2016/ODD/12/31/AE–301/689

B.Tech Odd Semester (CBCS) Exam., December—2016

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 of your own answer script.
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)* An inclined manometer is required to measure an air pressure of 3 mm of water to an accuracy of +/– 3%. The inclined arm is 8 mm in diameter and the larger arm has a diameter of 24 mm. The manometric fluid has density 740 kg/m^3 and the scale may be read to +/– 0·5 mm. What is the angle required to ensure the desired accuracy may be achieved? 6

(b) What would the pressure in kN/m^2 be, if the equivalent head is measured as 400 mm of the following? 4

(i) Mercury, 13·6

(ii) Water

(iii) Oil, specific weight 7·9 kN/m^3

(iv) A liquid of density 520 kg/m^3

2. *(a)* Derive the expression for pressure force and depth of centre of pressure for a curved surface. 6

(b) In the Fig. 1, the liquids at A and B are water ($_w$) and the manometer liquid is oil ($_o$) :

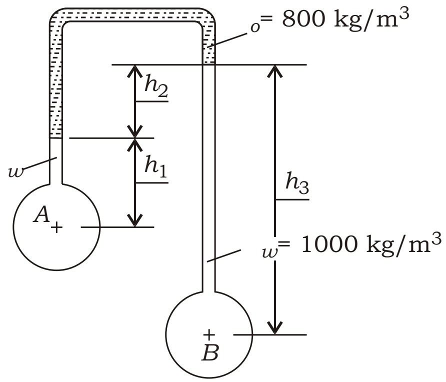

Fig. 1

h_1 300 mm, h_2 200 mm, h_3 600 mm. Find pressure difference p_A p_B. 4

3. Determine the moment M at A required to hold the gate (Fig. 2). The gate is 1·2 m wide :

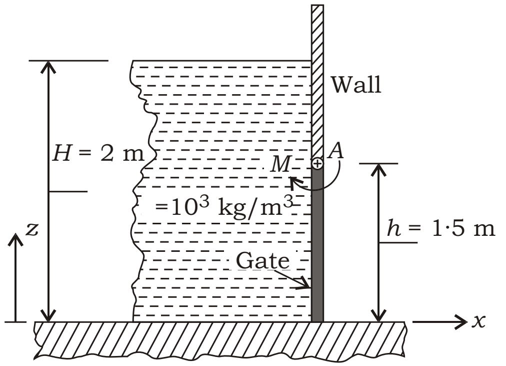

Fig. 2

Find the resultant force due to water on both sides of the gate including its line of action. 10

4. A cylindrical barrier (Fig. 3) holds water as shown below :

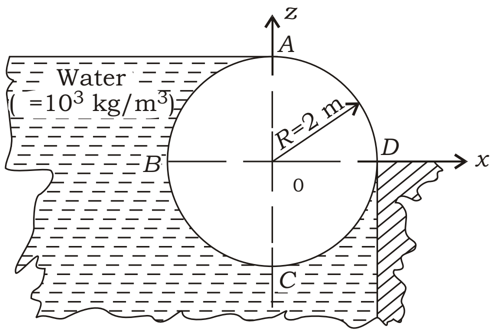

Fig. 3

The contact between cylinder and wall is smooth. Determine the *(a)* force per metre pushing the cylinder against the wall and *(b)* density of the cylinder ($_0$). 5+5

5. A three-dimensional flow is described by the velocity field

$$\vec{v} \quad v_0[x^2\vec{i} \quad y\vec{j} \quad (z \quad 1)\vec{k}]$$

where v_0 is a constant. Determine the *(a)* acceleration and *(b)* velocity potential (provided it exists). 5+5

6. Air flows steadily and at low speed through a horizontal nozzle, discharging to the atmosphere (Fig. 4) :

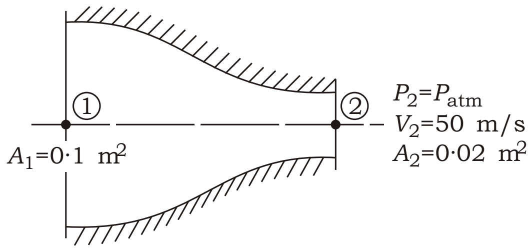

Fig. 4

At the nozzle inlet, the area is 0·1 m^2. At the nozzle exit, the area is 0·02 m^2. The flow is essentially incompressible and frictional effects are negligible. Determine the gauge pressure required at the nozzle inlet to produce an outlet speed of 50 m/s. (1·23 kg/m^3) 10

7. Fluid issues from a long slot and strikes against a smooth inclined flat plate (Fig. 5) :

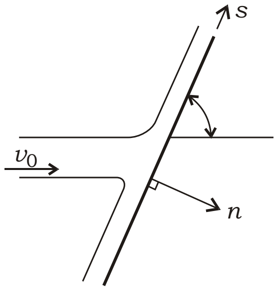

Fig. 5

Determine the division of flow (Q_1 and Q_2) and the force R exerted on the plate, neglecting loss due to impact. Given, 60°, v_0 10 m/s, Q_0 0·1 m^3/s, 1000 kg/m^3. 10

8. A tank with hemisphere shape (Fig. 6) has a well-rounded orifice with area A_i 0·01 m^2 :

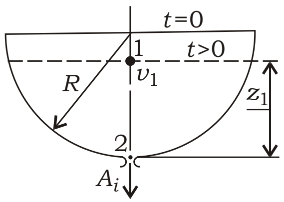

Fig. 6

At time t 0, the water level is at height R 2 m. Develop an expression for the water height z_1 at any later time t. Determine time T, belonging to z_1 $R/2$. You can neglect the unsteady term in the Bernoulli's equation. 10

★ ★ ★