ORT Braude College
Department of Mechanical Engineering

22840 – Rocket Propulsion

Lecturer: Dr. Avishag D. Pelosi
Credits: 2.5 points
Course Hours: 2 lecture, 1 tutorial
Prerequisites: 22600 Thermodynamics, 22610 Fluid Mechanics

Grade Composition:
70% – written final exam (a grade of 55 is required for passing the course);
30% – project (submitted in pairs or solo).
An organized visit outside campus (during lecture's hours) is part of the course and attendance is mandatory.

Consultation hours: Wednesday 11:30 – 13:30, Room D2-1.

Course Description:
Rocket motors are used in a wide range of applications, from small projectiles and tactical missiles to huge boosters enabling space exploration.
The course explores the main features of rocket motors, integrating the many scientific disciplines involved in chemical propulsion.
Students will acquire the knowledge needed for the preliminary design of an actual rocket motor (motor specifications and performance, trajectory prediction, choice of propellant, combustion chamber characteristics and nozzle geometry design), according to mission requirements and goals.
A basic knowledge of Matlab programming is required, in order for the student to achieve the simulation of a rocket flight, as part of the course's tasks.
The course will include the visit of a rocket propulsion lab and the witnessing of a hybrid rocket motor firing test (**participation is mandatory**).

Course Main Topics:

1 Introduction
Historical and conceptual review of rocket propulsion,
Classification of propulsion vehicles
Definition of the parameters needed to evaluate rocket motor performance
Conservation equations and thrust equation.

2 The equation of motion and the prediction of the rocket's trajectory
Design principles of single- and multiple-staged rockets,
Assignment: computer simulation of a rocket flight.

3 Theory of nozzles
Basic review of compressible fluid flows,
Nozzle geometry design,
Shock waves and Summerfield criterion.

4 Thermochemistry and combustion principles
A review of basic chemistry applied to combustion,
Properties of solid and liquid propellants and their energetic performance,
Adiabatic flame temperature.

5 Design characteristics and internal ballistics of solid and liquid propellant motors.
Advantages and drawbacks of solid, liquid and hybrid propellant motors,
Applications and design characteristics of solid and liquid propellant motors,
Internal ballistics of solid propellant motors: propellant geometry, burning rate characteristics,
Liquid motors: combustion chamber and injection requirements, characteristic design parameters.

Bibliography:

1. Sutton, G. P. and Biblarz, O., "Rocket Propulsion Elements", 7th edition, Wiley, New York, 2001.
2. Hill, P. G. and Peterson, C. R., "Mechanics and Thermodynamics of Propulsion", 2nd edition, Addison - Wesley, New York, 1992.
3. Timnat, Y. M., "Advanced Chemical Rocket Propulsion", Academic Press, London, 1987.

Learning Outcome:

The course – Rocket Propulsion – presents basic theoretical and practical knowledge about the main characteristics of a rocket motor, enabling the student to

	Learning Objective
1	Understand the operating features of solid and liquid propellant rocket motors
2	Evaluate the performance of a rocket motor
3	Choose the type of motor and propellant according to the mission requirements
4	Calculate the trajectory of a rocket
5	Design single stage and multiple-stage rockets
6	Understand and predict the flow characteristics in the nozzle
7	Design the geometry of the nozzle according to the mission requirements
8	Understand the combustion process of the propellant
9	Describe the characteristics of solid and liquid propellant rocket motors
10	Design the geometry of the solid propellant grain according to mission requirements
11	Understand the process of injection of liquid propellants

Last update: October 2019.