higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

FLUID MECHANICS N6

1 December 2023

This marking guideline consists of 9 pages.

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INSTRUCTIONS TO MARKERS

1. Mark all the questions.
2. Follow the answers according to the numbering system used in the question paper.
3. Use only a red pen.
4. Put your ticks and crosses neatly and legibly.

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QUESTION 1

1.1 1.1.1

$$h_f = \frac{4fLv^2}{2gd}$$
$$9 = \frac{4 \times 0{,}01 \times 100 \times v^2}{2 \times 9{,}81 \times 0{,}6} \checkmark$$
$$v = 4{,}202\ m/s \checkmark \quad (2)$$

1.1.2

$$Q_A = VA$$
$$Q = 4{,}202 \times \frac{\pi}{4} \times (0{,}6)^2 \checkmark$$
$$Q = 1{,}188\ m^3/s \checkmark \quad (2)$$

1.1.3

$$Q_B = VA$$
$$Q = 3{,}5 \times \frac{\pi}{4} \times (0{,}4)^2 \checkmark$$
$$Q_A = 0{,}4398\ m^3/s \checkmark$$

$$Q_A = Q_B + Q_C$$
$$1{,}188 = 0{,}4398 + Q_C$$
$$Q_C = 0{,}7483 m^3/s \checkmark \quad (3)$$

1.1.4

$$h_f = \frac{fLQ^2}{3d^5}$$
$$= \frac{0{,}01 \times 1\,125 \times (0{,}4398)^2}{3 \times (0{,}4)^5} \checkmark$$
$$= 5{,}038\ m \checkmark \quad (2)$$

1.1.5

$$f = 0{,}005\left(1 + \frac{1}{40d}\right)$$
$$\mathrm{f} = 0{,}005\left(1 + \frac{1}{40 \times \frac{1}{3} \times 0{,}6}\right) \checkmark$$
$$= 0{,}00563 \checkmark \quad (2)$$

1.2 The wetted perimeter is the portion of a pipe that is in contact with the fluid. (1)

1.3 1.3.1 The ratio of two quantities expressed in the same units (1)

1.3.2 1.3.2.1

$$\rho = 0{,}8 \times 1\,000$$
$$= 800\ kg/m^3 \checkmark \quad (1)$$

1.3.2.2

$$h_f = \frac{fLQ^2}{3d^5}$$
$$9 = \frac{f \times 1\,125 \times \left(\frac{1\,240}{3\,600}\right)^2}{3 \times (0{,}925)^5} \checkmark$$
$$f = 0{,}137 \checkmark \quad (2)$$

1.3.2.3 $A = \frac{\pi}{4} \times (0{,}925)^2$
$= 0{,}672\ m^2$

$C = \sqrt{\frac{2g}{f}}$
$= \sqrt{\frac{2 \times 9{,}81}{0{,}137}}$ ✓
$= 11{,}967$ ✓

$m = \frac{d}{4}$
$= \frac{0{,}925}{4}$
$= 0{,}23125\ m$ ✓

$Q = AC\sqrt{mi}$
$0{,}344 = 0{,}672 \times 11{,}967\sqrt{0{,}23125 \times i}$ ✓
$i = 0{,}00793$ ✓ (5)

1.3.2.4 $Q = VA$
$0{,}344 = V \times \frac{\pi}{4} \times (0{,}925)^2$ ✓
$V = 0{,}513\ m/s$ ✓

$h_L = \frac{0{,}5V_1^2}{2g}$
$= \frac{0{,}5(0{,}513)^2}{2 \times 9{,}81}$ ✓
$= 0{,}0067\ m$ ✓ (4)
[25]

QUESTION 2

2.1 2.1.1 $x = \frac{4}{\tan 29^0}$✓
$= 7{,}216\ m$✓ (2)

2.1.2
$A = \{[(7{,}216 \times 2) + 5] \times w\} + \{[(7{,}216 + 5)] \times 4\}$✓

$= 19{,}432w + 48{,}865$✓

$P = 2w + \left[\left(\frac{4}{\sin 29^0}\right) \times 2\right] + 5$✓

$= 2w + 21{,}501$✓

$2{,}3 = \frac{19{,}432w + 48{,}865}{2w + 21{,}501}$✓

$w = 0{,}03966\ m$✓ (6)

2.1.3 $Q = AC\sqrt{mi}$
$= \{(19{,}432 \times 0{,}03966) + 48{,}86\} \times 65\sqrt{2{,}3 \times \frac{4}{1000}}$ ✓
$= 309{,}456\ m^3/s$✓ (2)

2.2 $A = d^2$
$P = 3d$

$m = \frac{d^2}{3d}$✓
$= 0{,}333\ d$✓

$Q = AC\sqrt{mi}$
$20 = d^2 \times 50\sqrt{0{,}333\ d \times 1{,}235 \times 10^{-3}}$✓
$d = 3{,}295\ m$✓

$Dimensions = 3{,}295\ m \times 3{,}295\ m$ (4)

2.3 A notch is an opening in the side of a reservoir extending above the free surface and of a suitable geometric shape. (1)

2.4 $Q = C_d\ \frac{8}{15}\sqrt{2g}\ \tan\frac{\theta}{2}\ H^{2,5}$✓
$1{,}5 = C_d\ \frac{8}{15}\sqrt{2 \times 9{,}81}\ \tan\frac{90}{2} \times 0{,}9^{2,5}$✓

$C_d = 0{,}826$✓ (3)

2.5 2.5.1

$A_{th} = \frac{\pi}{4} \times (0{,}04)^2$
$= 1{,}257 \times 10^{-3}\ m^2$✓

$A_A = A_{th} \times C_c$
$A_A = 1{,}257 \times 10^{-3} \times 0{,}81$✓
$= 1{,}0179 \times 10^{-3}\ m^2$✓

$V_A = \frac{Q_A}{A_A}$
$C_v\sqrt{2gh} \times A_A = Q_A$
$0{,}83 \times \sqrt{2 \times 9{,}81 \times h} \times 1{,}0179 \times 10^{-3} = \frac{0{,}2}{60}$ ✓
$\mathrm{h} = 0{,}793\ \mathrm{m}$✓

(5)

2.5.2

$\mathrm{h_L} = \mathrm{h}(1 - \mathrm{C_v^2})$

$= 0{,}793(1 - 0{,}83^2)$✓
$= 0{,}247\ m$✓ (2)

2.5.3

$V_A = \sqrt{\frac{gx^2}{2y}}$
$0{,}83 \times \sqrt{2 \times 9{,}81 \times 0{,}793}$✓ $= \sqrt{\frac{9{,}81 \times x^2}{2 \times (4 - 0{,}793)}}$✓
$x = 2{,}648\ m$✓ (3)

[28]

QUESTION 3

3.1 3.1.1

$H_{pre} = H_{at} - h_s - h_{as}$
$3{,}5 = 12 - 6 - h_{as}$✓
$h_{as} = 2{,}5\ m$✓

$h_{as} = \frac{l}{g} \times \left(\frac{D}{d}\right)^2 \times \omega^2 R$
$2{,}5 = \frac{l}{9{,}81} \times \left(\frac{0{,}2}{0{,}1}\right)^2 \times \left(\frac{2\pi \times 40}{60}\right)^2 \times \frac{0{,}3}{2}$✓
$l = 2{,}3296\ m$✓

(4)

3.1.2

$5 = \frac{4 \times f \times 40}{2 \times 9{,}81 \times 0{,}1}\left(\left(\frac{0{,}2}{0{,}1}\right)^2 \frac{2\pi \times 40}{60} \times \frac{0{,}3}{2}\right)^2$ ✓
$\mathrm{f} = 0{,}167$✓

(2)

3.1.3 3.1.3.1

$$h_{ad} = \frac{9}{9,81} \times \left(\frac{0,2}{0,1}\right)^2 \times \left(\frac{2\pi \times 40}{60}\right)^2 \times \frac{0,3}{2}\checkmark$$
$$= 9,659\ m\checkmark$$

$$H_{pre} = H_{at} + h_d + h_{ad}$$
$$= 12 + 7 + 9,658$$

$$\mathrm{h_{pre}} = 28,658\ \mathrm{m}\checkmark$$

(3)

3.1.3.2

$$h_{fd} = \frac{4 \times 0,02 \times 9}{2 \times 9,81 \times 0,1}\left(\left(\frac{0,2}{0,1}\right)^2 \frac{2\pi \times 40}{60} \times \frac{0,3}{2}\right)^2\checkmark$$
$$h_{fd} = 2,318\ m\checkmark$$

$$H_{pre} = H_{at} + h_d + h_{fd}$$
$$= 12 + 7 + 2,318$$
$$= 21,318\ m\checkmark$$

(3)

3.1.3.3

$$H_{pre} = H_{at} + h_d - h_{ad}$$
$$= 12 + 7 - 9,658$$
$$h_{pre} = 9,342\ m\checkmark$$

(1)

3.1.4

$$Q = ALSEN/60$$
$$= \frac{\pi}{4}(0,2)^2 \times 0,\ 3 \times 2 \times 3 \times \frac{N}{60}\checkmark$$
$$= 0\ ,0377 \times \mathrm{m^3/s}\checkmark$$

(2)

3.1.5

$$H_{mano} = H_f + H_s$$
$$= 5 + 2,318 + 6 + 7 + 9,659 + 2,3296\checkmark$$
$$= 32,3066\ \mathrm{m}\checkmark$$

$$P = \rho g Q H_m$$
$$= 10^3 \times 9,81 \times 0\ ,0377 \times 32,3066\checkmark$$

$$= 11,948\ \mathrm{kW}\checkmark$$

(4)

3.2 3.2.1

$$\tan \emptyset = \frac{V_{fo}}{x}$$
$$\tan 29^0 = \frac{V_{fo}}{3,5}$$
$$V_{fo} = 1,94\ m/s\checkmark$$

$$Q = V_{fo} \times a$$
$$= 1,94 \times \frac{\pi}{4} \times (0,2)^2$$
$$= 0,061\ m^3/s\checkmark$$

$$Q = \frac{\pi}{4} \times (d)^2 \times w \times V_{fo}$$
$$0,261 = \frac{\pi}{4} \times (0,4)^2 \times \mathrm{w} \times 1\ 94\checkmark$$
$$\mathrm{w} = 250\ \mathrm{mm}\checkmark$$

(4)

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3.2.2 $U_o = \frac{\pi DN}{60}$
$= \frac{\pi \times 0,4 \times 1500}{60}$
$= 31,415\ m/s$✓

$x = U_o - V_{wo}$
$V_{wo} = 31,415 - 3,5$
$= 27,916\ m/s$✓

$\eta_m = \frac{gH}{U_o V_{wo}}$
$75 = \frac{9,81 \times H}{31,415 \times 27,916} \times 100$✓
$H = 67,049\ m$✓ (4)

3.2.3 $T = \rho Q V_{fo} \times impeller\ radius$
$= 10^3 \times 0,061 \times 27,916 \times \frac{0,4}{2}$✓
$= 340,292\ Nm$✓ (2)
[29]

QUESTION 4

4.1 $P = \rho g Q H_e$
$= \frac{42 \times 10^3}{10^3 \times 9,81 \times 0,3}$ ✓
$H_e = 14,271\ m$✓

$V_1 = \frac{0,3 \times 4}{\pi \times (0,31)^2}$
$= 3,974\ m/s$✓

$V_2 = \frac{0,3 \times 4}{\pi \times (D)^2}$
$= \frac{0,382}{D^2}$ ✓

$\frac{P_{r1}}{\rho g} + \frac{V_1^2}{2g} + z_1 - H_e = \frac{P_{r2}}{\rho g} + \frac{V_2^2}{2g} + z_2$
$\frac{150}{9,81} + \frac{(3,974)^2}{2 \times 9,81} + 2 - 14,271$✓ $= \frac{-35}{9,81} + \frac{0,382^2}{D^4 \times 2 \times 9,81} + 0$✓

$D^4 = 0,00100595$
$D = 178,0921\ mm$✓ (7)

4.2 True (1)

4.3 4.3.1

$$V_i = C_v\sqrt{2gh}$$
$$= 0{,}9\sqrt{2 \times 9{,}81 \times 350 \times 0{,}89}\ \checkmark$$
$$= 70{,}359\ m/s\checkmark$$

$$U = \frac{\pi DN}{60}$$
$$= \frac{\pi \times 1{,}5 \times 345}{60}\ \checkmark$$
$$= 27{,}096\ m/s\checkmark$$

$$P = \rho QU\ (V - U)[1 + cos(180^0 - y)]$$

$$Q = \frac{P}{\rho U\ (V-U)[1 + cos(180^0 - y)]}$$

$$= \frac{5\ 000 \times 10^3}{10^3 \times 27{,}096\ (70{,}359 - 27{,}096)[1 + cos(180^0 - 160^0)]}\checkmark$$
$$= 2{,}2934\ m^3/s\checkmark$$

$$\frac{Q}{No.of\ jets} = Va$$

$$\frac{2{,}2934}{No.of\ jets} = 70{,}359 \times \frac{\pi}{4} \times (0{,}073)^2\checkmark$$

$$Number\ of\ jets = 7{,}788, say\ 8\ jets\checkmark$$ (8)

4.3.2

$$h_f = \frac{fLQ^2}{3d^5}$$

$$38{,}5 = \frac{0{,}006 \times L \times 2{,}2934^2}{3 \times (0,\ 4)^5}\checkmark$$

$$L = 37{,}479\ m\checkmark$$ (2)

[18]

TOTAL: 100

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