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10MTP13

First Semester M.Tech. Degree Examination, December 2011
Advanced Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: *Answer any FIVE full questions.*

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. What is a continuum? Explain the concept of continuum. Also write the significance of Knudsen number. **(06 Marks)**

b. Explain the Lagrangian and Eulerian method of studying the fluid flow. **(04 Marks)**

c. A fluid flow is given by $\vec{V} = a(x^2 - y^2)i - 2axyj$. Check whether this flow is a possible 2D steady flow? If so, find the stream function. Also, check whether the flow is rotational or irrotational. If irrotational, find the velocity potential. **(10 Marks)**

2 a. Derive the continuity equation for a 3D incompressible steady inviscid flow in cylindrical co-ordinate. **(12 Marks)**

b. Consider an incompressible, steady flow field with constant viscosity. The velocity components are given by $u(y) = y\frac{U}{h} + \frac{h^2}{2\mu}\left(\frac{-dP}{dx}\right)\frac{y}{h}\left(1 - \frac{y}{h}\right)$ and $v = w = 0$

If body force is neglected, does u(y) satisfy the equation of motion? **(08 Marks)**

3 a. Write a note on wake frequency. **(04 Marks)**

b. Derive an expression for the velocity distribution for a laminar flow, through concentric annulus. **(10 Marks)**

c. Water at 20°C flows between two large parallel plates 1.5mm apart. If the average velocity is 0.15m/s, find i) the maximum velocity ii) the pressure drop iii) the wall shearing stress and frictional coefficient. [Take $\mu = 1.01\times10^{-3}$ kg/ms]. **(06 Marks)**

4 a. Explain the Reynold's time averaging concept. **(04 Marks)**

b. Derive an expression for velocity distribution for a turbulent flow, through a smooth pipe. **(10 Marks)**

c. Oil of specific gravity 0.9 and dynamic viscosity (μ) of 10^{-1} kg/ms, flows between two fixed parallel plates kept 12mm apart. If the average velocity is 1.5m/s, calculate
i) The maximum velocity ii) Shear stress on the plate iii) Velocity & shear stress at a distance 3mm from one of the plates. Also calculate head loss in a length of 30m. **(06 Marks)**

5 a. Starting from the N-S equation, derive an expression for the 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 notes on the hydrodynamic theory of lubrication. **(05 Marks)**

6 a. Using Von-Karman integral equation, derive an expression for boundary layer thickness for a flow over a flat plate, with suitable boundary conditions. **(08 Marks)**

b. Using the power law profile for a boundary layer on a flat plate $\frac{u}{U} = \left(\frac{y}{\delta}\right)^{1/7}$ and the Von-Karman integral $\frac{\tau_0}{\rho U^2} = \frac{d\theta}{dx}$, find the expressions for δ, τ_w, C_D' and C_D, where δ, τ_w, C_D' and C_D are boundary layer thickness, wall shear stress, local skin friction and drag coefficient respectively. **(12 Marks)**

7 a. Explain the development of lift and drag on an airfoil. **(10 Marks)**

b. Write a note on a streamlined body. **(04 Marks)**

c. A circular kite of 1.5 m^2 and negligible thickness is held by a chord when the wind velocity is 30 km/hr and blows horizontally. The angle of the chord to the horizontal is 60°. If the mass of the kite is 0.5kg and the tension in the chord holding the kite is 25N, calculate the drag and lift forces on the kite and the values of the drag and lift coefficients. [Take density of air as 1.2 kg/m^3.] **(06 Marks)**

8 a. Explain the sources of errors on measurement, with suitable graphs. **(06 Marks)**

b. List the salient features involved in the operation of a hot-wire anemometer. **(06 Marks)**

c. Explain the procedures to estimate the uncertainty. **(08 Marks)**

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