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10AE54

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Aerodynamics – I

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Derive continuity and momentum equations for any finite control volume fixed in space. **(10 Marks)**

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

c. Explain the following aerodynamics flows:
   i) Inviscid Vs Viscous flow
   ii) Laminar Vs Turbulent flow
   iii) Incompressible Vs Compressible flow. **(06 Marks)**

2 a. The stream function for a two – dimensional flow is given by $\psi = 2 \times y$, calculate the velocity at point P(2,3). Find the velocity potential function, ϕ. **(06 Marks)**

b. Derive the formulae for
   i) Vorticity
   ii) Circulation
   iii) Stream Function. **(06 Marks)**

c. Derive the integral form fo continuity equation and hence deduce the differential form. **(08 Marks)**

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

b. Name and classifications of NACA airfoils and write down the explanation of the digits in each if the following :
   i) NACA 2414
   ii) NACA 23014
   iii) NACA 65, -214. **(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 co-efficient. **(04 Marks)**

4 a. Derive both Bernoulli's and Euler's equation of motion for an inviscid incompressible fluid flow. **(10 Marks)**

b. Tabulate the velocity, ϕ and ψ expression for
   i) Uniform flow in X-direction
   ii) Source
   iii) Vortex
   iv) Doublet. **(10 Marks)**

PART – B

5 a. Consider a Lifting flow over a circular cylinder and derive the expression following :
   i) Stream function
   ii) Location of stagnation points
   iii) Pressure co-efficient. **(10 Marks)**

b. Consider the lifting flow over a circular cylinder. The lift co-efficient is 5. Calculate the location of the stagnation points and the points on the cylinder where the pressure equals force stream static pressure. **(10 Marks)**

6 a. Briefly explain the following, wit neat sketches and relevant expression :
   i) Kelvin's circulation theorem
   ii) The starting vortex
   iii) Vortex sheet. **(10 Marks)**

b. Derive an expression for left co-efficient for symmetric airfoil, using classical thin airfoil theory. **(10 Marks)**

7 a. Explain the boundary layer, with relevant sketch: Derive the expression for
   i) Displacement thickness
   ii) Momentum thickness. **(10 Marks)**

b. Derive Navier – Stokes equation for an unisteady, compressible, three – dimensional viscous flow. **(10 Marks)**

8 a. Draw a neat diagram of wind tunnel and Give a brief description how aerodynamic loads and moments are measured in a wind tunnel. **(12 Marks)**

b. Derive the Area – velocity relation and discuss the physical significance of subsonic supersonic and sonic flow with relevant sketches. **(08 Marks)**

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