Mechanics of Flight I

Academic Year: (2021 / 2022) **Review date: 27-06-2021**

Department assigned to the subject: Bioengineering and Aeroespace Engineering Department

Coordinating teacher: SANCHEZ ARRIAGA, GONZALO

Type: Compulsory ECTS Credits : 3.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Mechanics applied to Aerospace Engineering
Aerodynamics I
Aerospace Propulsion I

OBJECTIVES

Flight Mechanics I introduces students to aircraft performance. It includes the general equation of motion of aircraft and the analysis of the flight in cruise conditions, climbing and descent maneuvers in the vertical plane, coordinated turn, takeoff and landing. The course also discusses some basic concepts on stability and control like the neutral point. It makes emphasis on the mathematical models and analysis techniques of this engineering branch, simulation of the aircraft motion, and evaluation of flying qualities, with brief discussion on regulations, guidance, navigation, and control.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to Mechanics of Flight
   1.1. Subject of Mechanics of Flight
   1.2. Elements of the Aircraft
   1.3. Aircraft Reference Geometry
   1.4. Reference Frames
      1.4.1. Basic Reference Frames
      1.4.2. Transformations
   1.5. Summary of vocabulary

2. Equations of Motion
   2.1. Kinematics
   2.2. Dynamics
   2.3. External forces
      2.3.1. Aerodynamic Terms
      2.3.2. Propulsive Terms
   2.4. Examples

3. Performances
   3.1. Cruise condition.
      3.1.1 Required thrust and power
      3.1.2 Range and endurance. Control laws.
      3.1.3 Flight Envelope
      3.1.4 The Neutral Point
   3.2. Flight in Vertical Plane
      3.2.1 General Equations
      3.2.2 Quasi-static approximation
      3.2.3 Optimal maneuvers and control laws
      3.2.3 Gliding performance
      3.2.4 Range
   3.3. Turning Flight
      3.3.1 General Equations
      3.3.2 Coordinated turn. Instrumentation.
      3.3.3 Turning performances and control laws.
      3.3.4 Flight Envelope
   3.4. Takeoff and Landing
      3.4.1 Basic definitions and legal framework

3.4.2 Takeoff Phases and modeling
3.4.3 Balanced Field Length
3.4.4 Landing Phases and modeling
3.5. Advanced Performanc Determination
3.5.1 Ground Effects
3.5.2 Performances and Flight Envelope at high speeds
3.5.3 Energy Methods

LEARNING ACTIVITIES AND METHODOLOGY

Theoretical sessions.
Exercise sessions working individually and in groups.
Laboratory sessions with simulation software.

ASSESSMENT SYSTEM

Final exam (60%)
Practical problems with evaluation of reports (40%)
Required minimum mark on final exam: 4/10

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

BASIC BIBLIOGRAPHY

- Bernard Etkin and Lloyd D. Reid. Dynamics of Flight. , Wiley., 1996

- M. A. Gomez Tierno, M. Pérez Cortés y C. Puentes. . Mecánica de Vuelo., Instituto Universitario de Microgravedad "Ignacio Da Riva", 2009
- Mario Asselin An Introduction to Aircraft Performance., AIAA Educational Series, 1997

ADDITIONAL BIBLIOGRAPHY

- Alfred Cotterill Kermode Mechanics of Flight, Longman, 1996

- Bandu N. Pamadi Performance, Stability, Dynamics and Control of Airplanes, American Institute of Aeronautics and Astronautics, Inc., 2004
- Bernard Etkin Dynamics of Atmosopheric Flight, Dover Publications, 2005

- Francis J. Hale Introduction to Aircraft Performance, Selection and Design, Wiley, 1984

- Holt Ashley Engineering Analysis of Flight Vehicles, Courier Dover Publications, 1992

- M. V. Cook Flight Dynamics Principles., Elsevier. , 2007

- Robert C. Nelson Flight Stability and Automatic Control, WCB/McGraw Hill, 1998

- Shiva Kumar Ojha Flight Performance of Aircraft, American Institute of Aeronautics and Astronautics, 1995