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BME-028

B.Tech. MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING)

01905

Term-End Examination

December, 2014

BME-028 : FLUID MECHANICS

Time : 3 hours *Maximum Marks : 70*

Note : *Answer any* ***seven*** *questions. Use of scientific calculator is permitted. All questions carry equal marks.*

1. (a) A formula for estimating the volume rate of flow, Q, over the spillway of a dam is

$$Q = C \sqrt{2g}\ B\ (H + V^2/2g)^{3/2}$$

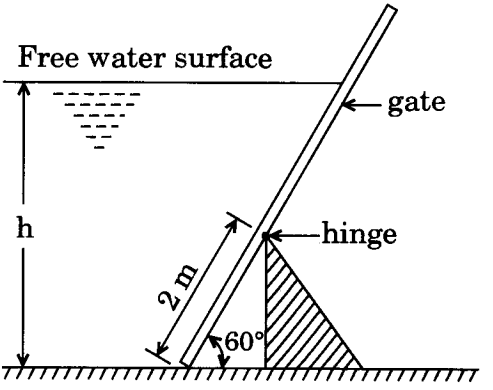
where C is a constant, g is the acceleration due to gravity, B is the spillway width, H is the depth of water passing over the spillway, and V is the velocity of water just upstream of the dam. Would this equation be valid in any system of units ? Explain. 5

(b) A Newtonian fluid having a viscosity of 0·38 $N.S/m^2$ and a specific gravity of 0·91 flows through a 25 mm diameter pipe with a velocity of 25 m/s. Determine the value of the Reynolds number. 5

2. (a) A 150 mm diameter vertical cylinder rotates concentrically inside another cylinder of diameter 151 mm. Both the cylinders are of 250 mm height. The space between the cylinders is filled with a liquid of viscosity 10 poise. Determine the torque required to rotate the inner cylinder at 100 rpm. *5*

(b) Explain the difference between U-tube differential manometers and inverted U-tube differential manometers. Where are they used ? *5*

3. (a) A gate supporting water is shown in Figure 1. Find the height 'h' of the water, so that the gate begins to tip about the hinge. Take the width of the gate as unity. *5*



(b) Define the terms : meta-centre, centre of buoyancy, meta-centric height, dynamic viscosity and centre of pressure. *5*

4. (a) Describe the use and limitations of the flow nets. Under what conditions can one draw flow nets ? 5

(b) The velocity components in a two- dimensional flow are :

$$u = 8x^2y - \frac{8}{3}y^3 \text{ and } v = -8xy^3 + \frac{8}{3}x^3$$

Show that these velocity components represent a possible case of an irrotational flow. 5

5. (a) For a two-dimensional potential flow, the velocity potential is given by :

$$\phi = 4x(3y - 4)$$

Determine the velocity and the value of stream function ψ at the point (2, 3). 5

(b) What do you mean by equipotential line and a line of constant stream function ? Prove that the equipotential lines are orthogonal to the stream lines at all points of intersection. 5

6. (a) What do you mean by geometric, kinematic and dynamic similarities ? Describe any two dimensionless numbers which should be same for the model and the prototype for dynamic similarity between the model and the prototype. 5

(b) The pressure drop in an aeroplane model of size 1:10 of its prototype is 80 N/cm^2. The model is tested in water. Find the corresponding pressure drop in the prototype. Take density of air to be 1·24 kg/m^3. The viscosity of water is 0·01 poise while viscosity of air is 0·0002 poise. Linear scale ratio, $L_r = 40$. 5

7. (a) Define an orifice-meter. Prove that the discharge through an orifice-meter is given by the relation.

$$Q = C_d \frac{a_0 \cdot a_1}{\sqrt{a_1^2 - a_0^2}} \cdot \sqrt{2gh}$$

Where; a_1 = area of pipe in which the orifice-meter is fitted.

a_0 = area of orifice

g = acceleration due to gravity

h = differential head 5

(b) A 250 mm diameter pipe carries water under a head of 20 meters with a velocity of 5 m/s. If the axis of the pipe turns through 45°, find the magnitude and direction of the resultant force at the bend. 5

8. (a) Explain the advantages of triangular notches over rectangular notches. A right angled V-notch measures a discharge of 1800 litre/minute. An error of 2 mm was made in measuring the head over the notch. Calculate the percentage error in measurement of the discharge.
Take $C_d = 0{\cdot}65$. *6*

(b) Prove that the maximum velocity in a circular pipe for viscous flow through it is equal to twice the average velocity of the flow. *4*

9. (a) Find the displacement thickness and the momentum thickness for the velocity distribution in the boundary layer given by

$$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$$ *5*

(b) What is circulation ? Find the circulation, lift force and the position of stagnation points for a cylinder rotating at 150 rpm with its axis perpendicular in an air stream which has a uniform velocity of 25 m/s. The cylinder is 1·5 m in diameter and 10 meters long. Take density of air as 1·24 kg/m^3. *5*

10. (a) Calculate the diameter of a parachute to be used for dropping an object of mass 80 kg, so that the maximum terminal velocity of dropping is 4 m/s. The co-efficient of drag for the parachute, which may be treated as hemispherical is 1·35 and the density of air is 1·24 kg/m^3. *5*

(b) Define and explain any ***two*** of the following terms : *5*

(i) Energy correction factor and momentum correction factor

(ii) Hydraulic gradient line and total energy line

(iii) Cavitation and water hammer