higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

NOVEMBER EXAMINATION

MECHANOTECHNICS N5

28 NOVEMBER 2016

This marking guideline consists of 10 pages.

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QUESTION 1

1.1 $\omega_2 = \omega_1 + a.t$
$= 0 + (2,5 \times 50)$
$= 125\ rad/s$ (2)

1.2 $a = \frac{\omega_2 - \omega_1}{t}$
$= \frac{0 - 125}{65}$
$= 1,923\ rad/s^2$ (2)

1.3 $\theta_a = \frac{1}{2} a.t^2 + \omega_1.t$
$= \frac{1}{2} \times 2,5(50)^2 + 0$
$= 3125\ rad$

$N = \frac{3125}{2 \times \pi}$
$= 497,359\ revs$ (5)

1.4 $\theta dec = \left(\frac{\omega_1 + \omega_2}{2} \right) \times t$
$= \left(\frac{125 + 0}{2} \right) \times 65$
$= 4062,5\ rad$

$N = \frac{4062,5}{2.\pi}$
$= 646,567\ revs$ (5)

1.5 $N_{tot} = N_{acc} + N_{dec}$
$N_{Total} = 646,567 + 497,359$
$= 1143,926\ revs$ (2)
[16]

QUESTION 2

2.1
- Holdback devices
- Pivoted prop stopping devices
- Beacon derailment device
- Self-locking worm gears
- Cut-out rails
- Drop rail
- Trip wire (Any 3 × 1) (3)

2.2 2.2.1

$$T_{/Min} = \frac{t_{/shift}}{60 \times hours \times t_{tub}}$$
$$= \frac{1300}{60 \times 7 \times 1}$$
$$= 3{,}095$$

$$T_{space} = \frac{V_{rope}}{T_{/\min}}$$
$$= \frac{3500}{60 \times 3{,}095}$$
$$= 18{,}848\ m$$

$$T_{/side} = \frac{L}{T_{/space}}$$
$$= \frac{1400}{18{,}848}$$
$$= 74.278$$
$$= say 74$$
$$T_{Total} = 2 \times 74$$
$$= 148$$ (5)

2.2.2 $F_g = M_b \times T_{/side} \times g \times gradient$

$= 1\,000 \times 74 \times 9{,}81 \times \frac{1}{10}$

$= 72594\ N$

$F_R = [M_L + M_E] \times T_R + [M_r \times R_{/ton}]$

$= [(1{,}8 \times 74) + (0{,}8 \times 74)] \times 200 + [2 \times 1400 \times 0{,}0015] \times 350$

$= [133{,}2 + 59{,}2] \times 200 + [4.200] \times 350$

$= 38480 + 1470$

$= 39950\ N$

$F_e = F_g + F_R$

$= 72\,594 + 39\,950$

$= 112544\ N$

$P = \frac{F_e \times v}{\eta}$

$= \frac{112544 \times 3{,}5 \times 10^3}{0{,}77 \times 3\,600}$

$= 142{,}101\ kW$ (8)

[16]

QUESTION 3

3.1
- Minimum length of rope is used.
- Minimum number of rope sheaves are used.
- Load on building structure is reduced. (3 × 1) (3)

3.2 3.2.1

$$T_1 = m_1(g + a) + F_\mu$$
$$= 1\,400(9{,}81 + 2{,}1) + 500$$
$$= 17174\ N$$
$$= 17{,}174\ kN$$

$$T_2 = m_2(g - a) - Fu$$
$$= 500(9{,}81 - 2{,}1) - 500$$
$$= 3355\ N$$
$$= 3{,}355\ kN$$

$$T_{Total} = T_h + T_a$$
$$= (T_1 - T_2).r + I.a$$
$$= [(17174 - 3355)0{,}8] + [(m.k^2) \times \frac{a}{r}]$$
$$= [13819] + [700 \times (0{,}5)^2 \times \frac{2{,}1}{0{,}8}]$$
$$= 13819 + (175\ x\ 2.625)$$
$$= 13819 + 459{,}375$$
$$= 14278{,}375\ N.m$$

$$P_{Motor} = T \times \frac{V}{r}$$
$$= 14278{,}375 \times \frac{2{,}5}{0{,}8}$$
$$= 44619{,}922\ W$$
$$= 44{,}619\ kW$$

(9)

3.2.2

$$a = \frac{v^2}{2 \times S}$$
$$= \frac{(5)^2}{2 \times 7}$$
$$= 1{,}786\ m/s^2$$

$$T_1 = m_1(g - a) + F_\mu$$
$$= 1\,400(9{,}81 - 1{,}786) + 500$$
$$= 11734\ N$$
$$= 11{,}734\ kN$$

$$T_2 = m_2(g + a) - F_\mu$$
$$= 500(9{,}81 + 1{,}786) - 500$$
$$= 5298\ N$$
$$= 5{,}298\ kN$$

(6)
[18]

QUESTION 4

$$T_A = 2T_P + T_S$$
$$= (2 \times 46) + 24$$
$$= 116$$

No	Condition	A	P	S	Arm L
1	Fix arm L and rotate A + 1 rev	+1	T_a/T_P = $\frac{116}{46} = +2{,}636$	T_a/T_s $2{,}636 \times \frac{46}{-24} = -5{,}053$	0
2	Multiply by x and add y	X + y	2,636x + y	-5,053x + y	y
3	$N_S = 280$ $N_A = 0$ $N_L = ?$	0		280	?
4	$N_L = 10$ $N_S = 280$ $N_A = ?$	?		280	10

x + y = 0
x = -y

-5,053x + y = 280
-5,053(-y) + y = 280
6,056y = 280
Y = 46,258
X = - y

= -46,258

$N_L = Y$
$\therefore N_L = -46{,}258\ r/\text{min}$
The speed of the output shaft = 46,258 r/min (opposite direction or anticlockwise)

$$P_1 = \frac{2 \times \pi \times N \times T_1}{60}$$
$$T_1 = \frac{60 \times P_1}{2 \times \pi \times N_1}$$
$$= \frac{60 \times 4\,500}{2 \times \pi \times 280}$$
$$= 153{,}451\ N.m$$

$$(T_1 \times N_1) + (T_0 \times N_0) + (T_h \times N_h) = 0$$
$$(153{,}451 \times 280) + (46{,}258 x T_0) + 0 = 0$$
$$42966{,}28 + 46{,}258 T_0 = 0$$
$$T_0 = \frac{-42966{,}26}{46{,}258}$$
$$= -928{,}839\ N.m$$

$$T_0 = -928{,}839 \times \frac{80}{100}$$
$$= -743{,}071\ N.m$$
Anticlockwise/opposite

$$y = 10$$
$$-5{,}053x + 10 = 280$$
$$-5{,}053x = 280 - 10$$
$$x = \frac{270}{-5{,}053}$$
$$= -53{,}434$$

$$N_A = x + y$$
$$= -53{,}434 + 10$$
$$= -43{,}434\ r/\text{min}$$
Opposite /anticlockwise

[16]

QUESTION 5

5.1
$$v = \frac{\pi \times (D + t).N}{60}$$
$$= \frac{\pi \times (1{,}4 + 0{,}014) \times 260}{60}$$
$$= 19{,}25\ m/s$$ (2)

5.2
$$M = v \times \rho$$
$$= w \times t \times L \times \rho$$
$$= 1 \times 0{,}014 \times 1 \times 800$$
$$= 11{,}2\ kg/m$$ (2)

5.3
$$T_C = M.v^2$$
$$= 11{,}2 \times (19{,}25)^2$$
$$= 4150{,}3\ N$$ (2)

5.4
$$T_1 = w \times n \times ft$$
$$= 1 \times 4 \times 7{,}8 \times 10^3$$
$$= 31200N$$

$$\theta = \frac{170}{57{,}3}$$
$$= 2{,}967$$

$$\frac{T_1 - T_C}{T_2 - T_C} = e^{\mu \times \theta}$$
$$\frac{31200 - 4150{,}3}{T_2 - 4150{,}3} = 2{,}718^{0{,}3 \times 2{,}967}$$
$$\frac{27049{,}7}{T_2 - 4150{,}3} = 2{,}435$$
$$2{,}435T_2 - 10106{,}597 = 27049{,}7$$
$$T_2 = \frac{37156{,}297}{2{,}435}$$
$$= 15259{,}259\ N$$ (6)

5.5 $P = (T_1 - T_2).v$
$= (31200 - 15259,259) \times 19,25$
$= 306859,264\ W$
$= 306,859\ kW$

$P_0 = P_1 \times \eta$
$= 306,859 \times 0,83$
$= 254693,189\ W$
$= 254,693\ kW$ (4)

5.6 $P = 214,801 - 5\%slip$
$= 254,693 - 12,735$
$241,958\ \ kW$ (2)
[18]

QUESTION 6

6.1 $V = \sqrt{g \times \cos\theta \times r}$
$1.5 = \sqrt{9,81 \times \cos 30^0}.r$
$(1.5)^2 = 8,4957 \times r$
$r = 0,265\ m$
$D = 0,5295\ m$
$= 530\ mm$ (4)

6.2 $L = 2 \times \pi.r + 2.c$
$= 2 \times 3,142 \times 0,265 + (2 \times 80)$
$= 161,665\ m$ (2)

6.3

$$B_{/S} = \frac{V}{Space}$$
$$= \frac{1{,}33}{0{,}7}$$
$$= 2$$

$$M_{/S} = 1\,300/7 hrs$$
$$= \frac{1\,300 \times 10^3}{7 \times 3\,600}$$
$$= 51{,}587\ kg/s$$

$$M_{/b} = \frac{M_{/S}}{B_{/s}}$$
$$= \frac{51{,}587}{2}$$
$$= 25{,}794\ kg/b$$

$$P_g = m.g.h$$
$$= 51{,}587 \times 9{,}81 \times 80$$
$$= 40{,}485\ kW$$

$$P_m = \frac{P_g}{\eta}$$
$$= \frac{40{,}485}{0{,}81}$$
$$= 49{,}981\ kW$$

(10)
[16]

TOTAL: 100

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