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12MTP13

First Semester M.Tech. Degree Examination, February 2013
Advanced Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions.*
2. Fluid mechanics charts and tables are permitted.

1 a. Describe the basic approaches to the analysis of fluid motion, and explain the Largrangian and Eulerian method of studying fluid flow. **(10 Marks)**

b. The velocity field in a fluid medium is given by, $\vec{V} = 3xy^2\,\vec{i} + 2xy\,\vec{j} + (2zy + 3t)\vec{k}$. Find the magnitude and direction of
i) Transitional velocity ii) Rotational velocity iii) The vorticity of fluid element at (1, 2, 1) and time t = 3. **(10 Marks)**

2 a. Derive an Euler's equation of fluid motion and obtain the Bernoulli's equation. **(08 Marks)**

b. Derive 3D continuity equation in cartisian coordinates. **(07 Marks)**

c. In a two – dimensional incompressible steady flow field with a velocity components in rectangular co – ordinates are given by

$$u(x,y) = \frac{k(x^2 - y^2)}{(x^2 + y^2)}, \quad v(x,y) = \frac{2xyk}{(x^2 + y^2)^2}$$

Where 'k' an orbitary non – zero constant. Verify is the equation of continuity is satisfied? **(05 Marks)**

3 a. Derive an expression for Hagen – Poiseuille equation for steady laminar flow in a pipe. And obtain an expression for Darcy Weisbach friction factor and Reynolds number in laminar flow. **(12 Marks)**

b. The average velocity of water in a smooth stainless steel pipe of diameter 50 mm is 5 m/s. The length of the pipe is 6m. Find the pressure drop across the pipe. Find the pumping power required to overcome losses in the tube. **(08 Marks)**

4 a. What is laminar and turbulence flow explain the neat sketch. Define intensity of turbulence and Reynolds stress. Explain the Prandtl mixing length hypothesis. **(12 Marks)**

b. Prove that for turbulent flow through a circular pipe the ratio of maximum velocity to average velocity is given by

$$\frac{u_{max}}{u_{avg}} = 1 + 1.43\sqrt{f}\,.$$ **(08 Marks)**

5 a. Beginning from the Navior – stokes equation for fluid flow derive an equation for normal and shearing stresses acting on the surface of a sphere. Assume incompressible, steady uniform flow. Hence deduce the total drag on the sphere. **(15 Marks)**

b. Write short on "Hele – Shaw" flow. **(05 Marks)**

6 a. Deduce an momentum integral equation of two –dimensional incompressible laminar boundary layer given by, $\frac{d}{dx}(U^2\delta) + \delta U\frac{dU}{dx} = \frac{\tau x}{y}$. **(12 Marks)**

b. 10000 kW power is required to cruise a passenger ship of 300 m length and 10 m draft at 40 km/hr. If γ = 1030 kg/m^3 and $\gamma = 1 \times 10^{-6}$ m^2/s. Determine the friction and wave resistance of the ship. **(08 Marks)**

7 a. Briefly explain the following with respect to flow around bodies
i) Drag force ii) Lift force iii) Skin friction drag iv) Wake
v) Form drag vi) Wave drag vii) Induced drag viii) Stokes flow
ix) Creeping flow x) Stream lined body. **(10 Marks)**

b. A vehicle having a projected area of 6 m^2 is traveling at 90 km/hr. The total resistance to the motion of the vehicle is 2.2 kN. If 20% and 10% of the total resistance area due to rolling friction and surface friction respectively and balance resistance is the form drag. Determine the form drag coefficient. Take density of air to be 1.2 kg /m^3. **(10 Marks)**

8 Write short note on any Four of the following :
a. Flow visualization techniques
b. Doppler velocity meter
c. Wind tunnel
d. Types of errors
e. Hot wire anemometer. **(20 Marks)**

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