B.M.E. 3rd Year 2nd Semester Examination, 2022

Subject: Aerodynamics

Time : Three hours **Full Marks: 100**

Question No. 1 is compulsory *and Answer* ***two*** *questions from each of groups A and B.*

1. Justify the following statements from aerodynamic point of view: **[6×4]**
   (a) Two high speed vehicles moving side by side tend to attract one another.
   (b) If a cricket match is organized in the moon, the bowlers cannot swing the ball.
   (c) Lift without Drag is possible.
   (d) 'Singing' of wires occurs in high power transmission line.

Group A

2. Consider a model of wing-body shape mounted in a wind tunnel. The flow conditions in the test section are standard sea level properties with a velocity of 100m/s. The wing area and chord are 1.5 sqm and 0.45m respectively. The zero lift moment about centre of gravity is found to be - 12.4Nm. When the model is pitched to another angle of attack, the lift and moment about CG are measured to be 3675N and 20.67Nm respectively. Find the location of aerodynamic centre and calculate the moment co-efficient about the same.

If a mass is added in a way that the CG is shifted rearwards by 0.2c, calculate the moment about CG when the lift is 4000N.

Assume a horizontal tail with no elevator is added to this model. The distance of the tail's aerodynamic centre from the CG of the airplane model is 1.0m. The area of the tail is 0.4 sqm, the tail setting angle being 2 degree. The lift slope of the tail is 0.12 per degree. From experimental measurements, α=5 degree, ε=0 and $\delta\varepsilon/\delta\alpha$ =0.42. If the lift at absolute angle of attack if 4134N, calculate the moment about CG. Does this model have longitudinal static stability and balance? **[18]**

3a. Explain the working principle of primary control surfaces of an airplane.
b. What do you mean by canard configuration? Why it is used? Comment on the disadvantages of the same. **[12+6]**

4a. Find the expression for total pitching moment about the CG of an airplane. From the expression, comment on the required configurations for ensuring longitudinal stability and balance of the airplane.
b. Write short note on: Aerodynamic Centre **[14+4]**

Group B

5a. An airplane in cruising in trimmed condition at an elevation of 11000mtr at a velocity of 570km/hr. The density of the ambient air is 0.4kg/m^3. The overall weight of the airplane is 6000kg and wing planform area is 32m^2. The drag co-efficient at cruise is 0.015. Calculate the lift co-efficient and the engine thrust required for the cruise.

b. How do you measure the velocity of a supersonic flow using Pitot tube? Find out the necessary expression for the same. **[10+10]**

6a. Consider a Boeing 747 airliner cruising at a velocity of 880kmph at a standard altitude of 11500mtr, where the free stream pressure and temperature are $2kN/m^2$ and 216K respectively. A one fifth scale model of the airliner is tested in a wind tunnel where the temperature is 240K. Calculate the velocity and pressure of the air stream in the tunnel so that dynamic similarity is maintained for drag and lift calculations. Assume both the viscosity and the sonic velocity to be proportional to the square root of temperature.

b. Write short notes on: i. Kutta condition, ii. Induced drag. **[10+(5x2)]**

7a. From the classical thin aerofoil theory for symmetric aerofoil, show that the lift slope is theoretically equal to 2π/rad.

b. Explain the nomenclature: NACA2412 **[15+5]**