higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

MECHANOTECHNICS N6

7 APRIL 2016

This marking guideline consists of 8 pages.

QUESTION 1

1.1

$$P = \frac{2\pi NT}{60}$$
$$T = \frac{60 \times 80 \times 10^3}{2 \times \pi \times 4200}$$
$$= 181{,}9\ Nm\checkmark$$
$$r = 104\ mm$$
$$R = 104 \times 1{,}25$$
$$= 130\ mm\ mm\checkmark$$
$$R_m = \frac{2}{3}\left(\frac{R^3 - r^3}{R^2 - r^2}\right)$$
$$= \frac{2}{3}\left(\frac{130^3 - 104}{130 - 104^2}\right)$$
$$= 117{,}5\ N\checkmark$$
$$F_A = p \times A$$
$$F_A = 245 \times 10^3 \times \pi \times (0{,}13^2 - 0{,}104^2)\checkmark$$
$$= 4683\ N\checkmark$$
$$T = \mu \times F_A \times R_m \times n$$
$$n = \frac{181{,}9}{0{,}07 \times 4683 \times 0{,}1175}\checkmark$$
$$= 4{,}72$$
$$use/gebruik\ 5\ pairs/pare\checkmark$$ (7)

1.2 1.2.1

$$PCD = m \times T$$
$$= 10 \times 35\checkmark$$
$$= 350\ mm\checkmark$$ (2)

1.2.2

$$CD = \frac{PCD_A}{2} + \frac{PCD_B}{2}$$
$$= \frac{40}{2} + \frac{350}{2}\checkmark$$
$$= 195\ mm\checkmark$$ (2)

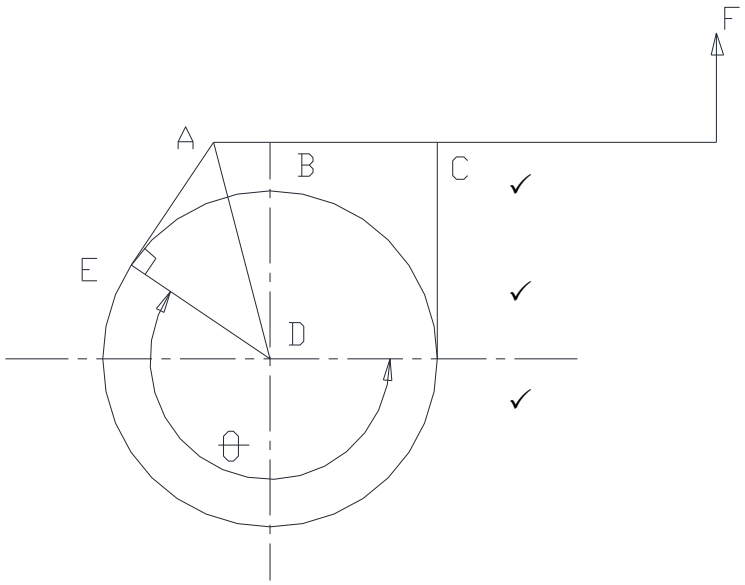
1.2.3

$$p = m \times \pi$$
$$= 10 \times \pi$$
$$= 31{,}4\ mm\checkmark$$
$$\tan\theta = \frac{p \times n}{\pi \times D_m}$$
$$= \frac{31{,}4 \times 4}{\pi \times 40}\checkmark$$
$$= 1\checkmark$$
$$\therefore\ \theta = 45°$$
$$\eta = \frac{\tan\theta}{\tan(\theta + \emptyset)} \times 100$$
$$\tan(\theta + \emptyset) = \tan\theta \times 100/\eta\checkmark$$
$$\tan(45° + \emptyset) = \tan 45° \times 100/80$$
$$= 1{,}25\checkmark$$
$$45° + \emptyset = 51{,}34°$$
$$\emptyset = 6{,}34°\checkmark$$

$\mu = \tan \emptyset$
$= \tan 6{,}34° ✓$
$= 0{,}111 ✓$ (8)
[19]

QUESTION 2

2.1



✓ ✓ ✓

$AD = \sqrt{76^2 + 290^2}$
$= 300\ mm ✓$
$A\hat{D}B = \tan^{-1} 76/290$
$= 14{,}7° ✓$
$A\hat{D}E = \cos^{-1} 225/300$
$= 41{,}4° ✓$
$\theta = 360° - (90° + 14{,}7° + 41{,}4°)$
$= 213{,}9° ✓$ (7)

2.2 $\frac{T_1}{T_2} = e^{\mu\theta}$
$\frac{T_1}{T_2} = e^{0{,}25 \times 213{,}91° \div 57{,}3}$
$T_1 = 2{,}54T_2 ✓$
$E\hat{A}D = 90° - 41{,}4° = 48{,}6° ✓$
$B\hat{A}D = 90° - 14{,}7° = 75{,}3° ✓$
$\hat{A} = 180° - 75{,}3° - 48{,}6° = 56{,}1° ✓$
$\sum \curvearrowright M = \sum \curvearrowleft M$
$T_2 \times 225 = 250 \times 600 + T_1 \times sin 56{,}1° \times 76$
$225T_2 = 150000 + 63{,}08T_1 ✓$
$\therefore 225T_2 - 63{,}08(2{,}54T_2) = 150000$
$\therefore 64{,}78T_2 = 150000 ✓$
$T_2 = 2316\ N ✓$

$T_1 = 5881N$✓ (8)

2.3 $T = (T_1 - T_2) \times r$
$= (5881 - 2316) \times 0{,}225$✓
$= 802\ Nm$✓ (2)
[17]

QUESTION 3

3.1 $I = mk^2$

$I_1 = 1000 \times 1{,}2^2$
$= 1440\ kgm^2$ ✓

$I_2 = 500 \times 0{,}8^2$
$= 320\ kgm^2$✓

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

$\omega_1 = \frac{2\pi \times 450}{60}$
$= 47{,}12\ rad/s$✓

$\omega_2 = \frac{2\pi \times 250}{60}$
$= 26{,}18\ rad/s$✓

$(I_1 + I_2)\omega_3 = I_1\omega_1 + I_2\omega_2$
$(1440 + 320)\omega_3 = 1440 \times 47{,}12 + 320 \times 26{,}18$ ✓✓
$\therefore\ \omega_3 = 43{,}3\ rad/s$✓
$\therefore\ N_3 = \frac{43{,}3 \times 60}{2\pi}$
$= 413{,}48\ r/min$✓ (8)

3.2 $E_{ki} = \frac{1}{2}I_1{\omega_1}^2 + \frac{1}{2}I_2{\omega_2}^2$
$= \frac{1}{2}(1440)(47{,}12)^2 + \frac{1}{2}(320)(26{,}18)^2$✓
$= 1708\ kJ$✓
$E_{kf} = \frac{1}{2}(I_1 + I_2){\omega_3}^2$
$= \frac{1}{2}(1440 + 320) \times (43{,}3)^2$✓
$= 1650\ kJ$✓
$\Delta E_k = E_{kf} - E_{ki}$
$= 1708 - 1650$✓
$= 58\ kJ$✓ (6)
[14]

QUESTION 4

4.1

$$F_R = m_L(60+80) + m_T(24+50)\checkmark$$
$$= 140m_L + 350 \times 74$$
$$= 140m_L + 25900\checkmark$$
$$F_g = (m_L + m_T) \times 10^3 \times g \times slope\checkmark$$
$$= (m_L + 350) \times 10^3 \times 9{,}81 \times 1/80$$
$$= 122{,}625m_L + 42919\checkmark$$
$$TE = F_R + F_g$$
$$= 140m_L + 25900 + 122{,}625m_L + 42919\checkmark$$
$$= 262{,}625m_L + 68819\checkmark$$
$$TE = m_L \times 10^3 \times \mu \times g \times \%\ on\ wheels\checkmark$$
$$= m_L \times 10^3 \times 0{,}26 \times 9{,}81 \times 0{,}7$$
$$= 1785{,}42m_L\ N\checkmark$$
$$\therefore\ 1785{,}42m_L = 262{,}625m_L + 68819\checkmark$$
$\therefore m_L$=45,19 ton✓ (10)

4.2

$$P = TE \times v \times 100/\eta\checkmark$$
$$= 1785{,}42 \times m_L \times 45/3{,}6 \times 100/\eta\checkmark$$
$$= 1785{,}42 \times 45{,}19 \times 45/3{,}6 \times 100/75\checkmark$$
$$= 1{,}3447\ MW\checkmark$$ (4)

4.3

$$n = \frac{m_L \times 0{,}7}{8}$$
$$= \frac{45{,}19 \times 0{,}7}{8}\checkmark$$
$$= 3{,}95$$
$use/gebruik\ \ 4axles/asse\checkmark$ (2)

[16]

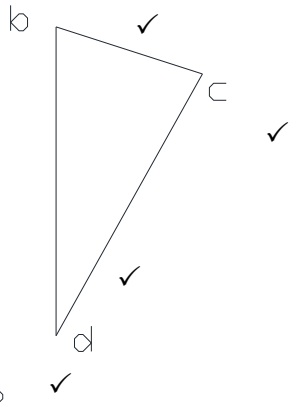
QUESTION 5

5.1

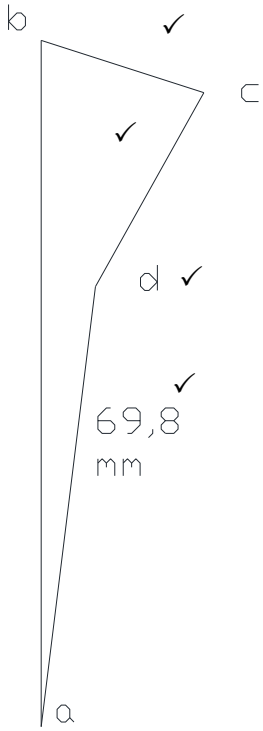
Plane	m (kg)	r (m)	mr (kgm)	l (m)	mrl (kgm^2)
A	m	0,12	0,12 m	0	0
B	12	0,18	2,16	0,45	0,972
C	6	0,09	0,54	0,9	0,486
D	5	0,14	0,7	1,35	0,945
		✓	✓	✓	✓

(4)

5.2 Couple diagram

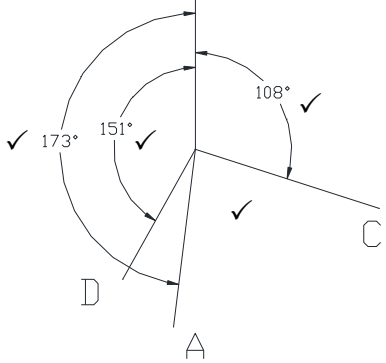


5.3 Force diagram



(3)

5.5 Space diagram



(4)

(4)

5.4 $0{,}12m = 69{,}8\ mm = 1{,}396\ kg.m$✓

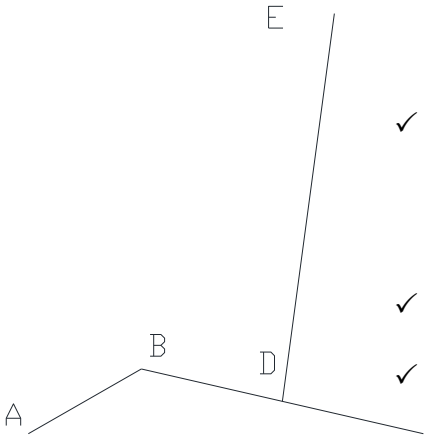
$\therefore\ m = 11{,}63\ kg$✓

(2)

[17]

QUESTION 6

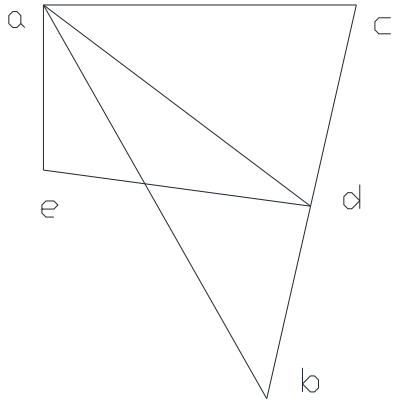
6.1



✓ ✓ ✓

Space diagram (3)

6.2



$$v_B = \frac{2\pi \overline{AB} N}{60}\checkmark$$
$$= \frac{2\pi \times 0{,}09 \times 1800N}{60}$$
$$= 16{,}96\ m/s\checkmark\checkmark$$

Vector diagram✓

(4)

6.3 6.3.1 $\omega_{AB} = v_B/AB$ = 16,96/0,09✓
$= 188{,}4\ rad/s$✓

6.3.2 $v_{DtoA} = 41{,}9 \times 0{,}3 = 12{,}57\ m/s$

6.3.3 $v_{CtoB} = 50{,}3 \times 0{,}3 = 15{,}09\ m/s$

6.3.4 $v_{EtoD} = 33{,}8 \times 0{,}3 = 10{,}14\ m/s$

6.3.5 $Centripital\ acceleration\ /sentripitale\ versnelling$
$\omega_{AB}{}^2 \times \overline{AB} = 188{,}4^2 \times 0{,}09 = 3195\ rad/s^2$

(5 × 2) (10)
[17]

TOTAL: 100