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10AE54

Fifth Semester B.E. Degree Examination, Dec.2015/Jan.2016
Aerodynamics – I

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Distinguish between inviscid and viscous flow. **(04 Marks)**

b. Explain Mach number regimes with a neat sketch. **(06 Marks)**

c. The air speed indicator fitted to an airplane has no instrument error, the airplane is flying at ISA condition and the airspeed indicator indicates 900 kmph. What is the true air speed? Given $\gamma = 1.4$, $\rho_{SL} = 1.226$ kg/m^3, sonic velocity at S.L. = 340.3 m/sec. Comment on the answer. **(10 Marks)**

2 a. For a control volume fixed in space, derive the integral form of energy equation. **(10 Marks)**

b. In a velocity field, prove the curl of the velocity is equal to the vorticity. **(06 Marks)**

c. Consider the velocity field given by $u = \frac{y}{(x^2+y^2)}$ and $v = \frac{-x}{(x^2+y^2)}$. Calculate the equation of the stream line passing through the point (0, 4). **(04 Marks)**

3 a. For a symmetrical section, show that a fixed centre of pressure coincides with the aerodynamic center. **(10 Marks)**

b. Find the pressure distribution of a bi-convex airfoil $\frac{y(t)}{c} = \frac{t}{2c}\left[1-\left(\frac{2x}{c}\right)^2\right]$ (with origin at mid chord) set at zero incidence in an undisturbed stream. **(10 Marks)**

4 a. Derive the Laplace equation for irrotational incompressible flow. **(08 Marks)**

b. Derive the stream function for a double flow. **(08 Marks)**

c. Consider the non – lifting flow over a cylinder. Calculate the location on the surface of the cylinder where the surface pressure equals the free steam pressure. **(04 Marks)**

PART – B

5 a. Explain D'Alembert's Paradox with neat sketches. **(04 Marks)**

b. What is the required cylinder diameter in order to have Re = 1. The data given are $\rho_\infty = 1.223$ kg/m^3 and $u_\infty = 1.79 \times 10^{-5}$ kg/m-sec and the air flow is 30 m/sec. **(04 Marks)**

c. Diameter of a cylinder is 0.5 m, the free stream velocity is 25 m/sec, the max velocity on the surface of the cylinder is 75 m/sec. The free stream conditions are those for a standard altitude of 3 kilometer is $\rho_{3000} = 0.90926$ kg/m^3. Calculate the lift/unit span of the cylinder. **(12 Marks)**

6 a. Explain with a neat sketch about the consequence of downwash of a wing. **(06 Marks)**

b. Explain Kelvin's circulation theory. **(08 Marks)**

c. Derive an expression for the lift for an elliptical distribution. **(06 Marks)**

7 a. Derive the Navier – Strokes equation for a 3 – D flow. **(12 Marks)**

b. In model testing, what is dynamic similarity? Explain with example. **(08 Marks)**

8 a. Explain the difference between closed circuit wind tunnel and open circuit wind tunnel. **(05 Marks)**

b. What are the advantages of a big wind tunnel over a small wind tunnel? **(05 Marks)**

c. In a low speed subsonic wind tunnel with a 12/1 nozzle contraction ratio, the flow is S.L. condition with a velocity of 50 m/sec. Calculate the height difference in a "u" – tube mercury manometer with one side connected to the nozzle inlet and the other to test section. Data given : $\rho_{SL} = 1.23$ kg/m^3 ; Sp gravity of Hg = 1.36×10^4 kg/m^3. **(10 Marks)**

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