higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T720**(E)**(A8)T

NATIONAL CERTIFICATE

FLUID MECHANICS N6

(8190216)

8 April 2019 (X-Paper)
09:00–12:00

Nonprogrammable calculators may be used.

This question paper consists of 7 pages and a formula sheet of 3 pages.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
FLUID MECHANICS N6
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Where applicable, round off your final answers to THREE decimal places.
5. Diagrams and sketches in this question paper are not drawn to scale.
6. Use g = 9,81 m/s^2.
7. Write neatly and legibly.

QUESTION 1

1.1 Define *density* in a fluid. (1)

1.2 State Bernoulli's theorem. (2)

1.3 Two new mild steel pipes A and B with different diameters are installed in parallel from the same pump to two different reservoirs.

Compare pipes A and B as requested below and give a REASON for each answer. NO calculations are required. Make use of the following words in your answers:

Sum
Equal/the same
Unequal/different

1.3.1 Their friction factors

1.3.2 Their hydraulic mean depths

1.3.3 Their friction head

1.3.4 Their discharge

(4 × 2) (8)

1.4 A pipe with a particular diameter discharges petrol with a relative density of 0,78 at a rate of 87 m^3 every hour and at a velocity of 9 m/s.

Determine:

1.4.1 The density of petrol (2)

1.4.2 The diameter of the pipe in mm (3)

1.4.3 The friction head if the pipe is new and clean and its coefficient of friction is $0{,}005\left(1 + \frac{1}{40d}\right)$ and it is 4 km long (4)

1.5 A siphon pipeline connecting two reservoirs, is 1 100 m long and rises to a height of 4,5 m above the upper reservoir for a distance of 301 m from the entrance before falling to the lower reservoir. The velocity of water in the pipe is 1,105 m/s. The pipe is 1 026 mm in diameter and the friction factor is f = 0,03.

1.5.1 What is a *tapered pipeline*? (1)

1.5.2 Determine the discharge in ℓ/s (2)

1.5.3 Determine the losses at entry (2)

1.5.4 Determine the losses at exit (2)

1.5.5 Determine the losses in the pipe due to friction (2)
[29]

QUESTION 2

2.1 FIGURE 1 shows a cross section of an open semicircular channel which is full of water. The gradient of the channel is 1 in 1 850 and C in the Chézy formula is 60. The maximum depth of the channel is 1 500 mm.

Calculate the discharge in ℓ/s.

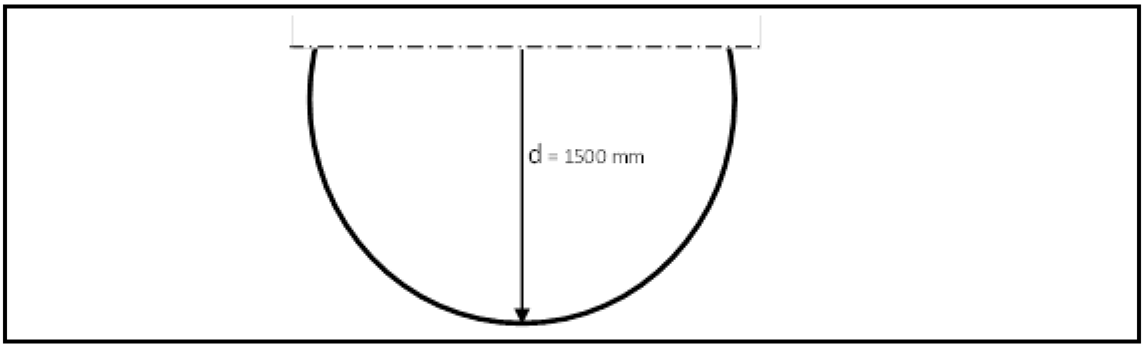

FIGURE 1 (9)

2.2 The maximum flow of water anticipated in a channel is 0,94 m^3/s.

If the coefficient of discharge of a 90° notch is 0,65, what should the minimum height (in mm) of a suitable notch be? (4)

2.3 A jet of water is discharging from an orifice in a vertical wall. The orifice has a diameter of 50 mm and the surface discharge is 1 m below the surface and the jet of water strikes 3,2 m from the opening. The coefficient of velocity is 0,97.

Calculate:

2.3.1 The time taken for the jet to strike the surface level (4)

2.3.2 The head of water above the orifice (2)

2.3.3 The theoretical discharge in ℓ/s (3)

[22]

QUESTION 3

3.1 Name TWO types of axial-flow fans. (2)

3.2 A fan extracts air at 9,2 m^3/s through a 750 mm square duct, 50 m long.

Calculate the pressure required to overcome the friction of the duct. Use k in Atkinson's formula as 0,003. (5)

3.3 A single-acting plunger pump has a stroke of 260 mm and a plunger diameter of 90 mm. The suction pipe has a diameter of 130 mm and is 10 m long. There is a negative suction head of 5 m. The pump is used to pump slime with a relative density of 1,1. The atmospheric pressure is 130 kPa and the vapour pressure at the temperature of the slime is 1,9 kPa.

Assume simple harmonic motion for the plunger and calculate the maximum speed in r/min at which the crankshaft can be run before cavitation takes place. (8)

3.4 Define cavitation and state TWO factors that can cause cavitation. (3)

3.5 A centrifugal pump delivers water at 1 400 ℓ/min at a speed of 1 430 r/min. The impeller has a diameter of 380 mm and the width of the vanes at outlet is 12 mm. The pressure exerted between the inlet and the outlet flanges is 285 kPa. The manometric efficiency of the pump is 74%.

Study FIGURE 2 and answer the questions.

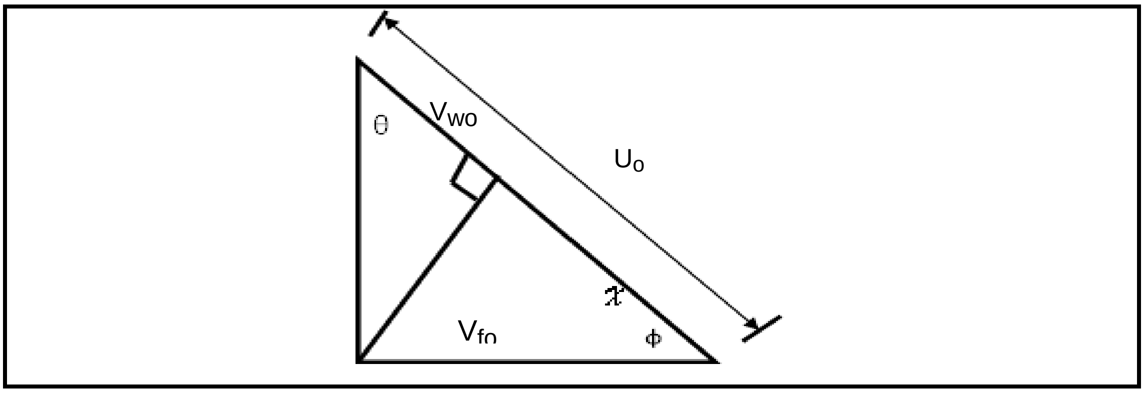

FIGURE 2

Calculate:

3.5.1 The total pressure head

3.5.2 The peripheral velocity of the impeller at outlet (U_o)

3.5.3 The radial flow velocity of the water leaving the impeller (V_{fo})

3.5.4 The tangential (whirl) velocity of the water leaving the impeller (V_{wo})

3.5.5 The difference between the impeller and whirl velocity (x)

3.5.6 The outlet angle (ϕ) of the impeller vanes

(6 × 2) (12)
[30]

QUESTION 4

4.1 The quantity of flow through a vertical shaft of a Francis turbine is 0,32 m^3/s. The pressure at inlet is 150 kPa and its diameter is 350 mm. The pressure at the tail water end is -35 kPa and 650 mm in diameter. The vertical height between the two points is 2 m.

Calculate:

4.1.1 The effective turbine pressure head (H_e) (7)

4.1.2 The input power supplied to the turbine (2)

4.2 A single jet Pelton wheel with a head of 250 m over a nozzle has buckets on a circle of 1,1 m. The deflecting angle of the buckets is 163^0 and the coefficient of velocity for the nozzle is 0,97.

Calculate:

4.2.1 The theoretical speed in r/min for maximum efficiency (6)

4.2.2 The power developed by the wheel if the flow rate is 71,7 ℓ/s (2)

4.2.3 The maximum hydraulic efficiency of the runner (2)
[19]

TOTAL: 100

FLUID MECHANICS N6

FORMULA SHEET

Any applicable formula may also be used.

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FORMULA SHEET

Any applicable formula may also be used.

$$Z_1 + \frac{P_{r1}}{\rho g} + \frac{V_1^2}{2g} = Z_2 + \frac{P_{r2}}{\rho g} + \frac{V_2^2}{2g} + h_L$$

$$hf = \frac{4fLV^2}{2gd}$$

$$hs = \frac{kV^2}{2g}$$

$$hs = \frac{(V_1 - V_2)^2}{2g}$$

$$hs = \frac{V^2}{2g} \times \left(\frac{1}{C_c} - 1\right)^2$$

$$Q = A.C\sqrt{mi}$$

$$Q = 1{,}84\ (L - 0{,}1\ n.H)\ H^{1{,}5}$$

$$Q = \frac{2}{3} Cd\sqrt{2g} \times L \times H^{1{,}5}$$

$$Q = \frac{8}{15} Cd\sqrt{2g} \times \tan\frac{\theta}{2} \times H^{2{,}5}$$

$$Q = \frac{2}{3} Cd\sqrt{2g}\ H^{1{,}5} \left(L + \frac{4}{5}\tan\frac{\theta}{2} \times H\right)$$

$$Q = \frac{ALSEN}{60}$$

$$Ha = \frac{L}{g} \times \frac{D^2}{d^2} \times \omega^2 \times r \times \cos\theta$$

$$hf = \frac{4fL}{2gd} \times \left[\frac{D^2}{d^2} \times \omega \times r\right]^2$$

$hf =$

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$$

$$\frac{P_{r1}}{P_{r2}} = \left(\frac{N_1}{N_2}\right)^2$$

$$\frac{kW_1}{kW_2} = \left(\frac{N_1}{N_2}\right)^3$$

$$\frac{Q_1}{Q_2} = \left(\frac{D_1}{D_2}\right)^3$$

$$\frac{P_{r1}}{P_{r2}} = \left(\frac{D_1}{D_2}\right)^2$$

$$\frac{kW_1}{kW_2} = \left(\frac{D_1}{D_2}\right)^5$$

$$\frac{P_{r1}}{P_{r2}} = \frac{\rho_1}{\rho_2}$$

$$\frac{kW_1}{kW_2} = \frac{1}{\rho}$$

$$\frac{H_1}{H_2} = \left(\frac{Q_1}{Q_2}\right)^2$$

$$\frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2 \quad ; \quad \frac{w.g._1}{w.g._2} = \left(\frac{N_1}{N_2}\right)^2$$

$$\frac{H_1}{H_2} = \frac{L_1}{L_2}$$

$$\frac{W_1}{W_2} = \left(\frac{D_1}{D_2}\right)^2$$

$$\frac{N_1^2 D_1^2}{gh_1} = \frac{N_2^2 D_2^2}{gh_2}$$

$$P_r = \frac{kSV^2}{a}$$

$$P = \rho \times g \times Q \times w.g.$$

$$P = \rho \times Q \times u(v - u)\,[1 + n \cos(180° - y)]$$

$$\eta = \frac{u}{gh}\,(v - u)\,[1 + n \cos(180° - y)] \times 100$$

-2-