O/E/TX

Reg. No: 22BME0482

VIT®
Vellore Institute of Technology

Final Assessment Test – May 2024

Course: **BMEE204L - Fluid Mechanics and Machines**

Class NBR(s): **4558 / 4559 / 4561 / 4562 / 4565** Slot: **E1+TE1**

Time: **Three Hours** Max. Marks: **100**

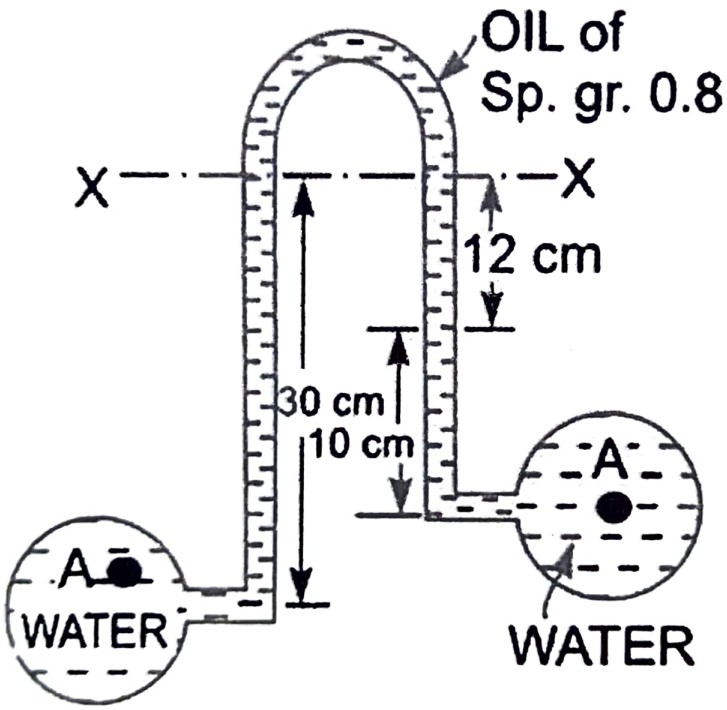
- **KEEPING MOBILE PHONE/ELECTRONIC DEVICES EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE**
- **DON'T WRITE ANYTHING ON THE QUESTION PAPER**

General Instruction: Use of Moody's chart is permitted

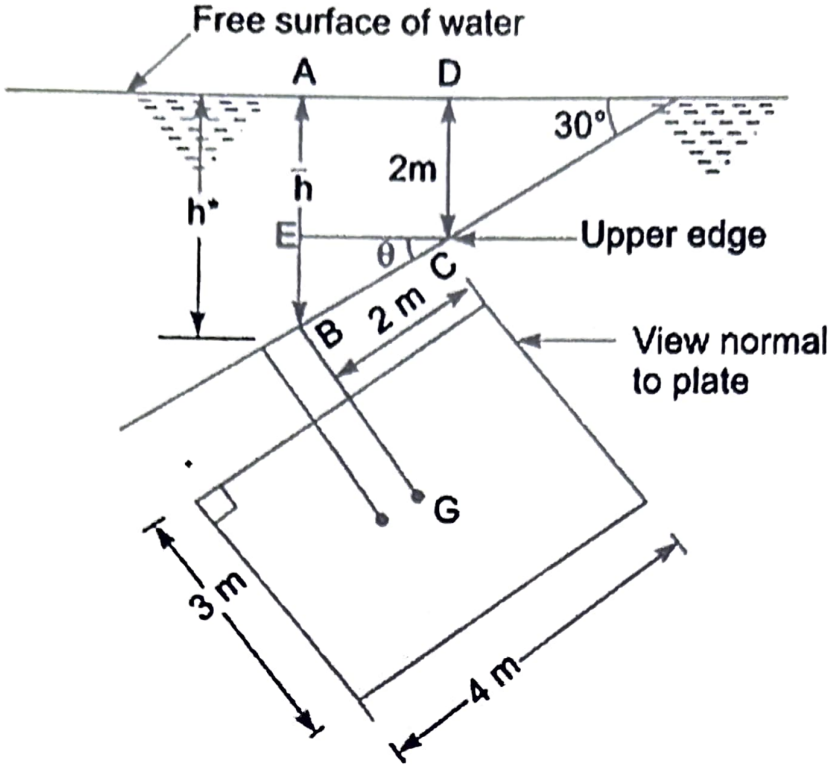
Answer any TEN Questions

(10 X 10 = 100 Marks)

1. Water is flowing through two different pipes to which an inverted differential manometer, shown in figure, having an oil of specific gravity 0.8 is connected. The pressure head in the pipe A is 2 m of water. Find the pressure in the pipe B for the manometer readings as shown in figure.



2. A rectangular plane surface 3 m wide and 4 m deep lies in water in such a way that its plane makes an angle of 30^0 with the free surface of water as shown in figure. Determine the total pressure force and position of centre of pressure, when the upper edge is 2 m below the free surface.



3. A Fluid Field is given by $V = x^2yi + y^2zj - (2xyz + yz^2)k$. Prove that the flow is a possible steady incompressible flow. Calculate the velocity and acceleration at point (2, 1, 3).

4. A pipeline carrying oil of specific gravity 0.87, changes in diameter from 200 mm at a position A to 500 mm at a position B which is 4 m at a higher level. If the pressure at A and B are 9.81 N/cm^2 and 5.886 N/cm^2 respectively and the discharge is 200 litres/s. Determine the loss of head and direction of flow.

5. Water flows at a rate of 0.035 m^3/s in a horizontal pipe whose diameter is reduced from 15 cm to 8 cm by a reducer. If the pressure at the centreline is measured to be 480 kPa and 445 kPa before and after the reducer, respectively, determine the irreversible head loss in the reducer. Take the kinetic energy correction factors to be 1.05.

6. A crude oil of viscosity 0.97 poise and relative density 0.9 is flowing through a horizontal circular pipe of diameter 100 mm and of length 10 m. Calculate the difference of pressure at the two ends of the pipe, if 100 kg of the oil is collected in a tank in 30 seconds.

7. Two sharp ended pipes of diameters 50 mm and 100 mm respectively, each of length 100 m are connected in parallel between two reservoirs which have a difference of level of 10 m. If the co-efficient of friction for each pipe is (4f) 0.32, calculate the rate of flow for each pipe and also the diameter of a single pipe 100 m long which would give the same discharge, if it were substituted for the original two pipes.

8. Derive on the basis of dimensional analysis suitable parameters to present the thrust developed by a propeller. Assume that the thrust P depends upon the angular velocity (ω), speed of advance (V), diameter (D), dynamic viscosity (μ), mass density (ρ), elasticity of the fluid medium which can be denoted by the speed of sound in the medium C.

9. Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$.

10. For the velocity profile given as,

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

Find the thickness of the boundary layer at the end of the plate and the drag force on one side of a plate 1 m long and 0.8 m wide when placed in water flowing with a velocity of 150 mm per second. Calculate the value of co-efficient of drag also. Take μ for water is 0.01 poise.

11. A Pelton wheel is to be designed for the following specifications:

Shaft power is 11722 kW; Head is 380 m; Speed is 750 rpm; Overall efficiency is 86%; Jet diameter is not to exceed one-sixth of the wheel diameter. Determine:

(i) The wheel diameter
(ii) The number of jets required
(iii) Diameter of the jet

Take $K_{v1} = 0.985$ and $K_{u1} = 0.45$

12. The internal and external diameters of the impeller of a centrifugal pump are 200 mm and 400 mm respectively. The pump is running at 1200 rpm. The vane angles of the impeller at inlet and outlet are 20^0 and 30^0 respectively. The water enters the impeller radially and the velocity of flow is constant. Determine the impeller work per unit weight of water.

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