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10AE54

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
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. State the law of conservation of mass. Derive an expression for one-dimensional form of continuity equation. **(06 Marks)**

b. Derive basic form of momentum equation. **(06 Marks)**

c. Consider an airfoil in a flow of air, where far ahead (upstream) of the airfoil, the pressure, velocity and density are 1.013 bar, 160 kmph and 1.23kg/m^3, respectively. At a given point A on the airfoil, the pressure is 0.99 bar. What is the velocity at point A? **(08 Marks)**

2 a. Derive the integral form of energy equation using control volume approach. **(10 Marks)**

b. Consider the velocity field given by $u = y/(x^2 + y^2)$ and $v = -x/(x^2 + y^2)$. Calculate the equation of the steam line passing through the point (0, 5). Calculate the vorticity and the circulation around a circular path of radius 5m. Assume that u and v are in units of meters per second. **(10 Marks)**

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

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

c. Consider an airfoil at 12° angle of attack. The normal and axial force co-efficient are 1.2 and 0.03 respectively. Calculate the lift and drag co-efficient. **(04 Marks)**

4 a. State and explain infinity boundary conditions and wall boundary conditions over any arbitrary body. **(06 Marks)**

b. Consider the P-35 cruising at a standard altitude of 4km. The pressure sensed by the pitot tube on its right wing is 6.7×10^4N/m^2. At what velocity is the P-35 flying. Take at altitude 4km, pressure and density are 6.166×10^4N/m^2 and 0.81935kg/m^3 respectively. **(04 Marks)**

c. Derive the stream function and velocity potential for doublet and vortex flow. **(10 Marks)**

PART – B

5 a. Consider the non lifting flow over a circular cylinder. Calculate the locations on the surface of the cylinder where the surface pressure equals the freesteam pressure. **(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 freestream static pressure. **(10 Marks)**

6 a. Derive the fundamental equation of thin airfoil theory. **(10 Marks)**

b. Consider a thin flat plate at 5deg. angle of attack. Calculate the :
i) Lift co-efficient, ii) Moment co-efficient about the leading edge iii) Moment coefficient about the quarter-chard point iv) Moment coefficient about the trailing edge. **(10 Marks)**

7 a. Obtain the expression for the following :
   i) Displacement thickness
   ii) Momentum thickness. **(10 Marks)**

b. Consider a flat plate at zero angle of attack in an airflow at standard sea level conditions ($P_\infty = 1.01 \times 10^5 N/m^2$ and $T_\infty = 288K$). The chord length of the plate is 2m. The planform area of the plate is $40m^2$. At standard sea-level conditions, $\mu_\infty = 1.7894 \times 10^{-5} kg/(ms)$. Assume the wall temperature is the adiabatic wall temperature T_{aw}. Calculate the friction drag on the plate when the freestream velocity is : i) 100m.s ii) 1000m/s. **(10 Marks)**

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

b. Consider a low-speed subsonic wind tunnel with a 12/1 contraction ratio for the nozzle. If the flow in the test section is at standard sea level conditions with a velocity of 50m/s, calculate the height difference in a U-tube mercury manometer with one side connected to the nozzle inlet and the other to the test section. **(10 Marks)**

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