4E 2051

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4E 2051

B.Tech. IV Semester (Main/Back) Examination 2012

Mechanical Engineering

4ME3 Fluid Mechanics

Time : 3 Hours **Maximum Marks : 80**

Min. Passing Marks : 24

Instructions to Candidates:

*Attempt Overall **Five questions** selecting **one question** from **each unit**. All questions carry **equal marks**. (Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used/ calculated must be stated clearly.)*

Unit - I

1. a) If the velocity profile over a flat plate is a parabola with vertex 15cm from the plate, where velocity is 1.0m/s. Calculate the velocity gradients and shear stress at a distance 0 cm, 5 cm and 10 cm from the stationary plate. Assume velocity distribution as $\mu = a+by+cy^2$ and $\mu = 8.5$ poise. **(8)**

   b) A square lamina, length = 3a, with a hole of radius 'a' cut centrally, held with its surface inclined at 30^0 to the horizontal and one of its surface at water surface is immersed in water. Calculate total pressure and location of centre of pressure. **(8)**

OR

1. a) If the equation of a velocity distribution over a plate is given by $u = (2y-y^2)$, where u is the velocity in metre/sec at a point y metre from the plate measured perpendicularly, determine

   i) The shear stress at the boundary and

   ii) At a point 15cm from the boundary. If the above velocity distribution occurs in a pipe of 3cm diameter, find the total resistance over a length of 100m, assuming $\mu = 8.60$ poise. **(8)**

   b) Compute the barometric pressure in bar at an attitude of 1200m if the pressure at sea level is 1.013 bar. Assume isothermal condition at 21^0C. **(8)**

Unit - II

2. a) Explain the various motion of a fluid element with the help of neat sketches. **(8)**

b) A window in a vertical wall is located at 30m above the ground level. A jet of water 50mm diameter (and located 1m above the ground) strikes the window and supplies 210 m^3/hr. Find the greatest distance from the wall at which fire nozzle be located so that the jet of water strikes the window. **(8)**

OR

2. a) Derive Bernoulli's equation. State assumptions also. **(8)**

b) Sketch the streamlines represented by

i) $\psi = x^2+y^2$ and (ii) $\psi = 2xy$

Also find the velocity and its direction at point (1,1). Also verify the conditions of continuity and irrotational flow are satisfied. **(8)**

Unit - III

3. a) Two orifices were placed in the side of a tank at depths H_1 and H_2 from the water surface and at height h_1 and h_2 from the base of the tank respectively. If the two jets from orifices intersect at a height 'k' from a plane through the base of the tank, prove that $k = \frac{(H_1 h_1 - H_2 h_2)}{(H_1 - H_2)}$. **(6)**

b) A pipe line of 0.6m diameter is 1.5km long. To augment the discharge, another pipeline of the same diameter is introduced parallel to the first one for the last one kilometer length. Neglecting the minor losses, find the increase in the discharge. The head at inlet is given as 30m and f = 0.04. **(10)**

OR

3. a) A cylindrical tank 1m in diameter, is filled with water and is provided with an orifice, (Cd = 0.64, Cv = 0.98), 5cm in diameter in its vertical side. Jet of water issuing out of the orifice strikes the horizontal floor 20cm below the centre of orifice. As the head in the tank falls, the striking jet on the floor approaches the tank. Determine the rate of approach of the tank. **(8)**

b) Two pipes, one of 15cm diameter, 300m long and the other of 30cm diameter and 800m long are connected in parallel. The total discharge through the pipe system is 0.8 m^2/s. Find the discharge through each pipe and the head loss. Assume f = 0.02 for 15cm diameter pipe and f = 0.03 for 30cm diameter pipe. **(8)**

Unit - IV

4. a) Derive Hagen-Poisenlle's equation for laminar flow through close conduits. State assumptions also. **(8)**

b) Show that the viscous force 'F' exerted by a fluid on a sphere of diameter 'D', in which it is moving with velocity 'v' is given by -

$$F = \varrho D^2 v^2 f(\varrho Dv/\mu)$$

OR

4. a) In a laboratory experiment on a 30cm diameter pipeline carrying water gave mean Velocity and velocity gradient as 2m/s and 12.5 m per sec at a point 2.5cm from the pipe wall. Assume rough turbulant flow, determine

(i) friction velocity,

(ii) average height of roughness

(iii) Doncy's friction coefficient and

(iv) flow rate in the pipeline. **(8)**

b) A 1:25 scale geometrically similar model of a spillway has been prepared in the laboratory following Froude's law. Determine -

i) rate of flow over the model to simulate 6250 m^3/s in the prototype.

ii) the corresponding velocity in the prototype corresponding to a velocity of 1.6 m/s observed in the model at a section, and

iii) the energy dissipated by the hydraulic jump in the prototype corresponding to 0.3kw in the model. **(8)**

Unit - V

5. a) What do you understand by boundary layer. Explain various boundary layer thickness, giving their formulas. Also, explain in brief the methods of controlling boundary layer. **(11)**

b) The drag coefficient due to boundary layer for a flat plate is given by

$$C_r = 0.454 / (\log_{10} R_{eL})^{2.58}$$

where R_{eL} is the Reynolds number based on length. If a plate 50cm wide and 5m long is kept parallel to the flow of water with free stream velocity of 3 m/s.

i) Calculate the drag force on both sides of the plate. Take $v = 10^{-6}$ m^2/s.

ii) determine the power required to tow the plate at 3 m/s in the stationary fluid. **(5)**

OR

5\. a) A flat plate 2m long and 1.5m wide moves at 50 km/hr in stationary air of specific weight 11.28 N/m^3. If the coefficients of drag and lift are 0.15 and 0.75 respectively, determine

i) lift force

ii) drag force

iii) resultant force and

iv) the power required to keep the plate in motion. **(6)**

b) What do you understand by separation of boundary layer? Draw neat sketch for velocity distribution and pressure variation in case of separation of boundary layer. Why the separation of flow is not desirable? **(6)**

c) Calculate shape factor 'H' i.e. ratio of displacement thickness and momentum thickness for the velocity distribution given by eq^n $\frac{u}{U_0} = \frac{y}{\delta}$. **(4)**