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14MTP/MTH13

First Semester M.Tech Degree Examination, Dec.2014/Jan.2015
Advanced Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Define the following i) Stream lines ii) Path lines iii) Streak lines iv) Vorticity v) Rotational flow. **(10 Marks)**

b. In a steady flow, the velocity components are u = 2kx , V = 2 ky , W = -4kz. Find equation of streamline passing through the points (1, 0, 1). **(10 Marks)**

2 a. Name the different forces present in a fluid flow and for the Euler's equation of motion, which forces are considered. **(02 Marks)**

b. Derive Euler's equation of motion along a stream line. **(08 Marks)**

c. Water is flowing through a pipe having diameter 300mm and 200mm at the bottom and upper end respectively. The intensity of pressure at the bottom end is 24.52N/cm^2 and at the upper end is 9.81N/cm^2. Determine the difference in datum head if rate of flow is 40lit/S. **(10 Marks)**

3 a. Establish a relation for the average and maximum velocity for one – dimensional viscous flow of fluid between two fixed parallel plates. **(10 Marks)**

b. Two fixed parallel plates 8cm apart have laminar flow of oil between them with a maximum velocity of 1.5m/s. Taking dynamic viscosity of oil as 2NS/m^2, compute i) Discharge per unit width ii) Shear stress at the plates iii) Pressure difference between two points 25m apart iv) Velocity at 2cm from the plate v) Velocity gradient at the plate ends. **(10 Marks)**

4 a. Derive the Reynold's equation of turbulence. **(10 Marks)**

b. The friction factor for turbulent flow can be given as $\frac{1}{\sqrt{f}} = 2\log_{10}\left(R_o/k\right) + 1.74$, where f = friction factor , R_o = Pipe radius. Two reservoirs with a surface level difference of 20m are to be connected by 1m diameter pipe 6km long. What will be the discharge when cast iron pipe of roughness k = 0.3mm is used? What will be the percentage increase in the discharge if cast iron is replaced by steel pipe of k = 0.1mm. **(10 Marks)**

5 a. Define the following terms : i) Boundary layer thickness ii) Displacement thickness iii) Momentum thickness iv) Skin friction co-efficient v) Energy thickness. **(10 Marks)**

b. Assume the velocity profile in the laminar boundary layer over a flat plate to be a 3rd order polynomial. Find the boundary layer thickness in terms of Reynold's number. **(10 Marks)**

6 a. Write a note on : i) Control of boundary layer separation ii) Boundary layer separation. **(10 Marks)**

b. State whether the flow is attached or deattached for the following velocity profiles.

i) $\frac{u}{U_0} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$ ii) $\frac{u}{U_0} = -2\left(\frac{y}{\delta}\right) + \left(\frac{y}{\delta}\right)^3 + 2\left(\frac{y}{\delta}\right)^4$ iii) $\frac{u}{U_0} = 2\left(\frac{y}{\delta}\right)^2 + \left(\frac{y}{\delta}\right)^3 - 2\left(\frac{y}{\delta}\right)^4$

(10 Marks)

7 a. Define the following terms : i) Streamlined body ii) Bluff body iii) Lift & drag. **(06 Marks)**

b. A flat plate 1m × 1m, moves at 6.5m/s normal to its plane. Compute the resistance of the plate when the surrounding fluid is i) Air with $\rho = 1.2$ kg/m^3 ii) Water $C_d = 1.15$. Assume drag co-efficient. **(04 Marks)**

c. State Stoke's law for finding drag force on a sphere moving in an infinite medium. How this law can be applied to determine viscosity of fluid. A 3mm diameter sphere made of steel (Sp wt 75kN/m^3) falls in glycerine Sp. wt. (12.5kN/m^3) at a terminal velocity of 0.035m/s. Find drag co-efficient on the sphere. **(10 Marks)**

8 Write short notes on the following :

a. Hot wire anemometer.
b. Laser Doppler velocity meter.
c. Lagrangian & Eulerian method.
d. Boundary layer theory. **(20 Marks)**

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