higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## MECHANOTECHNICS N6

## 25 November 2024

**This marking guideline consists of 9 pages.**

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## QUESTION 1

1.1
- Plate clutches
- Conical clutches
- Centrifugal clutches (3)

1.2 1.2.1

$$P = \frac{2\pi NT}{60}$$

$$T = \frac{60 \times 30\,1000}{2\pi \times 1100} \checkmark$$

$$= 260,4\ Nm \checkmark \quad (2)$$

1.2.2

$$Rf = \frac{1}{2}(R + r)$$

$$= \frac{1}{2}(100 + 75)$$

$$= 87,5\ mm \checkmark$$

$$T = \frac{\mu \times F_A \times R_f}{Sin\theta}$$

$$FA = \frac{260,4\ sin\ 15°}{0,28 \times 0,0875} \checkmark$$

$$= 2751\ \text{N} \checkmark \quad (3)$$

1.2.3

$$F\ engage = FA\left(1 + \frac{\mu}{tan\ \theta}\right)$$

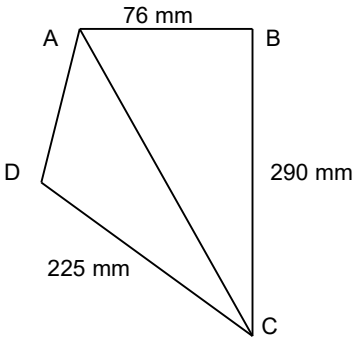
$$= 2751\left(1 + \frac{0,28}{tan\ 15°}\right) \checkmark$$

$$= 5626\ N \checkmark \quad (2)$$

**[10]**

## QUESTION 2

2.1




$$\boldsymbol{AC} = \sqrt{(\boldsymbol{AB})^2 + (\boldsymbol{BC})^2}$$

$$= \sqrt{(\mathbf{76})^2 + (\mathbf{290})^2} \checkmark$$

$$= \mathbf{299,793}\ \boldsymbol{mm} \checkmark$$

$$\tan \boldsymbol{\alpha} = \frac{\mathbf{AB}}{\mathbf{BC}} = \frac{\mathbf{76}}{\mathbf{290}}$$

$$\boldsymbol{\alpha} = \boldsymbol{tan} - \mathbf{1}\ (\frac{\mathbf{76}}{\mathbf{290}})\ \checkmark$$

$$= \mathbf{14,685°}\ \checkmark$$

*ACD*

AC = 299,793

$$\boldsymbol{COS}\ \boldsymbol{\beta} = \frac{\mathbf{CD}}{\mathbf{AC}} = \frac{\mathbf{225}}{\mathbf{299,793}}$$

$$\boldsymbol{\beta} = \cos^{-1}(\frac{\mathbf{225}}{\mathbf{299,793}})$$

$$= \mathbf{41,265°}\ \checkmark$$

$$\boldsymbol{\theta} = \mathbf{360°} - \mathbf{90°} - \boldsymbol{\beta} - \boldsymbol{\alpha} \checkmark$$

$$= \mathbf{360°} - \mathbf{90°} - \mathbf{41,365} - \mathbf{14,685}$$

$$= \mathbf{213,95°} \checkmark$$ (8)

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2.2 $\frac{T_1}{T_2} = 2,718^{\mu\theta}\ T_2$

$T1 = 2,718^{\mu\theta}\ T_2$

$= 2,718\left(0,25 \times \frac{213,95°}{57,3}\right) \times T_2$ ✓

$= 2,545\ T_2$ ✓

NOTE: Perpendicular distance of $T_2$ is not 76 mm

ACD $\hat{A}$ = $180° - 90° - 41,355 = 48,635$

ABC $\hat{A}$ = $180 - 90° - 14,685 = 75,315°$

So $\hat{A}$ = $180° - 48,635° - 75,315° = 56,05°$

Moments about B

Sum of clockwise moments = Sum of anti-clockwise moments

$T_2 \times 0,225 = (T_1\ sin\ 56,05 \times 0,076) + (F \times 0,6)$ ✓

$(T_2 \times 0,225) = (2,543 \times T_2\ sin\ 56,05° \times 0,076) + (250 \times 0,6)$ ✓

$0,225T2 - 0,16T_2 = 150$ ✓

$T_2$ = 2307,692 N ✓

$T_1$ = 5868,461 N ✓ (5)

2.3 T brake $= (T_1 - T_2)\ r$

= (5858,461 – 2307,692) × 0,225✓

= 801,173 Nm✓ (2)

**[15]**

**QUESTION 3**

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

$\frac{T_1}{T_2} = e^{(0,3 \times \frac{180}{57,3})}$ ✓

$T_1$ = 2566 $T_2$

$T_2$ = 1169,13 N✓

$T_1$ = 3000 N (2)

3.2 $T = F \times r$
$= (T_1 - T_2)\, r$
$= (3000 - 1169{,}13)\ 0{,}28$ ✓
= 512,64 Nm✓ (2)

3.3 $T = (T_1 - T_2)\, r$
$512{,}64 = (2{,}566T_2 - T_2)\ 0{,}16$ ✓
$T_2$ = 2045,9 N✓
$T_1$ = 5250 N✓ (3)

3.4 Clockwise moments = Anti-clockwise moments
(L × 1) = (3000 + 1169,13) × 0,6✓✓
L = 2501,478N✓
R = 1667,652N✓ (Upward forces = Downward forces) (4)

3.5 Clockwise moments = Anti-clockwise moments
(L × 1) = (5 250 + 2045,9) × 0,32✓✓
L = 2334,688 N✓
R = 4961,1 N✓ (Upward forces = Downward forces) (4)
**[15]**

**QUESTION 4**

4.1 4.1.1 $\boldsymbol{PCD = m \times t}$
$= 10 \times 35$✓
= 350 mm✓ (2)

4.1.2 $CD = \frac{\boldsymbol{PCD_A}}{\boldsymbol{2}} + \frac{\boldsymbol{PCD_B}}{\boldsymbol{2}}$
$= \frac{\boldsymbol{40}}{\boldsymbol{2}} + \frac{\boldsymbol{350}}{\boldsymbol{2}}$ ✓
= 195 mm✓ (2)

4.1.3 $\boldsymbol{P = m \times \pi}$
$= \boldsymbol{10\pi}$
= 31,42✓
$\boldsymbol{\tan\theta = \frac{p \times n}{\pi \times D_m}}$
$= \frac{31{,}42 \times 3}{\pi \times 40}$
= 0,75✓
$\theta = \tan^{-1}(0{,}75)$
= 36,87°✓
$n = \frac{\tan\theta}{\tan(\theta + \emptyset) \times 100}$
$\tan(\theta + \emptyset) = \tan\theta \times \frac{100}{n}$
$\tan(36{,}9° + \emptyset) = \tan 36{,}9° \times \frac{100}{80}$ ✓
= 0,9385✓
36,9° + ∅ = 43,18°✓
∅ = 6,28°✓
$\mu$ = tan 6,28°
= 0,11 ✓ (8)

4.2 4.2.1 $\alpha = \frac{W_2 - W_1}{t}$
$= \frac{720-300}{8}$
$= 5{,}49 \text{ rad/s}^2$✓

$T = I\alpha$
$= (mk^2)\alpha$
$= (50)(0{,}2)^2(5{,}49)$✓
$= 10{,}99 + 0{,}6$
$= 11{,}6\text{Nm}$✓ (3)

4.2.2 $P = \frac{2\pi\pi \times N \times T}{60}$
$= \frac{2\pi \times 720 \times 11.6}{60}$✓
$= 0{,}874\text{kW}$✓ (2)
**[17]**

**QUESTION 5**

5.1 5.1.1 $V = \sqrt{\mu g r}$
$= \sqrt{0{,}45 \times 9{,}81 \times 22}$✓
$= 9{,}85 \text{ m/s}$✓
$= 35{,}5 \text{ km/h}$ ✓

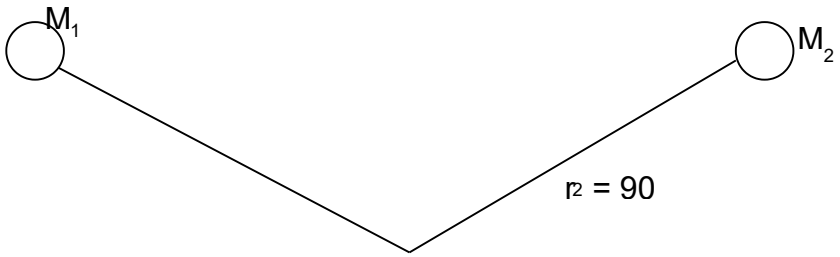
5.1.2 $V = \sqrt{\frac{gbr}{2h}}$
$= \sqrt{\frac{9{,}81 \times 1{,}2 \times 22}{2 \times 0{,}75}}$✓
$= 13{,}14 \text{ m/s}$✓
$= 47{,}3 \text{ km/h}$✓
(2 × 3) (6)

5.2 $W = 1\,400 \times 9{,}81$
$= 13734\text{N}$✓
$N_F = \frac{w \times y}{d}$
$= \frac{13734 \times 1{,}8}{3}$ ✓
$= 8240{,}40 \text{ N}$✓
$N_R = 13734 - 8240{,}4$
$= 5493{,}6\text{N}$✓
$\boldsymbol{w = \mu w \times \frac{h}{d}}$
$= 0{,}5 \times 13{,}734 \times \frac{0{,}6}{3}$
$= 1373{,}4\text{N}$✓
$N_F = 8240{,}4 + 1373{,}4$
$= 9613{,}8 \text{ N}$✓
$N_R = 5493{,}6 - 1373{,}4$
$= 4120{,}4$✓ (7)
**[13]**

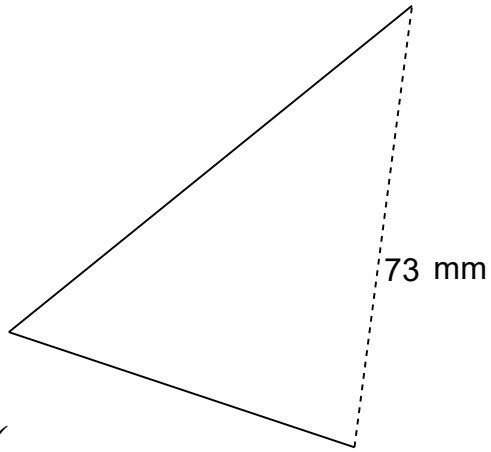
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## QUESTION 6

$m_1r_1 = 15 \times 80 = 1200\ kg\ mm$✓
$m_2r_2 = 19 \times 90 = 1710\ kgmm$✓
$m_3r_3 = \dfrac{73 \times 200}{10}$
$= 1460\ kgmm$✓
$\therefore\ r_3 = \dfrac{1460}{20}$
$= 73\ mm\ at\ 120°\ from\ M_1$✓✓




Space diagram✓✓✓

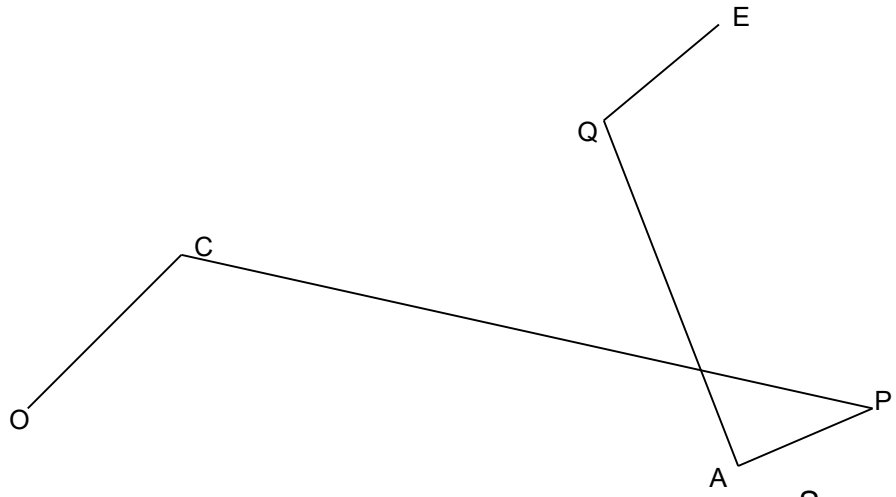



Scale: 10 mm = 200 kg.mm ✓
Vector diagram ✓✓✓ **[12]**

## QUESTION 7

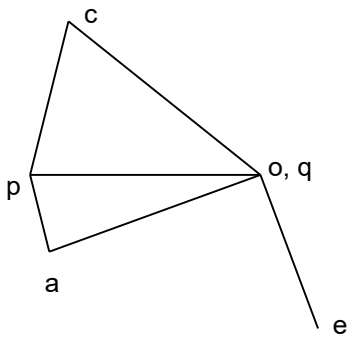
7.1 $V_{oe} = wr$
$= \left(\frac{2\pi N}{60}\right)(r)$
$= \frac{2\pi(120)}{60} \times 0{,}125$✓
$1{,}57\ m/s$✓ (2)

7.2




Space diagram✓✓✓✓ (4)

7.3




Velocity diagram ✓✓✓✓ (4)

7.4 7.4.1 $V_a = 0{,}5\ m/s$

7.4.2
$$\alpha_{cp} = \frac{(V_{0c})^2}{oc}$$
$$= \frac{(1{,}57)^2}{0{,}125} \checkmark$$
$$= 19{,}71\ m/s^2 \checkmark$$

7.4.3
$$\alpha_{cp} = \frac{(v_{cp})^2}{cp}$$
$$= \frac{(1{,}2)^2}{0{,}5} \checkmark$$
$$= 4{,}5\ m/s^2 \checkmark$$

7.4.4
$$\alpha_{AQ} = \frac{V_{aq}{}^2}{AQ}$$
$$= \frac{(1{,}25)^2}{0{,}25} \checkmark$$
$$= 6{,}25\ m/s^2 \checkmark$$

(4 × 2) (8)
**[18]**

**TOTAL: 100**

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