Propulsion systems performance and design

Academic Year: (2020 / 2021) **Review date: 02-11-2020**

Department assigned to the subject: Bioengineering and Aeroespace 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 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 appropriate propulsion system for an aerospace vehicle according to the prescribed mission, including the design of the subsystems composing the engine.
- Analyze the performances of turbomachines as part of aerospace propulsion systems.

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. Turbine heat transfer, film cooling, internal cooling (jet impingement, rib-turbulated, pin-fin); effects of rotation.

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

Theory and problems sessions
Problem session in computer room
Laboratory session
Study and personal work of the students

TEACHING METHODOLOGY

Frontal lectures with support of computer and audiovisual media, in which the main concepts of the subject are developed and the bibliography references are provided.

Critical reading recommended by the subject teacher: newspaper articles, reports, manuals and/or academic articles, either for further discussion in class, either to expand and consolidate the knowledge of the subject.

Resolution of practical cases, problems, etc. proposed by the teacher individually or in groups

Preparation of reports individually or in groups

ASSESSMENT SYSTEM

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%)

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

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