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## Fourth Semester B.E. Degree Examination, Feb./Mar. 2022 Aerodynamics- I

Time: 3 hrs.

Max. Marks:80

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

### Module-1

- 1 a. Derive the integral and differential form of energy equation using control volume approach. (10 Marks)
- b. Outline the following :  
i) Path-lines  
ii) Streamlines  
iii) Streak-lines. (06 Marks)

OR

- 2 a. Derive an equation for Vorticity  $\xi$ . (10 Marks)
- b. Consider the velocity field given by  $u = y/(x^2 + y^2)$  and  $v = \frac{x}{(x^2 + y^2)}$ . Calculate the equation of the stream line passing through the point (0, 5). (06 Marks)

### Module-2

- 3 Consider an NACA 23012 airfoil. The mean camber line for this airfoil is given by

$$\frac{z}{c} = 2.6595 \left[ \left( \frac{x}{c} \right)^3 - 0.6075 \left( \frac{x}{c} \right)^2 + 0.1147 \left( \frac{x}{c} \right) \right] \text{ for } 0 \leq \frac{x}{c} \leq 0.2025$$

$$\text{and } \frac{z}{c} = 0.02208 \left( 1 - \frac{x}{c} \right) \text{ for } 0.2025 \leq \frac{x}{c} \leq 1.0$$

Calculate :

- i) The angle of attack at zero lift  
ii) The lift coefficient when  $\alpha = 4^\circ$   
iii) The moment coefficient about the quarter chord,  
iv) The location of the center of pressure in terms of  $X_{cp/c}$ , when  $\alpha = 4^\circ$ . (16 Marks)

OR

- 4 Derive the following :  
a. Aerodynamic center  
b. Center of pressure. (16 Marks)

### Module-3

- 5 Consider a lifting flow over a circular cylinder. Derive the expression for the lift per unit span. Also discuss the location of stagnation points for various  $\Gamma$ . (16 Marks)

OR

- 6 Derive an expression for lift curve slope for a symmetric airfoil using classical thin airfoil theory. (16 Marks)

Module-4

- 7 Derive the expression for the induced angle of attack and induced drag coefficient using both elliptical and general lift distribution. (16 Marks)

OR

- 8 Derive an expression for lift coefficient and induced drag coefficient in terms of circulation strength  $\Gamma(Y)$  for a finite wing through Prandtl's classical lifting line theory and its limitations. (16 Marks)

Module-5

- 9 Explain the following with a neat sketch :  
a. The simplified horseshoe vortex  
b. Formation flying effects  
c. Influence of the downwash on the tail – plane. (16 Marks)

OR

- 10 Outline the advantages and disadvantages of forward – swept wing and high lift devices in supersonic aircraft. (16 Marks)

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