Roll No. | | | | | | | | | | | | Total No. of Pages : 03

Total No. of Questions : 09

B.Tech. (Marine Engg.) (2013 Onwards) (Sem.–4)

FLUID MECHANICS

Subject Code : BTME-403

Paper ID : [72436]

Time : 3 Hrs. Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION-A

1. Write briefly :

a) Define incompressible flow and incompressible fluid.

b) What is specific gravity? How is it related to density?

c) A vacuum gage connected to a chamber reads 24 kPa at a location where the atmospheric pressure is 92 kPa. Determine the absolute pressure in the chamber.

d) Define static, dynamic, and hydrostatic pressure. Under what conditions is their sum constant for a flow stream?

e) What is the hydraulic grade line? How does it differ from the energy grade line?

f) What is the difference between a dimension and a unit? Give three examples of each.

g) Which fluid at room temperature requires a larger pump to flow at a specified velocity in a given pipe : water or engine oil? Why?

h) How is the hydrodynamic entry length defined for flow in a pipe? Is the entry length longer in laminar or turbulent flow?

i) Define the Lagrangian description of fluid motion.

j) Define streamline and discuss what streamlines indicate.

SECTION-B

2. A thin 20-cm by 20-cm flat plate is pulled at 1 m/s horizontally through a 3.6-mm-thick oil layer sandwiched between two plates, one stationary and the other moving at a constant velocity of 0.3 m/s, as shown in **Figure-1**. The dynamic viscosity of oil is 0.027 Pa.s. Assuming the velocity in each oil layer to vary linearly,

   a) plot the velocity profile and find the location where the oil velocity is zero and

   b) Determine the force that needs to be applied on the plate to maintain this motion.

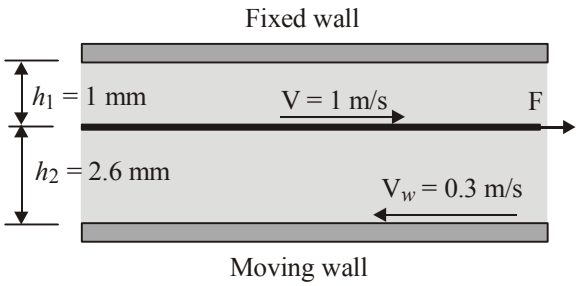

Fig. 1

3. The gage pressure of the air in the tank shown in Figure-2 is measured to be 65 kPa. Determine the differential height *h* of the mercury column.

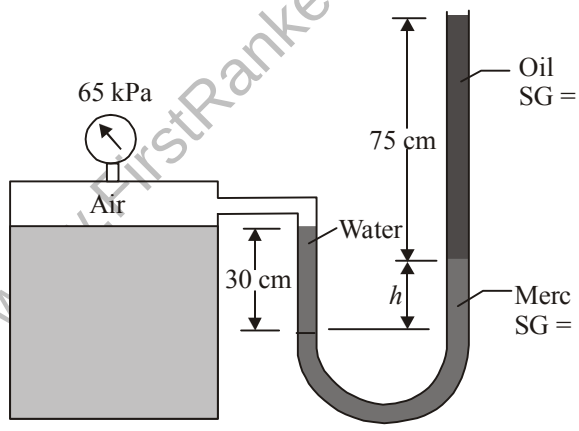

Fig. 2

4. A Pitot-static probe is used to measure the velocity of an aircraft flying at 3000 m. If the differential pressure reading is 3 kPa, determine the velocity of the aircraft.

5. Write the momentum equation for steady one-dimensional flow for the case of no external forces and explain the physical significance of its terms.

6. What is the physical significance of the Reynolds number? How is it defined for :

   a) Flow in a circular pipe of inner diameter D and

   b) Flow in a rectangular duct of cross section $a \times b$?

SECTION-C

7. Water at 10°C ($\rho = 999.7$ kg/m^3 and $\mu = 1.307 \times 10^{-3}$ kg/m · s) is flowing steadily in a 0.20- cm-diameter, 15-m-long pipe at an average velocity of 1.2 m/s. Determine :

   a) The pressure drop.

   b) The head loss.

   c) The pumping power requirement to overcome this pressure drop.

8. Explain how flow rate is measured with obstruction type flow meters. Compare orifice meters, flow nozzles, and Venturi meters with respect to cost, size, head loss, and accuracy.

9. A flow nozzle equipped with a differential pressure gage is used to measure the flow rate of water at 10°C ($\rho = 999.7$ kg/m^3 and $\mu = 1.307 \times 10^{-3}$ kg/m · s) through a 3-cm- diameter horizontal pipe. The nozzle exit diameter is 1.5 cm, and the measured pressure drop is 3 kPa. Determine the volume flow rate of water, the average velocity through the pipe, and the head loss. (Figure-3)

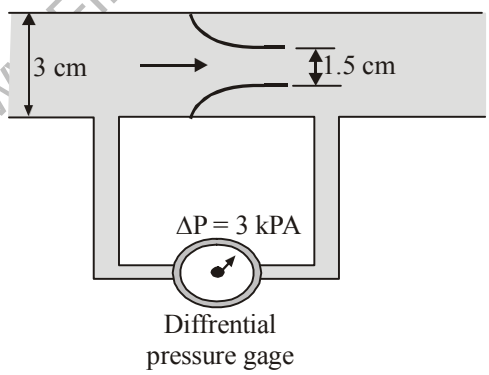

Fig. 3