higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## MECHANOTECHNICS N5

## 20 April 2021

**This marking guideline consists of 8 pages.**

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## QUESTION 1

1.1
- Spur gears
- Helical gears
- Double helical gears (3)

1.2 1.2.1

$$\frac{N_C}{N_D} = \frac{T_G x T_K}{T_F x T_H} \checkmark$$

$$\frac{T_G}{T_F} = \frac{T_K}{T_H}$$
$$\frac{10}{1} = \frac{T_K^2}{T_H^2}$$
$$\frac{10}{1} = \frac{T_K^2}{(20)^2} \checkmark$$
$$T_K = \sqrt{20^2 \times 10}$$
$$T_K = 63{,}24$$
$$say = 63 \ teeth \checkmark$$

$$\frac{m}{2}(T_F + T_G) = \frac{m}{2} \times (T_H + T_K) \checkmark$$
$$\frac{6}{2}(T_F + T_G) = \frac{8}{2} \times (20 \ + 63) \checkmark$$
$$3(T_F + T_G) = 332$$
$$(T_F + T_G) = \frac{332}{3}$$
$$T_F + T_G = 110{,}667 \ldots\ldots\ldots\ldots\ldots 1$$
$$but \frac{10}{1} = \frac{T_G^2}{T_F^2} \checkmark$$
$$\frac{T_G}{T_F} = \sqrt{10}$$
$$T_G = 3{,}162 T_F \ldots\ldots\ldots\ldots\ldots 2$$
$$T_F + 3{,}162 T_F = 110{,}667 \checkmark$$
$$4{,}162 T_F = 110{,}667$$
$$\frac{4{,}162 T_F}{4{,}162} = \frac{167{,}667}{4{,}162}$$
$$T_F = 26{,}589 \checkmark$$
$$Say \ T_F = 27 \ teeth \checkmark$$
$$T_G = 3{,}162 T_F$$
$$T_G = 3{,}162 \times 27$$
$$T_G = 85{,}374 \checkmark$$
$$say \ T_G = 86 \ teeth \checkmark$$

(11)

1.2.2
$$\frac{N_C}{N_D} = \frac{T_G \times T_K}{T_F \times T_H}$$
$$= \frac{85 \times 63}{27 \times 20} \checkmark$$
$$\frac{N_C}{N_D} = 9{,}917 : 1 \checkmark$$
(2)

1.2.3
$$C = \frac{m}{2} \times (T_F + T_G)$$
$$= \frac{6}{2} \times (27 + 85) \checkmark$$
$$C = 336mm \checkmark$$
(2)
**[18]**

## QUESTION 2

2.1
$$m = \frac{110 \times 10^3}{3600} = 30{,}556kg/s \checkmark$$
$$P_g = mgh$$
$$= 30{,}556 \times 9{,}81 \times 12 \checkmark$$
$$= 3{,}597kW \checkmark$$
(3)

2.2
$$P_\mu = 35\% x P_g$$
$$= 0{,}35 \times 3597 \checkmark$$
$$= 1{,}259kW \checkmark$$
(2)

2.3
$$P_l = P_g + P_\mu$$
$$= 3{,}597 + 1{,}259 \checkmark$$
$$= 4{,}856kW \checkmark$$
$$P_m = \frac{P_l}{\eta}$$
$$= \frac{4{,}856}{0{,}75}$$
$$= 6{,}475kW \checkmark$$
(3)

2.4 $\frac{T_1}{T_2} = e^{\mu\theta}$

$\frac{T_1}{T_2} = e^{(0,25)(\frac{220}{57,3})}$ ✓

$T_1 = 2,611T_2$

$P_l = (T_1 - T_2)v$ $\qquad v = \frac{85}{60} = 1,417m/s$ ✓

$4,856 = (T_1 - T_2)1,417$ ✓

$T_1 - T_2 = 3,428$

$2,611T_2 - T_2 = 3,428$ ✓

$T_2 = 2,128kN$ ✓

$T_1 = 2,611(2,128)$

$T_1 = 5,556kN$ ✓ (6)

2.5 $T_1 = \omega \times n \times f_t$

$n = \frac{T_1}{\omega \times f_t}$

$n = \frac{5556}{0,75 \times 2 \times 10^3}$ ✓

$= 3,704$ ✓

$say\ n = 4\ \ plies$ ✓ (3)

**[17]**

## QUESTION 3

3.1
- Longer life span
- Heavier load transported
- Steeper inclines accommodated
- Higher capacities handled (4)

3.2 3.2.1 $For\ \frac{6}{7}\ construction\ rope\ area = 0,36D^2$

$Ultimate\ stress = \frac{ultimate\ \ area}{rope\ \ area}$

$= \frac{ultimate\ \ area}{0,36D^2}$

$D^2 = \frac{ultimate\ \ strength}{0,36 \times \max\ \ stress}$ ✓

$D^2 = \frac{600 \times 10^3}{0,36 \times 1300 \times 10^6}$ ✓

$D = \sqrt{0,001282}$ ✓

$D = 0,0358m$

$D = 35,805mm$ ✓ (4)

3.2.2

$$rope\ \ mass/m = \frac{d^2}{250}$$
$$= \frac{(35{,}805)^2}{250} \checkmark$$
$$= 5{,}128 kg/m \checkmark$$

(2)

3.2.3

$$tension\ \ self\ \ weight = \frac{m_1 \times g \times s^2}{8h}$$
$$= \frac{5{,}128 \times 9{,}81 \times (90)^2}{8 \times 2{,}6} \checkmark$$
$$= 19590{,}193 N \checkmark$$

(2)

3.2.4

$$tension\ \ due\ \ to\ \ one\ \ load = \frac{m_2 \times g \times s}{4h}$$
$$= \frac{460 \times 9{,}81 \times 90}{4 \times 2{,}6} \checkmark$$
$$= 39051{,}34 N \checkmark$$

(2)

3.2.5

$$Factor\ of\ safety = \frac{ultimate\ \ strength}{working\ \ strength}$$
$$= \frac{600 \times 10^3}{tension\ \ weight + tension\ \ one\ \ load} \checkmark$$
$$= \frac{600 \times 10^3}{19590{,}193 + 39051{,}34} \checkmark$$
$$= \frac{600 \times 10^3}{58641{,}533} \checkmark$$
$$= 10{,}232 \checkmark$$

(4)
**[18]**

## QUESTION 4

4.1

$$v = \sqrt{g \times R \times \cos\theta}$$
$$1{,}167 = \sqrt{9{,}81 \times R \times \cos 30°} \checkmark$$
$$1{,}361 = 9{,}81 \times R \times \cos 30°$$
$$R = \frac{1{,}361}{9{,}81 \times \cos 30°} \checkmark$$
$$R = 0{,}160 m \checkmark$$
$$d = 2 \times 0{,}160$$
$$= 0{,}32 m$$
$$d = 320 mm \checkmark$$

(4)

4.2 $L = 2\pi r + 2C$

$L = 2\pi(0,16) + 2(85)$

$= 1,005 + 170$ ✓

$= 171,005m$ ✓ (2)

4.3 $m = \frac{1450}{7,5 \times 3,6} = 53,704kg/s$ ✓✓

$No\ of\ buckets = \frac{v}{spacing}$

$No\ of\ buckets = \frac{1,167}{0,8}$

$No\ of\ buckets = 1,459$ ✓

$Say\ 2\ buckets$ ✓

$h = \frac{L}{no\ of\ buckets}$

$h = \frac{171,005}{2}$ ✓

$h = 85,503$ ✓

$h = 86m$

$P = m \times g \times h$

$= 53,704 \times 9,81 \times 86$ ✓

$= 45307,917W$ ✓

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

$P_{in} = \frac{45307,917}{0,75}$ ✓

$= 60410,556W$

$= 60,411kW$ ✓ (10)

**[16]**

## QUESTION 5

5.1 $T_E = M_L \times 10^3 \times g \times \mu \times \%\ of\ driving\ wheels$

$T_E = 100 \times 10^3 \times 9,81 \times 0,29 \times 0,8$ ✓

$= 227592N$ ✓

$= 227,592kN$ ✓ (3)

5.2 $P = T_e \times v$

$= 227592 \times 25$ ✓

$= 5689800W$

$= 5689,8kW$ ✓ (2)

5.3 $T_E = F_a + F_R + F_g$

$F_R = M_L \times F_L$

$F_R = 100 \times 80$ ✓

$F_R = 8000N$ ✓

$F_g = M_L \times 10^3 \times g \times incline$

$F_g = 100 \times 10^3 \times 9{,}81 \times \frac{0{,}8}{100}$ ✓

$F_g = 7848N$ ✓

$F_a = T_E - F_R - F_g$

$F_a = 227592 - 8000 - 7848$ ✓

$F_a = 211744N$ ✓

$F_a = m_L \times 10^3 \times a$

$a = \frac{f_a}{m_L}$

$a = \frac{211744}{100 \times 10^3}$ ✓

$a = 2{,}117 m/s^2$ ✓

$v = u + at$

$25 = 0 + 2{,}117 \times t$ ✓

$t = \frac{25}{2{,}117}$

$t = 11{,}809 \sec$ ✓ (10)

5.4 $v^2 = u^2 + 2as$

$25^2 = 0^2 + 2 \times 2{,}117 \times s$ ✓

$s = \frac{625}{4{,}234}$ ✓

$s = 147{,}615m$ ✓ (3)

**[18]**

## QUESTION 6

6.1 To store energy ✓ (1)

6.2 6.2.1

$$\omega_1 = \frac{2\pi N}{60}$$
$$= \frac{2\pi 200}{60}$$
$$= 20{,}944 rad/s \checkmark$$
$$\omega_2 = 20{,}944 - (20{,}944 \times 0{,}06) \checkmark$$
$$= 19{,}687 rad/s \checkmark$$

6.2.2

$$E_k = \tfrac{1}{2} I(\omega_1^2 - \omega_2^2)$$
$$20 \times 10^3 = \tfrac{1}{2} I(20{,}944^2 - 19{,}687^2) \checkmark$$
$$\frac{20 \times 10^3}{25{,}529} = \frac{25{,}529 I}{25{,}529} \checkmark$$
$$I = 783{,}190 kgm^2 \checkmark$$

6.2.3

$$I = m.k^2$$
$$m = \frac{I}{k^2} \checkmark$$
$$= \frac{783{,}19}{(0{,}8)^2} \checkmark$$
$$= 1223{,}735 kg \checkmark$$

6.2.4

$$\omega_2 = \omega_1 + \alpha t$$
$$\alpha = \frac{\omega_2 - \omega_1}{t}$$
$$= \frac{20{,}944 - 0}{70}$$
$$= 0{,}299 rad/s^2 \checkmark$$
$$T = I.\alpha$$
$$= 783{,}19 \times 0{,}299 \checkmark$$
$$= 234{,}174 Nm \checkmark$$

(4 × 3) (12)
**[13]**

**TOTAL: 100**

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