2017/ODD/12/31/AE–301/403

B.Tech Odd Semester (CBCS) Exam., December—2017

AGRICULTURAL ENGINEERING

(3rd Semester)

Course No. : AECC–01

(Fluid Mechanics)

Full Marks : 50
Pass Marks : 15

Time : 2 hours

Note :
1. Answer *any* **five** questions.
2. Begin each answer in a new page.
3. Answer parts of a question at a place.
4. Assume reasonable data wherever required.
5. The figures in the margin indicate full marks for the questions.

1. *(a)* Define buoyancy. State Archimedes principle. 1+2=3

(b) A small gas bubble rising in an open batch fermenter has a radius of 0·5 cm when it is 3 m below the surface (shown in Fig. 1). Determine the radius of the bubble when it is 1 m below the surface. It may be assumed that the pressure inside the bubble is 2 $/r$ above the pressure outside the bubble, where r is the radius of the bubble and is the

surface tension of the gas-fermentation broth and has a value of 0·073 N/m. The pressure and volume of the gas in the bubble are related by the expression pV c, where c is a constant. 7

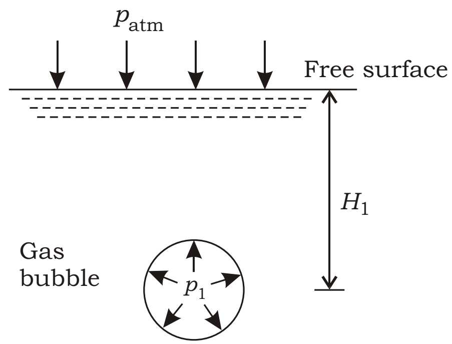

Fig. 1

2. *(a)* Define viscosity. How does kinematic viscosity differ from dynamic viscosity? 1+2=3

(b) A uniform block of steel (SG = 7·85) will 'float' at a mercury-water interface as shown in Fig. 2. What is the ratio of the distances a and b for this condition? 7

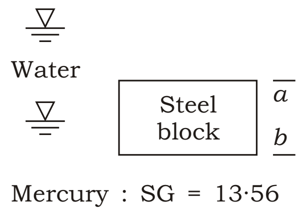

Fig. 2

3. *(a)* Explain the terms 'gauge pressure' and 'absolute pressure'. 3

(b) A laboratory rig is used to examine the frictional losses in small pipes (shown in Fig. 3). Determine the pressure drop in a pipe carrying water if a differential head of 40 cm is recorded using an inverted manometer. 7

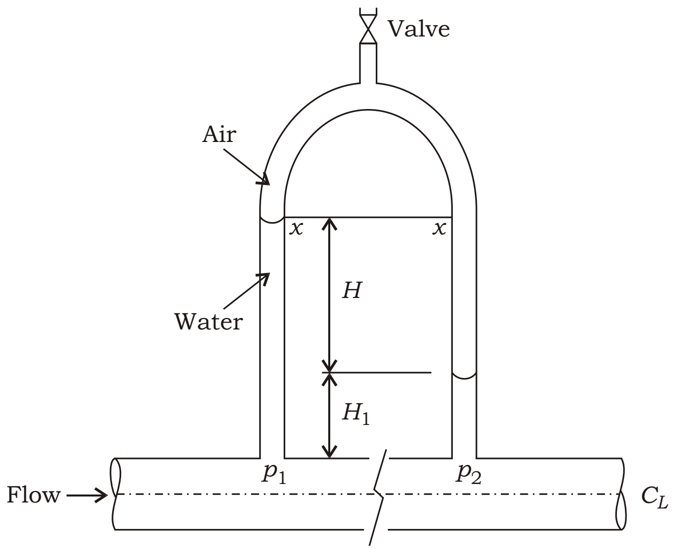

Fig. 3

4. *(a)* Differentiate between Euler's method and Lagrange's method of fluid analysis. 3

(b) The tank (shown in Fig. 4) contains benzene and is pressurized to 200 kPa (gage) in the air gap. Determine the vertical hydrostatic force on circular-arc section *AB* and its line of action. 7

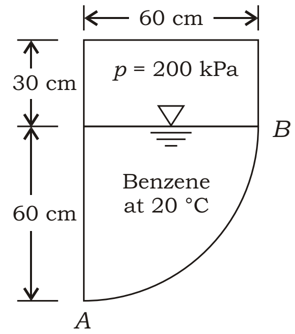

Fig. 4

5. *(a)* A steady, incompressible, two-dimensional velocity field is given by the following components in the *xy*-plane :

u 0 20 1 3x 0 85y

v 0 50 0 95x 1 3y

Calculate the acceleration field (find expressions for acceleration components a_x and a_y) and calculate the acceleration at the point (x, y) (1, 2). 6

(b) Explain the terms 'centre of pressure' and 'centre of buoyancy'. 4

6. *(a)* Define 'pathline' and 'streak line'. 4

(b) Water at 15 °C (= 999·1 kg/m^3 and 1 138 10^3 kg/m-s) is flowing steadily in a 30 m long and 4 cm diameter horizontal pipe made of stainless steel at a rate of 8 L/s. Determine *(i)* the pressure drop, *(ii)* the head loss and *(iii)* the pumping power requirement to overcome this pressure drop. 6

7. *(a)* State Bernoulli's theorem. 3

(b) Oil with a density of 850 kg/m^3 and kinematic viscosity of 0·00062 m^2/s is being discharged by a 5 mm diameter, 40 m long horizontal pipe from a storage tank open to the atmosphere (shown in Fig. 5). The height of the liquid level above the centre of the pipe is 3 m. Disregarding the minor losses, determine the flow rate of oil through the pipe. 7

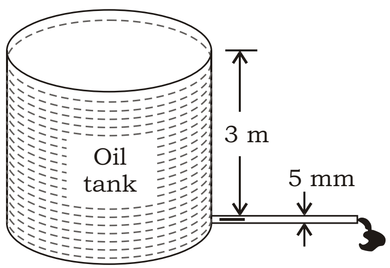

Fig. 5

8. *(a)* Define 'steady flow' and 'uniform flow'. 4

(b) Water enters a tank of diameter D_T steadily at a mass flow rate of $\dot{m}_{in}$. An orifice at the bottom with diameter D_o allows water to escape. The orifice has a rounded entrance, so the frictional losses are negligible. If the tank is initially empty, *(i)* determine the maximum height that the water will reach in the tank and *(ii)* obtain a relation for water height z as a function of time. 6

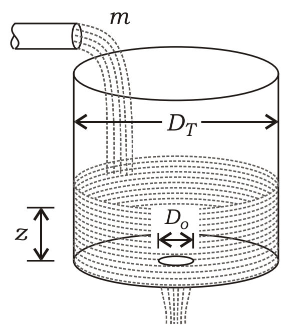

Fig. 6

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