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 11 pages.

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QUESTION 1

1.1 1.1.1

$$T_E = m_L.g.\mu.\%mass\ driving\ wheels$$
$$= 100 \times 10^3 \times 9{,}81 \times 0{,}3 \times 0{,}7 \checkmark\checkmark$$
$$= 206010\ N \checkmark$$

(3)

1.1.2

$$F_{R_{total}} = F_{R_{loco}} + F_{R_{trucks}}$$
$$F_{R_{total}} = (m_L + R_L) + (m_T \times R_T)$$
$$= \{(100 \times 80) + (500 \times 70)\} \checkmark$$
$$= 8000 + 35000 \checkmark$$
$$= 43000\ N \checkmark$$

(3)

1.1.3

$$T_E = F_{R_{total}}$$
$$T_E = 43000\ N \checkmark$$

(1)

1.1.4

$$T_E = F_{R_{total}} + F_{g_{total}}$$
$$= 43000 + (m_L + m_T) \times 10^3 \times 9{,}81 \times {}^{1}\!/_{90}$$
$$= 43000 + (100 + 500) \times 10^3 \times 9{,}81 \times {}^{1}\!/_{90} \checkmark$$
$$= 43000 + 65400 \checkmark$$
$$= 108400\ N \checkmark$$

(3)

1.1.5

$$T_E = F_{R_{total}} + F_{g_{total}} + F_{a_{total}}$$
$$F_a = T_E - F_{R_{total}} - F_{g_{total}}$$
$$= 206010 - 108400 - 43000$$
$$= 54610\ N \checkmark$$
$$F_a = (m_L + m_T) \times 10^3\, x\ a$$
$$54610 = (100 + 500) x 10^3.\ a \checkmark$$
$$a = \frac{54610}{600000}$$
$$a = 0{,}091\ m/s^2 \checkmark$$

(3)

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1.1.6

$$u = \frac{43,3 \times 1000}{3600} = 12,028\ m/s$$

$$v = \frac{32,4 \times 1000}{3600} = 9m/s$$

$$v = u + at$$

$$9 = 12,028 + a.180 \checkmark$$

$$a = \frac{9 - 12,028}{180}$$

$$a = \quad 0,0168\ m/s^2 \checkmark$$

$$T_E = F_{g_{total}} - F_{R_{total}} - F_{a_{total}}$$

$$T_E = 65400 - 43000 - (m_L + m_T).10^3.a$$

$$= 22400 - (100 + 500).10^3.(-0,0168) \checkmark$$

$$= 22400 + 10080$$

$$T_E = 32480\ N \checkmark$$

(4)
[17]

QUESTION 2

2.1

$$\omega_1 = \frac{2\pi N}{60}$$

$$= \frac{2x\pi \times 100}{60} \checkmark$$

$$= 10,472\ rad/s \checkmark$$

$$\omega_2 = \frac{2\pi N}{60}$$

$$= \frac{2x\pi \times 130}{60} \checkmark$$

$$= 13,614\ rad/s \checkmark$$

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

$$= \frac{13,614 - 10,472}{35} \checkmark$$

$$= 0,089\ rad/s^2 \checkmark$$

$$T = m.k^2.\alpha$$

$$= 1400x(0,82)^2 x0,089 \checkmark$$

$$= 83,781\ N.m \checkmark$$

(8)

2.2 2.2.1

$$\omega = \frac{2\pi N}{60}$$
$$= \frac{2x\pi x95}{60}$$
$$= 9{,}948 rad/s$$
$$E_k = \frac{1}{2} m.k^2.\omega^2$$
$$= \frac{1}{2} x600x(0{,}83)^2 x(9{,}948)^2 \checkmark$$
$$= 20452{,}622 \text{ J}$$
$$= 20{,}452 \text{ KJ} \checkmark$$

(2)

2.2.2

$$E_k = \theta.T$$
$$T = \frac{E_k}{\theta}$$
$$= \frac{120452}{376{,}991} \checkmark$$
$$= 54{,}253 \ Nm \checkmark$$

(2)

2.2.3

$$T = m.k^2.\alpha$$
$$\alpha = \frac{T}{m.k^2}$$
$$= \frac{54{,}253}{413{,}34}$$
$$= 0{,}131 rad/s^2 \checkmark$$
$$\omega_2 = \omega_1 + \alpha.t$$
$$t = \frac{\omega_2 - \omega_1}{\alpha}$$
$$= \frac{9{,}948 - 0}{0{,}131} \checkmark$$
$$= 75{,}9 \ s$$
$$say = 76 \ s \checkmark$$

(3)
[15]

QUESTION 3

3.1
- Installation costs are lower.
- Installation is much easier.
- Maintenance is cheaper.
- Does not require stronger bearings to support the head pulley. (4)

3.2 3.2.1

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

$$v = \frac{\pi(0,7+0,004)\times 750}{60} \checkmark$$

$$v = 27,6\ m/s \checkmark$$ (2)

3.2.2

$$m = w \times t \times l \times \rho$$

$$= 0,12 \times 0,004 \times 1 \times 1,2 \times 10^3 \checkmark$$

$$m = 0,576\ kg/m \checkmark$$ (2)

3.2.3

$$T_C = mv^2$$

$$= 0,576 \times (27,6)^2 \checkmark$$

$$T_C = 438,774\ N \checkmark$$ (2)

3.2.4

$$T_1 = w \times t \times f_t$$

$$= 120 \times 4 \times 2,5$$

$$T_1 = 1200\ N \checkmark$$

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

$$\frac{1200 - 438,774}{T_2 - 438,774} = e^{0,25x2,793} \checkmark$$

$$\frac{761,226}{T_2 - 438,774} = 2,01 \checkmark$$

$$2,01T_2 - 881,936 = 761,226 \checkmark$$

$$2,01T_2 = 761,226 + 881,936$$

$$= \frac{1643,162}{2,01} \checkmark$$

$$T_2 = 817,493N \checkmark$$ (6)

3.2.5

$$P_1 = (T_1 \quad T_2)\ v.n.\eta$$

$$= (1200 \quad 817,493)27,6 \times 1 \times 0,9 \checkmark$$

$$P_1 = 9501,473\ W$$

$$P_1 = 9,5\ kW \checkmark$$ (2)

[18]

QUESTION 4

4.1

$$v = \frac{95}{60} = 1{,}583\ m/s \checkmark$$

$$v = \sqrt{g.\cos\theta.r}$$

$$1{,}583 = \sqrt{9{,}81x\cos 30°xr} \checkmark$$

$$(1{,}583)^2 = 8{,}4957xr \checkmark$$

$$r = 0{,}295\ m \checkmark$$

$$d = 2xr$$

$$= 2 \times 0{,}295 \checkmark$$

$$= 0{,}59m$$

$$= 590\ mm \checkmark$$

(6)

4.2

$$L = 2\pi r + 2C$$

$$= 2(\pi \times 0{,}295) + (2 \times 80)$$

$$= 1{,}853 + 160 \checkmark$$

$$= 161{,}853\ m \checkmark$$

OR

ALTERNATIVE METHOD:

$$L = \pi D + 2C$$

$$= 3{,}142 \text{ x } 0{,}590 + 160 \checkmark$$

$$= 161{,}853 \checkmark$$

(2)

4.3

$$B_{/s} = \frac{v}{space}$$
$$= \frac{1,583}{0,7} \checkmark$$
$$= 2,261 \checkmark$$

$$m_{/s} = 1300/7 hours$$
$$= \frac{1300 \times 10^3}{7 \times 3600} \checkmark$$
$$= 51,587\ kg/s \checkmark$$
$$m_{/b} = \frac{m_{/s}}{B_{/s}}$$
$$= \frac{51,587}{2} \checkmark$$
$$= 25,794\ kg/b \checkmark$$
$$P_g = m.g.h$$
$$= 51,587 \times 9,81x80 \checkmark$$
$$= 40485,478\ W$$
$$= 40,485\ kW \checkmark$$
$$P_m = \frac{P_g}{\eta}$$
$$= \frac{40,483}{0,75} \checkmark$$
$$= 53980,637\ W$$
$$= 53,98\ kW \checkmark$$

(10)
[18]

QUESTION 5

5.1

$$M_T = M_{full} - M_{empty}$$
$$= 1200 - 300$$
$$= 900\ kg \checkmark$$

$$Tubs_{/h} = \frac{M_T}{m_{rope}}$$
$$= \frac{900}{8x0,9}$$
$$= 125/h \checkmark$$

$$T_{space} = \frac{speed\ rope}{Tubs_{/h}}$$
$$= \frac{2800}{125}$$
$$= 22,4\ m \checkmark$$

$$T_{number} = \frac{960}{22,4}$$
$$= 42,857$$
$$say = 43 \checkmark$$

(4)

5.2

$$M_{rope} = 4 \times 2 \times 960$$
$$= 7680kg \checkmark$$
$$M_{ft} = 900 \times 43$$
$$= 38700\ kg \checkmark$$
$$M_{empty} = 300 \times 43 \times 2$$
$$= 25800\ kg \checkmark$$
$$M_{total} = M_{rope} + M_{ft} + M_{empty}$$
$$= 7680 + 38700 + 25800 \checkmark$$
=72180 kg
$$= 72,18\ ton \checkmark$$

(5)

5.3

$$F_R = M_T x T_R$$
$$= 72{,}18 \times 220$$
$$= 15879{,}6N \checkmark$$
$$f_g = out\ balance \times \sin\theta$$
$$= 900 \times 9{,}81 \times 43 \times \sin 12 \checkmark$$
$$= 78933{,}049N \checkmark$$
$$T_E = F_R + F_g$$
$$= 15897{,}6 + 78933{,}049$$
$$= 94812{,}649N \checkmark$$

$$P = T_E \times v$$
$$= 94812{,}649 \times \frac{2{,}8x10^3}{3600} \checkmark$$
$$= 73743{,}172W \checkmark$$

$$P_o = \frac{P_i}{\eta}$$
$$P_o = \frac{73743{,}172}{0{,}75}$$
$$= 98324{,}229W \checkmark$$

(7)
[16]

QUESTION 6

6.1 $T_F + T_G = T_E + T_D$ *- two shafts are co – axial, module of the gears are the same*

$40 + 30 = 20 + T_D$

$T_D = 50 teeth$ ✓ (1)

Condition	Gear D	Gear E	Gear F	Gear G	Arm B
Fix arm B and rotate Gear D by +1rev	$+1$ √	$= -\frac{50}{20}$ $= -2,5$	$-2,5$ √	$\frac{50}{20} \times \frac{40}{30}$ $= 3,333$ √	*0*
Multiply by x and add y	$x + y$ √	$-2,5x + y$	$-2,5x + y$ √	$3,333x + y$ √	$+ y$ √
$N_D = 0$ $N_G = ?$ $N_B = 200r/\min$	$N_D = 0$ √			$N_G = ?$	$N_B = 200r/\min$
$N_B = 200r/\min$ $N_G = ?$ $N_D = 100$	$N_D = 100$			$N_G = ?$	$N_B = 200r/\min$

Determine x and y (4)

$3,333x + y = +N_G$

$y = 200$ ✓

$x + y = 0$

$x = -y$

$x = -200$ ✓

$3,333(-200) + 200 = +N_G$

$N_G = -466,667r/\min$ √

$N_G = 466,667r/\min$ *Anti – clockwise* ✓ (4)

6.2 $3,333x + y = +N_G$

$y = 200$ ✓

$x + y = 100$

$x = -200 + 100$

$x = -100$ ✓

$3,333(-100) + 200 = +N_G$

$N_G = -133,333r/\min$

$N_G = 133,333r/\min$ *Anti – clockwise* ✓ (3)

6.3

$$P = \frac{2\pi NT}{60}$$

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

$$T_{in} = \frac{7{,}5 \times 10^3 \times 60}{2\pi 200}$$

$$T_{in} = 358{,}098 N.m \checkmark$$

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

$$(358{,}098 \times 200) + (T_{out} \times -466{,}667) + (T_{hold} \times 0) = 0 \checkmark$$

$$466{,}667 T_{out} = 71619{,}6$$

$$T_{out} = 153{,}47 N.m \checkmark$$

$$T_{in} + T_{out} + T_{hold} = 0$$

$$T_{hold} = -358{,}098 - 153{,}47$$

$$T_{hold} = -511{,}568 N.m$$

$$T_{hold} = 511{,}568 N.m \quad opposite\ T_{in} \checkmark$$

(4)
[16]

TOTAL: 100

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