BE/MECA/Sem-IV/CBGS/Sub-FM&M/ Dt- 8/12/2016

mechatronics

Q.P. Code : 723602

(3 Hours) **[Total Marks : 80**

N.B. : (1) Question **No.1** is **compulsory.**
(2) Attempt **any Three** questions from question **No.2** to **6.**
(3) Use Illustrative **diagrams** wherever **required.**

1. (a) Explain variation of viscosity with temperature for gases and liquids? Justify the same and give the relation between viscosity and temperature for liquid and gasses. **5**
   (b) State the momentum equation and mention some of its engineering applications. **5**
   (c) What do you mean by dimensionless numbers? Name any four dimensionless numbers. **4**
   (d) Prove that the work done per second per unit weight of water in a reaction turbine is given as $\frac{1}{g}\left(V_{w_1}u_1 \pm V_{w_2}u_2\right)$. **6**

2. (a) Determine the total pressure and depth of centre of pressure on a plane rectangular surface of 1 m wide and 3 m deep when its upper edge is horizontal and (a) coincides with water surface (b) 2 m below the free water surface. **6**
   (b) State Bernoulli's theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli's theorem from first principle and state the assumptions made for such a derivation. **10**
   (c) Differentiate between a single-acting and double acting reciprocating pump. **4**

3. (a) Show that the difference of pressure head for a given length of the two parallel plates which are fixed and through which viscous fluid is flowing is given by **8**

$$h_f = \frac{12\mu\bar{u}L}{\rho g t^2}$$

Where μ = Viscosity of fluid,
$\bar{U}$ = Average velocity,
L = Length of the plates,
t = Distance between the two parallel plates.

TURN OVER

(b) A Pelton wheel is supplied with water under a head of 45 m and at a rate of 48 m^3/min. The buckets deflect the jet through 165° and the mean bucket speed is 14 m/s. Calculate the power delivered to shaft and overall efficiency of the machine. Assume coefficient of viscosity 0.985 and mechanical efficiency 0.95. 6

(c) Define indicator diagram. How will you prove that area of indicator diagram is proportional to the work done by the reciprocating pump? 6

4. (a) Find an expression for the head lost due to friction in suction and delivery pipe. 8

(b) In 1 in 20 model of stilling basin, the height of hydraulic jump in the model is observed to be 20 cm. What would be the corresponding height of jump in the prototype? If the energy dissipation in the model is 0.1 kW, what would be the corresponding value in the prototype? 4

(c) By means of a neat sketch explain the governing mechanism of Francis Turbine. 8

5. (a) Explain the terms : distorted models and undistorted models. What is the use of distorted models? 8

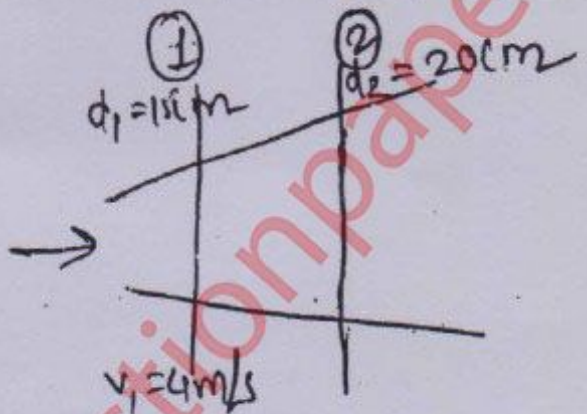
(b) Why pumps are generally less efficient than turbines? 6

A centrifugal pump is required to deliver 50 liters of water per second to a height of 30 m through a 100 mm long pipe of 15 cm diameter. The inlet losses in the suction pipe are estimated to be 0.35 m. Assuming an overall efficiency of 70 percent and taking Darcy's friction coefficient 0.015 for the pipeline, determine the power required to drive the pump.

(c) Define displacement thickness. Derive an expression for the displacement thickness? 6

6. (a) Derive an expression for the depth of centre of pressure from free surface of liquid of an inclined plane surface sub-merged in the liquid. **10**

(b) The diameter of a pipe at the sections 1 and 2 are 15 cm and 20 cm respectively. Find the discharge through the pipe if velocity of water at section 1 is 4 m/s. Determine also the velocity at section 2. **4**



(c) A single acting reciprocating pump has and a stroke length of 15 cm, the suction pipe is 7 m long and the ratio of suction pipe diameter to the plunger diameter is¾. The water level in the sump is 2.5 m below the axis of the pump cylinder and the pipe connecting the sump and pump cylinder is 7.5 cm diameter. If the crank is running at 75 rpm, determine the pressure head on the piston at the beginning, mid and end of the suction stroke. Take friction coefficient f = 0.1. **6**