Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Course: Flight Mechanics I **Semester: V**
Programme: B.Tech ASE & ASE+AVE
Time: 03 hrs. **Max. Marks: 100**
Instructions: Provide neat sketch(s)

SECTION A (20 MARKS)

S. No.		Marks	CO
Q 1	Derive the relation between airplane's true air speed and equivalent airspeed.	**4**	**CO1**
Q 2	Compare drag requirements of subsonic and transonic aircraft at cruise and take-off.	**4**	**CO2**
Q 3	What is the effect of high lifting devices on lift coefficient of a wing?	**4**	**CO3**
Q 4	Show that greatest *endurance* condition in *glide* is same as *minimum power* condition in level flight.	**4**	**CO4**
Q 5	Derive the relation for *load factor* of an airplane in steady level rutning flight.	**4**	**CO5**
	SECTION B (40 MARKS)		
Q 6	Differentiate between different altitudes in standard atmosphere.	**10**	**CO1**
Q 7	Consider a wing with a thin, symmetric airfoil section in a Mach 2 airflow at an angle of attack of 1.5 deg. Calculate the lift coefficient a) For the airfoil section b) For the wing if it is a straight wing with an aspect ratio of 2.56 c) For the wing if it is swept at an angle of 60 deg, with an aspect ratio of 2.56 and taper ratio unity.	**10**	**CO3**
Q 8	An airplane is powered by a turbojet engine whose thrust is independent of the flight speed. The airplane weights 150,000 N with S=45 m^2 and $C_D=0.14+0.045C_L^2$. Calculate thrust required for maximum rate of climb of 1000 m/min at a flight speed of 15 m/s at sea level.	**10**	**CO4**
Q9	A simple piston prop airplane weighing 12000N has wig span of 7.4 m and wing area of 9 m^2. The engine delivers 300 HP at sea level. $Cd_0=0.025$, e=0.85, $\eta_p=0.8$. Calculate Maximum Range and endurance of this aircraft if the fuel weight fraction is 0.15 of All up Weight. Engine specific fuel consumption may be taken as 7.3×10^{-7} N/w.s.	**10**	**CO5**
	SECTION-C		
Q 10	An airplane has a wing loading of 2500 N/m^2 and its drag equation is $C_D=0.015+0.005\ C_L^2$. Calculate its maximum L/D ratio at a speed of 110 m/s or An aircraft weighing 250000N has a wing area of 75 m^2 and its drag equation is	**20**	**CO4**

	$C_D=0.016+0.042C_L^2$. Calculate the minimum thrust required for Steady Level flight and corresponding airspeed at sea level. Also, Calculate the minimum power required and corresponding airspeed.		
Q 11	A) Compare the application of 'Winglets' and 'Area Rule' for drag minimization.	**10**	**CO2**
	B) Calculate the range of an airplane with the following data: a) Loaded Gross weight = 75000N, b) Fuel Capacity = 4000 L c) Average L/D for Flight = 15, d) Average Propeller efficiency = 85% e) Specific fuel consumption = 3 N/Kw-hr	**10**	**CO5**

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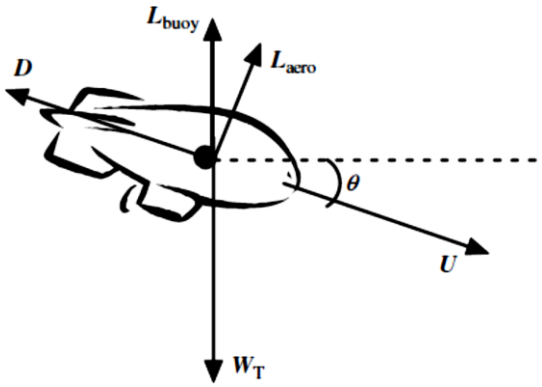
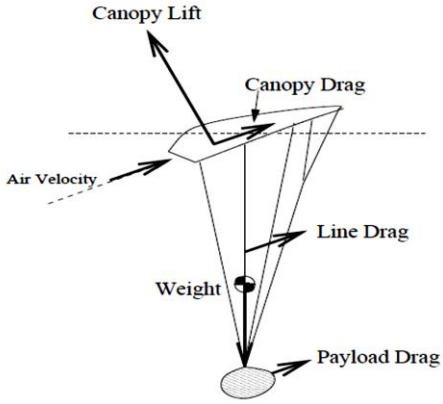
SECTION A (20 MARKS)

S. No.		Marks	CO
Q 1	Derive the relation between airplane's *true air speed* and *equivalent airspeed*.	**4**	**CO1**
Q 2	Explain the significance of "*drag polar*" of an airplane.	**4**	**CO2**
Q 3	What is the advantage of *area ruled* aircraft?	**4**	**CO3**
Q 4	Show that greatest *endurance* condition in *glide* is same as *minimum power* condition in level flight.	**4**	**CO4**
Q 5	Show that instantaneous turn rate in pull up maneuver is given by $R = \frac{V_\infty^2}{g(n-1)}$	**4**	**CO5**

SECTION B (40 MARKS)

Q 6	What is effect of altitude on TAS, EAS and CAS airspeeds?	**10**	**CO1**
Q 7	Compare different types high lifting devices.	**10**	**CO3**
Q 8	a) Prove that rate of climb depends upon excess power of the aircraft. b) An aircraft with a mass of 5000kg takes off from sea level with a forward speed of 50 m/s and starts to climb with a climb angle 15 deg. Find rate of climb and excess thrust available at the start of climb.	**10**	**CO4**
Q 9	Prove that the excess power during the takeoff climb is equal to sum of the time rate of the potential energy and kinetic energy	**10**	**CO5**

SECTION-C			
Q 10	Show that the rate of descent of an Hybrid(winged) airship is given by  $$U_V = \sqrt{\frac{2\cos^3\theta}{\rho_a C_{Laero}^3 / C_D^2} \cdot \frac{\Delta W}{S_{aero}}}$$ Or A glider having a mass of 500 kg is taken to an attitude of 1000m with a jeep moving on ground at 54 kmph. Upon reaching the required altitude in 50 sec, the glider is released and starts its decent. Find the *range* and *endurance* of the glider for a constant lift to drat ratio of 15.	**20**	**CO4**
Q 11	Estimate the Form drag , profile drag, Parasite Drag, lift dependent drag from given gliding Parafoil(parachute)-payload system. Compare various drag contributions in terms of percentage. Parameter / Value Basic airfoil drag, $C_{D_{ZL}}^{b}$ 0.015 Roughness drag, $C_{D_{ZL}}^{s}$ 0.004 Inlet drag $(h = 0.14c)$, $C_{D_{ZL}}^{n}$ 0.07 Induced drag at $C_L = 0.5$ 0.033 Line drag C_D^l 0.022 Payload Drag C_D^p 0.006  	**10**	**CO2**
	A) Derive the expression for gliding velocity for given gliding parachute. B) The given Parafoil system has wing loading 100 N/m^2 and launched from 500 m. Estimate the Glide velocity of the system at sea level.	**10**	**CO5**