AEROSPACE ENGINEERING (LM52)

(Brindisi - Università degli Studi)

Insegnamento SPACE PROPULSION MOD. 2

GenCod A003310

Docente titolare Maria Grazia DE GIORGI

Insegnamento SPACE PROPULSION MOD. 2

Insegnamento in inglese SPACE PROPULSION MOD. 2

Settore disciplinare ING-IND/07

Corso di studi di riferimento AEROSPACE ENGINEERING

Tipo corso di studi Laurea Magistrale

Crediti 6.0

Ripartizione oraria Ore Attività frontale: 54.0

Per immatricolati nel 2024/2025

Erogato nel 2024/2025

Anno di corso 1

Lingua

Percorso AERONAUTICS DESIGN

Sede Brindisi

Periodo Secondo Semestre

Tipo esame

Valutazione

Orario dell'insegnamento https://easyroom.unisalento.it/Orario

BREVE DESCRIZIONE DEL CORSO

This course provides an in-depth overview of rocket propulsion systems, exploring fundamental principles, advanced technologies, and practical applications in aerospace engineering. Through a series of modules, the course covers a wide range of topics including rocket nozzles, combustion thermochemistry, solid and liquid rocket motors, trajectory analysis and staging, as well as electric propulsion and hybrid rockets.
The program aims to equip students with both a solid theoretical understanding and practical skills through example problems, case study analyses, and simulation projects. Students will be prepared to tackle technical challenges in the design, development, and optimization of rocket propulsion systems, making them ready for careers in the aerospace industry and research.

PREREQUISITI

-Fluid dynamic and fluid machinery

OBIETTIVI FORMATIVI

1 Gain knowledge of different types of aero-engines (turbojets, turbofans, ramjets) and to understand the aerodynamic and thermodynamic characteristics of major rocket components.
2 Develop the knowledge and skills to analytically and numerically solve problems related to aerospace propulsion systems.
3 Develop skills in working independently.
4 Develop skills in critical evaluation of scientific literature.
5 Develop skills in planning and presentation of scientific talks and reports.

METODI DIDATTICI

Theory and practical activities

MODALITA' D'ESAME

The final exam consist of two part:
1)Written and oral examination covering all material covered in course
2)assignments and individual project

ALTRE INFORMAZIONI UTILI

Educational materials, resources, and additional information are available on the official course webpage at https://elearning.unisalento.it/

PROGRAMMA ESTESO

- **Rocket Nozzles and Thrust Performance**: This section delves into the design principles of rocket nozzles and their impact on engine performance. It covers topics such as nozzle shape optimization, thrust vectoring, and the effect of ambient pressure on exit flow. The module also explores convective heat transfer within the nozzle, addressing thermal protection strategies and material selection to withstand extreme heat loads.
- **Combustion and Thermochemistry**: This module reviews fundamental concepts of thermodynamics and the perfect gas law, essential for understanding combustion processes in rocket engines. It includes detailed discussions on equilibrium and non-equilibrium thermochemistry, methods for calculating adiabatic flame temperatures, and the specific challenges posed by rocket nozzle thermochemistry, such as chemical dissociation and recombination in high-temperature flows.
- **Solid Rocket Motors**: Focuses on the design and operation of solid rocket motors. It includes a general description of their components and operation, discussions on interior ballistics (the study of the combustion process and pressure generation inside the motor), and design considerations that address performance, safety, and manufacturability. The module also covers the typical constraints faced in designing these motors, such as weight, cost, and reliability.
- **Liquid Rocket Motors**: Provides a comprehensive overview of liquid rocket engines, including their general architecture and operational principles. Topics include different engine cycles (gas-generator, staged-combustion, expander cycle), power balance calculations, and the fundamental design of engine components. Special emphasis is placed on the combustion of liquid propellants, challenges in fuel and oxidizer injection and mixing, stability issues, pressurization, pump cycles, and the performance of turbomachinery.
- **Trajectory Analysis and Staging**: Examines how rockets are designed to achieve specific missions through trajectory analysis and staging techniques. This includes the application of the rocket equation, analysis of vertical and oblique trajectories, and the design considerations for multistage rockets to optimize payload delivery and minimize launch costs.
- **Electric Propulsion**: Discusses the various types of electric propulsion systems, such as ion thrusters, Hall effect thrusters, and electrothermal engines. The module provides a general description and classification, followed by an analysis of performance metrics like specific impulse and thrust efficiency. It also explores the applications, advantages, and limitations of electric propulsion in space missions.
- **Hybrid Rockets**: Covers hybrid rocket technology, which utilizes solid fuel and a liquid or gaseous oxidizer. The module discusses the classification of hybrid rockets, design challenges such as ignition, fuel regression rate control, and advantages over purely solid or liquid systems, such as throttling capabilities and safety improvements.

TESTI DI RIFERIMENTO

- Aerothermodynamics of Gas Turbine and Rocket Propulsion Gordon C. Oates eISBN: 978-1-60086-134-5 print ISBN: 978-1-56347-241-1 DOI: 10.2514/4.861345
- Hill, P., and Peterson, C., Mechanics and Thermodynamics of Propulsion, Addison-Wesley Publishing Co., 1992,
- George P. Sutton, Oscar Biblarz, Rocket Propulsion Elements, 7th Edition John-Wiley & Sons, Ltd., ISBN: 0-471-32642-9
- Course note