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10AE54

Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
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. Explain the following aerodynamic flows:
   i) Inviscid Vs viscous flow
   ii) Laminar Vs Turbulent flow
   iii) Steady Vs unsteady flow
   iv) Rotational Vs irrotational flow
   v) Incompressible Vs compressible flow. **(10 Marks)**

b. Derive the momentum equation for a one-dimensional steady flow. **(10 Marks)**

2 a. Bring out the difference between Eulerian and Langrangian approach. **(04 Marks)**

b. Derive the integral form of continuity equation and hence deduce the differential form. **(08 Marks)**

c. A flow field in given by $U = xy\,i + 2yzj - (yz + z^2)k$. Determine whether this is a possible steady incompressible flow. If so, calculate the x-component of acceleration, angular velocity and velocity at the point (1, 2, 3). **(08 Marks)**

3 a. Draw a schematic diagram of an airfoil and explain the salient geometric features. **(05 Marks)**

b. Name the classifications of NACA airfoils and write down the explanation of the digits in each if the following :
   i) NACA 2414
   ii) NACA 23014
   iii) NACA 65, -214 **(10 Marks)**

c. Explain the aerodynamic characteristics of 2D – wing. **(05 Marks)**

4 a. Obtain the expression for velocity potential and stream function for doublet flow and plot the streamlines in a doublet flow. **(10 Marks)**

b. Consider an airfoil in a flow at standard sea level condition with a free stream velocity of 50m/s. At a given point on the airfoil, the pressure is 0.9×10^5 N/m^2. Calculate velocity of flow at this point. **(04 Marks)**

c. Briefly discuss the significance and application of Bernouli's equation and give examples. **(06 Marks)**

PART – B

5 a. Consider Non-lifting flow over a circular cylinder and derive the expression. **(10 Marks)**
$C_p = 1 - 4\sin^2\theta$ and also show the C_p variation over the surface of the cylinder graphically.

b. Discuss the phenomena of Magnus effect. **(05 Marks)**

c. Briefly explain Kutta Jonkowski's theorem for the generation of lift. **(05 Marks)**

6 a. Briefly explain concept of vortex sheet with suitable sketches and obtain the expression for velocity potential 'ϕ' and circulation 'Γ'. **(08 Marks)**

b. Using the airfoil theory, prove that quarter chord point is both the center of pressure and the aerodynamic center for a symmetric airfoil. **(08 Marks)**

c. Explain the significance of Kutta condition. **(04 Marks)**

7 a. Discuss on the aspects of flow separation airfoil stall and different types of airfoil stall. **(10 Marks)**

b. Consider a flat plate kept parallel to the free stream at standard sea level conditions. The chord length of the plate is 4m, platform area is 80 sq.m. All the wall temperature is adiabatic wall temperature Taw. Calculate the friction drag on the plate when the free stream velocity is 90 m/s and 750 m/s.

(Assume : $\mu_\infty = 1.7894 \times 10^5$ NS/m^2, for compressible flow $C_f\sqrt{Re\,c} = 1.25$) **(10 Marks)**

8 a. Describe the force and moment measurement technique used on a wind tunnel model and also explain the design of wind tunnel. **(10 Marks)**

b. Derive the Area – Velocity relation and discuss the physical significance of subsonic, supersonic and sonic flow with relevant sketches. **(10 Marks)**

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