



UNIVERSITÀ DI PISA

ROCKET PROPULSION

LUCA D'AGOSTINO

Anno accademico

2016/17

CdS

AEROSPACE ENGINEERING

Codice

665II

CFU

12

Moduli	Settore/i	Tipo	Ore	Docente/i
ROCKET PROPULSION	ING-IND/07	LEZIONI	120	LUCA D'AGOSTINO

Learning outcomes

Knowledge

Students are expected to: – acquire a sound knowledge of the concepts, fundamentals and models of space propulsion necessary to understand conceive, analyze and assess the operation of chemical propellant rocket engines and their components and subsystems; -acquire familiarity with the formulation of suitable "ad hoc" models for the analysis of chemical propellant rocket propulsion systems at the expected level of approximation and accuracy required by the specific application; - develop the understanding, capability and critical assessment necessary for integrating the multidisciplinary aspects of chemical rocket propulsion problems into an effective and practical solution for the conception, analysis, design, integration and use of modern chemical rocket engine systems and subsystems.

Assessment criteria of knowledge

The final exam aims at evaluating the student preparation on the topics covered by the lectures with specific reference to the following aspects: - knowledge acquisition; - critical understanding; - capability of using in a creative and constructive way the information from the course lectures to develop original solutions to an engineering problem. The student will be assessed on his/her demonstrated ability to: - illustrate the derivation from first principles of his/her solution to the given problem(s) by the introduction of the relevant simplifications and/or approximation; - justify the introduction of the simplifications and/or approximations used in the derivation; - assess and discuss the expected level of accuracy and limits of application of the proposed solution. The student must be able to illustrate the reading matter thoughtfully, clearly, synthetically, ~~Methodically~~ and with propriety of expression.

- Final oral exam
- Final written exam

Further information:

The final exam consist in an interview where the student will typically be required to: – develop in writing of the solution to an original problem addressable by using in a creative and constructive way the information from the course lectures; - illustrate orally or answer questions on one or more topics of the course. Both aspects will be weighted equally (50%).

Teaching methods

Delivery: face to face

Learning activities:

- attending lectures
- participation in seminar
- individual study
- Bibliography search

Attendance: Advised

Teaching methods:

- Lectures
- Seminar

Syllabus

Rocket propulsion fundamentals, systems, technologies. Mission trajectories and propulsive requirements. Chemical rocket performance and parameters. Nozzles, configurations, limitations and optimization. Solid propellant rockets, grain combustion and design, transients, instabilities, two-phase effects, thermal protections. Liquid propellant rockets, propellant management, injection, combustion, non-equilibrium effects, chamber sizing, instabilities, cooling. Hybrid rockets, grain combustion and design, instabilities. Turbomachinery, architectures, performance, stresses and materials, parameters and similarity. Axial machines: bladings, losses, instabilities, reaction and impulse turbines, cooling. Radial machines: bladings, slip velocity. Turbopumps, inducers, compressors, gas and hydraulic turbines. Rotordynamics, critical speeds, damping, nonlinear oscillations. Cavitating turbopumps, similarity parameters, suction performance, thermal cavitation, instabilities, rotordynamic forces.



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Bibliography

Required reading: Course notes and homeworks from the instructor Recommended reading: • Sutton G. P., 1992, "Rocket Propulsion Elements", John Wiley & Sons • Humble R.W., Henry G.N. and Larson W.J., 1995, "Space Propulsion Analysis and Design", McGraw Hill College Custom Series • Huzel D. K. and Huang D. H., 1992, "Modern Engineering for Design of Liquid-Propellant Rocket Engines", AIAA • Yang V., Habiballah M., Hulka J. and Popp M., editors, 2004, "Liquid Rocket Thrust Chambers: Aspects of Modeling, Analysis and Design", AIAA, Vol. 200 • Yang V. Brill T.B., Wu-Zhen Ren editors, 2000, "Solid Propellant Chemistry, Combustion and Motor Interior Ballistics", AIAA, Progress in Aeronautics and Astronautics, Vol. 185 • Kuo K. K. and Summerfield M., editors, 1984, "Fundamentals of Solid-Propellant Combustion", AIAA, Vol. 90 • Chiaverini M. J. and Kuo K. editors, 2007, "Fundamentals of Hybrid Rocket Combustion and Propulsion", AIAA, Progress in Aeronautics and Astronautics, Vol. 218 • Yang V. & Anderson W., editors, 1995, "Liquid Rocket Engine Combustion Instability",

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