higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

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This marking guideline consists of 8 pages.

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QUESTION 1

1.1 $T_A = 2T_P + T_S$
$= 2(36) + 14$
$= 86\ Teeth$ ✓✓ (2)

1.2

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

$-6{,}143x + y = 230$……1
$x + y = 0$……2
$x = -y$……3

Substitute equation 3 in to 1

$-6{,}143(-y) + y = 230$ ✓
$7{,}143y = 230$
$y = 32{,}199$ ✓

$N_L = 32{,}199\ r/min$ ✓

$P_{IN} = \frac{2\pi NT}{60}$

$T_{IN} = \frac{3800\ x\ 60}{2\ x\ \pi\ x\ 230}$

$= 157{,}771\ N$ ✓

$(T_{IN}\ x\ N_{IN}) + (T_{out} x\ N_{out}) + (T_{hold} x\ N_{hold}) = 0$

$157{,}771x\ 230) + (T_{out} x\ 32{,}199) = 0$
$T_{out} = -1126{,}971\ N.m$ ✓

$T_{out} = -1126{,}971\ x\ 0{,}92 = 1036{,}813\ N.m$ ✓ (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

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

$$= \frac{600}{60 \times 7 \times 1} \quad ✓✓$$

$$= 1{,}429 tub_{/\min}$$

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

$$= \frac{70}{1{,}429} \quad ✓✓$$

$$= 48{,}985m$$ (4)

2.2.2

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

$$= \frac{650}{48{,}985} \quad ✓✓$$

$$= 13{,}27$$

$$say = 13 tub/\min$$ (3)

2.2.3

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

$$= \left(M_{tub} \times N_{tubs} \times g \sin 15^0\right) + \left(M_{tub} \times N_{tubs} \times F_R\right)$$

$$= (1500 \times 13 \times 9{,}81 \sin 15^0) + (1{,}5 \times 13 \times 180) \quad ✓✓✓$$

$$= 49510{,}789 + 3510$$

$$= 53{,}02kN$$

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

$$\boldsymbol{= 53,02 + \frac{16}{2}} ✓$$

$$\boldsymbol{= 61,02kN} ✓$$

$$\boldsymbol{F_{break} = F_{Total} \times ft}$$

$$\boldsymbol{= 61,02 \times 5} ✓$$

$$\boldsymbol{= 305,1kN} ✓$$ (7)

[20]

QUESTION 3

3.1 *Speed of worm gear* N_E

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

$N_E = 1000 \times \frac{1}{12}$ ✓

$N_E = 83{,}333 r/\min$ ✓

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

OR

1 000 turns of worm shaft will displace 1 000 × 3 = 3 000 teeth✓✓
NE 3 000/36 = 86,333 r/min✓
NE = NA = 86,333 r/min✓

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

$83{,}333 \times 20 \times 28 = N_D \times 40 \times 60$ ✓✓

$N_D = \frac{46666{,}667}{2400}$ ✓

$N_D = 19{,}444 r/\min$ ✓ (8)

3.2 $V_R = \frac{N_{worm}}{N_D}$

$= \frac{1000}{19{,}444}$ ✓

$= 51{,}428$ ✓ (2)

[10]

QUESTION 4

4.1 $L = \frac{\pi}{2}(D + d) + \frac{(D+d)^2}{4C} + 2C$

$L = \frac{\pi}{2}(1{,}8 + 0.75) + \frac{(1{,}8+0{,}75)^2}{4\ X\ 12} + 2\ X\ 12$ ✓

$L = 28.141\ m$ ✓ (2)

4.2 $V = l\ x\ b\ x\ h$

$= 28{,}03\ x\ 0{,}5\ x\ 0{,}012$

$= 0{,}169\ m^3$ ✓

$m = p\ x\ V$

$= 770\ x\ 0{,}169$

$= 130{,}13\ kg$ ✓ (2)

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

$= 140\ x\ \frac{2\pi}{60}$ ✓

$= 14{,}661\ rad/s$ ✓

$v = w\ x\ r$
$= 14{,}661\ x\ 0{,}75$
$= 10{,}996\ m/s$ ✓ (3)

4.4 $T_C = m\ x\ v^2$
$= 130.13\ x\ 10{,}996^2$
$= 15734{,}281\ N$ ✓✓

$T_1 = w\ x\ n\ x\ t$
$= 0{,}5\ x\ 4\ x\ 9500$ ✓
$= 19000\ N$ ✓

$\frac{135}{57{,}3} = 2{,}356$ ✓

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

$\frac{19000 - 15734{,}281}{T_2 - 15734{,}281} = e^{0{,}27\ x\ 2.356}$ ✓✓

$T_2 = 17462{,}964\ N$ ✓✓ (9)

4.5 $P = (T_1 - T_2)x\ v$
$= (19000 - 17462{,}964)(10{,}996)$ ✓✓
$= 16901{,}246\ W$ ✓✓ (4)

QUESTION 5

5.1 $F_R = F_\mu \times m \times g$
$= \frac{0{,}9}{100} \times 330 \times 10^3 \times 9{,}81$ ✓
$= 29135{,}7N$ ✓ (2)

5.2 $F_g = m \times g \times h$
$= 330 \times 10^3 \times 9{,}81 \times {}^{1}\!/_{125}$ ✓
$= 25898{,}4N$ ✓ (2)

5.3 $F_a = m \times a$

$= 330 \times 10^3 \times 0{,}065$ ✓

$= 21450N$ ✓ (2)

5.4 $T_E = F_R + F_g + F_a$

$= 29135{,}7 + 25898{,}4 + 21450$ ✓

$= 76484{,}1N$ ✓

$P_L = T_E \times v$

$= 76484{,}1 \times \frac{65 \times 10^3}{3600}$ ✓

$= 1380{,}963kN$ ✓ (4)

[10]

QUESTION 6

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

6.2 6.2.1

$m_{/s} = \frac{550 \times 10^3}{3600}$ ✓

$= 152{,}778kg/s$ ✓

$v_{/s} = \frac{m_{/s}}{\rho}$

$= \frac{152{,}778}{890}$ ✓

$= 0{,}172m^3/s$ ✓ (4)

6.2.2

$bucket_{/s} = \frac{v}{spacing}$

$= \frac{0{,}45}{1{,}2}$ ✓

$= 0{,}375$ ✓

$V_{bucket} = \frac{v_{/s}}{bucket_{/s}}$

$= \frac{0{,}172}{0{,}375}$ ✓

$= 0.459\ m^3$ ✓

$P_o = P_g = mgh$

$= 152{,}778 \times 9{,}81 \times 65$ ✓

$= 97418{,}892W$ ✓ (6)

6.2.3 $$\eta = \frac{P_o}{Pi}$$
$$= \frac{97418,892}{125000} \times 100 \checkmark\checkmark$$
$$= 78\% \checkmark$$

(3)
[15]

QUESTION 7

$$T_1 = m_1(g + a) + \boldsymbol{F_\mu}$$
$$= 1500(9,81 + 0,9) + 500 \checkmark$$
$$= 16,565\ kN \checkmark$$

$$T_2 = m_2(g - a) - \boldsymbol{F_{\mu 1}}$$
$$= 840(9,81 - 0,9) - 440 \checkmark$$
$$= 7,0444\ kN \checkmark$$

Torque to accelerate load

$$T_{load} = (T_1 - T_2)r$$
$$= (16,565 - 7,0444) \times 1.2$$
$$= 11424,72\ Nm \checkmark$$

Torque to accelerate drum

$$T_{drum} = \left(mk^2 \times \frac{a}{r}\right) + T_\mu$$
$$= \left(300(0,5^2) \times \frac{0,9}{1,2}\right) + 700 \checkmark$$
$$= 756,25\ N.m \checkmark$$

$$T_{Total} = T_{load} + T_{drum}$$
$$= 11424,72 + 756,25$$
$$= 12180,97\ Nm \checkmark$$

$$P = T_{Total} \times \frac{v}{r}$$
$$P = 12180,97 \times \frac{2}{1.2} \checkmark$$
$$= 20,301\ kW \checkmark$$

[10]

QUESTION 8

8.1
- Stores energy during the power stroke and
- Releases energy during the idler strokes.

(Any ONE) (1)

8.2 8.2.1

$$\omega_2 = \omega_1 + \alpha t$$
$$= 0 + (1,5 \times 47) \checkmark$$
$$= 70,5 rad/s \checkmark$$

(2)

8.2.2

$$\alpha = \frac{\omega_2 - \omega_1}{t}$$
$$= \frac{0 - 70,5}{68} \checkmark$$
$$= -1,037 rad/s^2 \checkmark$$

(2)
[5]

TOTAL: 100

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