higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

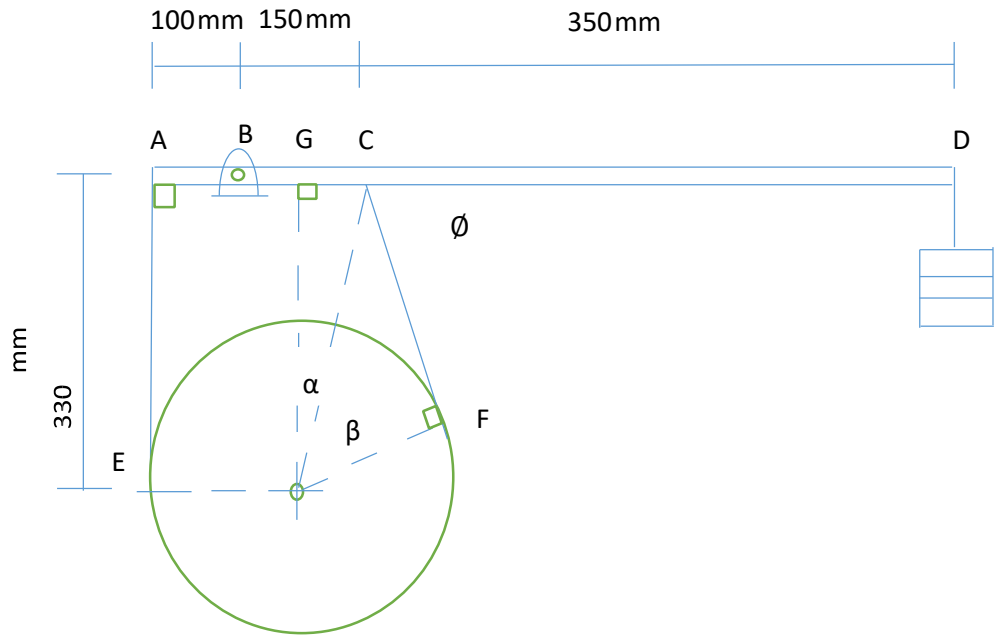
MECHANOTECHNICS N6

9 April 2021

This marking guideline consists of 10 pages.

QUESTION 1: BRAKES

1.1



$tan \propto = \frac{CG}{GO}$ $GC = 250 - 160 = 90$ mm✓

$\propto = tan^{-1}\left(\frac{90}{330}\right)$✓ $= 15{,}26°$✓

$OC^2 = GC^2 + GO^2$

$OC^2 = 90^2 + 330^2$

$OC = 342{,}052$ mm✓

$cos\beta = \frac{OF}{OC}$

$\beta = cos^{-1}(\frac{160}{342{,}052})$✓

$\beta = 62{,}11°$✓

$\theta = 360 - (90 + \propto + \beta)$

$= 360 - (90 + 15{,}26 + 62{,}11)$

$= 192{,}63°$✓ (7)

1.2 $T = \frac{P}{2\pi N} = \frac{16\,965}{2\pi(16{,}667)}$✓ $= 162$ Nm✓

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

$\frac{T_1}{T_2} = e^{(0,3)(3,362)}$✓

$T_1 = 2{,}742T_2$✓

$T = (T_1 - T_2)R$

$162 = (2{,}742T_2 - T_2)0{,}16$✓

$T_2 = 581{,}228$ N✓

$T_1 = (2{,}742)(581{,}228) = 1\,592{,}727$ N✓

The angle between belt and the horizontal lever:

$\emptyset = \propto + \beta = 77{,}37°$✓

$W \times BD + T_2 sin\emptyset \times BC = T_1 \times AB$

$W \times 0{,}5 + (581{,}228Ssin77{,}37°)$✓$(0{,}15) = 1\,592{,}727 \times 0{,}1$✓

$W = 148{,}397$ N✓

$\therefore W = mg$

$M = \frac{148{,}397}{9{,}81} = 15{,}127$ kg✓

(12)
[19]

QUESTION 2: CLUTCHES

$$w_1 = \frac{2\pi N}{60} = \frac{2\pi(600)}{60} = 62{,}832 \text{ rad/s}\checkmark$$

$$F_c = m(w_1{}^2)r$$

$$= 3{,}6(62{,}832)^2(0{,}15)$$

$$= 2\ 131{,}845 \text{ N}\checkmark$$

$$w_2 = \frac{2\pi N}{60} = \frac{2\pi(0{,}75 \times 600)}{60} = 47{,}124 \text{ rad/s}\checkmark$$

$$S = m(w_2{}^2)r$$

$$= 3{,}6(47{,}124)^2(0{,}15)$$

$$= 1\ 199{,}163 \text{ N}\checkmark$$

$$F_c - S = 2\ 131{,}845 - 1\ 199{,}163$$

$$= 932{,}682 \text{ N}\checkmark$$

$$T = \mu(F_c - S)R \times n$$

$$= 0{,}3(932{,}682)(0{,}175)(4)\checkmark$$

$$= 195{,}863 \text{ Nm}\checkmark$$

$$P = \frac{2\pi NT}{60} = \frac{2\pi(600)(195{,}863)}{60}\checkmark$$

$$= 12{,}306 \text{ kW}\checkmark$$ **[9]**

QUESTION 3: LINE SHAFTS

3.1 $N_A D_A = N_B D_D$

$(600)(0{,}12) = N_B(0{,}3)\checkmark$

$N_B = 240 \text{ r/min}\checkmark$ (2)

3.2 $T = \frac{60P}{2\pi N} = \frac{60(12 \times 10^3)}{2\pi(240)}\checkmark = 477{,}46 \text{ Nm}\checkmark$ (2)

3.3 $F_t = \frac{T \times 2}{PCD} = \frac{(477{,}465)2}{240}$✓ $= 3\ 978{,}875$ N✓

$F_n = \frac{F_t}{cos\emptyset} = \frac{3\ 978{,}875}{cos20°}$✓ $= 4\ 234{,}23$ N✓

$F_v = F_n sin50°$

$= 4\ 234{,}23 sin60°$✓

$= 3\ 674{,}75$ N✓ (6)

3.4 $\frac{T_1}{T_2} = e^{\mu\theta}$

$\frac{T_1}{T_2} = e^{(0{,}3)(\pi)}$✓

$T_1 = 2{,}566T_2$✓

$T = (T_1 - T_2)R$

$477{,}465 = (2{,}566T_2 - T_2)0{,}16$✓

$T_2 = 1\ 905{,}591$ N✓

$T_1 = 1\ 905{,}591 \times 2{,}566 = 4\ 889{,}747$ N✓ (5)

3.5 $\Sigma Cwm = \Sigma Acwm$

$0 = (4\ 889{,}747 + 1\ 905{,}591)0{,}16 + (3\ 674{,}75)0{,}6 + \text{Rr} \times 1{,}2$✓

$0 = 1\ 087{,}255 + 2\ 204{,}4 + 1{,}2\text{Rr}$

$\text{Rr} = -2\ 743{,}045$ N

$= -2\ 743{,}045$ N down✓

$\Sigma F_{up} = \Sigma F_{down}$

$R_L + F_V = R_R + T_1 + T_2$

$\text{Rl} + 3\ 243{,}609 = 2\ 743{,}045 + 4\ 889{,}747 + 1\ 905{,}591$✓

$\text{Rl} = 6\ 294{,}775$ N✓ (4)

[19]

QUESTION 4: FLYWHEELS

4.1 $A = \frac{\pi}{4}(D^2 - d^2)$

$A = \frac{\pi}{4}(0{,}4^2 - 0{,}15^2)$✓

$A = 107{,}992 \times 10^{-3}\ \text{m}^2$✓

$m = \delta A w$

$m = (7\ 500)(107{,}992 \times 10^{-3})(0{,}12)$✓

$m = 97{,}193\ \text{kg}$✓

$I = m(\frac{R^2 + r^2}{2})$

$I = 97{,}193(\frac{0{,}2^2 + 0{,}075^2)}{2})$✓

$I = 2{,}217\ \text{kg.m}^2$✓ (6)

4.2 $\Delta E_K = \frac{1}{2} I({w_2}^2 - {w_1}^2)$

$3{,}98 \times 10^3 = \frac{1}{2}(2{,}217)({w_2}^2 - 0^2)$✓

$w_2 = 59{,}92\ \text{rad/s}$✓

$w_2 = w_1 + \propto t$

$59{,}92 = 0 + \propto (1{,}8)$✓

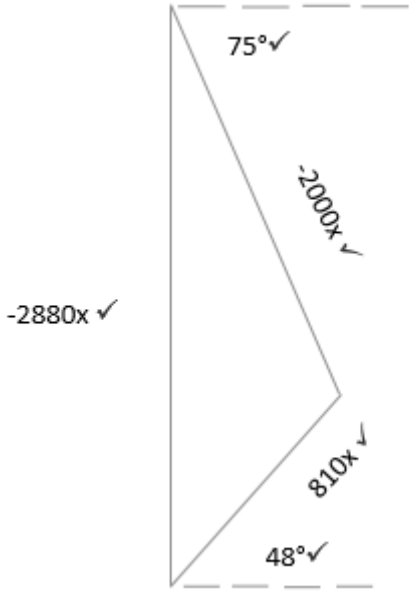
$\propto = 33{,}29\ \text{rad/s}^2$✓ (4)

[10]

QUESTION 5: BALANCING

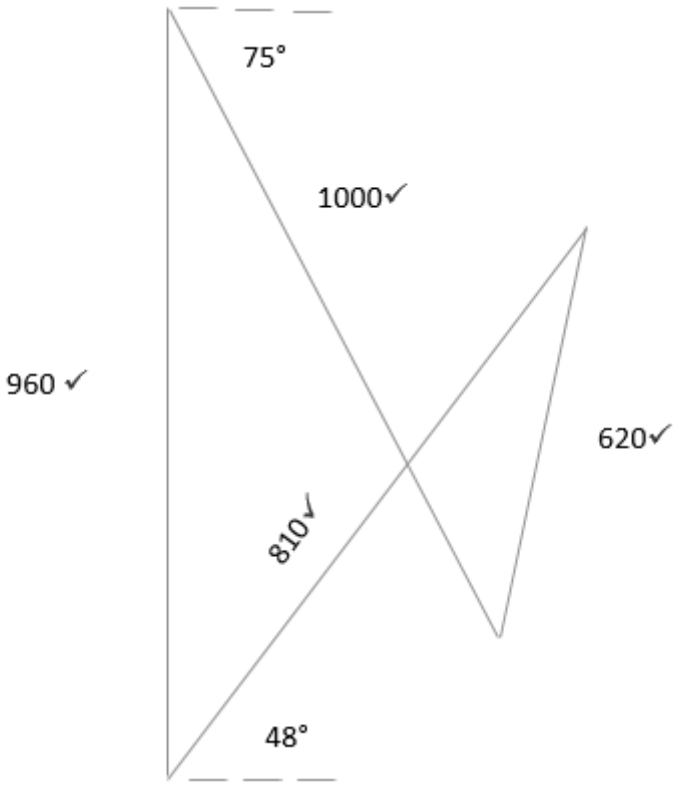
5.1

	m (kg)	r (mm)	mr (kg.mm)	ℓ (m)	mrℓ (kg.mm.m)
A	8	120	960√	-3x	-2 880x√
B	10	100	1 000√	-2x	-2 000x√
C	7	r	7r√	0	0√
D	9	90	810√	x	810x√



Angle between A and B is $75° + 90° = 165°$✓
Angle between A and D is $48° + 90° = 138°$✓ (11)

5.2



$7r = 620$✓
$r = 88{,}6 \text{ mm} = 89 \text{ mm}$✓ (6)
[17]

QUESTION 6: DYNAMICS

6.1 $F_g = W_T(\frac{4\%}{100\%})$

$= (30 \times 10^3 + 300 \times 10^3)\frac{1}{25}$✓

$= 13{,}2 \text{ kN}$✓

$F_R = R_L + R_T$

$= 30 \times 25 + 300 \times 30$

$= 750 + 9\,000$✓

$= 9{,}75 \text{ kN}$✓

$F_e = F_R + F_g$

$F_e = 9{,}75 + 13{,}2$

$F_e = 22{,}95 \text{ kN}$✓ (5)

6.2 $v = u + at$

$\frac{72}{3,6} = 0 + a(60 \times 1,5)$✓

$a = 0,222 \text{ m/s}^2$✓

$F_a = m_T a$

$= (330 \times 10^3)(0,222)$✓

$= 73,333 \text{ kN}$✓

$F_e = F_R + F_g + F_a$

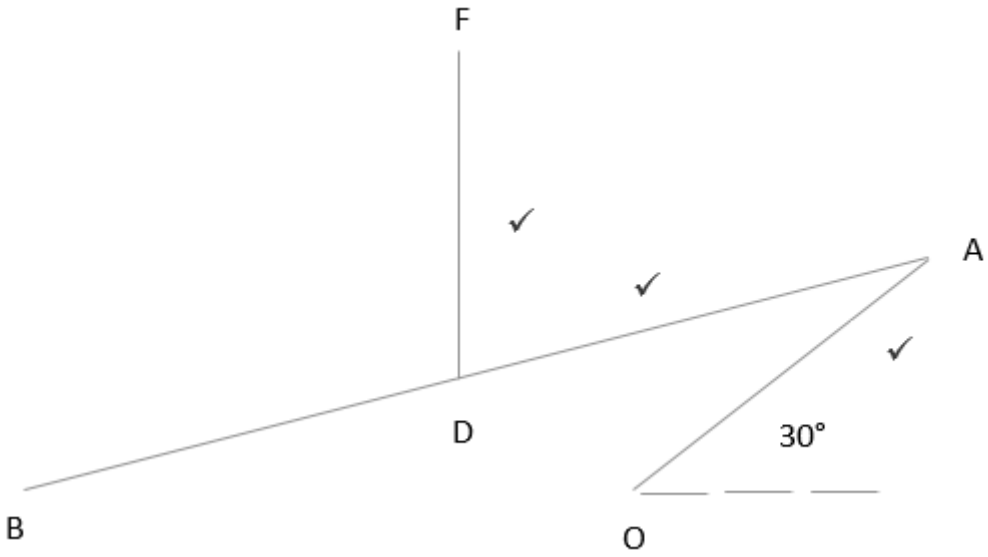
$= 7,95 + 13,2 + 73,333$

$= 96,283 \text{ kN}$✓ (5)

[10]

QUESTION 7: KINEMATICS

7.1

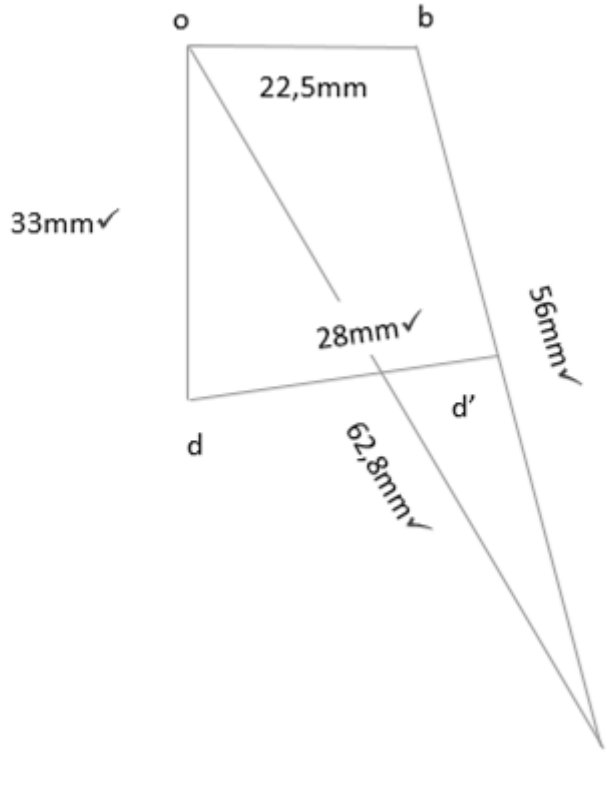


(3)

7.2 $v_{OA} = \frac{\pi ND}{60} = \frac{\pi(60)(0,2)}{60}$✓ $= 0,628 \text{ m/s}$✓

(2)

7.3 Scale: $0{,}1\ \text{m/s} = 10\ \text{mm}$



(1 mark for each velocity drawn) (5)

7.4 $v_{DE} = \frac{33}{100}$✓ $= 0{,}33\ \text{m/s}$✓ (2)

7.5 7.5.1 $a = \frac{v^2}{r} = \frac{(0{,}628)^2}{0{,}1}$✓ $= 3{,}944\ \text{m/s}^2$✓

7.5.2 $a = \frac{v^2}{r} = \frac{(\frac{56}{100})^2}{0{,}3}$✓ $= 1{,}045\ \text{m/s}^2$✓

(2 × 2) (4)
[16]

TOTAL: 100