higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T710**(E)**(A1)T

NATIONAL CERTIFICATE

FLUID MECHANICS N5

(8190205)

1 August 2018
09:00–12:00

Nonprogrammable calculators may be used.

Candidates will require drawing instruments.

This question paper consists of 5 pages and a formula sheet of 2 pages.

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NATIONAL CERTIFICATE

FLUID MECHANICS N5

TIME: 3 HOURS

MARKS: 100

NOTE: If you answer more than the required number of questions, only the required number will be marked. ALL work you do NOT want to be marked must be clearly crossed out.

INSTRUCTIONS AND INFORMATION

1. Answer any FIVE questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Use the value of $g = 9{,}81\ m/s^2$.
5. ALL units must be shown in the answers.
6. Write neatly and legibly.

QUESTION 1

1.1 Define each of the following terms:

1.1.1 Pressure

1.1.2 Atmospheric pressure

1.1.3 Gauge pressure

1.1.4 Absolute pressure

(4 × 2) (8)

1.2 A 2 m^3 square block of ice has a specific gravity of 1,1.

Calculating the following:

1.2.1 Density of the ice (2)

1.2.2 Weight of the ice (3)

1.2.3 Draught of the ice if it is floating in sea water of 1 030 kg/m^3 (4)

1.3 Briefly explain the *surface tension* of a fluid (liquid) and state its units. (3)

[20]

QUESTION 2

2.1 A cylindrical plug, 120 mm long with a diameter of 95 mm, slides concentrically in a fixed cylinder with an internal diameter of 95,2 mm. The radial clearance is filled with oil with a viscosity of 0,2 Pa.s

Calculate the following:

2.1.1 Force required to slide the plug along the cylinder at a speed of 5 m/s against the viscous resistance of the oil (7)

2.1.2 Power lost due to the viscous (2)

2.1.3 Kinematic viscosity of the oil if its density is 850 kg/m^3 (2)

2.2 A pressure intensifier is used in reverse to deboost the pressure in a hydraulic system from 15 MPa to 7 MPa. The volume of fluid required in the low-pressure side is 700 mℓ and the length of the stroke of the piston is to be half the diameter of the low-pressure piston.

Calculate the diameters of the high-pressure and low-pressure sides as well as the stroke length of the piston. (9)

[20]

QUESTION 3

3.1 A circular tank with a diameter of 4,5 m is filled with the two immiscible fluids water to a depth of 3 m and oil with a relative density of 0,9 to a depth of 2 m.

Determine the following:

3.1.1 Hydrostatic force acting on the vertical side of the tank (10)

3.1.2 Position of the centre of pressure from the oil-free surface (6)

3.2 State Archimedes' principle with regard to floating objects on fluid (liquid) and explain the major part that the fluid (liquid) density plays on floating objects. (4)

[20]

QUESTION 4

4.1 Explain what is meant by the following fluid flow patterns terms below and give example of each:

4.1.1 Steady flow

4.1.2 Unsteady flow

4.1.3 Uniform flow

4.1.4 Nonuniform

(4 × 1) (8)

4.2 A petrol transport lorry takes a maximum load of 10 tons of petrol with a relative density of 0, 95. The rate of flow at which the petrol is loaded into the tanker s 12 l/s.

Determine the following:

4.2.1 Time it would take to fully load the lorry (5)

4.2.2 Pressure in the feed pipe from the lorry at the valve at ground level if it is fully closed and the petrol-free surface is 4 m above the valve at that time (3)

4.2.3 Velocity as the petrol drops into a ventilated underground reservoir if the petrol-free surface is 2 m below ground level. The tanker is also vented. Assume no friction or shock loss occurs. (4)

[20]

QUESTION 5

5.1 A 25 mm diameter orifice in the bottom side of the tank discharges 13 m^3/h into the atmosphere. The head of water in the tank is 60 m above the centre of the orifice.

Calculate the following:

5.1.1 Coefficient of velocity, contraction and discharge of the system if the vena contractor diameter is measured at an average value of 13,852 mm during the discharge (11)

5.1.2 Head loss due to the fluid resistance in the orifice (3)

5.2 A pipe suddenly increases in diameter in such a way that the velocity drops from 6,9 m/s to 3,5 m/s.

Determine the following:

5.2.1 Shock head loss under these conditions (2)

5.2.2 Pressure rise under these conditions (4)
[20]

QUESTION 6

A reducing bend with an inlet diameter of 200 mm and exit diameter of 150 mm bends 40° upwards. The water velocity and corresponding pressure at the inlet to the bend is 4,5 m/s and 70 kPa respectively.

Determine the following:

6.1 Weight flow (2)

6.2 Water flow velocity at the exit to the bend (3)

6.3 Bend exit pressure if the friction head loss through the bend section is 2 m (4)

6.4 Magnitude and direction of the resultant force flowing through the bend (11)
[20]

TOTAL: 100

FORMULA SHEET

$$\rho = \frac{m}{v}$$

$$SG = Rel = \frac{\rho_{\text{substance}}}{\rho_{water}}$$

$$Specific\ \omega = \frac{weight}{volume} = \rho g$$

$$P = \frac{F}{A}$$

$$P_{absolute} = P_{gauge} + P_{atmospheric}$$

$$P_{gauge} = \rho g h$$

$$F_{Surface\ \ tension} = \sigma 2\pi R$$

$$\Delta P = P_i - P_o = \frac{2\sigma}{R} = \frac{4\sigma}{D}$$

$$F_{viscous} = \frac{\mu A v}{t} \text{ and } \upsilon = \frac{\mu}{\rho}$$

$$K_e = \frac{P}{\varepsilon_v}$$

$$\varepsilon_v = \frac{\Delta V}{V}$$

$$\frac{1}{K_e} = \frac{1}{K_\ell} + \frac{1}{K_c} + \frac{V_g}{V_t}\left(\frac{1}{K_g}\right)$$

$$K_g = \delta P \text{ and } K_c = \frac{E}{2{,}5}$$

$$F_{hydrostatic} = \rho g A \bar{y}$$

$$\bar{h} = \frac{I_g Sin^2\theta}{A\bar{y}} + \bar{y}$$

$$I_{g(\text{rectangular})} = \frac{bd^3}{12}$$

$$I_{g(\text{circular})} = \frac{\pi D^4}{64}$$

$$W = R = \rho g V$$

$$Q \text{ or } \overset{\circ}{V} = A_1 u_1 = A_2 u_2; \quad \overset{\circ}{m} = \rho \overset{\circ}{V}; \quad \overset{\circ}{W} = g\,\overset{\circ}{m} = \rho g A u; \quad P = H\overset{\circ}{W} = \rho g Q H$$

$$\frac{P_1}{\rho g} + \frac{u_1^2}{2g} + Z_1 + \frac{P_{pump}}{\overset{\circ}{W}} = H_{total} = \frac{P_2}{\rho g} + \frac{u_2^2}{2g} + Z_2 + \frac{P_{motor}}{\overset{\circ}{W}} + \frac{P_{turbine}}{\overset{\circ}{W}} + h_{loss}\,(J/N,\, m)$$

$$\frac{P_{turbine}}{\overset{\circ}{W}} = Turbine\ head; \quad \frac{P_{pump}}{\overset{\circ}{W}} = Pump\ head; \quad \eta = \frac{P_F}{P_m} \times 100; \quad R_e = \frac{\rho v D}{\mu}$$

$\underline{h_{loss}\,(J/N)\ or\ m:}$

$$h_s = k\,\frac{u^2}{2g}; \quad h_s = \left(\frac{1}{C_c} - 1\right)^2 \frac{u^2}{2g}; \quad h_a = h(1 - C^2{}_v); \quad h_f = 4f\left(\frac{L_e}{d}\right)_T \frac{u^2}{2g}$$

$$h_s = \frac{(u_1 - u_2)^2}{2g}$$

$$F_{inlet} = \overset{\circ}{m} u_1 + P_1 A_1 \quad and \quad F_{exit} = \overset{\circ}{m} u_2 + P_2 A_2$$

$$Flat\ plate: \quad Stationary\ F = \rho A u^2 \quad Moving\ F = \rho A (u - u_m)^2 \quad Angle\ F = \rho A u^2 Cos\theta$$

$$Curved: \quad X - Direction \quad F_x = \rho A u^2 (1 + Cos\theta) \quad Y - Direction \quad F_y = \rho A u^2 Sin\theta$$

$$U_m = \frac{\pi D n}{60}; \quad P = \overset{\circ}{m} V_{w_t}\, u_m; \quad \eta = \frac{2V_w u_m}{u_1^2}\ x\,100$$