Aerospace Vehicle Performance

Code	Credit Hours
AE-335	3-0

Prerequisites

Fundamentals of Compressible Aerodynamics

Course Description

The course introduces basic aircraft performance characteristics. It begins with a review of the physics of lift and drag generation followed by a comprehensive study of drag. The course later covers steady state analysis of performance parameters such as endurance, aircraft ceiling, range, climb, descent and glide. Accelerated performance parameters are then evaluated using energy state approximation and results are compared with exact solutions. The last part of the course deals with instantaneous and sustained turning performance. For a Complex Engineering Problem, the students are required to evaluate the performance of an aircraft and analyses trends under various conditions.

Text Books:

1. "Performance, Stability, Dynamic and control of Airplanes" by Bandu N Pamadi, AIAA Series, Latest Available Edition
2. "Aircraft Performance and Design" by John D Anderson, McGraw Hill Education, NY, Latest Available Edition
3. Basic Aerodynamics by Aviation Maintenance Technician Certification Series, Latest Available Edition
4. Gas Turbine Engine by Aviation Maintenance Technician Certification Series, Latest Available Edition

Reference Material:

1. "Aircraft Design: A conceptual Approach" by Daniel P Raymer, AIAA , 5th Edition,2014.
2. "Aircraft Performance: An Engineering Approach" by Mohammah H. Sadraey, CRC Press, 1st Edition, 2017.

ASSESSMENT SYSTEM:

Quizzes	10%
Assignments	10%
Mid Terms	30%
ESE	50%

Teaching Plan

Lec No	Description	Ref
1-2	**Course Introduction** Introduction to Aircraft Performance, Evolution of Airplane, Performance beauties of Wright Flyer, Later performance considerations International Standard Atmosphere (ISA), application to aerodynamics.	Ch 1, Text 1, Ch 1 Text 2
3-7	**Aerodynamic of the Airplane** Source of Aerodynamic force, lift, drag and moments, Aerodynamic coefficients and their variation with AOA and Mach number, Aerodynamic Centre, Lift for high aspect ratio wings,lift for low aspect ratio wings, swept wings, delta wings, subsonic airfoil drag, induced drag, transonic drag, supersonic drag	Ch 2 Text 2 (Sections 2.1 to 2.6, 2.8, Examples 2.1to 2.10, 2.12, 2.14)
8-9	**Drag Polar** The information it provides and itsvariation with mach number	Ch 2 Text 2 (Section 2.9)
10-11	**Some Propulsion Characteristics** Introduction, Thrust and Efficiency, Thereciprocating engine/propeller combination, Turbojet, Turbofan, Turboprop,	Ch 3 Text 2 (Section 3.1-3.6)
12-13	**The Equations of Motion** Four forces of 2D steady level flight, climbing flight and climb and roll and the equations of motion	Ch 4,5 Text 2 (Sec 4.2, 5.2)
14-18	Thrust Power and Velocity Thrust required and factors affecting it, fundamental performance parameters (T/W, W/S, Drag polar & L/D) velocity instability, VTRmin, L/Dmax, Thrust available, Power required, PRmin, Power available, max velocity	Ch 5, Text 2 (sections 5.3-5.9, Examples 5.1 to 5.9, 5.12)
19-22	**High Lift Devices** Minimum velocity and high lift devices	Ch 5, Text 2 (sec5.9, ex5.12)
23	**Complex Engineering Problem** Complete Aircraft Performance Evaluation using MATLAB®/Microsoft Excel	Text 1, Text 2

24-30	**Climb, Ceiling, Glide, Range and Endurance** Rate of Climb, Climb performance Hodograph, Service and absolute Ceiling, Time to Climb, Gliding Flight, Sink rate, Glide Performance Hodograph, Range, Breguet Range equation, Endurance for jet and propeller aircraft	Ch 5, Text 2 (section5.10 to5.15, Examples 5.13 to 5.19)
31-34	**Accelerated Flight: Turning, *V-n* diagram, Energy Concepts** Level turn, *Rmin*, *wmax*, *nmax*, Pull-upand Pull- down manoeuvres, load factor limiting case	Ch 6, Text 2 (section6.2 to 6.6, Examples 6.1to 6.5)
35-39	**Accelerated Flight: Turning, *V-n* Diagram, Energy Concepts** Energy height, specific excess power subsonic and supersonic Pscontours, minimum time toaccelerated climb path, V- n diagram	Ch 6, Text 2 (section 6.2 to 6.6, Examples 6.1to 6.5)
40-42	**Takeoff Performance** Takeoff ground roll calculation, variation of forces during takeoff,calculation of distance to clearobstacle during takeoff, calculation of landing approach distance, flaredistance and landing ground roll, variation of forces during landing	Ch 6, Text 2 (sections 6.7,and Example6.6)
43-44	**Landing Performance** Calculation of landing approach distance, flare distance and landing ground roll, variation of forces during landing	Ch 6, Text 2 (sections 6.8 Example 6.7)
45-48	Revision	