



Model Question Paper

Sixth Semester BE Degree Examination

Aircraft Performance

Time: 3Hours (180 Minutes)

Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.

2. M: Marks, L: RBT (Revised Bloom's Taxonomy) level, C: Course outcomes.

Module -1			M	L	C
Q1	a.	The drag polar of a propeller driven airplane is given by: $C_D = 0.05 + 0.03C_L^2$, lift curve slope of the wing, $C_{L\alpha} = 0.1/\text{deg}$ and zero lift angle $\alpha_{l=0} = -1.0 \text{ deg}$ Note (Stall Angle of wing =17 degree). Calculate i. Lift to Drag ratio (aerodynamic efficiency) at minimum power condition ii. The angle of attack (in degrees) of airplane for minimum power condition iii. The Lift to Drag ratio at maximum range condition	10	L3	CO1
	b.	Derive the expression for the power required for an aircraft in steady level flight and establish the aerodynamic condition necessary for minimum power required. Illustrate your answer with a neat power-velocity curve	10	L3	CO1
OR					
Q2	a.	A turbojet airplane weighs 45,000 N and has a wing loading W/S of 1450 N/m ² . The drag polar is given by $C_D = 0.014 + 0.038C_L$, $C_{Lmax} = 1.5$, and the thrust $T = 20,000 \sigma$. Determine the maximum and minimum speeds in level flight at sea level and at an altitude of 9000 m ($\sigma = 0.3813$).	10	L3	CO1
	b.	Represent the forces on the airplane in steady climb and derive the expression for rate of climb in terms of T/W, W/s and density.	10	L3	CO1
Module- 2					
Q3	a.	Describe the aerodynamic significance of the hodograph in defining aircraft climb performance. How do the vertical and horizontal velocity components interact within this plot to represent the aircraft's flight path?	10	L2	CO2
	b.	With neat diagram, illustrate the excess power for i) Propeller driven airplanes and ii) jet driven airplanes.	10	L2	CO2
OR					
Q4	a.	Define the unpowered flight hodograph and illustrate the glide polar to show the conditions for minimum glide angle and maximum endurance.	10	L2	CO2
	b.	Using suitable sketches, discuss the physical and practical distinctions between the absolute ceiling and the service ceiling. Also plot the rate of climb (R/C) vs.	10	L2	CO2

		altitude (h)			
Module - 3					
Q5	a.	Derive the equation of maximum range and endurance for jet engine airplane. List out the conditions at which it occurs	10	L3	CO3
	b.	A jet airplane has a weight of 922,140 N and wing area of 158 m ² . The weight of the fuel and oil together is 294,300 N. The drag polar is given by $C_D = 0.017 + 0.0663 C_L^2$. Obtain the maximum range in constant C_L flight at an altitude of 8 km assuming the TSFC to be 0.95 hr ⁻¹ .	10	L3	CO3
OR					
Q6	a.	Derive the aerodynamic relations associated with maximum lift to drag ratio ($\frac{C_L}{C_D}$) maximum endurance factor ($\frac{C_L^{3/2}}{C_D}$) and maximum range factor ($\frac{C_L^{1/2}}{C_D}$)	10	L3	CO3
	b.	Determine the maximum range at 30,000 ft for the gulfstream IV. The maximum usable fuel weight is 29,500 lb. The thrust specific fuel consumption of the rolls-Royce tay turbofan at 30,000 ft is 0.69 lb of fuel consumed per hour per pound of thrust. Also, at 30,000 ft, $\rho_\infty = 8.9068 \times 10^{-4}$ slug/ft ³ . Take initial weight of the aircraft 73,000lb.	10	L3	CO3
Module – 4					
Q7	a.	Outline the forces acting on an aircraft during takeoff and derive for the ground roll expression	10	L3	CO4
	b.	Calculate the flare distance for airplane at standard sea level assuming that the landing weight is the same as the take-off gross weight of 73000 lb. Assume that no thrust reversal is used and the runway is dry concrete with a brake on value of $\mu_r = 0.4$. The approach angle is 3 degrees, $C_{Lmax} = 2.39$, $S = 950$ ft ²	10	L3	CO4
OR					
Q8	a.	Define load factor. Obtain the load factor for (a) level flight (b) free fall (c) in a turn of radius 200 m at a speed of 100 m/s and (d) in a loop of radius 200 m at a speed of 100 m/s?	10	L3	CO4
	b.	Prove that $\frac{THP_{climb}}{THP_{level}} = \left[1 + \left(\frac{L}{D} \right) \tan \theta \right] \cos^3 \theta$ where, THP is thrust horse power	10	L3	CO4
Module – 5					
Q9	a.	Derive the expression for minimum turn radius (R_{min}) and maximum turn rate (ω_{max})	10	L3	CO5
	b.	An airplane has a jet engine which produces a thrust of 24525 N at sea level. The weight of the airplane is 58860 N. The wing has an area of 28 m ² , zero-lift angle of -2.2° and a slope of lift curve of 4.6 per radian. Find (a) the radius of a correctly banked 4g level turn at the altitude where $\sigma = 0.8$ and the wing incidence is 8° , (b) time required to turn through 180° and (c) thrust required in the	10	L3	CO5

		maneuver if the drag coefficient at this angle of attack be 0.055.			
OR					
	a.	Derive the limiting case for large load factor and discuss how it affects stall speed and turning performance.	10	L3	CO5
Q10	b.	An airplane having a wing area of 20m^2 and a weight of 19620 N dives with power off along a straight line inclined at 60° to the horizontal. Determine the acceleration of the airplane when the flight speed is 300 kmph. If the airplane has to pullout of this dive at a radius of 180m, what will be the lift coefficient required and the load factor? Drag polar is given by: $C_D = 0.02 + 0.06C_L^2$ and the maneuver takes place around an altitude of 2 km.	10	L3	CO5
