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 9 pages.

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QUESTION 1

1.1 $$M_T = M_{full} - M_{empty}$$
$$= 1\,000 - 250$$
$$= 750\ kg \checkmark$$

$$Tubs_{/h} = \frac{M_T}{m_{rope}}$$
$$= \frac{800}{8 \times 0{,}75}$$
$$= 133{,}333/h \checkmark$$

$$T_{space} = \frac{speed\ \ rope}{tubs_{/h}}$$
$$= \frac{3{,}5 \times 10^3}{133{,}333}$$
$$= 26{,}25\ m \checkmark$$

$$T_{number} = \frac{800}{26{,}25} \checkmark$$
$$= 30{,}476$$
$$say = 30 \checkmark$$

(5)

1.2 $$M_{rope} = 2 \times 900 \times 3$$
$$= 5\,400\ kg \checkmark$$
$$M_{ft} = 1\,000 \times 30$$
$$= 30\,000\ kg \checkmark$$
$$M_{empty} = 250 \times 30$$
$$= 7\,500\ kg \checkmark$$

$$M_{total} = M_{rope} + M_{ft} + M_{empty}$$
$$= 5{,}4 + 30 + 7{,}5 \checkmark$$
$$= 42{,}9\ ton \checkmark$$

(5)

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1.3

$$F_R = M_T \times T_R$$
$$= 42{,}9 \times 180$$
$$= 7\ 722\ N \checkmark$$
$$L_{balance} = 30 \times 750$$
$$= 22\ 500\ kg \checkmark$$

$$F_{rope} = 22\ 500 \times 9{,}81 \times \sin 12°$$
$$= 45\ 891{,}308\ N \checkmark$$

$$F_{total} = 45\ 891{,}308 + 7\ 722$$
$$= 53\ 613{,}308\ N$$
$$= 53{,}613\ kN \checkmark$$

$$WD_{/s} = F_t \times V$$
$$= 53{,}613{,}308 \times \frac{3{,}5 \times 10^3}{3\ 600} \checkmark$$
$$= 52\ 124{,}049\ kg/s \checkmark$$

$$P_o = \frac{P_0}{\eta}$$
$$P_o = \frac{52\ 124{,}049}{0{,}8} \checkmark$$
$$= 63\ 565{,}913\ W \checkmark$$
$$= 63{,}566\ KW$$

(8)
[18]

QUESTION 2

2.1

$$v = \frac{95}{60} = 1{,}583\ m/s$$
$$v = \sqrt{g.\cos\theta.r} \checkmark$$
$$1{,}583 = \sqrt{9{,}81 \times \cos 30 \times r}$$
$$(1{,}583)^2 = 8{,}4957 \times r \checkmark$$
$$r = 0{,}295\ m \checkmark$$

$$d = 2 \times r$$
$$= 2 \times 0{,}295 \checkmark$$
$$= 0{,}59\ m$$
$$= 590\ mm \checkmark$$

(5)

2.2 $L = 2\pi r + 2C$

$L = \pi D + 2C$

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

$= 1{,}853 + 160$ ✓

$= 161{,}853\ m$ ✓ (3)

2.3 $B_{/s} = \dfrac{v}{space}$ $V = \dfrac{95}{60} = 1{,}583$ m/s

$= \dfrac{1{,}583}{0{,}7}$ ✓

$= 2{,}261$ ✓

$m_{/s} = 1\,300 / 7\ hours$

$= \dfrac{1\,300 \times 10^3}{7 \times 3\,600}$ ✓

$= 51{,}587\ kg/s$ ✓

$m_{/b} = \dfrac{m_{/s}}{B_{/s}}$

$= \dfrac{51{,}587}{2}$ ✓

$= 25{,}794\ kg/b$ ✓

h = C + 2R(D)

= 80 + 0,590

= 80,59

$P_g = m.g.h$

$= 51{,}587 \times 9{,}81 \times 80{,}59$ ✓

$= 40\,784{,}058\ W$ ✓

= 40,784 kW

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

$= \dfrac{40{,}784}{0{,}75}$ ✓

$= 54{,}378\ KW$ ✓ (10)

[18]

QUESTION 3

3.1

$$\omega_1 = \frac{2\pi N}{60}$$
$$= \frac{2 \times \pi \times 110}{60}$$
$$= 11{,}519\ rad/s \checkmark$$

$$\omega_2 = \frac{2\pi N}{60}$$
$$= \frac{2 \times \pi \times 150}{60}$$
$$= 15{,}708\ rad/s \checkmark$$

$$\alpha = \frac{\omega_2 - \omega_1}{t}$$
$$= \frac{15{,}708 - 11{,}519}{40} \checkmark$$
$$= 0{,}105\ rad/s^2 \checkmark$$

$$T = m.k^2.\alpha$$
$$= 1\,300 \times (0{,}81)^2 \times 0{,}105 \checkmark$$
$$= 89{,}558\ N.m \checkmark$$

(6)

3.2 3.2.1

$$\omega = \frac{2\pi N}{60}$$
$$= \frac{2 \times \pi \times 105}{60}$$
$$= 10{,}996\ rad/s \checkmark$$

$$E_k = \frac{1}{2} m.k^2.\omega^2$$
$$= \frac{1}{2} \times 560 \times (0{,}81)^2 \times (10{,}996)^2 \checkmark$$
$$= 22\,212{,}504\ J \checkmark$$
$$= 22{,}212\ \text{KJ}$$

(3)

3.2.2
$$\theta = 2\pi N$$
$$= 2\pi(\omega_2 - \omega_1)$$
$$= 2\pi(120 - 58)$$
$$= 389{,}557\ rads \checkmark$$

$$E_k = \theta.T$$
$$T = \frac{E_k}{\theta}$$
$$= \frac{22\ 212{,}504}{389{,}557} \checkmark$$
$$= 57{,}019\ Nm \checkmark$$ (3)

3.2.3
$$T = m.k^2.\alpha$$
$$\alpha = \frac{T}{m.k^2}$$
$$= \frac{57{,}019}{560 \times (0{,}81)^2} \checkmark$$
$$= 0{,}155\ rad/s^2 \checkmark$$

$$\omega_2 = \omega_1 + \alpha.t$$
$$t = \frac{\omega_2 - \omega_1}{\alpha}$$
$$= \frac{10{,}996 - 0}{0{,}155} \checkmark$$
$$= 70{,}942s \checkmark$$ (4)

[16]

QUESTION 4

4.1
$$P_g = m.g.h$$
$$= \frac{120 \times 10^3}{3\ 600} \times 9{,}81 \times 12 \checkmark\checkmark$$
$$= 3\ 924\ W \checkmark$$ (3)

4.2
$$P_f = 0{,}35 \times P_g$$
$$= 0{,}35 \times 3\ 924 \checkmark$$
$$= 1\ 373{,}4\ W \checkmark$$ (2)

4.3 $P_{total} = P_g + P_f$
$= 3\,924 + 1\,373{,}4$
$= 5\,297{,}4 \ W$ ✓

$P_i = \frac{P_o}{\eta}$
$= \frac{5\,297{,}4}{0{,}8}$ ✓
$= 6\,621{,}75 \ W$ ✓ (3)

4.4 $\frac{T_1}{T_2} = e^{\mu\theta}$
$\frac{T_1}{T_2} = e^{0{,}25\times 3{,}927}$
$T_1 = 2{,}669T_2$ ✓

$P_t = (T_1 - T_2)v$
$2{,}669T_2 - T_2 = \frac{5\,297{,}4}{1{,}5}$ ✓
$T_2 = \frac{3\,531{,}6}{1{,}669} = 2\,115{,}998 \ N$ ✓
$T_1 = 2{,}669T_2$ ✓
$= 2{,}669 \times 2\,115{,}998$ ✓
$= 5647{,}599 \ N$ ✓ (6)

4.5 $n = \frac{T_1}{Allowable_{tension}}$
$= \frac{5\,647{,}599}{2{,}3\times 10^3 \times 0{,}65}$ ✓
$= 3{,}778$ ✓
$say = 4 \ \ plies$ ✓ (3)
[17]

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QUESTION 5

5.1
$$T_E = m_L \times g \times \mu \times \eta$$
$$= 150 \times 10^3 \times 9{,}81 \times 0{,}3 \times 0{,}72 \checkmark$$
$$= 317\ 844\ \text{N}$$
$$= 317{,}844\ kN \checkmark$$
(2)

5.2
$$F_R = (m_L \times R_L) + (m_T + R_T)$$
$$= (150 \times 160) + (700 \times 120) \checkmark$$
$$= 24\ 000 + 84\ 000$$
$$= 108\ 000\ \text{N}$$
$$= 108\ kN \checkmark$$

$$F_g = (m_L + m_T) \times 10^3 \times g \times incline$$
$$= (150 + 700) \times 10^3 \times 9{,}81 \times \frac{1}{140} \checkmark$$
$$= 59\ 560{,}714\ N \checkmark$$

$$T_E = F_R + F_g + F_a$$
$$F_a = T_E - F_R - F_g$$
$$= 317{,}844 - 108 - 59{,}561$$
$$= 150{,}283\ kN \checkmark$$
(5)

5.3
$$T_E = 317{,}844 \times 0{,}68$$
$$= 216{,}134\ kN \checkmark$$

$$F_a = T_E - F_R - F_g$$
$$= 2\ 16{,}134 - 108 - 59{,}561 \checkmark$$
$$= 48{,}573\ kN \checkmark$$

$$F_a = m.a$$
$$a = \frac{F_a}{m}$$
$$a = \frac{48{,}573 \times 10^3}{(150 + 700) \times 10^3} \checkmark$$
$$= 0{,}057 m/s^2 \checkmark$$

$$v = u + a.t$$
$$t = \frac{v - u}{a}$$
$$t = \frac{10 - 0}{0{,}057} \checkmark$$
$$= 175{,}439 s \checkmark$$
(7)

5.4
$$v^2 = u^2 + 2aS$$
$$S = \frac{v^2 - u^2}{2a}$$
$$= \frac{10^2 - 0^2}{2(0{,}057)} \checkmark$$
$$= 877{,}193\ m \checkmark$$
(2)
[16]

QUESTION 6

6.1
- Minimum length of rope is used.
- Minimum number of rope sheaves is used.
- Load on building structure is reduced. (3)

6.2 6.2.1
$$T_1 = m_1(g + a) + f_{\mu_1}$$
$$= 1\,600(9{,}81 + 0{,}6) + 620 \checkmark$$
$$= 17\,276\ N \checkmark$$

$$T_2 = m_2(g - a) - f_{\mu_2}$$
$$= 850(9{,}81 - 0{,}6) - 480 \checkmark$$
$$= 7\,348{,}5\ N \checkmark$$

$$T_{a_1} = (T_1 - T_2)r$$
$$= (17\,276 - 73\,48{,}5)0{,}49 \checkmark$$
$$= 4\,864{,}475\ Nm \checkmark$$

$$T_{a_2} = T_a + T_\mu$$
$$T_{a_2} = (m.k^2 \times \frac{a}{\alpha}) + T_\mu$$
$$= \{400(0{,}6)^2 \times \frac{0{,}6}{0{,}49}\} + 320 \checkmark$$
$$= 496{,}326 \checkmark$$

$$T_{total} = T_{a_1} + T_{a_2}$$
$$= 48\,64{,}475 + 4\,96{,}327 \checkmark$$
$$= 53\,60{,}802\ Nm \checkmark$$
(10)

6.2.2
$$P = T_{total} \times \frac{v}{r}$$
$$P = 5\,360{,}802 \times \frac{1{,}8}{0{,}8} \checkmark$$
$$= 12\,061{,}805\ W$$
$$= 12{,}062\ kW \checkmark$$
(2)
[15]

TOTAL: 100

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