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10AE54

Fifth Semester B.E. Degree Examination, Dec.2013/Jan.2014
Aerodynamics – I

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. State the law of conservation of mass. Derive an expression for one-dimensional form of continuity equation. **(06 Marks)**

b. Define and explain the compressibility. **(04 Marks)**

c. Define mach number. Explain the classification of the flow regimes based on mach number with a neat sketch. **(10 Marks)**

2 a. Obtain the relation between stream function and velocity potential stating its inference. **(04 Marks)**

b. Define the following:
(i) Path line (ii) Stream line (iii) Streak line. **(06 Marks)**

c. Derive the integral form of momentum equation for a control volume fixed in space. **(10 Marks)**

3 a. With a neat sketch, explain in detail the airfoil nomenclature. **(06 Marks)**

b. Derive an expression for axial force co-efficient (C_a) and normal force co-efficient (C_n) of an airfoil. **(10 Marks)**

c. Consider an airfoil at 12° angle of attack. The normal and axial force coefficients are 1.2 and 0.03 respectively. Calculate the lift and drag coefficients. **(04 Marks)**

4 a. Derive the Euler's equation of motion. Hence deduce the Bernoulli's equation. Discuss its applications. **(12 Marks)**

b. If for a 2-dimensional flow, the stream function is given by, $\psi = 2xy$, calculate the velocity at the point (3, 6). Show that the velocity potential 'ϕ' exist for this case and deduce it. **(08 Marks)**

PART – B

5 a. Obtain an expression for the following for a lifting flow over cylinder:
(i) Stream function (ψ) (ii) Location of stagnation points
(iii) Pressure co-efficient
Also explain with a neat sketch, the location of stagnation points for different values of Γ. **(12 Marks)**

b. What is Kutta-Joukowski theorem? Obtain an expression for the same and explain with neat sketch. **(08 Marks)**

6 a. Write short notes on the following:
(i) Kutta condition. (ii) Kelvin's circulation theorem. **(10 Marks)**

b. Consider a NACA 230/2 airfoil. The mean camber line for the airfoil is given by,

$$\frac{Z}{C} = 2.6595\left[\left(\frac{u}{C}\right)^3 - 0.6075\left(\frac{u}{C}\right)^2 + 0.1147\left(\frac{u}{C}\right)\right] \text{ for } 0 \le \frac{x}{C} \le 0.2025 \text{ and}$$

$$\frac{Z}{C} = 0.02208\left[1 - \frac{X}{C}\right] \text{ for } 0.2025 \le \frac{x}{C} \le 1$$

Calculate (i) The angle of attack at zero lift.
(ii) The lift co-efficient when $\alpha = 4°$ **(10 Marks)**

7 a. Write down the Navier-Stokes equation. **(06 Marks)**

b. Define and obtain the expressions for,
(i) Boundary layer thickness.
(ii) Displacement thickness.
(iii) Momentum thickness. **(09 Marks)**

c. Explain the boundary layer separation of an airfoil. **(05 Marks)**

8 a. With a neat sketch, explain the operation of open and closed circuit low speed wind tunnel. **(10 Marks)**

b. Explain in detail the smoke and tuft flow visualization techniques. **(10 Marks)**

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