higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

MECHANOTECHNICS N6

6 April 2020

This marking guideline consists of 9 pages.

QUESTION 1: BRAKES

1.1 $$T = \frac{60P}{2\pi N} = \frac{60(9 \times 10^3)}{2\pi(1\,067{,}725)} \checkmark = 80{,}492 \text{ N} \cdot \text{m} \checkmark$$ (2)

1.2 $$W \times S + \mu R \times \ell = R \times L$$
$$9\,810 \times 0{,}8 + 0{,}25R \times 0{,}0 = R \times 0{,}3 \checkmark$$
$$R = 2\,683{,}077 \text{ N} \checkmark$$

$$T = (\mu R)r$$
$$80{,}492 = 0{,}25 \times 2\,683{,}077r \checkmark$$
$$R = 0{,}119 \text{ mm}$$
$$r = 120 \text{ mm} \checkmark$$
$$\therefore D = 2r = 120 \times 2 = 240 \text{ mm} \checkmark$$ (5)

[7]

QUESTION 2: CLUTCHES

2.1 $$T = \mu F_A R_f n \text{ but } R_f = \frac{r_1 + r_2}{2} = \frac{175 + 125}{2} = 150 \text{ mm} \checkmark$$

$$= (0{,}3)(1{,}4 \times 10^3)(0{,}15)(2) \checkmark$$

$$= 126 \text{ N} \cdot \text{m} \checkmark$$ (3)

2.2 Net deccelerating torque engine: $126 - 50 = 76 \text{ N} \cdot \text{m} \checkmark$

Decceleration of engine: $\propto_e = \frac{I}{I} = \frac{76}{2{,}662} \checkmark = 28{,}546 \text{ rad/s}^2 \checkmark$

Net acceleration torque output shaft: $126 - 9 = 117 \text{ N} \cdot \text{m} \checkmark$

Acceleration of output shaft: $\propto_s = \frac{I}{I} = \frac{117}{6{,}08} \checkmark = 19{,}243 \text{ rad/s}^2 \checkmark$

Combined speed of engagement:

$$N = \frac{\propto_s \times N_e}{\propto_s + \propto_e}$$

$$= \frac{(19{,}243)(450)}{(19{,}243) + (28{,}546)} \checkmark$$

$$= 181{,}2 \text{ r/min} \checkmark$$ (8)

2.3 $t = \frac{2\pi(N_e - N_e)}{\propto_e}$ **OR** $t = \frac{w_s}{\propto_s} = \frac{2\pi(181,2)}{60(19,243)}$ ✓

$t = \frac{2\pi(450-181,2)}{60(28,546)}$ ✓ $t = 0,99s$✓

$t = 0,99s$✓ (2)

2.4 Combined accelerating torque after slip: $T = 50 - 9 = 41\ N \cdot m$✓

Combined moment of inertia: $I = I_e + I_s = 2,662 + 6,08 = 8,742\ kg.m^2$

$\therefore \propto_c = \frac{I}{I} = \frac{41}{8,742} = 4,69\ rad/s^2$✓

Tie table to reach 450 r/ min after engagement:

$t = \frac{2\pi(N_e - N)}{\propto_e} = \frac{2\pi(450 - 181,2)}{60(4,69)}$ ✓ $= 6\ s$✓

Total time taken to reach 450 r/ min including the duration of slip:

$t = 6 + 0,99 = 6,99\ s$✓ (5)
[18]

QUESTION 3: LINE SHAFTS

3.1 $N_A D_A = N_B D_B$

$(500)(100) = N_B(250)$✓

$N_B = 200\ r/min$✓

$Tb = 60P(10 \times 10^3)/2 \times \pi(200)$✓

$= 477,465\ N \cdot m$✓ (4)

3.2 $\frac{T_1}{T_2} = e^{\mu\theta}$

$\frac{T_1}{T_2} = e^{(0,25)(\pi)}$✓

$T_1 = 2,193T_2$✓

$T = (T_1 - T_2)R$

$477,465 = (2,193T_2 - T_2)0,15$✓

$T_2 = 2\ 668,148\ N$✓

$T_1 = 2,193(2\ 668,148) = 5\ 851,249\ N$✓ (5)

3.3 $F_t = \frac{T \times 2}{PCD} = \frac{(477{,}465)(2)}{0{,}25}$ ✓ $= 3\ 819{,}72$ N✓

$F_r = F_t \tan\emptyset$

$= 3\ 819{,}72 \times \tan 20°$✓

$= 1\ 390{,}264$ N✓ (4)

3.4 $\Sigma cwm = \Sigma acwm$

$(120 \times 9{,}81)0{,}4 + 60 \times 9{,}81 \times 1{,}12 = 1\ 390{,}26 \times 0{,}7 + R_R \times 1$

$470{,}88 + 659{,}232 = 973{,}182 + R_R$✓

$R_R = 156{,}93$ N✓

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

$R_L + 156{,}93 = 1\ 177{,}2 + 588{,}6$✓

$R_L = 1608{,}87$ N✓ (4)

3.5 $\Sigma cwm = \Sigma acwm$

$(2\ 668{,}142 + 5\ 851{,}249) \times 1{,}12 = 3\ 819{,}72 \times 0{,}7 + 1 \times R_R$✓

$R_R = 6\ 867{,}914$ N✓

$\Sigma F_{left} = \Sigma F_{right}$

$R_L + 6\ 867{,}914 = 2\ 668{,}142 + 5\ 851{,}249$✓

$R_L = 1\ 651{,}477$ N✓ (4)
[21]

QUESTION 4: REDUCTION GEARBOXES

4.1 $\text{lead} = p \times n$
$= 12 \times 2$
$= 24 \text{ mm}$✓

$$\tan\theta = \frac{\text{lead}}{\pi D}$$

$$\tan\theta = \frac{24}{\pi \times 70}$$ ✓

$$\tan\theta = 0{,}109$$

$$\theta = 6{,}23°$$✓

$$\tan\emptyset = \mu$$

$$\tan\emptyset = 0{,}05$$

$$\emptyset = 2{,}86°$$✓

$$\eta_w = \frac{\tan\theta}{\tan(\theta + \emptyset)} \times 100\%$$

$$\eta_w = \frac{\tan 6{,}23}{\tan(6{,}23 + 2{,}86)}$$ ✓ $\times 100\%$

$$\eta_w = 68{,}23\%$$✓ (6)

4.2 $$P_w = \frac{P_{out}}{\eta_w} = \frac{25 \times 10^3}{0{,}6823}$$ ✓ $= 36{,}64 \text{ kW}$✓

$x = 2 \times 12 = 24 \text{ mm}$✓(movement on the worm)

$$V_w = x \times N = 24 \times \frac{100}{60} = 400\frac{\text{mm}}{\text{s}} = 0{,}4 \text{ m/s}$$✓

$V_w = x \times N = 24 \times 100/60$

$= 40 \text{ mm/s}$

$= 0{,}0\ 4 \text{ m/s}$

$P_{out} = F_w V_w$

$Fw = 25\ 0000/0{,}04$

$= 625\ 0000 \text{ N}$

$= 625 \text{ kN}$✓

$\text{Tu} = \mu\text{FwR} = 0{,}05(625 \times 10^3) \times 0{,}04$✓

$= 1\ 250\ \text{N} \cdot \text{m}$✓

$\text{P}\mu = (2\pi\text{N}/60)\text{T}\mu$

$= (2\pi 1\ 000/60)1\ 250$✓

$= 130\ 916{,}667\ \text{W}$

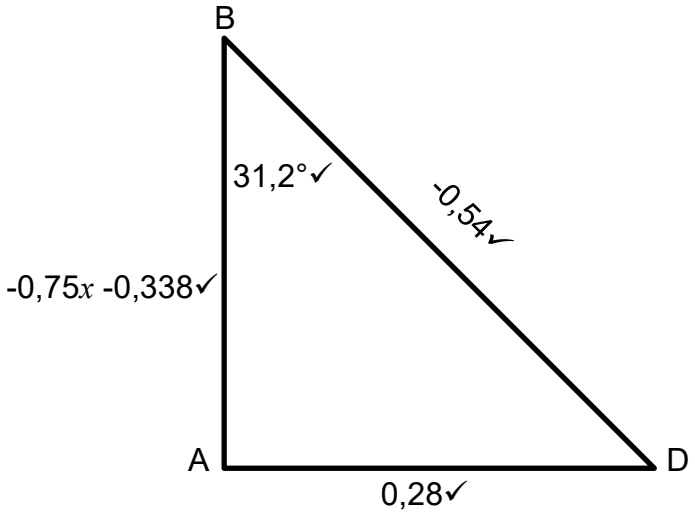
$= 130{,}916\ \text{kW}$✓ (9)

4.3 $P_{in} = 36{,}64 + 130{,}916 = 1167{,}556\ \text{kW}$ (1)
[16]

QUESTION 5: BALANCING

5.1

	m (kg)	r (m)	mr (kg.m)	ℓ (m)	mrℓ (kg.m²)
A	3	0,25	0,75√	-(x + 0,45)	-0,75x -0,338√
B	4	0,3	1,2√	-0,450	-0,54√
C	m	0,2	0,2m√	0	0√
D	2	0,35	0,7√	0,4	0,28√

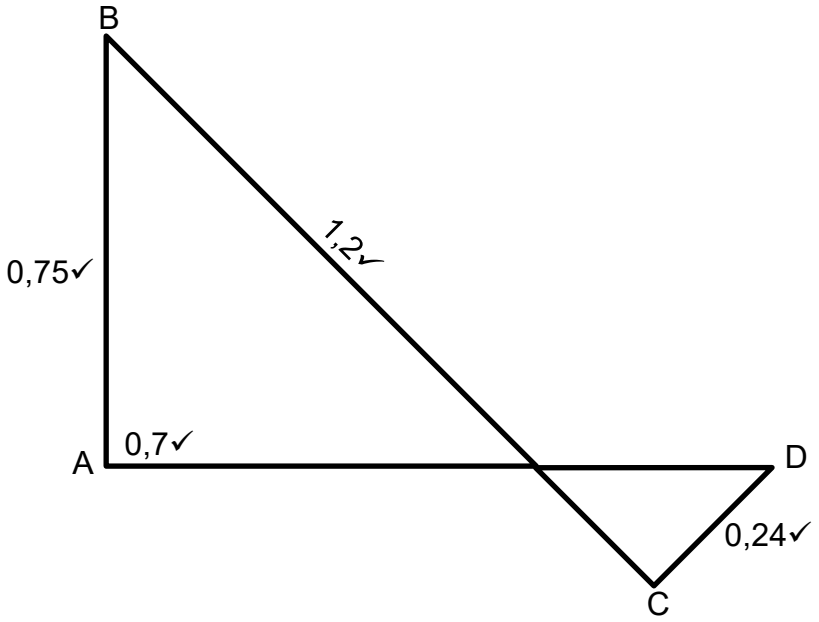


$-0{,}462 = -0{,}75x - 0{,}338$✓

$x = 165\ \text{mm}$✓ (10)

5.2 Angle between A and B $= 180° - 31{,}2° = 148{,}8°$✓ (1)

5.3 $0{,}24 = 0{,}2\ \text{m}$✓
$\text{m} = 1{,}2\ \text{kg}$✓



(6)
[17]

QUESTION 6: DYNAMICS

6.1 $\text{v} = \sqrt{\mu\text{gr}}$

$\text{v} = \sqrt{0{,}4 \times 9{,}81 \times 90}$✓

$\text{v} = 18{,}79\ \text{m/s}$✓

6.2 $\text{v} = \sqrt{\dfrac{\text{gbr}}{2\text{h}}}$

$\text{v} = \sqrt{\dfrac{(9{,}81)(1{,}2)(90)}{2(0{,}75)}}$✓

$\text{v} = 26{,}58\ \text{m/s}$✓

6.3 $\text{v} = \sqrt{\text{gr}\dfrac{\mu + \tan\theta}{1 - \mu\tan\theta}}$

$\text{v} = \sqrt{(9{,}81)(90)\dfrac{(0{,}4) + \tan 18°}{1 - 0{,}4\tan 18°}}$✓

$\text{v} = 27{,}12\ \text{m/s}$✓

6.4 $$v = \sqrt{gr\frac{h\tan\theta + \frac{b}{2}}{h - \frac{b}{2}\tan\theta}}$$

$$v = \sqrt{(9{,}81)(90)\frac{0{,}75\tan16° + \frac{1{,}2}{2}}{0{,}75 - \left(\frac{1{,}2}{2}\right)\tan16°}}\checkmark$$

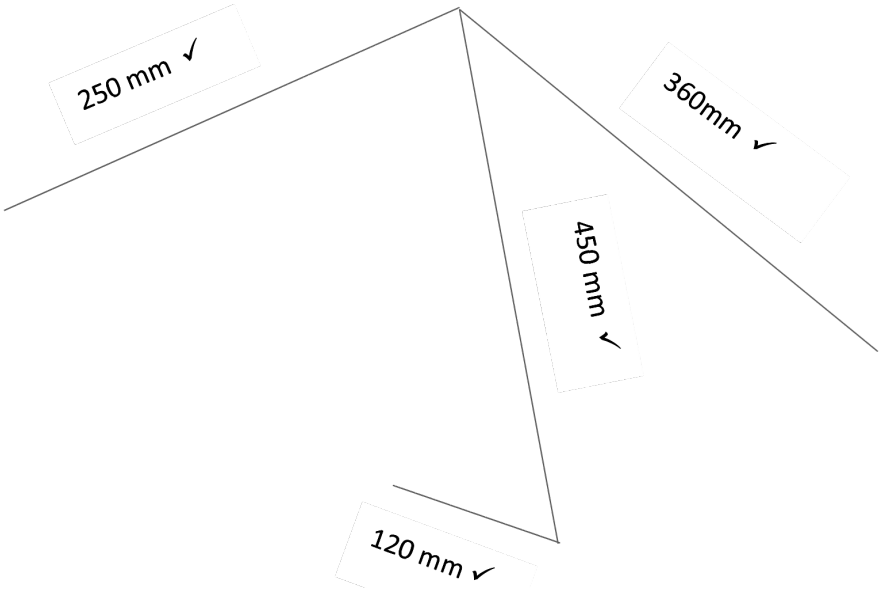
$v = 35{,}29\ m/s\checkmark$

(4 × 2) **[8]**

QUESTION 7: KINEMATICS

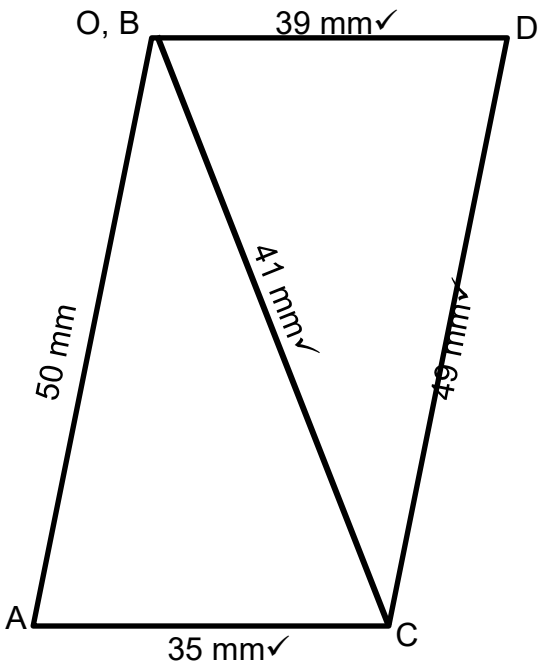
7.1 $$v = wr = \frac{\pi ND}{60} = \frac{\pi(100)(0{,}24)}{60}\checkmark = 1{,}257\ m/s\checkmark$$ (2)

7.2



(Any 3 × 1) (3)

7.3 Scale: 1 m/s = 40 mm



(4)

7.4 $v_D = 39 \div 40$✓ $= 0{,}975 \text{ m/s}$✓ (2)

7.5 $a = \frac{v^2}{r} = \frac{(49 \div 40)^2}{0{,}32}$✓ $= 4{,}689 \text{ m/s}^2$✓ (2)

[13]

TOTAL: 100