, Blades
The Design Process.
Aircraft Engine Design, cap. 1.
propDESIGNPRO2
for further study:
Propulsion Technologies for Future Commercial Aircraft
Combustion for aerospace
Constraint Analysis.
Mission Analysis.
Aircraft Engine Design, cap. 2 (no par. 2.2.2, 2.2.3, 2.2.4, 2.2.6, 2.2.7, 2.2.8, 2.2.9, 2.2.10, 2.2.11, 2.2.12).
Aircraft Engine Design, cap. 3 (no par. 3.2.1, 3.2.2, 3.2.3, 3.2.6, 3.2.7, 3.2.8, 3.2.9, 3.2.10, 3.2.11).
propCONSTRAINTRA01
propMISSIONR02
propEXAMPLE-CONSTRAINTR00
for in-depth analysis:
constraintSTRALCIO2
constraintEXAMPLESTRALCIO
missionSTRALCIO
missionEXAMPLESTRALCIO
Aircraft Engine Efficiency and Thrust Measures.
Aircraft Engine Design, app. E.
propMEASURESRO2
Engine Selection: Parametric Cycle Analysis.
Engine Selection: Performance Cycle Analysis.
Sizing the Engine: Installed Performance.
Aircraft Engine Design, cap. 4 (for 4.2.3, 4.2.4, 4.2.7 only concepts, no 4.3.4, 4.4 only concepts).
Aircraft Engine Design, cap. 5 (5.2.4, 5.2.5, 5.4 only concepts).
Aircraft Engine Design, cap. 6 (6.2.2, 6.3, 6.4 only concepts).
propPARAMETRICR03
propPERFORMANCER03
propINSTALLEDR03
propEXAMPLE-PARAMETRICR00
Aircraft Engine Design, cap. 7.
propENGINEDESIGNR03
Aircraft Engine Design, cap. 8.
propROTATINGR08

COMBUSTION

Aircraft Engine Design, cap. 9 (no par. 9.1.4.5, 9.1.5.4, 9.3).
propCOMBUSTIONR05
propCOMBUSTIONEXAMPLER02
THE NEW FRONTIERS FOR THE CONTROL-FICARELLAslidesR31
for in-depth analysis:
propCOMBUSTIONEXAMPLESR02
Some important chemical mechanisms, Pollutant emissions.
Combustion Physics, cap. 3. (no 3.10, 3.11, 3.12)
Droplet evaporation and burning.  
*Combustion Physics*, cap. 13. (no 13.4.3, 13.4.4, 13.8, 13.9)

Introduction to turbulent flow, Turbulent premixed flames, Turbulent non-premixed flames.  
*Combustion Physics*, cap. 11.

DESIGN AND PRODUCTION OF INNOVATIVE TURBOMACHINERY

Material Properties.

SUPERALLOYS FOR TURBINES and MANUFACTURING METHODS.

*Aircraft Engine Design*, app. M.  
*Turbo-Machinery Dynamics*, chap. 11, 12.

Fan and Compressor Airfoils.  
*Turbo-Machinery Dynamics*, chap. 6. (no 6.12, 6.18)  
*Turbo-Machinery Dynamics*, chap. 8.

Additive manufacturing.

INTRANET:

OK01-Whitis  
OK02-Aerospace_Broschuere_WEB_en

Combustion system.  
*Turbo-Machinery Dynamics*, chap. 9.

ENGINE CONTROL

Engine Control Systems.

*Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration*, Chap. 2.  
*Aircraft Engine Design*, app. O.  
*The Jet Engine (Rolls Royce)*, cap. 2.6.

Aircraft Engine Controls.  
- Engine Modeling and Simulation.  
*Aircraft Engine Controls*, chap. 2.

for in-depth analysis:

AIRCRAFT ENGINE CONTROLSch02
AIRCRAFT ENGINE CONTROLS
Design of Set-Point Controllers. Design of Transient and Limit Controllers.
Aircraft Engine Controls, chap. 4, chap. 5.
propAECdesignspcR02
propAECTransientlR01
for in-depth analysis:
AIRCRAFT ENGINE CONTROLSch04
AIRCRAFT ENGINE CONTROLSch05
Advanced Control Concepts.
Aircraft Engine Controls, chap. 7.
propAECadvancedR00

AIRWORTHINESS AND ENGINE HEALTH MANAGEMENT
Turbin Engine Life Management.
Aircraft Engine Design, app. N.
propLIFEMANR01
Engine Monitoring and Health Management, Integrated Control and Health Monitoring.
Aircraft Engine Controls, chap. 8.
propAECmonitoringR01

INTRANET:
OK01-EASN_2018_R06
AIRWORTHINESS AND ENVIRONMENTAL CERTIFICATION
- Aircraft Certification and Production Standards.
- Type Certificates.
- Rules for Initial Airworthiness.
- Certification Specification (CS).
INTRANET:
OK01-General publications _ EASA
OK02-Easy Access Rules for Engines (CS-E) (Amendment 4)
OK03-EASA IM.E.126 EASA TCDS issue 04_20150803_1.0
OK04-EASA E.001_TCDS_issue 09_20150708_1.0
OK05-217487_EASA_EPAS_2018
OK06-documentiR00

ADVANCED PROPULSION CONCEPTS
Aircraft Reciprocating Engines
Hybrid propulsion, electric propulsion, more electrical engine and aircraft.
INTRANET:
OK01-25-TVF2018-Danis-ESAero-Jan191
OK02-3-hybrid-power-in-light-aircraft
OK03-Rodger-Dyson-NASA-Hybrid-Electric-Aircraft-Propulsion-10-4-2017-FULL
OK04-2bfa6572afc09ad13008ca74cefdb0a9b130
OK05-EASN2018ORIZEDOE
COURSE BOOKS


Contact the instructor (antonio.ficarella@unisalento.it) for more lecture notes.