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 10 pages.

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QUESTION 1

No	Condition	Gear A	Gear P	Gear S	Arm L
1	Fix arm L and rotate gear A +1 rev	+1	$\frac{T_A}{T_P}=\frac{100}{40}=2,5$	$\frac{T_A}{T_P}x\frac{T_P}{T_S}=\frac{100}{40}x\frac{40}{20}=-5$	0
2	Multiply by x and add y	$x+y$	$2,5x+y$	$-5x+y$	$+y$
3	NS = 300 NA = 0 NL = ?	0		300	NL=?
4	NL = 10 NS = 300 NA = ?	NA=?		300	10

1.1 $T_A = 2T_p + T_s$

$= 2(40) + 20$ ✓

$= 100$ teeth ✓

Determine x and y:

$x + y = 0$

$x = -y$ ✓

But : $-5x + y = 300$

$-5(-y) + y = 300$ ✓

$6y = 300$

$y = \frac{300}{6}$ ✓

$y = 50$

$N_L = y$

$N_L = 50$ r/min ✓

$\therefore$ The speed of the output shaft = 50 r/min (6)

1.2 $$P_{in} = \frac{2\pi N T_{in}}{60}$$

$$T_{in} = \frac{60 \times P_{in}}{2\pi N}$$

$$T_{in} = \frac{60 \times 4\,000}{2\pi \times 300} \checkmark$$

$$T_{in} = 127{,}324 \text{ N.m} \checkmark$$

$$(T_{in} \times N_{in}) + (T_{out} \times N_{out}) + (T_{hold} \times N_{hold}) = 0$$
$$(127{,}324 \times 300) + (T_{out} \times 50) + 0 = 0 \quad \checkmark$$
$$T_{out} = \frac{-38\,197{,}2}{50}$$
$$T_{out} = -763{,}944 \text{ N.m} \checkmark$$
$$T_{out} = -763{,}944 \times \frac{86}{100} \checkmark$$
$$T_{out} = -656{,}992 \text{ N.m} \checkmark$$ (6)

1.3 $$y = 10$$
$$\text{But} : -5x + y = 300$$
$$-5x + 10 = 100$$
$$-5x = 290$$
$$x = \frac{290}{-5} \checkmark$$
$$x = -58 \checkmark$$

$$N_A = x + y$$
$$N_A = -58 + 10 \checkmark$$
$$N_A = -48 \text{ r/min} \checkmark$$ (4)

[16]

QUESTION 2

2.1
- 6: diameter
- 19: number of strands
- 12.6: number of wires per strand
- 12.1.1: number of wires in each layer (starting from the outside)

(Any 3 × 1) (3)

2.2 2.2.1

$$v = \frac{\pi(D + t)N}{60}$$
$$= \frac{\pi(1{,}6 + 0{,}014)230}{60} \checkmark$$
$$= 19{,}437 \text{ m/s} \checkmark$$

(2)

2.2.2

$$p = \frac{m}{v}$$
$$m = p \times w \times t \div l$$
$$= 800 \times 1 \times 0{,}014 \times 1 \checkmark$$
$$m = 11{,}2 \text{ kg/m} \checkmark$$

(2)

2.2.3

$$\frac{T_1 - T_C}{T_2 - T_C} = e^{\mu\theta}$$
$$T_C = mv^2$$
$$T_C = 11{,}2 \times (19{,}437)^2 \checkmark$$
$$= 4\ 231{,}341 \text{ N}$$
$$T_C = 4{,}231 \text{ kN} \checkmark$$

$$T_1 = w \times n \times ft$$
$$= 1 \times 4 \times 14 \times 10^3 \checkmark$$
$$T_1 = 56\ 000 \text{ N} \checkmark$$

$$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta}$$
$$\frac{5\ 600 - 4\ 231{,}341}{T_2 - 4\ 231{,}341} = e^{0{,}4 \times 3{,}051} \checkmark$$
$$3{,}397T_2 - 14{,}37 \times 10^3 = 51{,}769 \times 10^3 \checkmark$$
$$T_2 = 11\ 008{,}44 \text{ N} \checkmark$$

(7)

2.2.4

$$P = (T_1 - T_2)v$$
$$= (56 \times 10^3 - 11 \times 10^3)437 \checkmark$$
$$P = 874{,}665 \text{ kW} \checkmark$$

(2)

2.2.5

$$Belt\ width = \frac{P_{total}}{P/_{m\ width}}$$

$$= \frac{50}{874{,}665}\ ✓$$

$$Belt\ width = 0{,}057\ \text{m}$$

$$= 57\ \text{mm}\ ✓$$

(2)
[18]

QUESTION 3

3.1
- 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
- Overloading of buckets
- Uneven spacing of buckets on chain or belt
- Excessive bucket speed resulting in improper loading and discharge of buckets (Any 3 × 2) (6)

3.2 3.2.1 The volume of each bucket

$$= \frac{300 \times 10}{3\ 600}$$

$$= 83{,}333\ \text{kg/s}\ ✓$$

$$V_{delivered} = \frac{m_n}{P}$$

$$= \frac{83{,}333}{800}\ ✓$$

$$V_{delivered} = 0{,}104\ \text{m}^3/\text{s}✓$$

$$B/s = \frac{0{,}4}{1}$$

$$= 0{,}4\ \text{s}✓$$

$$V = \frac{V_{delivered}}{B/s}$$

$$= \frac{0{,}104}{0{,}4}✓$$

$$V = 0{,}26\ \text{m}^3/\text{s}✓$$

(6)

3.2.2 $P_g = mgh$

$= 83{,}333 \times 9{,}81 \times 60$ ✓

$= 49{,}05 \text{ kW}$ ✓

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

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

$P_{in} = \frac{49{,}05 \times 10^3}{0{,}88}$ ✓

$P_{in} = 55{,}739 \text{ kW}$ ✓ (4)

[16]

QUESTION 4

4.1 $M_r = 1\,000 - 250$

$= 750 \text{ kg}$

$Tubs/_h = \frac{750}{8 \times 0{,}8}$

$= 117{,}118$ ✓

$T_{space} = \frac{3{,}5 \times 103}{117{,}188}$

$= 29{,}87$ ✓

$T_{number} = \frac{800}{29{,}87}$ ✓

$= 26{,}78$

$\text{say} = 27$ ✓ (4)

4.2 $M_{rope} = 2 \times 900 \times 3$

$= 5\,400 \text{ kg} \checkmark$

$M_{ft} = 1\,000 \times 27$

$= 27\,000 \text{ kg} \checkmark$

$M_{gm} = 250 \times 27$

$= 6\,750 \text{ kg} \checkmark$

$M_{total} = 6\,750 + 27\,000 + 5\,400 \checkmark$

$= 39\,150 \text{ kg}$

$= 39{,}15 \text{ tons} \checkmark$ (5)

4.3 $F_R = M_T + T_R$

$= 70{,}6 + 200$

$F_R = 14\,120 \text{ N} \checkmark$

$L_{balance} = 27 \times 180$

$= 4\,860 \text{ kg}$

$F_{rope} = 4\,860 \times 9{,}81 \sin 12^\circ$

$F_{rope} = 9\,912{,}522 \text{ N}$

$F_{total} = 14\,120 + 9\,912{,}522$

$= 24\,32{,}522 \text{ N} \checkmark$

$F_{total} = 24{,}033 \text{ kN} \checkmark$

$W_{d/s} = F_T \times v$

$W_{d/s} = 24{,}033 \times 10^3 \times \left(\frac{3{,}5 \times 10^3}{3\,600} \right) \checkmark$

$W_{d/s} = 23{,}365 \text{ kJ/s}$

$= 23{,}365 \text{ kW} \checkmark$

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

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

$P_{in} = \frac{23{,}365 \times 10^3}{0{,}82} \checkmark$

$P_{in} = 28{,}494 \text{ kW} \checkmark$ (7)

[16]

QUESTION 5

5.1 **Goods elevators**

- Cars are of robust construction and the sides may be enclosed by brattice cloth or grillwork.
- Doors may open vertically.
- Cars require only a roof over the portion of the car occupied by the operator. (Any TWO)

Passenger elevators

- Cars must be closed on all sides by panels.
- Doors must open horizontally.
- Cars must be covered with a substantial roof without glass panels. (Any TWO)

(2 + 2) (4)

5.2 5.2.1

$$T_1 = M_1(g + a) + F_v$$
$$= 1\,500(9{,}81 + 1{,}9) + 60$$
$$T_1 = 18\,165 \text{ N}$$

$$T_2 = M_2(g - a) - F_v$$
$$= 500(9{,}81 - 1{,}9) - 600$$
$$T_2 = 3\,355 \text{ N} \checkmark$$

$$\text{Torque to accelerate load} = (T_1 - T_2)R$$
$$= (18\,165 - 3\,355)0{,}8$$
$$= 11\,848 \text{ N.m} \checkmark$$

$$\text{Torque to accelerate drum} = I \times a$$
$$= Mk^2 \times \frac{a}{r}$$
$$= (700)(0{,}6)^2 \times \frac{1{,}9}{0{,}6} \checkmark$$
$$= 798 \text{ N.m} \checkmark$$

$$T_{total} = T_{load} + T_{drum}$$
$$= 11\,848 + 798 \checkmark$$
$$T_{total} = 12\,646 \text{ N.m} \checkmark$$

$$P_m = T_{total} \times \frac{v}{r}$$
$$12\,646 \times \frac{2{,}4}{0{,}8} \checkmark$$
$$P_m = 37{,}938 \text{ kW} \checkmark$$

(8)

5.2.2

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

$$a = \frac{5^2}{2 \times 4} \checkmark$$

$$a = 3{,}125 \text{ m/s}^2 \checkmark$$

$$T_1 = M_1(g - a) + F_\upsilon$$

$$= 1\,500(9{,}81 - 3{,}125) + 600 \checkmark$$

$$T_1 = 10\,627{,}5 \text{ N} \checkmark$$

$$T_2 = M_2(g + a) - F_\upsilon$$

$$= 500(9{,}81 - 3{,}125) - 600 \checkmark$$

$$T_2 = 5\,867{,}5 \text{ N} \checkmark$$

(6)
[18]

QUESTION 6

6.1

$$\omega_1 = \frac{2\pi \times 120}{60} \checkmark$$

$$= 12{,}566 \text{ rad/s} \checkmark$$

$$\omega_2 = \frac{2\pi \times 160}{60} \checkmark$$

$$= 16{,}755 \text{ rad/s} \checkmark$$

$$a = \frac{\omega_2 - \omega_1}{t}$$

$$= \frac{16{,}755 - 12{,}566}{40} \checkmark$$

$$a = 0{,}105 \text{ rad/s}^2 \checkmark$$

$$T = m.k^2.a$$

$$= 1\,200.(0{,}8)^2.0{,}105 \checkmark$$

$$T = 80{,}64 \text{ N.m} \checkmark$$

(8)

6.2 6.2.1

$$\omega = \frac{2\pi \times N}{60}$$

$$\omega = \frac{2\pi \times 110}{60}$$

$$= 11{,}519 \text{ rad/s} \checkmark$$

$$E_k = \frac{1}{2}.m.k^2.\omega^2$$

$$= \frac{1}{2} \times 580 \times (0{,}81)^2.(11{,}519)^2$$

$$E_k = 25{,}264 \text{ kJ} \checkmark$$ (2)

6.2.2

$$\theta = 2.\pi.(\omega_2 - \omega_1)$$

$$= 2.\pi.(110 - 56)$$

$$\theta = 339{,}292 \text{ rads} \checkmark$$

$$E_k = T \times \theta$$

$$T = \frac{E_k}{\theta}$$

$$= \frac{25\,246}{339{,}292}$$

$$T = 74{,}408 \text{ N.m} \checkmark$$ (2)

6.2.3

$$T = I \times a$$

$$a = \frac{T}{m.k^2}$$

$$a = \frac{74{,}408}{580.(0{,}81)^2} \checkmark$$

$$a = 0{,}196 \text{ rad/s}^2 \checkmark$$

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

$$t = \frac{\omega_2 - \omega_1}{a}$$

$$t = \frac{\left(\frac{2\pi \times 110}{60}\right) - \left(\frac{2\pi \times 56}{60}\right)}{0{,}196} \checkmark$$

$$t = 28{,}85 \text{ seconds} \checkmark$$ (4)

[16]

TOTAL: 100

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