Propulsion systems performance and design

Academic Year: (2024 / 2025) **Review date: 26-04-2024**

Department assigned to the subject: Aerospace Engineering Department

Coordinating teacher: DISCETTI , STEFANO

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Students are expected to have basic knowledge of aerospace propulsion systems and turbomachinery.

OBJECTIVES

The main objective of the course is to develop the ability to design and calculate the performance of air-breathing engines and their components. The students are expected to be able to:
- Understand the processes of heat and mass transfer applied to the aerospace propulsion systems
- Analyze the performances of the aerospace propulsion systems.
- Select and design the most suitable powerplant for an aerospace vehicle according to its mission, including the design of the subsystems composing the engine.
- Test the correct operation of the turbomachinery as part of an aerospace propulsion system.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Review of requirements of engine components

2. The engine design process
   a. The request for proposal
   b. Constraint analysis and mission analysis
   c. Parametric cycle analysis
      i. Turbojet
      ii. Turbojet with afterburner
      iii. Turbofan with mixed/unmixed stream
   d. Performance cycle analysis
      i. Off-design behavior
      ii. Component matching
      iii. Installed performances
   e. Ramjets and scramjets

3. Sensors, instrumentation and control
   a. Control systems requirements and strategy
   b. Basic engine control functions

4. Lubrication and cooling
   a. Oil systems: lube supply, tank, piping, scavenge system.
   b. Secondary Air System
   c. Turbine heat transfer, film cooling, internal cooling (jet impingement, rib-turbulated, pin-fin).

5. Bearing and seals
   a. Mainshaft bearing types;
   b. Fatigue life considerations;
   c. Dynamic seals types (labyrinth seals, carbon seals)

6. Structural analysis

a. Fundamentals of rotordynamics
b. Balancing procedures and vibrations suppression.
c. Elements of turbomachinery flutter.

7. Engine testing and certification

LEARNING ACTIVITIES AND METHODOLOGY

LEARNING ACTIVITIES
AF1 - Theoretical session
AF2 - Practical session
AF3 - Computer room practical session
AF4 - Laboratory sessions
AF5 - Individual student work
AF6 - Tutorials
AF7 - Partial and final exams

TEACHING METHODOLOGY
MD1 - Class lectures by the professor with the support of computer and audiovisual media, in which the main concepts of the subject are developed and the bibliography is provided to complement the student's learning.
MD3 - Resolution of practical cases, problems, etc. posed by the teacher individually or in groups.
MD5 - Preparation of reports individually or in groups.

ASSESSMENT SYSTEM

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

The following requirements have to be met in order to pass the subject:
1) to have a MINIMUM mark of 4.0/10 in the end-of-term exam;
2) to have a minimum overall mark of 5.0/10 (weighing 60% the end-of-term exam mark and 40% the mark of the continuous evaluation).
The continuous evaluation includes assignments and reports of laboratory practices (40% of the final mark).

Note that in the extraordinary call it is possible to pass the course either by completing the previous points or by obtaining a MINIMUM grade of 5.0/10 (valuing the final exam 100%)

BASIC BIBLIOGRAPHY

- Mattingly J.D., Heiser W.H., Pratt D.T. Aircraft Engine Design, AIAA EDUCATION SERIES J. S. Przemieniecki Series Editor-in-Chief, 2003

ADDITIONAL BIBLIOGRAPHY

- Boyce M.P. Gas Turbine Engineering Handbook, Butterworth-Heinemann, 2011

- Kerrebrock J.L. Aircraft Engines and Gas Turbines, The MIT Press, 1992

- Oates G.C. Aerothermodynamics of Aircraft Engine Components , AIAA, 1985

- Walsh P.P., Fletcher P. Gas Turbine Performance, Blackwell Science Inc, 2004

- null The Jet Engine, Rolls Royce Technical Publications, 1996