Exam Date & Time: 30-Nov-2023 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

THIRD SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV 2023

FLUID MECHANICS [MIE 2123]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions. Section Duration: 180 mins

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) What is capillarity? Derive the expression for height of capillarity rise. (3)

A)

B) A plate having an area of 0.6 m^2 is sliding down the inclined plane at 45° to the horizontal with a velocity of 0.36 m/s. There is a cushion of fluid 1.8 mm thick between the plane and the plate. Find the viscosity of the fluid if the weight of the plate is 280 N. (3)

C) An inverted U-tube manometer containing a manometric light fluid (specific gravity = 0.7) is connected to two pipes at points A and B. Pipe A carries liquid of specific gravity 1.2 and pipe B carries water. The pipes are at the same level. The height of the liquid of specific gravity 1.2 from the centre of the pipe is 30 cm. If all liquids are immiscible and the pressure in pipe B is 0.2 kPa above the pressure in the pipe A, determine the differential reading of the manometer. (4)

2) A circular plate 3.0 m diameter is immersed in water in such a way that its greatest and least depth below the free surface are 4 m and 1.5 m respectively. Determine the total pressure on one face of the plate and position of the center of pressure. (4)

A)

B) State and prove Pascal's law. What do you understand by Hydrostatic Law? (3)

C) Explain briefly the following:

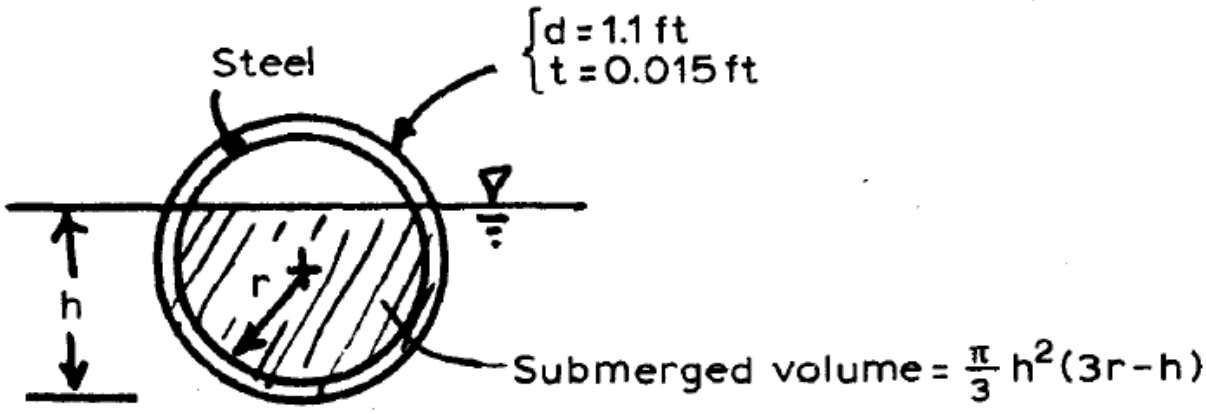
(a)U-tube Manometer.

(b)Vertical Single Column Manometer (3)

(c)Inverted U-tube Differential Manometer.

3) A 1.1 ft diameter hollow sphere is made of steel (specific gravity = 7.85) with 0.015 ft wall thickness. How deep will the sphere sink in water (i.e., find h in figure below)? How much weight must be added inside to make the sphere neutrally buoyant. (4)

A)



B) A uniform body of dimensions 3m x 2m x 1m floats in water, what is the weight of the body if the depth of immersion is 0.8 m? Determine the meta centric height. (3)

C) The volume and the average density of an irregularly shaped body are to be determined by using a spring scale. The body weighs 7200 N in air and 4790 N in water. Determine the volume and the density of the body. State your assumptions. (3)

4) Find the convective acceleration at the middle of a pipe which converges uniformly from 0.4 m diameter to 0.2 m diameter over 2m length. The rate of flow is 20 Lt / s. Assume this is a one dimensional flow and the velocity components in the y and z directions are zero. (4)

A)

B) Define the following: a) Streamline b) Streak line d) Path line e) Stream tube (3)

C) In a two dimensional incompressible flow, the fluid velocity components are given by u = x - 4y and v = - y - 4x. Show that velocity potential exists and determine its form. Also find the stream function. (3)

5) Oil is pumped along a horizontal 15 cm diameter pipe 200 m long. The specific gravity of oil is 0.89 and its kinematic viscosity is 1.3 stokes. Flow is laminar so that the friction factor of pipe is $64Re^{-1}$, in which Re is the Reynold's Number. It takes 18 kW to drive the pump which has efficiency of 65%. (3)

A) Find the quantity of oil flowing through the pipe in liters/minute.

B) Find the discharge of water flowing through a pipe 30cm diameter placed in an inclined position where a venturimeter is inserted, having a throat diameter of 15 cm. The difference of pressure between the main and the throat is measured by a liquid of specific gravity 0.6 in an inverted U tube which gives a reading of 30 cm. The loss of head between the main and the throat is 0.2 times the kinetic head of the pipe. (3)

C) The resisting force R of a supersonic plane during flight can be considered as dependent upon the length of the aircraft l, velocity V, air viscosity μ, air density ρ and bulk modulus of air K. Express the functional relationship between these variables and the resisting force using Buckingham's Π-theorem. (4)

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