Reg. No. :

Question Paper Code : 71323

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Fourth Semester

Aeronautical Engineering

AE 6401 — AERODYNAMICS – I

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate finite control volume approach and infinitesimal fluid element approach.
2. State the importance of stream function.
3. What is meant by Stokes flow?
4. State Kutta condition.
5. Differentiate leading – edge stall and trailing - edge stall.
6. Give Cauchy — Riemann relations.
7. State the physical significance of Prandtl's lifting – line theory?
8. What is drag due to lift?
9. How the Prandtl number does affect the velocity and thermal boundary layer?
10. What is the contribution of viscosity on drag?

PART B — (5 × 13 = 65 marks)

11. (a) (i) The velocity field in a fluid is given by $V = 3xy^2\, i + 2xy\, j + (2zy + 3t)k$. find the magnitudes and directions of

(1) translational velocity

(2) rotational velocity and

(3) the vorticity of a fluid elements at (1, 2, 1) and at time t = 3. (8)

(ii) Under what condition does the streamlines, pathlines and steaklines are exists as same and difference in a flow field? Explain. (5)

Or

(b) (i) Derive and state the necessary assumption made to obtain the Euler's equation from momentum equation. (8)

(ii) Consider the velocity field given by $u = y/(x^2+y^2)$ and $v = -x/(x^2+y^2)$. Calculate the circulation around a circular path of radius 5 m. Assume that u and v are given in m/s. (5)

12. (a) (i) Consider the non lifting flow over a circular cylinder of a given radius. Where the velocity is 20 m/s. if velocity is doubled as 40 m/s, does the shape of the streamline change? Explain. (8)

(ii) State and prove Kelvin's circulation theorem. (5)

Or

(b) Flow past a rotating cylinder can be simulated by superposition of a doublet, a uniform flow and a vortex. The peripheral velocity of the rotating cylinder alone is given by V_θ at $r = R$. Use the expression for the combined velocity potential for the superimposed uniform flow, double and vortex (clockwise direction) and show that the resultant velocity at any point on the cylinder is given by $-2U_0 \sin\theta - V_\theta$ at $r = R$ the angle e is the angular position of the point of interest. A cylinder rotates at 360 rpm around its own axis which is perpendicular to the uniform air stream (density 1.24 kg/m³) having velocity of 25m/s. the cylinder is 2 m in diameter. Determine :

(i) Circulation

(ii) Lift per length and

(iii) Position of stagnation points.

13. (a) Using the transformation functions. Trace the symmetric airfoil from a circle of radius 'a' where $a = b + be$. The value of b = 25 mm and eccentricity e = 0.143. Determine the chord length, maximum thickness and thickness to chord ratio. Trace the airfoil shape using graph sheet in your answer sheet. (6 + 7)

Or

(b) Show that the center of pressure is at the quarter – chord point for a symmetric airfoil.

14. (a) The variation of circulation over a wing having elliptic plan form with span b' is given below :

$$L'(y) = \rho_\infty V_\infty \Gamma_\theta \sqrt{1-\left(\frac{2y}{b}\right)^2}$$

Determine :

(i) Downwash.

(ii) Induced angle of attack

(iii) Induced drag.

Or

(b) Prove that the geometric angle of attack is equal to the sum of the effective angle of attack plus the induced angle of attack.

15. (a) Using order analysis, reduce the Navier stroke equations into boundary layer equations for flow over a flat plate.

Or

(b) For the give velocity profile as $(u/U) = 2n - n^2$ where $n = (y/\delta)$. Determine the displacement thickness, momentum thickness, energy and shape factor. Where δ is the boundary layer thickness.

PART C — (1 × 15 = 15 marks)

16. (a) Find the resultant velocity vector induced at point A in Fig. 16(a) due to the combination of uniform stream, line source, line sink and line vortex.

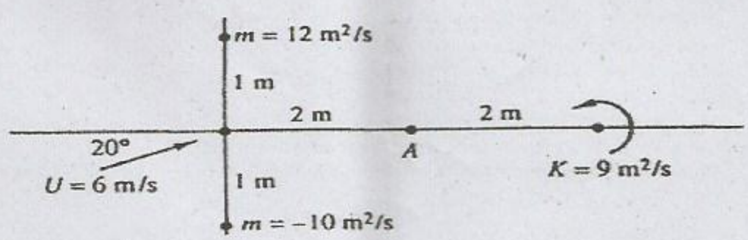

Fig. 16(a)

Or

(b) A thin aerofoil has a camber line defined by the relation $y = kx(x-1)(x-2)$ where x and y are its co-ordinates expressed in terms of unit chord and the origin is at the leading edge. If the maximum chamber is 2% of the chord, determine the low speed two dimensional pitching moment coefficient at 3° incidence.