B.E. Fifth Semester (Aeronautical Engineering) (C.B.S.)

Aircraft Flight Mechanics

P. Pages : 3 **NKT/KS/17/7371**

Time : Three Hours * 0 0 7 6 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.
12. Use of the standard altitude tables is allowed.

1. a) With the help of dimensional analysis : Buckingham - pi theorem : Prove that **5**

$$C_L = \frac{L}{(q_\infty s)} \text{ and } C_D = \frac{D}{(q_\infty s)}$$

b) Write a short note on ISA. **3**

c) Calculate pressure and temperature at a Geo-potential altitude of 7 km. **5**

OR

2. a) The resisting force R, of a supersonic plane during flight can be considered as dependent upon the length of the aircraft ℓ, velocity γ, air viscosity μ, air density ρ, and bulk modulus of air K. Express the functional relationship between these variables and the resisting force. **5**

b) Derive an expression for variation of pressure and density ratios in stratosphere region of ISA. **5**

c) Why SFC varies with velocity and altitude? **3**

3. a) What is Drag? Discuss different types of drag acting on Air plane. **6**

b) Draw and explain power available and power required curves for both propeller driven and jet driven airplane. **7**

OR

4. a) Derive an expression for the forces and moments acting on flight vehicle with suitable diagram. **6**

b) Explain the variation of thrust required with respect to velocity, thereby establish concept of "velocity stability". **7**

5. a) An aircraft weighing 25 kN has a wing area of $80\,m^2$ and its drag co-efficient is $C_D = 0.016 + 0.04C_L^2$. Calculate the minimum thrust required for straight and level flight, and the corresponding TAS at sea level and at 10 km. Calculate also the minimum power required and the corresponding TAS at the above conditions. **8**

b) Derive the Briquet range formula for a jet propelled air plane and write its implications. **5**

OR

6. a) Prove that the condition for minimum thrust required in steady state level flight is $C_{D.O} = C_{D.i}$. **4**

b) An airplane having an engine propeller combination weighs 88,290 N and has a wing area of $45\,m^2$. Its drag polar is given by : $C_D = 0.022 + 0.059C_L^2$. **9**

Obtain the maximum range and endurance at sea level in a steady level flight at a constant angle of attack from following additional data :

weight of fuel and oil = 15,450 N,

BSFC = $2.67\,N/kw-hr$,

Propeller efficiency $(\eta_p) = 85\%$.

7. a) What is the condition for minimum rate of sink and shallowest angle of powerless glide flight? **6**

b) Explain V - n diagram with its significance. **8**

OR

8. a) Derive an expression for total ground run during 'take off' for any general aircraft. **10**

b) Explain in brief - Bank angle and load factor. **4**

9. a) Distinguish between stability and controllability. **3**

b) Derive an expression for wing contribution to static longitudinal stability and offer comments on this expression. **10**

OR

10. a) Distinguish between static and dynamic stability with neat sketch. **5**

b) Explain longitudinal static stability criterion as applicable to an aircraft. **5**

c) Describe briefly : **3**

i) Elevator

ii) Rudder

iii) Aileron

11. a) Explain the effect of fuselage and nacelle on longitudinal static stability. **6**

b) What is meant by stick fixed neutral point. How it is obtained in actual practice. (Flight test) **8**

OR

12. a) Write short note on :

i) Static Margin **3**

ii) Hinge Moment Coefficient **3**

iii) Elevator control power. **3**

b) Explain the "POWER EFFECTS" in short, on longitudinal static stability of a jet aircraft. **5**

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