higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

FLUID MECHANICS N6

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This marking guideline consists of 6 pages.

QUESTION 1

1.1 1.1.1 $h_{fT} = h_{f1} + h_{f2}$

$= \frac{flQ^2}{3d^5} + \frac{flQ^2}{3d^5}$

$12{,}2 = \frac{0{,}006\ x\ 10\ x\ Q^2}{3(0{,}182)^5} + \frac{0{,}006\ x\ 8\ x\ Q^2}{3(0{,}102)^5}$ ✓

Q = 0,0887 m^3/s ✓

= 88,738 l/s ✓ (3)

1.1.2 $v_1 = \frac{Q}{A}$ $v_2 = \frac{Q}{A}$

$= \frac{0{,}0887\ x\ 4}{\pi\ x\ (0{,}182)^2}$ ✓ =

$\frac{0{,}0887\ x\ 4}{\pi\ x\ (0{,}102)^2}$ ✓

= 3,411 m/s ✓ =

10,86 m/s ✓ (4)

1.1.3 $h_T = h_x + h_y + h_z$

$= \frac{0{,}5\ v_1^2}{2g} + \frac{0{,}5\ v_2^2}{2g} + \frac{(v_2 - v_1)^2}{2g}$ ✓

$= \frac{0{,}5\ x\ 3{,}411^2}{2\ x\ 9{,}81} + \frac{0{,}5\ x\ 10{,}8597^2}{2\ x\ 9{,}81} + \frac{(10{,}8597 - 0)^2}{2\ x\ 9{,}81}$ ✓

= 9,16 m ✓ (3)

1.1.4 $m_1 = \frac{d_1}{4}$ $m_2 = \frac{d_2}{4}$

$= \frac{0{,}182}{4}$ ✓ $= \frac{0{,}102}{4}$ ✓

= 0,0455 ✓ = 0,0255 m ✓ (4)

1.1.5 $i_1 = \frac{h_{f1}}{L}$ $i_2 = \frac{h_{f2}}{L}$

$i_1 = \frac{0{,}788}{10}$ ✓ $= \frac{11{,}411}{8}$ ✓

= 0,0788 ✓ = 1,426 ✓ (4)

1.2 $h_{fp} = h_{fq}$

$\left(\frac{flQ^2}{3d^5}\right)_p = \left(\frac{flQ^2}{3d^5}\right)_q$

$\frac{Q_p^2}{d^5} = \frac{Q_p^2}{(3d)^5} = \frac{Q_p^2}{243d^5}$ ✓

Q_q = 15,588 Q_P alternatively Q_P = 0,0642Q_q

$Q_T = Q_P + Q_q$ $Q_T = Q_P + Q_q$

1,5 = 15,588 $Q_P + Q_P$ ✓ 1,5 = 0,0642$Q_q + Q_q$ ✓

Q_P = 0,0904 m^3/s ✓ Q_q = 1,41 m^3/s ✓

Q_q = 1,41 m^3/s ✓ Q_P = 0,0904 m^3/s ✓ (4)

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QUESTION 2

2.1 2.1.1

$V_A = \sqrt{\frac{gx^2}{2y}}$

$= \sqrt{\frac{9,81\ x\ 1,8^2}{2\ x\ 0,55}}$ ✓

= 5,375 m/s ✓

Reaction of the jet = ρQV_A

= 10^3 x $\frac{0,13}{60}$ ✓ x 5,375 ✓

= 11,647 N ✓ (5)

2.1.2 $A_A = \frac{Q_A}{V_A}$

$= \frac{0,00217}{5,375}$✓

= 0,000403 m^2 ✓

$A_{th} = \frac{\pi}{4}(0,035)^2$✓

= 0,000962 m^2✓

$C_c = \frac{A_A}{A_{th}}$

$= \frac{0,000403}{0,000962}$ ✓

= 0,419✓ (6)

2.2 x = $\frac{2}{\tan 26,67^0}$ = 3,981 m ✓

Perimeter = 2(4,456) + 4

= 12,912 m ✓

r = $\frac{2}{\sin 26,67^0}$ = 4,456 m ✓

Area = ½$[4 + (4 + 7,963)] \times 2$✓

= 15,963 m^2 ✓

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

= $\frac{15,963}{12,912}$

= 1,236 m✓

Alternatively

Area = $[(4 + 3,981)\ x\ 2\ ]$✓

= 15,963 m^2✓

Q = AC$\sqrt{mi}$

= 15,963 x 55 $\sqrt{1,236\ x\ \frac{2}{3000}}$ ✓

= 25,207 m^3/s ✓

It will not cope since the designed channel can handle less discharge than the expected.✓ (9)

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QUESTION 3

3.1 $H_{at} = \frac{P}{\rho g}$

$= \frac{101\ x\ 10^3}{0,77\ x\ 10^3\ x\ 9,81}$ ✓

= 13,371 m ✓

$H_{sep} = \frac{P}{\rho g}$

$= \frac{1,4\ x\ 10^3}{0,77\ x\ 10^3\ x\ 9,81}$ ✓

= 0,185 m ✓

$H_a = H_{at} – H_s – H_{sep}$

= 13,371 – 5 – 0,185 ✓

= 8,186 m ✓

$H_a = \frac{l}{g}\left(\frac{D}{d}\right)^2 x\ \omega^2 R$

$8,186 = \frac{9}{9,81}\left(\frac{0,08}{0,11}\right)^2 \times \omega^2 \times \frac{0,355}{2}$ ✓

ω = 9,749 rad/s ✓

$\omega = \frac{2\pi N}{60}$

$N = \frac{9,749 \text{ x } 60}{2\pi}$ ✓

= 93,096 rev/s ✓ (10)

3.2 3.2.1 $Q = ALSE\frac{N}{60}$

$= \frac{\pi}{4}(0,13)^2 \times 0,28 \times 1 \times 1 \times \frac{39}{60}$ ✓

= 0,00242 m^3/s ✓

3.2.2 $P = \rho gASHN$

$=10^3 \times 9,81 \times \frac{\pi}{4}(0,13)^2 \times 0,28 \text{ x } 25 \times \frac{39}{60}$ ✓

= 592,457 W ✓

Alternatively

$P = \rho gQH$

$= 10^3 \times 9,81 \times 0,00242 \times 25$ ✓

= 592,457 W ✓

(2 × 2) (4)

3.3 $Q = \frac{3}{60}$ = 0,05 m^3/s ✓

$\tan\phi = \frac{V_{fo}}{x}$

$x = \frac{1,5}{\tan 38^0}$ ✓

= 1,919 m/s ✓

$V_{wo} = U_o – x$

= 9 – 1,919

= 7,08 m/s ✓

$T = \rho Q V_{wo} R_{imp}$

$= 10^3 \times 0,05 \times 7,08 \times \frac{1,2}{2}$ ✓

= 212,403 Nm ✓ (6)

3.4 a = $\frac{\pi}{4}(0{,}793)^2$ = 0,494 m²✓ v = $\frac{9{,}3}{0{,}494}$ = 18,83 m/s✓

S = □ × 0,793 × L = 2,491L✓

$$Pr = \frac{kS\,v^2}{a}$$

$$198{,}3 = \frac{0{,}00225\ x\ 2{,}491\ L\ x\ (18{,}83)^2}{0{,}494}$$ ✓

L = 49,279 m✓ (5)

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QUESTION 4

4.1 4.1.1 $V_i = 0{,}17\sqrt{2gH}$

$= 0{,}17\sqrt{2\ x\ 9{,}81\ x\ 14}$ ✓

= 2,817 m/s ✓ (2)

4.1.2 E = $\frac{H\ x\ \eta}{100}$ E = $\frac{U_i^2}{g}$ $\tan\theta_i = \frac{V_i}{U_i}$

= $\frac{14\ x\ 0{,}81}{100}$✓ $U_i = \sqrt{11{,}34\ x\ 9{,}81}$✓ = $\frac{2{,}817}{10{,}547}$✓

= 11,34 m✓ = 10,547 m/s✓ θ_i = 14,956°✓ (6)

4.1.3 Internal diameter = ½ External diameter

U_o = ½U_i $V_o = V_i$

= ½(10,547) ✓ $\tan\beta_O = \frac{V_O}{U_0}$

= 5,274 m/s ✓ = $\frac{2{,}817}{5{,}274}$ ✓

β_O = 28,114°✓ (4)

4.1.4 $U_i = \frac{\pi\ D\ N}{60}$

D = $\frac{10{,}547\ x\ 60}{\pi\ x\ 295}$✓ d = ½(682,842)

= 682,842 mm✓ = 341,421 mm✓ (3)

4.1.5 Q = V_i x A

A = $\frac{0{,}4}{2{,}817}$ ✓

= 0,142 m² ✓

But A = □DW

$W_i = \frac{0{,}142}{0{,}89\ x\ \pi\ x\ 0{,}683}$ ✓ $W_o = \frac{0{,}142}{0{,}89\ x\ \pi\ x\ 0{,}341}$ ✓

= 73,533 mm ✓ = 147,067 mm ✓ (6)

4.2 4.2.1 $U = \frac{\pi DN}{60}$ $H = \frac{P}{\rho g}$ $V = 0{,}98\sqrt{2gH}$

$= \frac{\pi \ x \ 0{,}95 \ x \ 300}{60}$ ✓ $= \frac{700}{9{,}81}$ ✓ =

$0{,}98\sqrt{2 \ x \ 9{,}81 \ x \ 71{,}356}$ ✓

= 14,923 m/s ✓ = 71,356 m ✓ = 36,668 m/s ✓

Q = V x A

$= 36{,}668 \times \frac{\pi}{4} (0,,075)^2$ ✓

$= 0{,}162 \ m^3/s$ ✓

P = ρQU (V – U)(1 + nCosy)

$= 10^3 \times 0{,}162 \times 14{,}923(36{,}668 - 14{,}923)(1 + 0{,}86Cos(180^0 - 160^0)$✓

=95,05 kW✓ (10)

4.2.2 $\eta = \frac{U}{gH}$(V – U)(1 + nCosy) × 100%

$=\frac{14{,}923}{9{,}81 \ x \ 71{,}356}$ (36,668 - 14,923)(1 + 0,86Cos(180° - 160°) × 100%✓

=83,820%✓ (2)

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TOTAL: 100