AEROSPACE ENGINEERING (LM52)

(Brindisi - Università degli Studi)

Teaching AIRCRAFT POWERPLANT DESIGN AND MANTENANCE

GenCod A005140

Owner professor Antonio FICARELLA

Teaching in italian AIRCRAFT POWERPLANT DESIGN AND

Teaching AIRCRAFT POWERPLANT DESIGN AND MANTENANCE

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 2018/2019

Taught in 2019/2020

Course year 2

Language INGLESE

Curriculum PERCORSO COMUNE

Location Brindisi

Semester Primo-Semestre

Exam type Orale

Assessment Voto-Finale

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.
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

TOPIC: AIRWORTHINESS AND ENVIRONMENTAL CERTIFICATION, Aircraft Certification and Production Standards, Type Certificates, Rules for Initial Airworthiness, Certification Specification (CS); COURSE BOOK: ; LECTURE NOTES: .

TOPIC: The Design Process; COURSE BOOK: Aircraft Engine Design, cap. 1.; LECTURE NOTES: propDESIGNPR02.

TOPIC: Constraint Analysis, Mission Analysis; COURSE BOOK: 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); LECTURE NOTES: propCONSTRAINTRA01, propMISSIONR02, propEXAMPLE-CONSTRAINTR00, for in-depth analysis: constraintSTRALCIO2, constraintEXAMPLESTRALCIO, missionSTRALCIO, missionEXAMPLESTRALCIO.

TOPIC: Aircraft Engine Efficiency and Thrust Measures; COURSE BOOK: Aircraft Engine Design, app. E.; LECTURE NOTES: propMEASURESR02.

TOPIC: Engine Selection: Parametric Cycle Analysis, Engine Selection: Performance Cycle Analysis, Sizing the Engine: Installed Performance; COURSE BOOK: 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).; LECTURE NOTES: propPARAMETRICR03, propPERFORMANCER03, propINSTALLEDR03, propEXAMPLE-PARAMETRICR00.

TOPIC: Engine Component Design: Global and Interface Quantities. Concept, Design Tools, Engine Systems Design; COURSE BOOK: Aircraft Engine Design, cap. 7; LECTURE NOTES: propENGINEDESIGNR03.

TOPIC: Engine Component Design: Rotating Turbomachinery. Concept, Design Tools; COURSE BOOK: Aircraft Engine Design, cap. 8; LECTURE NOTES: propROTATINGR08.

TOPIC: Material Properties. SUPERALLOYS FOR TURBINES and MANUFACTURING METHODS; COURSE BOOK: Aircraft Engine Design, app. M, Turbo-Machinery Dynamics, chap. 11, 12; LECTURE NOTES: propMATERIALR01, propTMDsuperalloysR00, propTMDmanufacturingR00, for in-depth analysis: Turbomachinery_DynamicsCh11, Turbomachinery_DynamicsCh12.

TOPIC: Turbine Engine Life Management; COURSE BOOK: Aircraft Engine Design, app. N; LECTURE NOTES: propLIFEMANR01.

TOPIC: Fan and Compressor Airfoils, Turbine Blade and Vane; COURSE BOOK: Turbo-Machinery Dynamics, chap. 6. (no 6.12, 6.18), Turbo-Machinery Dynamics, chap. 8; LECTURE NOTES: propTMDfecairfoilsR01, propTMDturbinebvR00, for in-depth analysis: Turbomachinery_DynamicsCh06, propTMDimpellerbdR01, Turbomachinery_DynamicsCh08.

TOPIC: Engine Component Design: Combustion Systems. Concept, Main Burner, Afterburners; COURSE BOOK: Aircraft Engine Design, cap. 9 (no par. 9.1.4.5, 9.1.5.4, 9.3); LECTURE NOTES: propCOMBUSTIONR05, propCOMBUSTIONEXAMPLER02, THE NEW FRONTIERS FOR THE CONTROL-FICARELLAslidesR31, for in-depth analysis: propCOMBUSTIONEXAMPLESR02.

TOPIC: Combustion system; COURSE BOOK: Turbo-Machinery Dynamics, chap. 9; LECTURE NOTES: propTMDcombsysR00.

TOPIC: Engine Control Systems; COURSE BOOK: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Chap. 2; LECTURE NOTES: propASEngineControlR00.

TOPIC: Engine Controls.; COURSE BOOK: Aircraft Engine Design, app. O; LECTURE NOTES: propCONTROLR00.

TOPIC: Aircraft Engine Controls - Engine Modeling and Simulation; COURSE BOOK: Aircraft Engine Controls, chap. 2; LECTURE NOTES: propAECemodelingR03, for in-depth analysis: AIRCRAFT ENGINE CONTROLSch02, AIRCRAFT ENGINE CONTROLSapp.

TOPIC: Design of Set-Point Controllers. Design of Transient and Limit Controllers; COURSE BOOK: ; LECTURE NOTES: propAECdesignspcR02, propAECtransientlR01, for in-depth analysis: AIRCRAFT ENGINE CONTROLSch04, AIRCRAFT ENGINE CONTROLSch05.

TOPIC: Advanced Control Concepts; COURSE BOOK: Aircraft Engine Controls, chap. 8; LECTURE

NOTES: propAECadvancedR00.
TOPIC: Engine Monitoring and Health Management, Integrated Control and Health Monitoring; COURSE BOOK: Aircraft Engine Controls, chap. 9; LECTURE NOTES: propAECemonitoringR01.
TOPIC: Aircraft Fuel Systems, Fuel System Deign Drivers, Fuel System Functions of Commercial Aircraft; COURSE BOOK: AIRCRAFT FUEL SYSTEMS cap. 2 - 3 (no 3.5) - 4.; LECTURE NOTES: propAFuelSfueldesignR00, propAFuelSfuelstorageR01, propAFuelSfuelfunctionsR01, AFUELSYSTEMSch020304.
TOPIC: Hydraulic Systems, Electrical Systems, Pneumatic Systems, Environmental Control Systems; COURSE BOOK: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Chap. 4, 5, 6, 7; LECTURE NOTES: propAShydraulicR00, propASpneumaticR01, propASenvironmentalR00, propASelectricalR00.
TOPIC: Advanced Systems; COURSE BOOK: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Chap. 10; LECTURE NOTES: propASadvancedR00.
TOPIC: System Design and Development; COURSE BOOK: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Chap. 11; LECTURE NOTES: propASdesignR00.

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.