Karunya University
(Karunya Institute of Technology and Sciences)
(Declared as Deemed to be University under Sec.3 of the UGC Act, 1965)

End Semester Examinations - 2015-16 Even Semester - May 2016

14AE2006 Aerodynamics

Set A

Time : 3 hrs
Total Marks: 100

1. (a) In an incompressible flow field with free-stream velocity 50 m/s, the value of pressure coefficient Cp at a point P is -5. What is the velocity at point P? (5 marks)

   (b) Derive continuity equation in cylindrical ploar coordinates (r, θ, z). (15 marks)

OR

2. For incompressible flow field given by following velocity components, find the missing velocity components.

   (a) For Cartesian coordinate system $v_y = \frac{Ay}{(x^2+y^2+z^2)^{\frac{3}{2}}}, v_z = \frac{Az}{(x^2+y^2+z^2)^{\frac{3}{2}}}, v_x = ?$, (10 marks)

   (b) For 2D cylindrical coordinate system (r, θ), $v_r = \frac{3}{2}Ar^{\frac{3}{2}} \cos\frac{3\theta}{2}, v_\theta = ?$ (10 marks)

3. (a) Find the stream function for 2D velocity field in Cartesian coordinate system given by $v_x = x^2 - 2x + 1$ and $v_y = -2xy + 2y - x$. (8 marks)

   (b) Find the stream function for 2D velocity field in Cylindrical coordinate system given by $v_r = \frac{A}{\sqrt{r}} \cos\theta.$. Find velocity component v_θ. (12 marks)

OR

4. (a) For a velocity field with velocity potential given by $\Phi = x^3 - 3xy^2$, find the stream function Ψ(x, y). (10 marks)

   (b) For a velocity field with stream function given by Ψ = Aθ, find the potential function Φ(r, θ). (10 marks)

5. A sink of strength 20π m^2/s is located 3m upstream of source of strength 40π m^2/s . The combination is placed in uniform velocity field along the line joining sink to source. It is noted that at a point 2.5m equi-distant from source and sink, the velocity is normal to line joining source and sink. Find

   (a) the velocity of the uniform flow field. (10 marks)

   (b) the velocity at the point mentioned above. (10 marks)

OR

6. Consider a pair of source and sink of equal strength Λ in a uniform stream with velocity U. The uniform velocity is aligned with line joining source and sink. The SINK is at (-c,0) and SOURCE is at (c,0) while uniform flow is along x-axis towards +∞.

   (a) What is velocity potential for the combination? (5 marks)

   (b) What is stream function for the combination? (5 marks)

   (c) What is the velocity at a point (x,y)? (5 marks)

   (d) What are the stagnation points of the combination? (5 marks)

7. (a) Find the induced velocity due to Circular vortex of strength Γ at the centre of the circle. (10 marks)

   (b) Find the induced velocity at the centre of the square vortex of strength Γ. The side of square is 2a. (10 marks)

OR

8. (a) State the assumptions for Thin Aerofoil Theory. What are the implications of these assumptions of Thin Aerofoil Theory? (6 marks)

(b) The camber line of an airfoil is given by $y = kx(x-1)(x-2)$. Here x and y are in terms of chord c and the origin is at leading edge. The maximum camber is 2.2%. Using thin aerofoil theory, find out

i. Lift coefficient at $\alpha=0$, (5 marks)

ii. Pitching moment about leading edge at $\alpha=0$ and (5 marks)

iii. angle of attack α for zero lift $\alpha_{L=0}$ (4 marks)

9. (a) A wing has taper ratio of 4 and planform area of $7.5m^2$. Its span is 15m. What are the root and tip chord lengths? (6 marks)

(b) Consider a finite wing of elliptic planform without twist and same airfoil section across the span. Using Prandtl lifting line theory, show that downwash is constant along the span. (14 marks)

Wishing you All the Best
