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 7 pages.

QUESTION 1

1.1 A flow in which particles move in an orderly manner and retain their relative positions in successive cross sections. (2)

1.2 Portion of pipe in contact with fluid (1)

1.3 1.3.1 $Q = \frac{820}{1000 \times 60}$ ✓
$= 0,014\ m^3/s$ ✓

1.3.2 $S = \pi DL$
$= \pi \times 0,36 \times 45$ ✓
$= 50,894\ m^2$ ✓

1.3.3 $A = \frac{\pi D^2}{4}$
$= \frac{\pi(0,36)^2}{4}$ ✓
$= 0,102\ m^2$ ✓

1.3.4 $h = 45 \sin 35^\circ$ ✓
$= 25,811\ m$ ✓

1.3.5 $V = \frac{Q}{A}$
$= \frac{0,014}{0,102}$ ✓
$= 0,134\ m/s$ ✓

(5 × 2) (10)

1.4 $V_1 = \frac{0,08 \times 4}{\pi \times (0,35)^2}$ ✓ $= 0,832\ m/s$ ✓
$V_2 = \frac{0,08 \times 4}{\pi \times (0,15)^2}$ ✓ $= 4,527\ m/s$ ✓

$Q = \frac{288}{3600} = 0,08\ m^3/s$ ✓
$\frac{Pr_1}{\rho g} + \frac{v^2}{2g} + z_1 = \frac{Pr_2}{\rho g} + \frac{v^2}{2g} + z_2$
$\frac{Pr_1}{9,81} + \frac{0,832^2}{2 \times 9,81} + 0 = \frac{Pr_2}{9,81} + \frac{4,527^2}{2 \times 9,81} + 0$ ✓
$Pr_1 - Pr_2 = 19,803\ kPa$ ✓

alternatively

$Pr_2 - Pr_1 = -19,803\ kPa$ ✓ (7)

1.5 $C = \sqrt{\frac{2g}{f}}$

$= \sqrt{\frac{2\ x\ 9,81}{0,02}}$✓

$= 31,321$✓

$m = \frac{d}{4}$

$= \frac{0,4}{4}$

$= 0,1$ m✓

$Q = \frac{2,37}{60}$

$= 0,0395$ m³/s✓

$A = \frac{\pi d^2}{4}$

$= \frac{\pi\ x\ 0,4^2}{4}$

$= 0,126$ m²✓

$Q = AC\sqrt{mi}$

$0,0395 = 0,126\ x\ 31,321\ \sqrt{0,1\ x\ i}$✓

$i = 0,001$✓

$i = \frac{h_f}{L}$

$0,001 = \frac{h_f}{1500}$ ✓ $h_f = 1,512$ m✓ (9)

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QUESTION 2

2.1 $A = ½ \times B \times H$

$= ½ \times 4 \times 3$✓

$= 6$ m²✓

$P = 2\left(\sqrt{2^2 + 3^2}\right)$✓

$= 7,211$ m✓

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

$= \frac{6}{7,211}$ ✓

$= 0,832$ m✓

$i = \frac{1}{2550}$

$= 0,392 \times 10^{-3}$✓

$Q = AC\sqrt{mi}$

$= 6 \times 50 \times \sqrt{0,832\ x\ 0,392\ x\ 10^{-3}}$ ✓

$= 5,419$ m³/s

$= 5419,908$ ℓ/s✓ (9)

2.2 $Q = Cd \times \frac{8}{15} \times \sqrt{2g}\ \tan\frac{\theta}{2} \times H^{2,5}$ ✓

$= 0,8 \times \frac{8}{15} \times \sqrt{2\ x\ 9,81}\ \tan\frac{90}{2} \times 0,895^{2,5}$ ✓

$= 1,432$ m³/s✓ (3)

2.3 2.3.1 $V_A = \sqrt{\frac{gx^2}{2y}}$

$= \sqrt{\frac{9,81\ x\ 1,87^2}{2(0,77)}}$✓

$= 4,72$ m/s✓

Reaction of the jet $= \rho Q V_A$✓

$= 10^3 \times 0,24 \times 4,72$✓

$= 1132,732$ N✓ (5)

2.3.2 $V_A = C_V\sqrt{2gh}$

$4,72 = 0,98\sqrt{2\ x\ 9,81\ x\ h}$✓

$h = 1,182$ m✓ (2)

2.3.3 $Q_{th} = V_{th} \times A_{th}$

$= \sqrt{2gh} \times \frac{\pi d^2}{4}$

$= \sqrt{2\ x\ 9,81\ x\ 1,182}$✓ $\times \frac{\pi(0,05)^2}{4}$✓

$= 9,456$ ℓ/s✓ (3)

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QUESTION 3

3.1
- Axial flow fans
- Centrifugal fans (2)

3.2 $a = \frac{\pi(0,75)^2}{4}$ ✓

$= 0,442$ m²✓

$S = \pi DL$

$= \pi \times 0,75 \times 60$✓

$= 141,372$ m²✓

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

$180 = \frac{0,005\ x\ 141,372\ x\ Q^2}{0,442^3}$✓

$= 4,686$ m³/s✓ (6)

3.3 3.3.1 $Q = \frac{42300}{1000\ x\ 3600}$✓

$= 0,01175$ m³/s✓

$P = \frac{\rho g Q H}{\eta}$

$= \frac{10^3 x\ 9,81\ x\ 0,01175\ x\ 258,5}{0,85}$✓

$= 35,055$ kW✓ (4)

3.3.2 $Hf_1 = 258,5 - 206$

$= 52,5$ m✓

$\frac{hf_2}{hf_1} = \left(\frac{Q_2}{Q_1}\right)^2$

$= \left(\frac{0,0235}{0,01175}\right)^2 \times 52,5$✓

$= 210$ m✓

$H = 210 + 206 = 416$ m ✓

$P = \frac{\rho g Q H}{\eta}$

$= \frac{10^3 x\ 9,81\ x\ 0,0235\ x\ 416}{0,85}$✓

$= 112,827$ kW✓ (6)

3.4
- Reciprocating pump uses impeller to suck and deliver fluid
- Centrifugal fan uses piston/plunger to suck and deliver fluid (2)

3.5 3.5.1 Velocity of water relative to impeller

3.5.2 Velocity of water relative to pump casing

(2 × 1) (2)

3.6 $Q = \frac{12,24 \times 10^6}{24\ x\ 10^3\ x\ 3600}$✓

$= 0,142\ m^3/s$✓

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

$= \frac{0,007\ x\ 26000\ x\ 0,142^2}{3\ x\ 0,45^5}$✓

$= 65,982$ m ✓

$P = \frac{\rho g Q H}{\eta}$

$= \frac{10^3 x\ 9,81\ x\ 0,142\ x\ 65,982}{0,78}$ ✓

$= 117,561$ Kw✓ (6)

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QUESTION 4

4.1. 4.1.1 Sin 60° = $\frac{V_{wi}}{36}$✓

V_{wi} = 31,177 m/s✓

Alternatively

Cos30° = $\frac{V_{wi}}{36}$ ✓

V_{wi} = 31,177 m/s✓

Cos60° = $\frac{V_{wo}}{3}$ ✓

V_{wo} = 1,5 m/s✓

Alternatively

Sin30° = $\frac{V_{wo}}{3}$ ✓

V_{wo} = 1,5 m/s✓ (4)

4.1.2 $U_i = \frac{\pi D N}{60}$

$= \frac{\pi \ x \ 1{,}2 \ x \ 300}{60}$✓

= 18,849 m/s✓

Cos60^0 = $\frac{V_i}{36}$ ✓ Alternatively Sin30° = $\frac{V_i}{36}$✓

V_i = 18 m/s✓ V_i = 18 m/s✓

x = V_{wi} - U_i

= 31,177 – 18,849✓

= 12,327 m/s✓

Tan β_i = $\frac{V_i}{x}$

β_i = Tan$^{-1}\frac{18}{12{,}327}$ ✓

= 55,595°✓ (8)

4.2 4.2.1 $V_A = C_V\sqrt{2gh}$

$= \sqrt{2\ x\ 9{,}81\ x\ 245}$ ✓

$= 69{,}332$ m/s✓

For maximum efficiency $U = 0{,}5\ V_A$

$U = 0{,}5\ (69{,}332)$✓

$= 34{,}666$ m/s✓

$U = \frac{\pi\ D\ N}{60}$

$34{,}666 = \frac{\pi\ x\ 0{,}9\ x\ N}{60}$✓

$= 735{,}633$ r/min✓ (6)

4.2.2 $\eta = \frac{U}{gh}\ (V - U)\ (1 + \cos\ (180° - y) \times 100\%$✓

$= \frac{34{,}666}{9{,}81\ x\ 245}\ (69{,}332 - 34{,}666)\ [1 + \cos\ (180° - 160°)] \times 100\%$✓

$= 96{,}985\%$✓ (3)

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TOTAL: 100