



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

MECHANOTECHNICS N4

31 March 2023

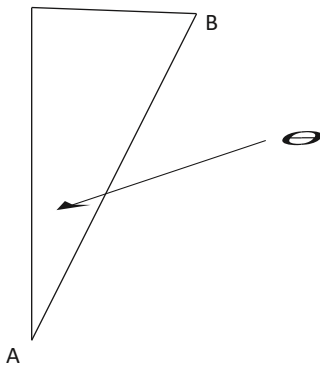
This marking guideline consists of 8 pages.

QUESTION 1

- 1.1
- High demand for the product.
 - Increased productivity because high volumes are produced in less time.
 - High level of standardisation because all products are identical.
 - High level of mechanisation because specialised machines do the work with minimum handling.
 - Large quantities are produced. (5)
- 1.2
- Cathodic protection
 - Electroplating
 - Anodising
 - Galvanising
 - Phosphating (5)
- 1.3
- Serve as a coolant by carrying away heat.
 - Reduce friction between two surfaces.
 - Protect surfaces from corrosion.
 - Prevent impurities and carry them to a sump.
 - Absorb shocks between moving parts. (5)
- [15]**

QUESTION 2

2.1



$$\begin{aligned}
 BC &= R - r \\
 &= 15 - 10 \checkmark \\
 &= 5 \text{ mm} \checkmark \\
 AB &= (X + r) - (Y + R) \checkmark \\
 &= (36,75 + 10) - (15 + 4,25) \\
 &= 46,75 - 19,25 \\
 &= 27,5 \checkmark
 \end{aligned}$$

$$\sin \theta = \frac{BC}{AB} \checkmark$$

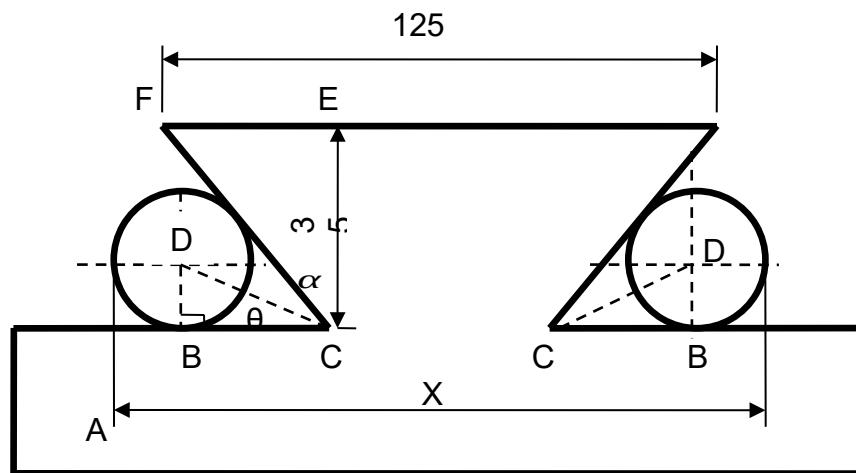
$$\theta = \sin^{-1} \frac{5}{27,5}$$

$$= 10,476^\circ \checkmark$$

$$\begin{aligned} \text{Included angle} &= 2\theta \checkmark \\ &= 2(10,476) \\ &= 20,952 \checkmark \end{aligned}$$

(8)

2.2



$$\theta = 32,5^\circ$$

$$\alpha = 90 - 65 = 25^\circ \checkmark$$

in ΔCEF to find EF

$$\tan \alpha = \frac{EF}{CE}$$

$$EF = \tan 25^\circ \times 35 \checkmark$$
$$= 16,321 \text{ mm} \checkmark$$

in $\triangle BCD$ to find BC

$$\tan 32,5 = \frac{BD}{BC}$$

$$\begin{aligned} BC &= \frac{BD}{\tan 32,5} \\ &= \frac{12,5}{\tan 32,5} \checkmark \\ &= 19,621 \text{ mm} \checkmark \end{aligned}$$

$$X = 125 - 2EF + 2AB + 2BC \checkmark$$

$$X = 125 - 2(16,321) + 2(19,621) + 2(12,5) \\ = 156,6mm \checkmark$$

(7)
[15]

QUESTION 3

3.1

Condition	Gear A	Gear P	Gear S	Arm E
<i>Fix arm E and rotate Gear A by +1 rev</i>	+1 ✓	$\frac{T_A}{T_D} = \frac{80}{20} = 4$ ✓	$\frac{80}{20} \times \frac{20}{-40} = -2$ ✓	0
<i>Multiply by x and add y</i>	$x + y$ ✓	$4x + y$ ✓	$-2x + y$	$+y$ ✓
$N_A = 0$ $N_S = 60$	$N_A = 0$		$N_S = 60$	$N_D = ?$ ✓
$N_D = -60$ $N_S = 0$	$N_A = ?$ ✓		$N_S = 0$	$N_D = -60$?

[half marks inside the table]

$$x + y = 0 \dots\dots\dots 1 \checkmark$$

$$-2x + y = 60 \dots\dots\dots 2 \checkmark$$

Subtract equation 1 from equation 2

$$3x = -60$$

$$x = -20 \checkmark$$

$$\text{And } y = 20$$

$$\text{But } N_D = y \checkmark$$

$$N_D = 20 \text{ r / min (clockwise)} \checkmark$$

(9)

3.2

$$-2x + y = 0 \dots\dots\dots 1 \checkmark$$

$$y = -60 \dots\dots\dots 2 \checkmark$$

Subtract equation 1 from equation 2

$$x = -30 \checkmark$$

and

$$y = -60 \checkmark$$

$$\text{And } N_A = x + y \checkmark$$

$$N_A = -30 + (-60)$$

$$N_A = -90 \text{ r / min (anticlockwise)} \checkmark$$

(6)
[15]

QUESTION 4

$$v = \frac{\pi d N}{60}$$

$$v = \frac{\pi \times 0,13 \times 240}{60}$$

$$v = 1,633 \text{ m/s} \checkmark$$

$$\frac{T_1}{T_2} = e^{(0,3 \times \frac{170}{57,3})}$$

$$T_1 = 2,435 T_2 \checkmark$$

$$P = (T_1 - T_2)v$$

$$24000 = (2,435 T_2 - T_2)1,633 \checkmark$$

$$T_2 = 10241,7 \text{ N} \checkmark$$

$$T_1 = 2,435(10241,7)$$

$$T_1 = 24938,6 \text{ N} \checkmark$$

[5]**QUESTION 5**

5.1

$$h_f = \frac{4 \times f \times l \times v^2}{2 \times g \times d} \checkmark$$

$$h_f = \frac{4 \times 0,005 \times 50 \times (2,5)^2}{2 \times 9,81 \times 0,025} \checkmark \checkmark$$

$$= 12,742 \text{ m} \checkmark \checkmark$$

$$v = C \sqrt{mi}$$

$$c = \sqrt{\frac{2 \times 9,81}{f}} \checkmark$$

$$c = \sqrt{\frac{2 \times 9,81}{0,005}} \checkmark$$

$$c = 62,64 \checkmark$$

$$= 62,642 \checkmark$$

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

$$= \frac{0,025}{4} \checkmark \checkmark$$

$$= 0,00625 \checkmark \checkmark$$

$$\frac{v^2}{c^2} = \frac{0,00625 \times h_f}{l}$$

$$h_f = \frac{2,5^2 \times 50}{62,64^2 \times 0,00625} \checkmark$$

(11)

$$h_f = 12.742m \quad h \checkmark \checkmark$$

5.2 5.2.1
$$h_f = \frac{f_x l x Q^2}{3,026 x d^5}$$

$$p = \rho g h_f$$

$$h_f = \frac{40 \times 10^3}{1000 \times 9,81} \checkmark$$

$$= 4,077 m \checkmark$$

$$f = \frac{h_f \times 3,026 x d^5}{l x Q^2}$$

$$= \frac{4,077 \times 3,026 \times (0,09)^5}{30 \times (0,02)^2} \checkmark \checkmark$$

$$= 0,006 \checkmark \quad (5)$$

5.2.2
$$m = \frac{d}{4}$$

$$m = \frac{0,09}{4} \checkmark$$

$$m = 0,023 \checkmark \quad (2)$$

5.2.3
$$i = \frac{h_f}{l}$$

$$i = \frac{4,077}{30} \checkmark$$

$$i = 0,136 \checkmark \quad (2)$$

[20]

QUESTION 6

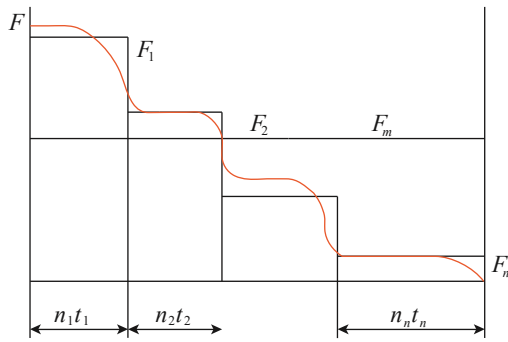
6.1
$$P = X.F_x + Y.F_y$$

$$P = (0,55 \times 4000) + (1,7 \times 6000) \checkmark$$

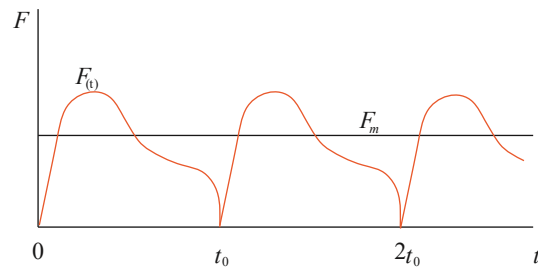
$$P = 2200 + 10200 \checkmark$$

$$P = 12400 N \checkmark \quad (3)$$

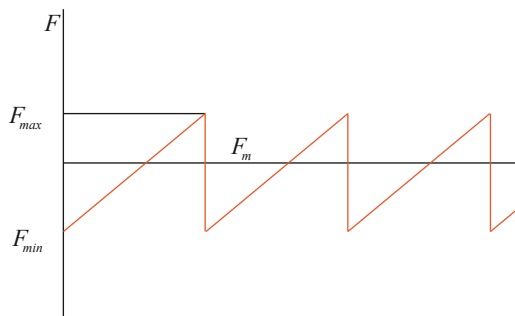
6.2



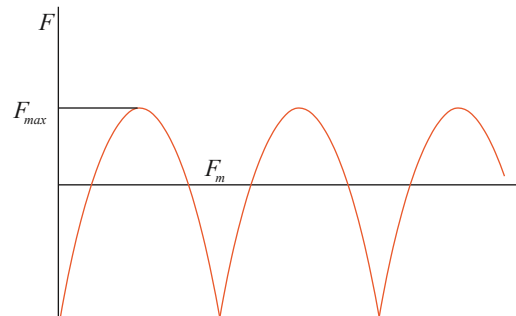
Fluctuating Stepped Load



Continuously fluctuating load



Linear fluctuating load



Sinusoidal fluctuating load

(2 marks for correct sketch)

(8)

6.3

$$L_0 = \left(\frac{1 \times 10^6}{60 \times n} \right) \times \left(\frac{C_r}{P_r} \right)^p$$

 $p = 3$ for ball bearing ✓

$$L_0 = \left(\frac{1 \times 10^6}{60 \times 1100} \right) \times \left(\frac{48,2 \times 10^3}{3500} \right)^3 \quad \checkmark \checkmark$$

$$L_0 = 39572,46 \text{ hours} \quad \checkmark$$

(4)

[15]**QUESTION 7**

7.1

$$F_f = \mu \times m \times g$$

$$C = \frac{m}{2} (T_A - T_B)$$

$$= 441,45 \text{ N} \quad \checkmark$$

$$WD_f = F_f \times S_l$$

$$= 441,45 \times 0,2 \quad \checkmark$$

$$= 88,29 \text{ J} \quad \checkmark$$

(3)

7.2

$$WD_{total} = WD_{cutting} + WD_{friction}$$

$$WD_{cutting} = WD_{total} - WD_{friction}$$

$$= 120 - 88.29$$

$$= 31.71 J \checkmark$$

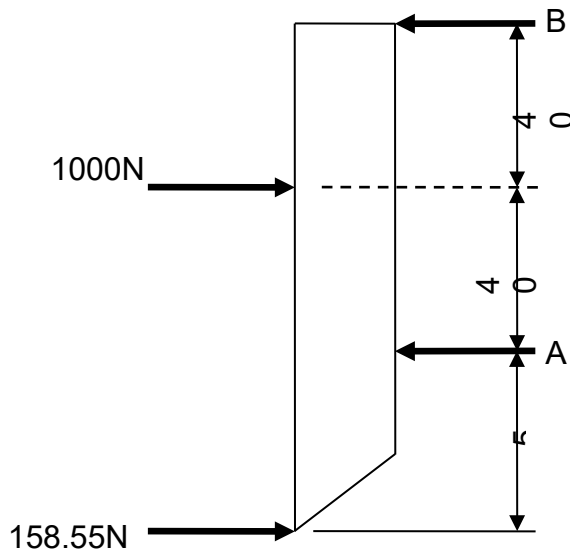
$$F_{cutting} = \frac{WD_{cutting}}{S_l}$$

$$F_{cutting} = \frac{31.71}{0.2} \checkmark$$

$$= 158.55 N \checkmark$$

(3)

7.3



Take moments about B to find A

$$\sum CWM = \sum ACWM$$

$$A \times 80 = (158.55 \times 130) + (1000 \times 40) \checkmark \checkmark$$

$$A = \frac{60611.5}{80} \checkmark$$

$$= 757.64 N \checkmark$$

Take moments about A to find B

$$\sum CWM = \sum ACWM$$

$$(1000 \times 40) = (158.55 \times 50) + (B \times 80) \checkmark \checkmark$$

$$B = \frac{32072.5}{80} \checkmark$$

$$= 400.91 N \checkmark$$

$$F_{up} = F_{down}$$

$$400.91 + 757.64 = 1000 + 158.55$$

$$1158.54 N = 1158.54 N \checkmark$$

(9)

[15]

TOTAL: 100