



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

5 December 2023

This marking guideline consists of 8 pages.

QUESTION 1

1.1 $T_A = 2T_P + T_S$
 $\dot{2}(36) + 14$
 $\dot{86} \text{ Teeth } \checkmark \checkmark$

(2)

1.2

Condition	A	P	S	L
Fix arm L and rotate A +1 rev	1	$\frac{TA}{TP} = \frac{86}{36} = 2,389 \checkmark$	$\frac{TA}{TS} = \frac{86}{14} = -6,143 \checkmark$	0
Multiple by x and add y	x+y	2,389x+y	-6,143x + y	y
	0		230	

$$-6,143x + y = 230 \dots\dots\dots 1$$

$$x + y = 0 \dots\dots\dots 2$$

$$x = -y \dots\dots\dots 3$$

Substitute equation 3 in to 1

$$-6,143(-y) + y = 230 \checkmark$$

$$7,143y = 230$$

$$y = 32,199 \checkmark$$

$$N_L = 32,199 \text{ r/min } \checkmark$$

$$P_i = \frac{2\pi NT}{60}$$

$$T_i = \frac{3800 \times 60}{2 \times \pi \times 230}$$

$$\dot{157,771} \text{ N } \checkmark$$

$$(T_{\dot{i}} \times N_i) + (T_{out} \times N_{out}) + (T_{hold} \times N_{hold}) = 0 \dot{i}$$

$$157,771 \times 230 \dot{i} + (T_{out} \times 32,199) = 0$$

$$T_{out} = -1126,971 \text{ N.m } \checkmark$$

$$T_{out} = -1126,971 \times 0,92 = 1036,813 \text{ N.m } \checkmark$$

(8)
[10]

QUESTION 2

- 2.1
- Trip wire
 - Drop rail
 - Cut-out rails
 - Self-locking worm gears
 - Beacon derailment device
 - Pivoted prop stopping devices
- (6)

2.2 2.2.1

$$T_{Tubs/min} = \frac{Ton_{shift}}{60 \times hrs \times ton_{tub}}$$

$$\frac{600}{60 \times 7 \times 1}$$

$$1,429 tub/min \quad \checkmark \checkmark$$

$$Spacing = \frac{Vr}{Tubs/min}$$

$$\frac{70}{1,429}$$

$$48,985 m \quad \checkmark \checkmark$$

(4)

2.2.2

$$No_{tubs} = \frac{L}{Spacing}$$

$$\frac{650}{48,985}$$

$$13,27$$

$$say = 13 tub/min \quad \checkmark \checkmark$$

(3)

2.2.3

$$F_{tub} = F_g + F_R$$

$$(M_{tub} \times N_{tubs} \times g \sin 15^\circ) + (M_{tub} \times N_{tub} \times F_R)$$

$$(1500 \times 13 \times 9,81 \sin 15^\circ) + (1,5 \times 13 \times 180)$$

$$49510,789 + 3510$$

$$53,02 kN \quad \checkmark \checkmark \checkmark$$

$$F_{Total} = F_{tubs} + F_\mu$$

$$53,02 + \frac{16}{2}$$

$$61,02 kN$$

$$F_{break} = F_{Total} \times ft \quad 61,02 \times 5$$

$$305,1 kN \quad \checkmark$$

(7)

QUESTION 33.1 *Speed of worm gear N_E*

$$\text{One turn of worm moves worm gear} = \frac{3}{36} = \frac{1}{12} \checkmark$$

$$N_E = 1000 \times \frac{1}{12} \checkmark$$

$$N_E = 83,333 \text{ r/min} \checkmark$$

$$\therefore N_E = N_A = 83,333 \text{ r/min} \checkmark$$

OR1 000 turns of worm shaft will displace 1 000 $\times$ 3 = 3 000 teeth $\checkmark \checkmark$

$$N_E = 3\,000/36 = 86,333 \text{ r/min} \checkmark$$

$$N_E = N_A = 86,333 \text{ r/min} \checkmark$$

$$N_A \times T_A \times T_C = N_D \times T_B \times T_D$$

$$83,333 \times 20 \times 28 = N_D \times 40 \times 60 \checkmark \checkmark$$

$$N_D = \frac{46666,667}{2400} \checkmark$$

$$N_D = 19,444 \text{ r/min} \checkmark$$

(8)

3.2

$$V_R = \frac{N_{\text{worm}}}{N_D}$$

$$= \frac{1000}{19,444} \checkmark$$

$$= 51,428 \checkmark$$

(2)

[10]**QUESTION 4**

4.1

$$L = \frac{\pi}{2}(D+d) + \frac{(D+d)^2}{4C} + 2C$$

$$L = \frac{\pi}{2}(1,8+0,75) + \frac{(1,8+0,75)^2}{4 \times 12} + 2 \times 12 \checkmark$$

$$L = 28,141 \text{ m} \checkmark$$

(2)

4.2

$$V = l \times b \times h$$

$$= 28,03 \times 0,5 \times 0,012$$

$$= 0,169 \text{ m}^3 \checkmark$$

$$m = \rho \times V$$

$$= 770 \times 0,169$$

$$= 130,13 \text{ kg} \checkmark$$

(2)

$$4.3 \quad w = N \times \frac{2\pi}{60}$$

$$\hookrightarrow 140 \times \frac{2\pi}{60}$$

$$\hookrightarrow 14,661 \text{ rad/s}$$

$$v = w \times r$$

$$\hookrightarrow 14,661 \times 0,75$$

$$\hookrightarrow 10,996 \text{ m/s} \quad (3)$$

$$4.4 \quad T_c = m \times v^2$$

$$\hookrightarrow 130,13 \times 10,996^2$$

$$\hookrightarrow 15734,281 \text{ N}$$

$$T_1 = w \times n \times t$$

$$\hookrightarrow 0,5 \times 4 \times 9500$$

$$\hookrightarrow 19000 \text{ N}$$

$$\frac{135}{57,3} = 2,356$$

$$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta}$$

$$\frac{19000 - 15734,281}{T_2 - 15734,281} = e^{0,27 \times 2,356}$$

$$T_2 = 17462,964 \text{ N} \quad (9)$$

$$4.5 \quad P = (T_1 - T_2) \times v$$

$$\hookrightarrow (19000 - 17462,964)(10,996)$$

$$\hookrightarrow 16901,246 \text{ W} \quad (4)$$

QUESTION 5

$$5.1 \quad F_R = F_\mu \times m \times g$$

$$= \frac{0,9}{100} \times 330 \times 10^3 \times 9,81 \quad \checkmark$$

$$= 29135,7 \text{ N} \quad \checkmark \quad (2)$$

$$5.2 \quad F_g = m \times g \times h$$

$$= 330 \times 10^3 \times 9,81 \times \frac{1}{125} \quad \checkmark$$

$$= 25898,4 \text{ N} \quad \checkmark \quad (2)$$

$$\begin{aligned}
 5.3 \quad F_a &= m \times a \\
 &= 330 \times 10^3 \times 0,065 \checkmark \\
 &= 21450 \text{ N} \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 5.4 \quad T_E &= F_R + F_g + F_a \\
 &= 29135,7 + 25898,4 + 21450 \checkmark \\
 &= 76484,1 \text{ N} \checkmark \\
 P_L &= T_E \times v \\
 &= 76484,1 \times \frac{65 \times 10^3}{3600} \checkmark \\
 &= 1380,963 \text{ kN} \checkmark
 \end{aligned}
 \tag{4}$$

[10]

QUESTION 6

- 6.1
- Belt bucket elevators
 - Chain buckets elevators
- (2)

$$\begin{aligned}
 6.2 \quad 6.2.1 \quad m_{i_s} &= \frac{550 \times 10^3}{3600} \\
 &= 152,778 \text{ kg/s} \\
 v_{i_s} &= \frac{m_{i_s}}{\rho} \\
 &= \frac{152,778}{890} \\
 &= 0,172 \text{ m}^3/\text{s}
 \end{aligned}
 \tag{4}$$

$$\begin{aligned}
 6.2.2 \quad bucket_{i_s} &= \frac{v}{spacing} \\
 &= \frac{0,45}{1,2} \\
 &= 0,375 \\
 V_{bucket} &= \frac{v_{i_s}}{bucket_{i_s}} \\
 &= \frac{0,172}{0,375} \\
 &= 0,459 \text{ m}^3 \\
 y &= 15 \\
 &= 152,778 \times 9,81 \times 65 \\
 &= 97418,892 \text{ W}
 \end{aligned}
 \tag{6}$$

$$\begin{aligned}
 6.2.3 \quad \eta &= \frac{P_o}{P_i} \\
 &= \frac{97418,892}{125000} \times 100 \\
 &= 78\%
 \end{aligned}$$

(3)
[15]**QUESTION 7**

$$\begin{aligned}
 T_1 &= m_1(g+a) + F_\mu \\
 &= 1500(9,81+0,9) + 500 \\
 &= 16,565 \text{ kN}
 \end{aligned}$$

$$\begin{aligned}
 T_2 &= m_2(g-a) - F_{\mu 1} \\
 &= 840(9,81-0,9) - 440 \\
 &= 7,0444 \text{ kN}
 \end{aligned}$$

Torque to accelerate load

$$\begin{aligned}
 T_{load} &= (T_1 - T_2)r \\
 &= (16,565 - 7,0444) \times 1,2 \\
 &= 11424,72 \text{ Nm}
 \end{aligned}$$

Torque to accelerate drum

$$\begin{aligned}
 T_{drum} &= \left(m k^2 \times \frac{a}{r} \right) + T_\mu \\
 &= \left(300(0,5^2) \times \frac{0,9}{1,2} \right) + 700 \\
 &= 756,25 \text{ N.m}
 \end{aligned}$$

$$T_{Total} = T_{load} + T_{drum}$$

$$\begin{aligned}
 &= 11424,72 + 756,25 \\
 &= 12180,97 \text{ Nm}
 \end{aligned}$$

$$P = T_{Total} \times \frac{v}{r}$$

$$P = 12180,97 \times \frac{2}{1,2}$$

[10]

$$= 20,301 \text{ kW}$$

