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10AE54

Fifth Semester B.E. Degree Examination, June/July 2015

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. Define Mach number and describe the different aerodynamic flows with reference to mach number regimes. **(07 Marks)**

b. Derive an expression for one dimensional form of momentum equation. **(08 Marks)**

c. Consider a convergent duct with an inlet diameter 3m. Air enters this duct with a velocity of 20 m/sec and leaves the duct with a velocity of 50 m/sec. What is the diameter of the duct of exit? Calculate the pressure at the exit if the air pressure and temperature at the inlet are 1.5 bar and 340 k respectively. **(05 Marks)**

2 a. Derive the integral form of momentum equation using control volume approach and hence deduce the partial differential form of Navier-Stokes equation. **(15 Marks)**

b. The components of velocity field in an incompressible flow is given by $u = x^3 - y^3$ and $v = z^3 - y^3$. Determine the third component assuming that the origin is a stagnation point. **(05 Marks)**

3 a. Derive the relation to calculate the aerodynamic forces N' and A' and the momentum M'_{CE} in terms of P, θ and τ. **(10 Marks)**

b. Define the term center of pressure and aerodynamic center and derive the relation to calculate the location of aerodynamic center. **(06 Marks)**

c. In low speed incompressible flow, the following experimental data are obtained for an NACA 4412 airfoil section at an angle of attack of 4° ; $C_l = 0.85$; $Cmc/4 = 0.09$. **(04 Marks)**

4 a. Derive the Euler equation and hence deduce the Bernoulli's equation for an incompressible, irrotational flow and discuss the physical significance and application. **(10 Marks)**

b. Obtain the governing equations for irrotational and incompressible flow. **(05 Marks)**

c. If for a 2D flow, the stream function is given by $\psi = 2xy$. Calculate the velocity at the point (3,6). Show that the potential ϕ exist for this case and deduce it. **(05 Marks)**

PART – B

5 a. Generate a lifting flow over circular cylinder by super position of elementary flows and derive the expression for lift per span and also obtain the location of stagnation point for three different values of circulations. **(14 Marks)**

b. Consider a lifting flow over a circular cylinder with a diameter of 0.8m. The free stream velocity of 30m/sec and maximum velocity on the surface of the cylinder is 80m/sec. the free stream conditions are those for the standard altitude of 3.5 Km. Calculate the lift per unit span of the cylinder. (Assume density at 3.5 Km = 0.8634 Kg/m^3). **(06 Marks)**

6 a. Briefly explain the following with relevant sketches ;
i) Kutta condition ii) Kelvin`s circulation theorem and starting vortex. **(06 Marks)**

b. Using classical airfoil theory obtain the expression $\frac{dc_l}{d\alpha} = 2\pi$ for a symmetric airfoil. **(14 Marks)**

7 a. Derive Navier-Stokes equation for an unsteady, there dimensional viscous flow in Cartesian co-ordinates. **(15 Marks)**

b. Define and obtain the expression for displacement thickness. **(05 Marks)**

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

b. What are the objective of flow visualization technique and list down techniques at low speed and high speed? **(05 Marks)**

c. Explain the advantages of flow visualization in flight vehicle development process. **(05 Marks)**

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