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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 9 pages.

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QUESTION 1

1.1
$$T_B = 2T_C + T_D$$
$$T_C = \frac{T_B - T_D}{2} \checkmark$$
$$= \frac{140 - 60}{2}$$
$$= 40 \text{ teeth} \checkmark$$
(2)

1.2
$$T_B \times N_B = T_A \times N_A$$
$$N_B = \frac{T_A \times N_A}{-T_B}$$
$$\frac{T_1 - T_C}{T_2 - T_C} = e^{\mu\theta} \checkmark$$
$$= 27{,}875 r/\min \quad anti-clockwise/opposite\ direction \checkmark$$
(2)

1.3

Condition	Gear B	Gear C	Gear D	Arm E	
Fix arm E and rotate B by + rev	+1	$\frac{T_B}{T_C} = \frac{100}{40}$ $= 2{,}5$	$= 2{,}5 \times \frac{40}{-60}$ $= -1{,}667$	0	✓
multiply by x and add y	$x + y$	$2{,}5x + y$	$-1{,}667x + y$	$+ y$	✓
$N_B = -27{,}875$ r/min $N_D = 35$ r/min $N_E = ?$	$-27{,}875$ r/min		35r/min	$N_E = ?$	✓
$N_B = -27{,}875$ r/min $N_D = 0$ $N_E = ?$	$-27{,}875r$/min		0	$N_E = ?$	✓

$x + y = -27{,}875$
$x = -27{,}875 - y$ ✓
$But\ -1{,}667x + y = 35$
$-1{,}667(-27{,}875 - y) + y = 35$ ✓
$46{,}467 + 1{,}667y + y = 35$ ✓
$46{,}468 + 1{,}667y + y = 35$
$y = -4{,}299$
$\therefore N_E = -4{,}299r/\min$ ✓

$Also: x = -25 - y$
$x = -25 - (-4{,}299)$ ✓
$= -20{,}704$ ✓

(11)

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1.4
$$x + y = -27,875$$
$$x = -27,875 - y$$
$$But\ -1,667x + y = 0 \checkmark$$
$$-1,667(-27,875 - y) + y = 0$$
$$46,468 + 1,667y + y = 0 \checkmark$$
$$2,667y = -46,468$$
$$y = -17,423$$
$$N_E = y$$
$$Ne = -17,423r/\min \checkmark$$
$$(T_{in} \times N_{in}) + (T_{out} \times N_{out}) + (T_{hold} \times N_{hold}) = 0$$
$$(20 \times 130) + (-17,423T_{out}) + (T_{hold} \times 0) = 0 \checkmark$$
$$-17,423T_{out} = -2600$$
$$T_{out} = 149,228\ Nm \checkmark$$

(5)
[20]

QUESTION 2

2.1
- Malfunction of chain and belt tensioners causing chain and belt slackness
- Misalignment of sprockets and pulleys causing uneven wear on sprocket, chain and shaft bearings
- Uneven spacing of buckets on chain or belt
- Excessive bucket speed resulting in improper loading and discharge of buckets
- Overloading of buckets (Any 2 × 3) (6)

2.2 2.2.1
$$m/s = \frac{380 \times 10^3}{3600} = 105,556\ kg/s \checkmark$$

$$v_{delivered} = \frac{m/s}{\rho}$$
$$= \frac{105,556}{900} \checkmark$$
$$v_{delivered} = 0,117\ m^3/s \checkmark$$

$$B/s = \frac{0,6}{1}$$
$$= 0,6/s \checkmark$$

$$v_{each} = \frac{v_{delivered}}{B/s}$$
$$= \frac{0,117}{0,6} \checkmark$$
$$v_{each} = 0,195\ m^3 \checkmark$$

(5)

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2.2.2 $P_g = mgh$

$= 105,556 \times 9,81 \times 65$ ✓

$= 67307,783\ W$

$T_E = m_L \times g \times \mu \times \eta$ ✓

$\eta = \frac{P_o}{P_i}$

$P_{in} = \frac{P_o}{\eta}$

$= \frac{67307,783}{0,78}$ ✓✓

$= 86292,03\ W$

$= 86,292\ kW$ ✓

(5)
[16]

QUESTION 3

3.1 3.1.1 Biconical and self-centring roller (1)

3.1.2 Prevents the rope from dragging on the ground when there are no trucks to keep the haulage in the air (2)

3.2 $M_T = M_{full} - M_{empty}$

$= 950 - 240$

$= 710\ kg$ ✓

$Tubs_{/\min} = \frac{ton/shift}{60 \times running\ \ hours \times ton/tub}$

$= \frac{600 \times 1\,000}{60 \times 8 \times 710}$

$1,761$ ✓

$T_{spacing} = \frac{speed\ \ rope/\min}{Tubs_{/\min}}$

$= \frac{4,6 \times 1\,000}{60 \times 1,761}$

$= 43,536\ m$ ✓

$T_{number} = \frac{length}{T_{spacing}}$

$T_{number} = \frac{900}{43,536}$

$= 20,673$

$say = 21\ \ tubes$ ✓

$mass_{rope} = 2 \times 900 \times 2,5$

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$$= 4\,500\ kg \checkmark$$

$$mass_{full\ tubs} = 950 \times 21$$
$$= 19950\ kg \checkmark$$

$$mass_{empty\ tubs} = 240 \times 21$$
$$= 5040\ kg \checkmark$$

$$M_{total} = M_{rope} + M_{ft} + M_{empty}$$
$$= 4\,500 + 19950 + 5040 \checkmark$$
$$= 29490\ kg$$
$$= 29{,}49\ ton \checkmark$$

$$Force_{to\ overcome\ friction} = 29{,}49 \times 190$$
$$= 5603{,}1\ N \checkmark$$

$$f_g = out\ \ balance \times \sin\theta$$
$$= 710 \times 9{,}81 \times 21 \times \sin 15$$
$$= 37856{,}711\ N \checkmark$$

$$T_E = F_R + F_g$$
$$= 5603{,}1 \ + \ 37856{,}711$$
$$= 43459{,}811\ N \checkmark$$

$$P = T_E \times v$$
$$= 43459{,}811 \times \frac{4{,}6 \times 10^3}{3600} \checkmark$$
$$= 55531{,}981\ W \checkmark$$

$$P_o = \frac{P_i}{\eta}$$
$$P_o = \frac{55531{,}981}{0{,}8}$$
$$= 69414{,}976\ \ W$$
$$= 69{,}415\ kW \checkmark$$

(15)
[18]

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QUESTION 4

4.1

$$T_1 = m_1(g + a) + f\mu$$
$$= 1100(9{,}81 + 1{,}6) + 400 \checkmark$$
$$= 12951\ N \checkmark$$

$$T_2 = m_2(g - a) - f\mu$$
$$= 400(9{,}81 - 1{,}6) - 400 \checkmark$$
$$= 2884\ N \checkmark$$

$$T_L = (T_1 - T_2)r$$
$$= (12951 - 2884)0{,}6 \checkmark$$
$$= 6040{,}2\ Nm \checkmark$$

$$I = m \times k^2$$
$$= 550 \times (0{,}6)^2$$
$$= 198\ kgm^2 \checkmark$$

$$a = \alpha \times r$$
$$\alpha = \frac{a}{r}$$
$$= \frac{1{,}6}{0{,}6}$$
$$= 2{,}667\ rad/s^2 \checkmark$$

$$T_d = I \times \alpha$$
$$= 198 \times 2{,}667$$
$$= 528{,}066\ Nm \checkmark$$

$$T_{TOTAL} = T_L + T_d$$
$$= 6040{,}2 + 528{,}066$$
$$T_{TOTAL} = 6568{,}266\ Nm \checkmark$$

$$P = T_{tot} \times \omega$$
$$P = T_{tot} \times \frac{v}{r}$$
$$P = 6568{,}2 \times \frac{3{,}2}{0{,}6} \checkmark$$
$$P = 35030{,}752\ W \checkmark$$

(12)

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4.2

$$v = \sqrt{2as}$$

$$a = \frac{v^2}{2s}$$

$$= \frac{(4,8)^2}{2 \times 4,8} \checkmark$$

$$= 2,4\ m/s^2 \checkmark$$

$$T_1 = m_1(g - a) + f\mu$$

$$= 1100(9,81 + 2,4) - 400 \checkmark$$

$$= 4484\ N \checkmark$$

$$T_2 = m_2(g + a) - f\mu$$

$$= 400(9,81 - 2,4) + 400 \checkmark$$

$$= 3364\ N \checkmark$$

(6)
[18]

QUESTION 5

5.1

$$T_E = m_L \times g \times \mu \times \eta$$

$$= 100 \times 10^3 \times 9,81 \times 0,3 \times 0,8 \checkmark$$

$$= 235440\ N \checkmark\checkmark$$

(3)

5.2

$$F_R = (m_L \times R_L) + (m_T \times R_T)$$

$$= (100 \times 120) + (500 \times 90) \checkmark$$

$$= 12\ 000 + 45\ 000 \checkmark$$

$$= 57\ 000\ N \checkmark$$

$$F_g = (m_L + m_T) \times 10^3 \times g \times incline$$

$$= (100 + 500) \times 10^3 \times 9,81 \times \frac{0,7}{100} \checkmark\checkmark$$

$$= 41202\ N \checkmark$$

$$T_E = F_R + F_g + F_a$$

$$F_a = T_E - F_R - F_g$$

$$= 235440 - 57000 - 41202 \checkmark$$

= 137238 N

$$= 137,238\ kN \checkmark$$

(8)

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5.3

$$F_a = (m_L + m_T) \times 10^3 \times a$$
$$137238 = (100 + 500) \times 10^3 \times a$$
$$a = \frac{137238}{600000} \checkmark$$
$$= 0{,}228\ m/s^2 \checkmark$$

$$v_f = u_i + a.t$$
$$t = \frac{v_f - u_i}{a}$$
$$t = \frac{8{,}333 - 0}{0{,}228} \checkmark$$
$$= 36{,}55\ s \checkmark$$

(4)

5.4

$$v_f{}^2 = u_i{}^2 + 2aS$$
$$S = \frac{v_f{}^2 - u_i{}^2}{2a}$$
$$= \frac{8{,}333^2 - 0^2}{2(0{,}228)} \checkmark\checkmark$$
$$= 152{,}3\ m \checkmark$$

OR

$$s = \left(\frac{v_f - u_i}{2}\right)t$$
$$= \left(\frac{8{,}333 - 0}{2}\right)36{,}55 \checkmark\checkmark$$
$$= 152{,}3\ m \checkmark$$

(3)
[18]

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QUESTION 6

$\omega_2 = \omega_1 + \alpha.t$

$\omega_2 = 0 + (1{,}8 \times 55)$

$= 99\ rad/s$ ✓

$\alpha = \dfrac{\omega 3 - \omega_2}{t}$

$= \dfrac{0 - 99}{66}$ ✓

$= -1{,}5\ rad/s^2$ ✓

$\theta = \left(\dfrac{\omega_2 + \omega_1}{2}\right)t$

$= \left(\dfrac{99 + 0}{2}\right)55$ ✓

$= 2722{,}5\ rad$ ✓

$\theta = 2\pi N$

$N = \dfrac{\theta}{2\pi}$

$= \dfrac{2722{,}5}{2 \times \pi}$ ✓

$= 433{,}3\ rev$ ✓

during deceleration

$\theta = \left(\dfrac{\omega_2 + \omega_3}{2}\right)t$

$= \left(\dfrac{0 + 99}{2}\right)66$ ✓

$= 3267\ rad$ ✓

$total\ number\ of\ revs = 433{,}3 + 519{,}95$

$= 953{,}259\ rev$ ✓

[10]

TOTAL: 100

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