Ref. No.: Ex/PROD/PC/B/T211/2024

B.E. PRODUCTION ENGINEERING SECOND YEAR FIRST SEMESTER EXAM - 2024

Subject: FLUID MECHANICS AND MACHINES

Time: 3 hours **Fullmarks:100**

(Answer any five questions)

1. (a) Define the kinematic viscosity and specific gravity? The equation of state for liquid is $P=\left(3500\rho^{\frac{1}{2}}+2500\right)\frac{N}{m^2}$. Then find the bulk modulus at a pressure of $10^5\ \frac{N}{m^2}$.

   (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.

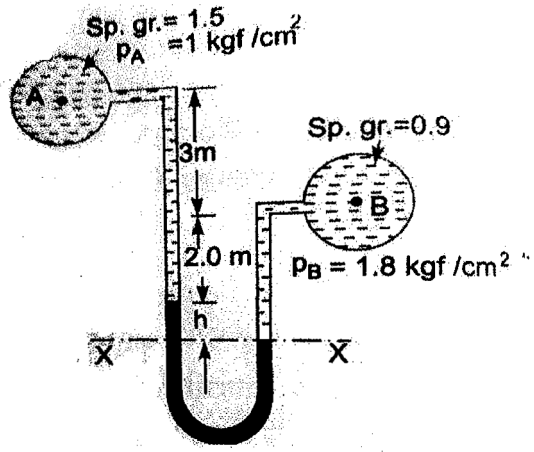

Fig.1

   (c) The pressure outside the droplet of water of diameter 0.04 mm is 10.32 $\frac{N}{cm^2}$ (at atmospheric pressure). Calculate the pressure within the droplet if the surface tension is given as 0.0725 $\frac{N}{m}$ of water. **(8+7+5=20)**

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.

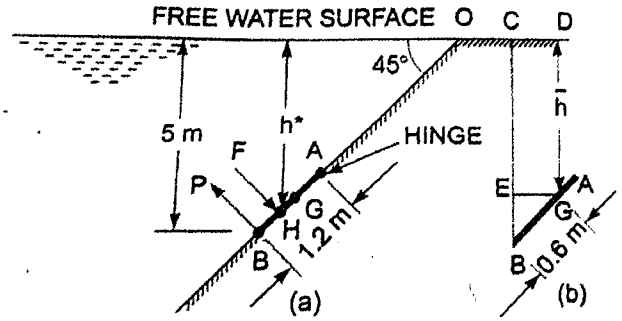

Fig.2

(b) Explain elaborately about the (i) Stream line (ii) path line.

(c) Water flows through a pipe AB 1.2 m diameter at 3 m/s and then passes through a pipe BC 1.5 m diameter. At C, the pipe branches. Branch CD is 0.8 m in diameter and carries one-third of the flow in AB. The flow velocity in branch CE is 2.5 m/s. Find the volume rate of flow in AB, the velocity in BC, the velocity in CD and the diameter of CE.

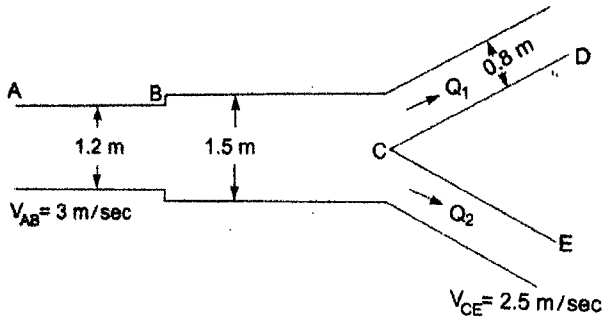

Fig.3

(9+6+5 = 20)

3. (a) The following cases represent the two velocity components, determine the third components of velocity such that they satisfy the continuity equation (i) $u = x^2 + y^2 + z^2$; $v = xy^2 - yz^2 + xy$; (ii) $v = 2y^2$; $w = 2xyz$.

(b) A 20 cm x 10 cm venturimeter is inserted in a vertical pipe carrying oil of specific gravity 0.8, the flow of the oil is upward direction. The difference of levels between the throat and inlet section is 50 cm. the oil mercury differential manometer gives a reading of 30 cm of mercury. Find the discharge of oil, neglect losses. ($C^d = 1.0$)

(c) Prove the Euler's equation and motion and define the necessary assumption required for Euler's equation. **(5+9+6=20)**

4. (a) 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.

(b) Distinguished between venturimeter and orifice meter.

(c) Derive the Chezy's formula for loss of head due to friction in pipe. **(8+4+8= 20)**

5. (a) Explain the layout of hydroelectric power plant. What type of data measured from the design of 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 to be designed for the following specifications: shaft power = 11,772 Kw; Head = 380 meters; Speed = 750 rpm; Overall efficiency = 86%; jet diameter is not to exceed $\frac{1}{6}$ of the wheel diameter. Determine: (i) The wheel diameter, (ii) the number of jet required, and (iii) Diameter of the jet. (Take $K_{v_1} = 0.985$ and $K_{u_1} = 0.45$)

(6+4+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) Distinguish 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?

[Turn over

(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)**