



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

4 December 2024

This marking guideline consists of 10 pages.

QUESTION 1: EPICYCLIC GEAR AND GEAR TRAINS

Condition	Gear A	P	S	Arm L
Fix Arm L & rotate A +1 rev	+1	$\frac{T_A}{T_P} = \frac{116}{46} = 2,522\checkmark$	$\frac{T_A}{T_P} \times \frac{T_P}{T_S} = \frac{116}{46} \times \frac{46}{-24} = -4,833\checkmark$	0
Multiply by X & Add Y	$x + y$	$2,522x + y\checkmark$	$-4,833x + y\checkmark$	y
$N_S = 280$ $N_A = 0$	$0\checkmark$		$280\checkmark$	$N_L = ?$

Solve for x & y

$$-4,833x + y = 280 \dots\dots\dots 1$$

$$x + y = 0 \dots\dots\dots 2$$

$$(1 - 2) - 5,833x = 280\checkmark \dots\dots\dots 3$$

$$x = \frac{280}{-5,833}$$

$$x = \boxed{-48}\checkmark$$

subst x into eqt 2

$$x + y = 0$$

$$-48 + y = 0$$

$$y = 48\checkmark$$

$$\therefore N_L = \boxed{48 \text{ rpm}}\checkmark (\text{clockwise})$$

[10]

QUESTION 2: CONVEYOR BELTS AND BELT DRIVES

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

$$v = \frac{\pi(1,4 + 0,016)250}{60}\checkmark$$

$$v = \boxed{18,53 \text{ m/s}}\checkmark$$

(2)

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

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

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

$$M = \boxed{12,8 \text{ kg/m}}\checkmark$$

(3)

$$\begin{aligned}
 2.3 \quad T_c &= M \times v^2 \\
 T_c &= 12,8 \times (18,53)^2 \checkmark \\
 T_c &= \boxed{4395,02 \text{ N}} \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 2.4 \quad T_1 &= w \times n \times ft \\
 T_1 &= 1 \times 3 \times 7,8 \times 10^3 \checkmark \\
 T_1 &= \boxed{23400 \text{ N}} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \theta &= \frac{170}{57,3} \\
 \theta &= \boxed{2,967} \checkmark
 \end{aligned}$$

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

$$\frac{23400 - 4395,02}{T_2 - 4395,02} = e^{0,3(2,967)} \checkmark$$

$$\frac{19004,98}{T_2 - 4395,02} = 2,435$$

$$T_2 = \frac{19004,98}{2,435} + 4395,02 \checkmark$$

$$T_2 = \boxed{12199,94 \text{ N}} \checkmark
 \tag{6}$$

$$\begin{aligned}
 2.5 \quad P &= (T_1 - T_2)v \\
 P &= (23400 - 12199,94)18,53 \checkmark \\
 P &= 207537,11 \text{ W} \\
 P &= \boxed{207,54 \text{ kW}} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 P_o &= P \times \eta \\
 P_o &= 207,53711 \times 0,8 \checkmark \\
 P_o &= \boxed{166,03 \text{ kW}} \checkmark
 \end{aligned}
 \tag{4}$$

$$\begin{aligned}
 2.6 \quad P &= P_o - 6\% \text{ slip} & \text{OR} & P = P_o \times 0,94 \\
 P &= 166,03 - 6\% \text{ slip} & & P = 166,03 \times 0,94 \checkmark \\
 P &= 166,03 - 9,978 \checkmark & & P = \boxed{156,068 \text{ kW}} \checkmark \\
 P &= \boxed{156,052 \text{ kW}} \checkmark
 \end{aligned}$$

(3)
[20]

QUESTION 3: BUCKET ELEVATORS

$$3.1 \quad V = \sqrt{g \times \cos \theta \times r}$$

$$1,5 = \sqrt{9,81 \times \cos 30^\circ \times r} \checkmark$$

$$1,5^2 = 9,81 \times \cos 30^\circ \times r$$

$$r = \frac{1,5^2}{9,81 \times \cos 30^\circ} \checkmark$$

$$r = 0,265 \text{ m}$$

$$D = 0,530 \text{ m}$$

$$D = \boxed{530 \text{ mm}} \checkmark$$

$$V = \frac{90}{60}$$

$$V = \boxed{1,5 \text{ m/s}}$$

$$3.2 \quad L = 2 \times \pi r + 2c$$

$$L = 2 \times \pi(0,265) + 2(85)$$

$$L = \boxed{171,665 \text{ m}} \checkmark$$

$$3.3 \quad \text{Buckets/sec} = \frac{V}{\text{Spacing}}$$

$$\text{Buckets/sec} = \frac{1,5}{0,8} \checkmark$$

$$\text{Buckets/sec} = 1,875 \checkmark$$

$$\frac{\text{Buckets}}{\text{sec}} = \boxed{2 \text{ buckets per second}} \checkmark$$

$$\text{Mass/sec} = \frac{1350 \times 10^3}{7 \times 3600} \checkmark$$

$$\frac{\text{Mass}}{\text{sec}} = \boxed{53,571 \text{ kg/s}} \checkmark$$

$$\text{Mass/bucket} = \frac{\text{Mass/sec}}{\text{Bucket/sec}}$$

$$\text{Mass/bucket} = \frac{53,571}{2} \checkmark$$

$$\frac{\text{Mass}}{\text{bucket}} = \boxed{26,786 \text{ kg/b}} \checkmark$$

$$P_g = m \cdot g \cdot h$$

$$P_g = 53,571(9,81)(85) \checkmark$$

$$P_g = 44670,18 \text{ W}$$

$$P_g = \boxed{44,67 \text{ kW}} \checkmark$$

$$P_m = \frac{P_g}{\eta}$$

$$P_m = \frac{44,67}{0,8}$$

$$P_m = \boxed{55,84 \text{ kW}} \checkmark$$

(4)

(2)

(9)

1451

QUESTION 4: ELEVATORS

4.1 This **balance force** reduces the weight the motor must lift and ensures that the elevator cannot fall out of control while the cable is intact. (1)

4.2
$$T_1 = m_1(g + a) + F_\mu$$

$$T_1 = 1500(9,81 + 2,1) + 300 \checkmark$$

$$T_1 = \boxed{18165 \text{ N}} \checkmark$$

$$T_2 = m_1(g - a) - F_\mu$$

$$T_2 = 450(9,81 - 2,1) - 300 \checkmark$$

$$T_2 = \boxed{3169,5 \text{ N}} \checkmark$$

$$T_\alpha = I\alpha$$

$$T_\alpha = mk^2 \times \frac{a}{r}$$

$$T_\alpha = 700(0,5)^2 \times \frac{2,1}{0,8}$$

$$T_\alpha = \boxed{459,379 \text{ N.m}} \checkmark$$

$$T_h = (T_1 - T_2)r$$

$$T_h = (18165 - 3169,5)0,8$$

$$T_h = \boxed{11996,4 \text{ N.m}} \checkmark$$

$$T_{total} = T_h + T_\alpha$$

$$T_{total} = 11996,4 + 459,379$$

$$T_{total} = \boxed{12455,78 \text{ N.m}} \checkmark$$

$$P_{motor} = T_{total} \times \omega$$

$$P_{motor} = T_{total} \times \frac{V}{r}$$

$$P_{motor} = 12455,78 \times \frac{2,5}{0,8} \checkmark$$

$$P_{motor} = 38924,31 \text{ W}$$

$$P_{motor} = \boxed{38,92 \text{ kW}} \checkmark$$

(9)
[10]

QUESTION 5: RAIL AND ROAD TRACTION

5.1 $T_E = M_L \times g \times \mu \times \% \text{ mass of driving wheels}$

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

$$T_E = \boxed{235440 \text{ N}} \checkmark$$

(2)

5.2 $F_{Rtotal} = F_{Rloco} + F_{Rtrucks}$

$$F_{Rtotal} = (M_L \times R_L) + (M_T \times R_T)$$

$$F_{Rtotal} = (100 \times 80) + (400 \times 70) \checkmark$$

$$F_{Rtotal} = 8000 + 28000 \checkmark$$

$$F_{Rtotal} = \boxed{36000 \text{ N}} \checkmark$$

(3)

5.3 $T_E = F_{Rtotal}$

$$T_E = \boxed{36000 \text{ N}} \checkmark$$

(1)

5.4 $F_{gtotal} = (M_L + M_T) \times 10^3 \times g \times \sin \theta$

$$F_{gtotal} = (100 + 400) \times 10^3 \times 9,81 \times \frac{1}{90} \checkmark$$

$$F_{gtotal} = \boxed{54500 \text{ N}} \checkmark$$

$$T_E = F_{Rtotal} + F_{gtotal}$$

$$T_E = 36000 + 54500 \checkmark$$

$$T_E = 90500 \text{ N}$$

$$T_E = \boxed{90,5 \text{ kN}} \checkmark$$

(4)

[10]

QUESTION 6: FLYWHEELS

$$\theta = \frac{1}{2}at^2 + \omega_1 \times t$$

$$\theta = \frac{1}{2}(2,5)(50)^2 \checkmark + 0 \times 50 \checkmark$$

$$\theta = \boxed{3125 \text{ rad}} \checkmark$$

$$\theta = 2\pi N$$

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

$$N = \frac{3125}{2\pi} \checkmark$$

$$\boxed{7.36 \text{ rpm}} \checkmark$$

QUESTION 7: ROPE HAULAGES AND AERIAL ROPEWAYS

- 7.1
- Endless rope haulages
 - Head and tail rope haulages
- (2)

7.2 7.2.1 $M_T = M_{full} - M_{empty}$
 $= 1\,000 - 250$
 $= 750\text{ kg} \checkmark$

$$Tubs_{/h} = \frac{M_T}{m_{rope}}$$

$$= \frac{850}{8 \times 0,75}$$

$$= 141,667 / h \checkmark$$

$$T_{space} = \frac{speed\ rope}{tubs_{/h}}$$

$$= \frac{3,5 \times 10^3}{141,667}$$

$$= 24,71\text{ m} \checkmark$$

$$T_{number} = \frac{800}{24,71} \checkmark$$

$$= 32,376$$

$$say = 32 \checkmark$$

(5)

7.2.2 $M_{rope} = 2 \times 900 \times 3$
 $= 5\,400\text{ kg} \checkmark$
 $M_{ft} = 1\,000 \times 32$
 $= 32\,000\text{ kg} \checkmark$
 $M_{empty} = 250 \times 32$
 $= 8\,000\text{ kg} \checkmark$

$$M_{total} = M_{rope} + M_{ft} + M_{empty}$$

$$= 5,4 + 32 + 8 \checkmark$$

$$= 45,4\text{ ton} \checkmark$$

(5)

7.2.3

$$\begin{aligned}F_R &= M_T \times T_R \\&= 45,4 \times 180 \\&= 8172 \text{ N} \checkmark\end{aligned}$$

$$\begin{aligned}L_{balance} &= 32 \times 750 \\&= 24000 \text{ kg} \checkmark\end{aligned}$$

$$\begin{aligned}F_{rope} &= 24000 \times 9,81 \times \sin 10^\circ \\&= 40883,727 \text{ N} \checkmark\end{aligned}$$

$$\begin{aligned}F_{total} &= 40883,727 + 8172 \\&= 49055,727 \text{ N} \\&= 49,056 \text{ kN} \checkmark\end{aligned}$$

$$\begin{aligned}WD_{ts} &= F_t \times V \\&= 49055,727 \times \frac{3,5 \times 10^3}{3600} \checkmark \\&= 47693,068 \text{ kg/s} \checkmark\end{aligned}$$

$$\begin{aligned}P_o &= \frac{P_0}{\eta} \\P_o &= \frac{47693,068}{0,8} \checkmark \\&= 59616,335 \text{ W} \checkmark \\&= 59,616 \text{ KW}\end{aligned}$$

(8)
[20]

QUESTION 8: REDUCTION GEARBOX

Given: $T_A = T_H = 18$ & Sum of any two meshing gears = 54

$$T_A + T_B = T_C + T_D = T_E + T_F = T_G + T_H = 54 \quad \checkmark$$

$$T_A + T_B = 54$$

$$18 + T_B = 54$$

$$T_B = 54 - 18$$

$$T_B = \boxed{36 \text{ teeth}} \quad \checkmark \quad \therefore T_G = \boxed{36 \text{ teeth}} \quad \text{because } T_G + T_H = T_A + T_B$$

For 2nd Gear:

$$\frac{N_A}{N_E} = \frac{T_B \times T_E}{T_A \times T_F}$$

$$\frac{3}{1} = \frac{36 \times T_E}{18 \times T_F}$$

$$\frac{3}{1} \times \frac{18}{36} = \frac{T_E}{T_F} \quad \checkmark$$

$$\frac{3}{2} = \frac{T_E}{T_F}$$

$$T_E = 1.5 T_F \dots \dots \dots (1) \quad \checkmark$$

$$T_E + T_F = 54$$

$$T_F = 54 - T_E \dots \dots \dots (2)$$

Subst. eqt 2 in eqt 1

$$T_E = 1.5 (54 - T_E)$$

$$T_E = 81 - 1.5 T_E$$

$$2.5 T_E = 81$$

$$T_E = 32.4$$

$$\therefore T_E = \boxed{32 \text{ teeth}} \quad \checkmark$$

$$T_F = 54 - T_E$$

$$T_F = 54 - 32$$

$$T_F = \boxed{22 \text{ teeth}} \quad \checkmark$$

For 3rd Gear

$$\frac{N_A}{N_C} = \frac{T_B \times T_C}{T_A \times T_D}$$

$$\frac{1,75}{1} = \frac{36 \times T_C}{18 \times T_D}$$

$$\frac{1,75}{1} \times \frac{18}{36} = \frac{T_C}{T_D} \checkmark$$

$$\frac{1,75}{2} = \frac{T_C}{T_D}$$

$$T_C = 0,875 T_D \dots \dots \dots (3) \checkmark$$

$$T_C + T_D = 54$$

$$T_D = 54 - T_C \dots \dots \dots (4)$$

$$T_C = 0,875 (54 - T_C)$$

$$T_C = 47,25 - 0,875 T_C$$

$$1,975 T_C = 47,25$$

$$T_C = 25,2$$

$$\therefore T_C = \boxed{25 \text{ teeth}} \checkmark$$

From equation 4

$$T_D = 54 - T_C$$

$$T_D = 54 - 25$$

$$T_D = \boxed{29 \text{ teeth}} \checkmark$$

[10]

TOTAL: 100