AEROSPACE ENGINEERING (LM52)

(Brindisi - Università degli Studi)

Teaching

GenCod A006483

Owner professor Antonio FICARELLA

Teaching in italian AIRCRAFT POWERPLANT NEW CONCEPTS,

Teaching

SSD code ING-IND/09

Reference course AEROSPACE ENGINEERING

Course type Laurea Magistrale

Credits 9.0

Teaching hours Front activity hours: 81.0

For enrolled in 2022/2023

Taught in 2023/2024

Course year 2

Language

Curriculum CURRICULUM AEROSPACE DESIGN

Location Brindisi

Semester

Exam type

Assessment

Course timetable
https://easyroom.unisalento.it/Orario

BRIEF COURSE DESCRIPTION

ADVANCED PROPULSION CONCEPTS, FLUID MECHANICAL DESIGN OF AIRCRAFT ENGINE TURBOMACHINERY, DESIGN AND PRODUCTION OF INNOVATIVE TURBOMACHINERY, AIRWORTHINESS AND ENGINE HEALTH MANAGEMENT, ENGINE CONTROL, COMBUSTION.

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). Software applications for the design of aircraft engines and systems, using software as Python, TESPY, Colaboratory, OPENMODELICA, Octave, OpenFoam.

Laboratory

Engine performance Lab, Engine Monitoring Lab.

https://sites.google.com/site/greenenginelab2/home

Homework (desig project)

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

TEACHING MATERIAL IS AVAILABLE ON THE E-LEARNING PAGE
https://elearning.unisalento.it/?redirect=0

PYTHON
https://www.python.org/
COLAB
https://colab.research.google.com/#
ANACONDA
https://www.anaconda.com/products/distribution
JUPITER
https://jupyter.org/

OCTAVE
https://octave.org/

OPENFOAM
http://www.cfdsupport.com/openfoam-for-windows.html

SCILAB
https://www.scilab.org/
https://cloud.scilab.in/
https://atoms.scilab.org/
https://atoms.scilab.org/toolboxes/XCPL/0.1.1
https://atoms.scilab.org/toolboxes/coselica/0.6.6
XCOS
https://www.scilab.org/software/xcos
https://xcos.fossee.in/
https://xcos.fossee.in/example

OPENMODELICA
https://www.openmodelica.org/
https://om.fossee.in/
https://modelica.org/libraries.html
https://modelon.com/products/modelon-library-suite-modelica-libraries/

DESIGN
https://tespy.readthedocs.io/en/main/
https://github.com/tvlady/TED
https://www.linkedin.com/pulse/preliminary-design-f110-3-stage-fan-using-custom-python-ted-vlady
https://github.com/NAnand-TUD/parablade
https://dafoam.github.io/index.html
https://dafoam.github.io/mydoc_tutorials_aero_rotor37.html
https://python.hotexamples.com/it/examples/engine_turbofan/Propulsion/-/python-propulsion-class-examples.html
https://github.com/alopezrivera/huracan
https://dergipark.org.tr/en/pub/ijeat/issue/66272/1029803
https://www.alexkenan.com/pymae/more/
https://www.kaggle.com/code/vinayak123tyagi/damage-propagation-modeling-for-aircraft-engine/notebook
https://github.com/junzis/openap

https://github.com/AeroPython/PyFME
https://aedsys.software.informer.com/1.2/
https://www.fzt.haw-hamburg.de/pers/Scholz/PreSTo.html
https://github.com/fsandre/mcflight
https://github.com/zeta-plusplus/AircraftDynamics
https://github.com/modelica-3rdparty/PropulsionSystem
https://modelon.com/library/jet-propulsion-library/
https://github.com/juri117/hybrid-propulsion-simulation
http://www.aircraftdesign.ca/software/pyacdt/pyacdt.html
https://github.com/modelica-3rdparty/PropulsionSystem
https://pypi.org/project/propeller-design-tools/

COMBUSTION
https://cantera.org/examples/python/index.html

NASA
http://www.grc.nasa.gov/WWW/K-12/freesoftware_page.htm
https://www.grc.nasa.gov/www/k-12/Enginesim/index.htm
https://www.kaggle.com/datasets/behrad3d/nasa-cmaps
https://www.kaggle.com/code/sanchitapaul/nasa-turbofan-degradation-model

CAD 3D
https://grabcad.com/library
https://sketchfab.com/3d-models/airbus-a320-airplane-enigne-turbofan-eaef1f155d7c4d0984063a8360c432cd
https://www.caeses.com/

OTHER REFERENCES

An Introduction to Combustion, McGrawHill.
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.
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.
Fluid Mechanics and Thermodynamics of Turbomachinery, S. L. Dixon, Elsevier.
Jet Engine and Propulsion Systems for Engineers *(GE Aircraft Engine).*

INTERNET RESOURCES
http://www.grc.nasa.gov/WWW/K-12/airplane/bgp.html

FULL SYLLABUS

ADVANCED PROPULSION CONCEPTS
Hybrid propulsion, electric propulsion, more electrical engine and aircraft.
FLUID MECHANICAL DESIGN OF AIRCRAFT ENGINE TURBOMACHINERY
The Design Process.
Constraint Analysis.
Mission Analysis.
Aircraft Engine Efficiency and Thrust Measures.
Engine Selection: Parametric Cycle Analysis.
Engine Selection: Performance Cycle Analysis.
Sizing the Engine: Installed Performance.
Engine Component Design: Global and Interface Quantities. Concept, Design Tools, Engine Systems Design.
Engine Component Design: Rotating Turbomachinery. Concept, Design Tools.
DESIGN AND PRODUCTION OF INNOVATIVE TURBOMACHINERY
Material Properties.
SUPERALLOYS FOR TURBINES and MANUFACTURING METHODS.
Additive manufacturing.
AIRWORTHINESS AND ENGINE HEALTH MANAGEMENT
Turbine Engine Life Management.
Engine Monitoring and Health Management, Integrated Control and Health Monitoring.
AIRWORTHINESS AND ENVIRONMENTAL CERTIFICATION
- Aircraft Certification and Production Standards.
- Type Certificates.
- Rules for Initial Airworthiness.
- Certification Specification (CS).
ENGINE CONTROL
Engine Control Systems.
Aircraft Engine Controls.
- Engine Modeling and Simulation.
Design of Set-Point Controllers. Design of Transient and Limit Controllers.
Advanced Control Concepts.
COMBUSTION
Engine Component Design: Combustion Systems. Concept, Main Burner, Afterburners.

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.