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

Teaching 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

AIRWORTHINESS AND ENVIRONMENTAL CERTIFICATION; The Design Process; Engine Selection: Parametric Cycle Analysis; Engine Selection: Performance Cycle Analysis; Engine Component Design: Rotating Turbomachinery, Concept, Design Tools; Engine Component Design: Combustion Systems, Concept, Main Burner, Afterburners; Aircraft Engine Controls - Engine Modeling and Simulation; Aircraft Systems.

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

ASSESSMENT TYPE

Exam procedures

The exam consists in the preparation of a Homework (desig 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.

OTHER USEFUL INFORMATION

OTHER REFERENCES

An Introduction to Combustion, McGrawHill.

Combustion Physics, Chung K. Law, Publisher: Cambridge University Press; ISBN-10: 0521870526, ISBN-13: 978-0521870528.

Performance of Light Aircraft (Aiaa Education Series), ISBN-10: 1563473305, ISBN-13: 978-1563473302, http://www.amazon.com.

Aerothermodynamics of Aircraft Engine Components, Author W. S. Blazowski, E.E. Zukoski, ISBN 978-1-60086-005-8, Publisher AIAA.

Flight Performance of Fixed and Rotary Wing Aircraft - Elsevier (Butterworth-Heinemann), Antonio Filippone, ISBN: 978-0-7506-6817-0, ISBN10: 0-7506-6817-2, http://textbooks.elsevier.com/web/product_details.aspx?isbn=9780750668170.

Civil Jet Aircraft Design - Lloyd R. Jenkinson, Paul Simpkin, Darren Rhodes, AIAA Education Series, ISBN-10: 1-56347-350-X, ISBN-13: 978-1-56347-350-0, http://www.aiaa.org/content.cfm?pageid=360&id=621.

Elements of Propulsion: Gas Turbines and Rockets, Jack Mattingly, Hans von Ohain, AIAA Education Series, ISBN-10: 1-56347-779-3, ISBN-13: 978-1-56347-779-9, http://www.aiaa.org/content.cfm?pageid=360&id=1343, http://www.amazon.com.

Jeppesen Aircraft Gas Turbine Powerplants, Charles E. Otis, ISBN: 0884873110, http://www.flightstore.co.uk/jeppesen_aircraft_gas_turbine_powerplants.pilot.books/use.id.10.item_id.585/.

Principles of Helicopter Aerodynamics (Cambridge Aerospace Series), J. Gordon Leishman, Cambridge University Press, ISBN-10: 0521858607, ISBN-13: 978-0521858601, http://www.amazon.com.

PPSG Volume 1 - Piston Engines & Supercharging, http://shop.pilotwarehouse.co.uk/product222023catno0.html.

Aircraft Gas Turbine Engine Technology, Irwin E Treager, ISBN-13 9780028018287, McGraw-Hill, http://catalogs.mhhe.com/mhhe/viewProductDetails.do?isbn=0028018281.

Flow and Combustion in Reciprocating Engines, Arcoumanis, C.; Kamimoto, Take (Eds.), SpringerLink, Hardcover, ISBN 978-3-540-64142-1, Softcover, ISBN 978-3-642-08385-3, http://www.springer.com/materials/mechanics/book/978-3-540-64142-1.

INTERNET RESOURCES

http://www.aircraftenginedesign.com/index.html

http://www.aircraftenginedesign.com/custom2.html

FULL SYLLABUS

FLUID MECHANICAL DESIGN OF AIRCRAFT ENGINE TURBOMACHINERY

Turbomachinery flow physics
Turbomachinery losses, Efficiencies, Blades
The Design Process.
Aircraft Engine Design, cap. 1.
propDESIGNPR02
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.
propMEASURESR02
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
Engine Component Design: Global and Interface Quantities. Concept, Design Tools, Engine Systems Design.
Aircraft Engine Design, cap. 7.
propENGINEDESIGNR03
Engine Component Design: Rotating Turbomachinery. Concept, Design Tools.
Aircraft Engine Design, cap. 8.
propROTATINGR08

COMBUSTION

Engine Component Design: Combustion Systems. Concept, Main Burner, Afterburners.
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)

propOXIMECHR00
CFOxidationMechanismOfFuelsB
Droplet evaporation and burning.
Combustion Physics, cap. 13. (no
13.4.3, 13.4.4, 13.8, 13.9)
propCOMBUSTION2PHFLOWR00
CFCombustionInTwoPhaseFlow
Introduction to turbulent flow, Turbulent premixed flames, Turbulent non-premixed flames.
Combustion Physics, cap. 11.
propCOMBUSTIONTURFLOWR00
CFCombustionInTurbulenFlow
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.
propMATERIALR01
propTMDsuperalloysR00
propTMDmanufacturingR00 *for in-depth analysis:*
Turbomachinery_DynamicsCh11, Turbomachinery_DynamicsCh12.
Fan and Compressor Airfoils.
Turbine Blade and Vane.
Turbo-Machinery Dynamics, chap. 6. (no 6.12, 6.18)
Turbo-Machinery Dynamics, chap. 8.
propTMDfecairfoilsR01
propTMDturbinebvR00
propTMDimpellerbdR01
for in-depth analysis:
Turbomachinery_DynamicsCh06
Turbomachinery_DynamicsCh08
Additive manufacturing.
INTRANET:
OK01-Whitis
OK02-Aerospace_Broschuere_WEB_en
Combustion system.
Turbo-Machinery Dynamics, chap. 9.
propTMDcombsysR00
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.
propASEngineControlR00
propCONTROLR00
Aircraft Engine Controls.
- Engine Modeling and Simulation.
Aircraft Engine Controls, chap. 2.
propAECemodelingR03
for in-depth analysis:
AIRCRAFT ENGINE CONTROLSch02

AIRCRAFT ENGINE CONTROLSapp
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

Turbine Engine Life Management.
Aircraft Engine Design, app. N.
propLIFEMANR01
Engine Monitoring and Health Management, Integrated Control and Health Monitoring.
Aircraft Engine Controls, chap. 8.
propAECemonitoringR01
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-EASN2018_DONATEO

REFERENCE TEXT BOOKS

COURSE BOOKS

Aircraft Engine Design, Second Edition - Jack D. Mattingly, William H. Heiser, David T. Pratt, AIAA Education Series, ISBN-10: 1-56347-538-3, ISBN-13: 978-1-56347-538-2, http://www.aiaa.org/content.cfm?pageid=360&id=975, http://www.amazon.com.

Turbo-Machinery Dynamics: Design and Operations, A. S. Rangwala, S. Rangwala a., McGraw-Hill Professional Publishing, ISBN: 0071453695, ISBN-13: 9780071453691.

Aircraft Engine Controls: Design, System Analysis, and Health Monitoring, Link C. Jaw, Jack D. Mattingly, AIAA Education Series, ISBN-10: 1-60086-705-7, ISBN-13: 978-1-60086-705-7, http://www.aiaa.org/content.cfm?pageid=360&id=1759.

Aircraft Fuel Systems, Roy Langton, Chuck Clark, Martin Hewitt, Lonnie Richards, AIAA Education Series, ISBN-10: 1-56347-963-X, ISBN-13: 978-1-56347-963-2, http://www.aiaa.org/content.cfm?pageid=360&id=1741.

Design and Development of Aircraft Systems, 2nd Edition, Ian Moir, Allan Seabridge, ISBN: 978-1-1184-6914-9, E-book, November 2012, Wiley.

Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, 3rd Edition, Ian Moir, Allan Seabridge, ISBN: 978-1-1199-6520-6, E-book, August 2011, Wiley.

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