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# UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

**End Semester Examination, December 2017**

**Program/course: B.Tech ASE, ASE(AVE)** | **Semester – V**
**Subject: Flight Mechanics I** | **Max. Marks : 100**
**Code : ASEG 301** | **Duration : 3 Hrs**
**No. of page/s: 2**

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NOTE:. Make use of *sketches/plots* to elaborate your answer. Brief and to the point answers are expected.

## Section A (4X5M=20M)

Q1. Calculate the atmospheric properties at 20 km. $T_{11}$ km = 216.66 deg K, $P_{11}$ km = 22631.95 Pascals, density $_{11}$ km = 0.3639 kg/m3.

Q2. What are the fundamental differences between leading and trailing edge high lift devices.

Q3. Show that the condition for Maximum Rate of Climb is

$$\frac{T}{W}Cl - 3Cd_o + KCl^2 = 0$$

Q4. Derive the relation between pitching moment at various points along the chord line and also derive the magnitude of pitching moment at Quarter chord location?

## Section B (4X10M=40M)

Q5. An aircraft is flying at sea-level at a speed of M = 0.8. a). Determine the speed of the aircraft. b) Determine the actual difference between the stagnation and static pressure sensed by the aircraft. c) Determine the speed of the aircraft based on incompressible flow with the same pressure difference.

Q6. Sketches the forces acting on an airplane during takeoff and landing ? Derive the relation for calculating the ground distance covered during takeoff.

Q8. For a Steep angle climb exceeding $13^0$ , Show that

$$\frac{T}{T_o} = \left(Cos\,\theta + \frac{L}{D}sin\theta\right) \text{ and } \frac{P}{P_o} = \left(1 + \frac{L}{D}tan\,\theta\right) tan\,\theta^{3/2}$$

Q6. Prove that the condition of maximum range in the case of a propeller driven aircraft is the condition of maximum endurance in the case of jet engine aircraft.

**Section C (2X 20=40M)**

Q9. An airplane weighs 160,000 N and has a wing are of 42 $m^2$. At a flight speed of 100 m/s the engine gives a thrust of 27000 N. If the aircraft drag equation is CD = 0.014 + 0.05 $C_L^2$ find the angle and the rate of climb at sea level at 100m/s flight speed. Assuming that the angle of climb is small. Also compute the maximum rate of climb and corresponding flight speed and angle of climb if the engine thrust is 27000N at all speeds at sea level.

Q10. Obtain a drag polar of an aircraft from the following test data obtained:

$Cd_w$=0.02, $Cd_f$=0.12, $Cd_{U/C}$=0.014, $Cd_{TU}$=0.05,
$S_W = 25m^2$, $S_f = 6m^2$, $S_{U/C} = 3m^2$, $S_{TU} = 10m^2$,

a) Assuming the contribution of the other component of the lift dependent drag is 8% that of the minimum of the wing.

b) if e=0.8 the contribution of the other component is 15% to that of the wing:

Assume C=2.5m.

Or

Consider an aircraft that has a wing span of 15 m, a wing area of 37.5 $m^2$ , and a gross weight of 88000 N. In level flight, the lift equals the weight. The aircraft is flying at 102.88 m/s. Also the Oswald efficiency factor is 0.9, and the zero-lift drag coefficient is 0.0220. Determine the following:

a) lift coefficient

b) induced drag coefficient

c) total drag coefficient

d) induced drag (N)

e) zero-lift drag (N)

f) total drag (N)

g) lift to drag ratio, (L/D)