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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

MECHANOTECHNICS N5

8 APRIL 2016

This marking guideline consists of 8 pages.

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QUESTION 1

1.1 $T_B = 2T_C + T_D$

$T_C = \frac{T_B - T_D}{2}$

$= \frac{104 - 44}{2}$

$= 30$ (2)

1.2 $T_B \times N_B = T_A \times N_A$

$N_B = \frac{T_A \times N_A}{T_B}$

$= \frac{20 \times 130}{120}$

$= -21{,}67 r/\min$ (2)

1.3

CONDITION	GEAR B	GEAR C	GEAR D	ARM E
Fix arm E and rotate B + 1 rev	+ 1	$\frac{104}{30} = 3{,}467$	$3{,}467 \times \frac{30}{44} = -2{,}364$	0
Multiply by x and add y	x + y	3,467x + y	- 2,364x + y	+ y
$N_B = -21{,}67$ $N_D = 30$ $N_E = ?$	- 21,67		30	N_E =?
$N_B = -21{,}67$ $N_D = 0$ $N_E = ?$	- 21,67		0	$N_E = ?$

x + y = -21,67

x = -21,67 – y

But: -2,364x + y = 30

-2,364(-21,67 – y) + y = 30

51,228 + 2,364y + y = 30

3,364y = -21,228

y = -6,31

Also: $N_E = y$

$= -6{,}31 r/\min$

Also: x = -21,67 – y

= -21,67 – (-6,31)

= -21,67 + 6,31

= -15,36 (11)

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1.4 $x + y = -21,67$

$x = -21,67 - y$

But: $-2,364x + y = 0$

$-2,364(-21,67 - y) + y = 0$

$51,228 + 2,364y + y = 0$

$3,364y = -51,228$

$y = -15,228$

Also: $N_E = y$

$= -15,62 r/\min$

$(T_{in} \times N_{in}) + (T_{out} \times N_{out}) + (T_{hold} \times N_{hold}) = 0$

$(26 \times 130) + (-15,62T_{out}) + (T_{hold} \times 0) = 0$

Also: $3\,380 - 15,62T_{out} + 0 = 0$

$-15,62T_{out} = -3\,380$

$T_{out} = 216,251\ N.m$ (5)

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QUESTION 2

2.1 $$v = \frac{\pi \times (D + t).N}{60}$$

$$= \frac{\pi \times (1,6 + 0,016) \times 240}{60}$$

$$= 20,307\ m/s$$ (2)

2.2 $$M = v \times \rho$$

$$= w \times t \times L \times \rho$$

$$= 1 \times 0,016 \times 1 \times 800$$

$$= 12,8\ kg/m$$ (2)

2.3 $$T_C = M.v^2$$

$$= 12,8 \times (20,307)^2$$

$$= 5\,278,39\ N$$ (2)

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2.4 $T_1 = w \times n \times ft$

$= 1 \times 4 \times 8 \times 10^3$

$= 32\ 000\ N$

$\theta = \dfrac{160}{57,3}$

$= 2,792$

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

$= \dfrac{32\ 000 - 5\ 278,39}{T_2 - 5\ 278,39} = 2,718^{0,35 \times 2,792}$

$\dfrac{26\ 721,61}{T_2 - 5\ 278,39} = 2,656$

$= 2,656T_2 - 14\ 019,404 = 26\ 721,61$

$T_2 = \dfrac{40\ 741,014}{2,656}$

$= 15\ 339,237\ N$ (6)

2.5 $P = (T_1 - T_2).v$

$= (32\ 000 - 15\ 339,239) \times 20,307$

$= 338,33\ kW$

$P_0 = P_1 \times \eta$

$= 338,33 \times 0,75$

$= 253,748\ kW$ (4)

2.6 $P = 253,748 - 5\%\ slip$

$= 253,748 - 12,687$

$= 238,523\ kW$ (2)

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QUESTION 3

3.1 3.1.1 Positive discharge elevator
3.1.2 Continuous bucket elevator
3.1.3 Centrifugal bucket elevator

(3 × 1) (3)

3.2 3.2.1

$$M_L = \frac{430 \times 10^3}{3\,600}$$
$$= 119{,}444\ kg/s$$

$$V_{/s} = \frac{M_L}{P_L}$$
$$= \frac{119{,}444}{900}$$
$$= 0{,}133\ m^3/s$$ (4)

3.2.2

$$B_{/S} = \frac{0{,}3}{1{,}2}$$
$$= 0{,}25/s$$

$$V_{Bucket} = \frac{V_{/S}}{B_{/S}}$$
$$= \frac{0{,}133}{0{,}25}$$
$$= 0{,}532\ m^3$$
$$P_{Out} = mgh$$
$$= 119{,}444 \times 9{,}81 \times 50$$
$$= 58\,587\ W$$
$$= 58{,}587\ kW$$ (8)

3.2.3

$$\eta = \frac{P_O}{P_I}$$
$$= \frac{58{,}587}{90} \times 100$$
$$= 65{,}1\%$$ (2)

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QUESTION 4

4.1 A dead-weight tensioning device is used when the haulage is comparatively light. The tension gear is operated on the return-rope sheave by suspending a dead weight over a pulley. (3)

4.2 4.2.1

$$T_{/Min} = \frac{t_{/shift}}{60 \times hours \times t_{tub}}$$
$$= \frac{1\,380}{60 \times 7 \times 1}$$
$$= 3{,}286$$
$$T_{Space} = \frac{V_{rope}}{T_{/\min}}$$
$$= \frac{3 \times 10^3}{60 \times 3{,}286}$$
$$= 15{,}216$$
$$T_{/side} = \frac{L}{T_{/space}}$$
$$= \frac{1\,370}{15{,}216}$$
$$= 90{,}037$$

Say = 90 tubs

$$T_{Total} = 2 \times 90$$
$$= 180$$

(5)

4.2.2

$$F_g = M_b \times T_{Side} \times g \times gradient$$
$$= 1\,300 \times 90 \times 9{,}81 \times \frac{1}{15}$$
$$= 76\,518N$$

$$F_R = [M_L + M_E] \times T_R + [M_r \times R_{/ton}]$$
$$= [(1\,300 + 880) \times 90) + (880 \times 90)] \times 240 + [2 \times 1\,370 \times 0{,}0015] \times 380$$
$$= 66\,096 + 1\,561{,}8$$
$$= 67\,657{,}8\ N$$

$$F_e = F_g + F_R$$
$$= 76\,518 + 67\,657{,}8$$
$$== 144{,}176\ kN$$
$$P = \frac{F_e \times v}{\eta}$$
$$= \frac{144{,}176 \times 3 \times 10^3}{0{,}84 \times 3\,600}$$
$$= 143{,}032\ kW$$

(8)

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QUESTION 5

5.1 5.1.1 The maximum permissible capacity of a goods elevator is 3 000 kg. (2)

5.1.2 The maximum allowable speed of a goods elevator is 80 m/minute. (2)

5.2 5.2.1

$$T_1 = m_1(g + a) + F_{\mu_1}$$
$$= 1\,450(9{,}81 + 0{,}94) + 500$$
$$= 16\,087{,}5\ N$$

$$T_2 = m_2(g - a) - F_{\mu_2}$$
$$= 650(9{,}81 - 0{,}94) - 300$$
$$= 5\,465{,}5\ N$$

$$T_{a_1} = (T_1 - T_2) \times r$$
$$= (16\,087{,}5 - 5\,465{,}5) \times 0{,}45$$
$$= 4\,779{,}9\ N.m$$

$$T_{a_2} = I_a + T_\mu$$
$$= \left(m.k^2 \times \frac{a}{r}\right) + T_\mu$$
$$= \left[250 \times (0{,}4)^2 \times \frac{0{,}94}{0{,}45}\right] + 200$$
$$= 83{,}556 + 200$$
$$= 283{,}556\ N.m$$

$$T_{Total} = T_{a_1} + T_{a_2}$$
$$= 4\,779{,}9 + 283{,}556$$
$$= 5\,063{,}456\ N.m$$ (10)

5.2.2

$$P = T_{Total} \times \frac{v}{r}$$
$$= 5\,063{,}456 \times \frac{3}{0{,}45}$$
$$= 33\,756{,}37\ W$$
$$= 33{,}756\ kW$$ (3)

[17]

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QUESTION 6

6.1
$$\omega_2 = \omega_1 + \alpha.t$$
$$= 0 + (3 \times 75)$$
$$= 225\ rad/s$$
(2)

6.2
$$\alpha = \frac{\omega_2 - \omega_1}{t}$$
$$= \frac{225 - 0}{93}$$
$$= 2{,}419\ rads/s^2$$
(2)

6.3
$$\theta = \frac{1}{2} \times \alpha.t^2 + \omega_1.t$$
$$= \frac{1}{2} \times 3 \times (75)^2 + 0$$
$$= 8\ 437{,}5\ rad$$

$$2.\pi rad = 1\ rev$$
$$N = \frac{8\ 437{,}5}{2 \times \pi}$$
$$= 1\ 342{,}87\ revs$$
(4)

6.4
$$\theta = \frac{\omega_2 + \omega_1}{2} \times t$$
$$= \frac{225 + 0}{2} \times 93$$
$$= 10\ 462{,}5\ rads$$

$$2.\pi rad = 1\ rev$$
$$N = \frac{10\ 462{,}5}{2 \times \pi}$$
$$= 1\ 665{,}159\ revs$$
(4)
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TOTAL: 100

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