AIRCRAFT PERFORMANCE

V Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAE011	Core	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

COURSE OBJECTIVES:

The course should enable the students to:

I. Learn the different regimes of aircraft and performance requirements at different atmospheric conditions.
II. Understand different types of velocities and gives differences between stall velocity and maximum and minimum velocities.
III. Estimate the time to climb and descent and relate between rate of climb and descent and time to climb and descent at different altitudes.
IV. Illustrate the velocity and radius required for different type of maneuvers like pull-up, pull down and steady turn.
V. Evaluate the equations of motions for an airplane in different flight modes like takeoff, cruise and landing.

COURSE OUTCOMES (COs):

CO 1: Understand the design mission, performance, standard atmosphere, aerodynamic and propulsive forces, different speeds and estimation methods of aircraft.
CO 2: Remember and describe the cruise performance of an airplane in relation with range and endurance with different types of engines also to understand effects of weight, altitude and temperature on performance
CO 3: Determine and apply the concept of climb and descent performance and to calculate power for best climb and descent performance.
CO 4: Describe about aircraft maneuver performance in turn, pull-ups by considering limitations of power for military and civil aircrafts.
CO 5: Explore the methods to calculate take off and landing runway distances and to understand fuel planning, safety and environment effects of aircraft performance.

COURSE LEARNING OUTCOMES (CLOs):

1. Remember the atmospheric conditions that are suitable for better performance of an aircraft.
2. Understand the basics of mathematics, science and engineering for problem solving.
3. Describe different atmospheric models that an aircraft encounters in its real-time flight.
4. Demonstrate different methods for the measurement of air data and their respective systems working principle.
5. Describe mission profiles that an aircraft adapts depending upon its category and requirements.
6. Understand different phases of design process from performance standpoint.
7. Identify definition of aircraft performance for different categories of aircraft.
8. Explain the force system of the aircraft and the development of equations of motion.
9. Evaluate the performance of aircraft in cruising phase and appropriate conclusions are drawn.
10. Illustrate the climb and descent performance of the aircraft and its performance parameters are measured.
11. Understand the concept behind various methods that are employed during takeoff and landing phases depending upon its mission.

12. Evaluate the factors that enhance the performance of aircraft during takeoff and landing.
13. Understand the maneuver performance of typical transport and military aircrafts.
14. Understand the parametric performance data analysis for different phases of aircraft and various methods of measurement.
15. Understand the concept of flight planning, fuel planning and how it affects the performance of aircraft.
16. Understand the propulsive force characteristics like thrust that affects the aircraft performance.
17. Describes the flight measurement of performance, with detailed sections on airworthiness certification and the performance manual.
18. Evaluate the calibration methods that are used for the aircraft instruments to derive air data.
19. Understand the aerodynamic force characteristics like lift and drag that affects the aircraft performance.
20. Evaluate the full equation of motion, which are developed and used in the expressions for maneuver performance.

UNIT-I	INTRODUCTION TO AIRCRAFT PERFORMANCE	Classes: 10

The role and design mission of an aircraft; Performance requirements and mission profile; Aircraft design performance, the standard atmosphere; Off-standard and design atmosphere; Measurement of air data; Air data computers; Equations of motion for performance - the aircraft force system; Total airplane drag- estimation, drag reduction methods; The propulsive forces, the thrust production engines, power producing engines, variation of thrust, propulsive power and specific fuel consumption with altitude and flight speed; The minimum drag speed, minimum power speed; Aerodynamic relationships for a parabolic drag polar.

UNIT-II	CRUISE PERFORMANCE	Classes: 10

Maximum and minimum speeds in level flight; Range and endurance with thrust production, and power producing engines; Cruise techniques: constant angle of attack, constant mach number; constant altitude, methods- comparison of performance. The effect of weight, altitude and temperature on cruise performance; Cruise performance with mixed power-Plants.

UNIT-III	CLIMB AND DESCENT PERFORMANCE	Classes: 9

Importance of Climb and descent performance, Climb and descent technique generalized performance analysis for thrust producing, power producing and mixed power plants, maximum climb gradient, and climb rate. Energy height and specific excess power, energy methods for optimal climbs - minimum time, minimum fuel climbs. Measurement of best climb performance. Descent performance in Aircraft operations. Effect of wind on climb and decent performance.

UNIT-IV	AIRCRAFT MANEUVER PERFORMANCE	Classes: 8

Lateral maneuvers- turn performance- turn rates, turn radius- limiting factors for turning performance. Instantaneous turn and sustained turns, specific excess power, energy turns. Longitudinal aircraft maneuvers, the pull-up, maneuvers. The maneuver envelope, Significance. Maneuver boundaries, Maneuver performance of military Aircraft, transport Aircraft.

UNIT-V	SAFETY REQIREMENTS – TAKEOFF AND LANDING PERFORMANCE AND FLIGHT PLANNING	Classes: 8

Estimation of takeoff distances. The effect on the takeoff distance of weight wind, runway conditions, ground effect. Takeoff performance safety factors. Estimation of landing distances. The discontinued landing, Baulk landing, air safety procedures and requirements on performance. Fuel planning fuel requirement, trip fuel, Environment effects, reserve, and tankering.

Text Books:

1. Anderson, J.D. Jr., "Aircraft Performance and Design", International Edition McGraw Hill, 1st Edition, 1999.
2. Eshelby, M.E., "Aircraft Performance theory and Practice", AIAA Education Series, AIAA, 2nd Edition, 2000.

Reference Books:

1. McCormick, B.W, "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, 2ndEdition, 1995, ISBN: 0
2. Yechout, T.R. et al., "Introduction to Aircraft Flight Mechanics", AIAA Education Series, AIAA, 1st Edition, 2003, ISBN: 1
3. Shevel, R.S., "Fundamentals of Flight‖, Pearson Education", 2nd Edition, 1989, ISBN: 81