

## Aerospace Propulsion II

Academic Year: ( 2022 / 2023 )

Review date: 01-06-2022

Department assigned to the subject: Aerospace Engineering Department

Coordinating teacher: RAIOLA , MARCO

Type: Electives ECTS Credits : 3.0

Year : 4 Semester :

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Fluid Mechanics I  
 Fluid Mechanics II  
 Thermal Engineering  
 Introduction to structural analysis  
 Aerospace Propulsion I

We strongly advise you not to take this course if you have not passed Fluid Mechanics II and Thermal Engineering

## OBJECTIVES

Adequate knowledge, with application to the engineering of: the methods of calculation and development of facilities of the propulsive systems; the regulation and control of propulsive systems installations; the handling of experimental techniques, equipment and measuring instruments of the discipline; the fuels and lubricants used in aviation and automotive engines; the numerical simulation of the most significant physical-mathematical processes; the maintenance and certification systems of aerospace engines.

Applied knowledge of: internal aerodynamics; propulsion theory; performances of airplanes and jet aircrafts; propulsion system engineering; Mechanics and thermodynamics.

Upon completion of the subject of Aerospace Propulsion II, the student will be able to explain the methods of calculation, design and certification of reciprocating propulsion systems and the development of propulsion system installations. In addition, he/she will be able to apply this knowledge in solving design problems in the field of aerospace engineering.

## DESCRIPTION OF CONTENTS: PROGRAMME

Introduction to reciprocating engines.  
 Basics. Pros and cons. Classification. Geometric parameters. Indicated parameters.  
 Thermodynamic cycles.  
 Ideal Otto and Diesel cycle. Efficiencies. Actual cycles.

Breathing exercises  
 The flow through a valve. Mach index and volumetric efficiency. Partial throttle

Breathing exercises II  
 Combustion chamber, valve, manifolds

Turbochargers and intercoolers  
 Supercharging. Intercoolers. Classification. Physical modeling of turbochargers.

Engine cooling  
 Types of cooling systems (air cooling vs. water cooling). Types of heat transfer. Heat transfer in an engine: correlations. Heat transfer in the coolant.

Engine friction and Lubrication  
Engine friction, lubrication, efficiency and losses

Flow in the cylinder:  
Phases of flow, turbulence, swirl and tumble, compression

Combustion and fuels:  
Spark ignition engines. Normal combustion in spark ignition engines. Parameter influence in normal combustion.  
Model of normal combustion. Abnormal combustion.

Combustion and fuels II:  
Compression ignition engines. Analysis of the combustion process. Delay time reduction. Fuel quality. Combustion process model. Types of compression ignition engines.

Overall engine Performance:  
Carburation and injection. Transient response.

Design Considerations:  
Introduction to Kinematics in reciprocating engines. Crank handle connecting rod system kinematics. Introduction to dynamics in reciprocating engines. Torque calculation. Mechanical loads in the engine.

#### LEARNING ACTIVITIES AND METHODOLOGY

Theory sessions.  
Problem sessions working individually and in groups.  
Computer sessions.

#### ASSESSMENT SYSTEM

<b>% end-of-term-examination:</b>	60
<b>% of continuous assessment (assignments, laboratory, practicals...):</b>	40

In order to pass the subject, two requirements need to be met:

- 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 1 partial exams (corresponding to 20% of the final mark) and 2 homeworks (each one corresponding to 10% of the final mark).

#### BASIC BIBLIOGRAPHY

- C.F. Taylor The internal combustion engine in theory and practice, MIT Press, 1985
- D.R. Greatrix Powered Flight, The engineering of Aerospace Propulsion, Springer, 2012
- John L. Lumley Engines: An Introduction, Cambridge University Press, 1999