Ref. No.: Ex/PROD/PC/B/T211/2023

**B.E. PRODUCTION ENGINEERING SECOND YEAR FIRST SEMESTER EXAM 2023**

**Subject: FLUID MECHANICS AND MACHINES**

**Time: 3 hours** **Fullmarks:100**

**Answers any three questions from (1 to 5) and any two from (6 to 8)**

1. (a) Explain the pressure variation in a fluid at rest a condition at any depth following hydrostatic law.

(b) A differential manometer is connecting at the two points A and B of two pipes as shown in the figure 1. The pipe A contains a liquid of specific gravity = 1.5 while pipe B contains a liquid of specific gravity = 0.9. The pressure at A and B are 1 kgf/cm$^2$ and 1.80 kgf/cm$^2$ respectively. Find the difference in mercury level in the differential manometer.

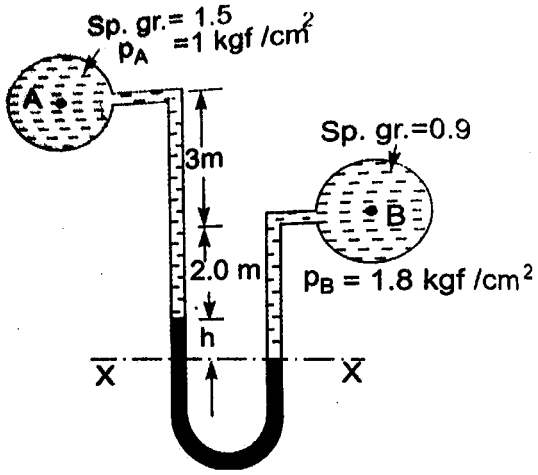


Fig.1

(c) A square aperture in the vertical side of a tank has one diagonal vertical and is completely converted by a plane plate hinged one of the upper sides of the aperture. The diagonals of the aperture are 2 m long and the tank contains a liquid of specific gravity 1.15. The centre of aperture is 1.5 m below the free surface. Calculate the thrust exerted on the plate by the liquid and position of its centre of pressure. **(5+7+8 = 20)**

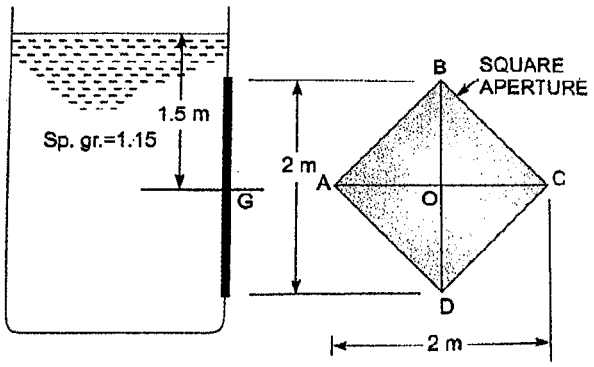


Fig.2

[ Turn over

2. (a) An inclined rectangular sluice gate AB, 1.2 m by 5 m size as shown in the figure 3 is installed to control the discharge of water. The end A is hinged is hinged. Determine the force normal to the gate applied at B to open it.

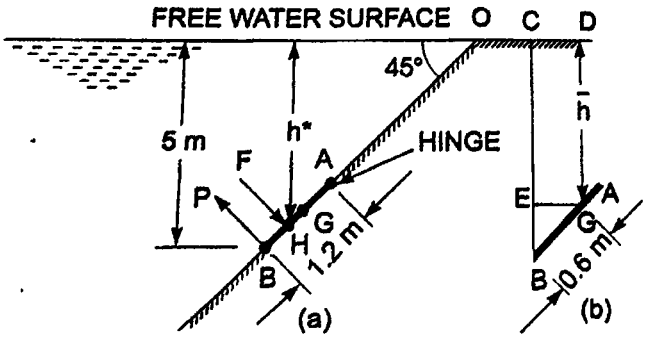


Fig.3

(b) Explain the (i) Lamina flow, (ii) Turbulent flow and (iii) non uniform flow.

(c) The stream function for a two-dimensional flow is given by $\Psi = 2xy$. Calculate the velocity at a point P (2,3). Find the velocity potential function ø. **(10+6+4 = 20)**

3. (a) Discussed the relation between steam function and velocity potential function. What are those properties obtaining from steam function? Prove that $\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$, from three dimensional continuity equation.

(b) A 30 cm x 15 cm venturimeter is provided in a vertical pipe line carrying oil of specific gravity 0.9, the flow being upwards. The difference in elevation of the throat section and the entrance of the venturimeter is 30 cm. The differential U-tube mercury manometer shows a gauge deflection of 25 cm. Calculate:

(i) The discharge of oil, and

(ii) the pressure difference between the entrance section and the throat section. Take the co-efficient of discharge as 0.98 and the specific gravity of mercury as 13.6. **(10+10=20)**

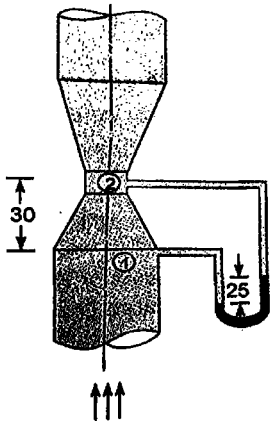


Fig.5

4. (a) States Bernoulli's theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli's equation from the first principle and state the assumptions made for a such a derivation.

   (b) A pitot tube is inserted in a pipe of 300 mm diameter. The static pressure in pipe is 100 mm in mercury (vacuum). The stagnation pressure at the centre of the pipe, recorded by the pitot-tube is 0.981 N/cm$^2$. Calculate the rate of flow of water through pipe, if the mean velocity of flow is 0.85 times the central velocity. Take $C_V$=0.98.

   (c) Distinguished between venturimeter and orifice meter. **(7+9+4=20)**

5. (a) Derive the expression for

   $C_d$(co efficient of discharge) =

   $C_v$ (co efficient of velocity) × $C_c$(co efficient of contraction).

   (b) A horizontal pipe of diameter 500 mm is suddenly contracted to a diameter of 250 mm. the pressure intensities in the large and smaller pipe is given as 13.734 N/cm$^2$ and 11.772 N/cm$^2$ respectively. Find the loss of head due to contraction if $C_c = 0.62$. And also determine the rate of flow of water.

   (c) Derive the Chezy's formula for loss of head due to friction in pipe. **(3+10+7= 20)**

6. (a) Explain the layout of hydroelectric power plant. What are those parameters required to design the pelton wheel?

   (b) A pelton wheel is working under a gross head of 400 m. The water is supplied through penstock of diameter 1 m and length 4 km from reservoir to the pelton wheel. The co-efficient of friction for the penstock is given as 0.008. The jet of water of diameter 150 mm strikes the buckets of the wheel and gets deflected through an angle of 165$^0$, the relative velocity of water at outlet is reduced by 15% due to friction between inside surface of the bucket and water. If the velocity of the bucket is 0.45 times the jet of velocity an inlet and mechanical efficiency as 85%. Determined:

   (i) Power given to the runner
   (ii) Shaft power
   (iii) Hydraulic efficiency and overall efficiency.

(c) Explain the Thoma's cavitation factors for centrifugal pumps? Write down the effects of cavitation for centrifugal pump. **(5+10+5 = 20)**

7. (a) As inward forward reaction turbine has external and internal diameters as 1.0 m and 0.6 m respectively. The hydraulic efficiency of the turbine is 90% when the head of the turbine is 36 m. The velocity of flow at outlet is 2.5 m/s and the discharge at outlet is radial. If the vane angle at outlet is $15^0$and the width of the wheel is 100 mm at inlet and outlet, determine: (i) the guide blade angle, (ii) speed of the turbine, (iii) vane angle of the runner at inlet, (iv) volume flow rate of turbine and (v) power developed.

   (b) Distinguished between centrifugal and reciprocating pump? Explain the multistage centrifugal pump in a parallel condition and what makes the difference between high head and high discharge?

   (c) Define the slip for reciprocating pump? **(10+8+2=20)**

8. (a) A $\frac{1}{5}$ th scale model of a pump was tested in a laboratory at 1000 rpm. The head developed and the power input at the best efficiency point were found to be 8 m and 30 Kw respectively. If the prototype pump has to work against a head of 25 m, determined its working speed, the power required to drive it and the ratio of the flow rates handled by the two pumps.

   (b) The length and the diameter of a suction pipe of a single-acting reciprocating pump are 5 m and 10 cm respectively. The pump has a plunger of diameter 15 cm and a stroke length of 35 cm. the center of pump is 3 m above the water surface in the pump. The atmospheric pressure head is 13.3 m of water and pump is running at 35 rpm. Determine:

   (i) Pressure head due to acceleration at the beginning of the suction stroke,
   (ii) Maximum pressure head due to acceleration
   (iii) Pressure head at the cylinder at the beginning and the end of the stroke,

   **(10 +10=20)**