Ref. No.: Ex/PROD/PC/B/T/211/2023(S)

B.E. PRODUCTION ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM - 2023

Subject: FLUID MECHANICS AND MACHINES

Time: 3 hours **Fullmarks:100**

Answers any five questions

1. (a) A fluid obeying the equation $\tau = \tau_o + k\left(\frac{du}{dy}\right)^{1/2}$ is held between two parallel plates 'd' apart if the stress applied to the top plate is $3\tau_o$, then find the velocity with which top plate moves.

   (b) (i) Explain the relation between atmospheric pressure and gauge pressure and absolute pressure with diagram.

   (ii) A differential manometer, with mercury as the gauge fluid is fitted across a water pump, as shown in the figure. If the deflection of the gauge Z is 62 cm of mercury. Find the differential pressure between A and B.

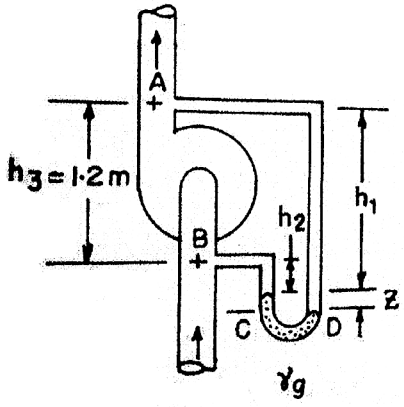

Fig.1

(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)**

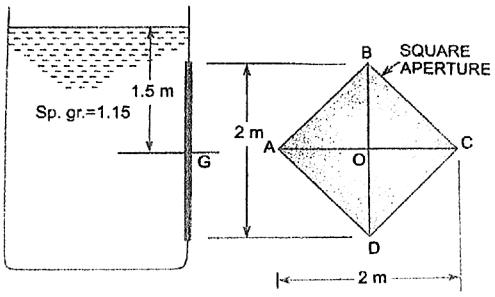

Fig.2

2. (a) A circular plate 3 m in diameter is submerged in water in such a way that the greatest and least depth of the plate below the water surface is 2 m and 1 m, respectively, calculate

   (i) The total pressure on the front face of the plate.
   (ii) The position of the center of pressure.

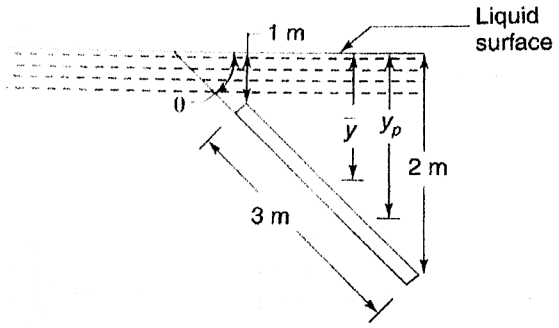

Fig.3

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

(c) velocity component in x and y direction are given by, $\vec{u} = \lambda xy^3 - x^2y$, $\vec{v} = xy^2 - \frac{3}{4}y^4$. Then find the value of λ for incompressible flow. **(8+6+6 = 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 30cm diameter pipe conveying water branches in to two pipes of diameters 20cm and 15cm respectively. If the average velocity in the 30cm diameter pipe is 2.5m/s. find

the discharge in this pipe. Also determine the velocity in 15cm pipe if the average velocity in 20cm diameter pipe is 2m/s.

(10+10=20)

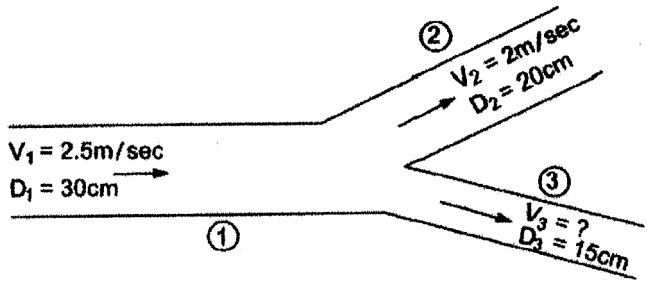

Fig.5

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 path line and stream line. **(7+9+4=20)**

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

   (b) Explain the Thoma's cavitation factors for centrifugal pumps? Write down the effects of cavitation for centrifugal pump.

   (c) 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. **(5+5+10 = 20)**

6. (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) Explain the main parts of the centrifugal pumps using suitable diagram.
   (c) Define the slip for reciprocating pump? **(10+8+2=20)**
7. (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) **write down the short note**
   (i) Multistage centrifugal pump for high heads.
   (ii) Multistage centrifugal pump for high discharge. **(10 +10=20)**