higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

MECHANICAL DRAWING AND DESIGN N6

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This marking guideline consists of 9 pages.

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QUESTION 1

1.1 $$sin \propto = \frac{D-d}{2c}$$

$$sin \propto = \frac{0{,}36-0{,}24}{2(0{,}9)} \checkmark$$

$$\propto = 3{,}82° \checkmark$$

$$\theta = 180° - 2 \propto = 180° - 2(3{,}82°) = 172{,}36° \checkmark \quad (3)$$

1.2 $$\frac{T_1}{T_2} = e^{\mu\theta}$$

$$T_1 = e^{(0{,}3)(3{,}01)} T_2 \checkmark$$

$$T_1 = 2{,}466T_2 \ldots\ldots\ldots\ldots (1) \checkmark$$

$$v = \frac{\pi DN}{60} = \frac{\pi(0{,}24)(1\ 500)}{60} = 18{,}85 \text{ m/s} \checkmark$$

$$P = (T_1 - T_2)v$$

$$70 \times 10^3 = (2{,}466T_2 - T_2)18{,}85 \checkmark$$

$$T_2 = 2\ 533{,}102 \text{ N} \checkmark$$

$$T_1 = 2{,}466 \times 2\ 533{,}102 = 6\ 246{,}63 \text{ N} \checkmark \quad (6)$$

1.3 $$\sigma_1 = \frac{T_1}{wt} \quad \text{but} \quad w = 3t$$

$$\therefore \ \sigma_1 = \frac{\pi}{3t^2} \checkmark$$

$$2{,}5 \times 10^6 = \frac{6\ 246{,}63}{3t^2} \checkmark$$

$$t = 28{,}86 \text{ mm} \quad \therefore t = 29 \text{ mm} \checkmark$$

$$w = 3t = 3 \times 29 = 87 \text{ mm} \checkmark$$

$$L = \frac{\pi}{2}[D+d] + \frac{(D-d)^2}{4c} + 2c$$

$$L = \frac{\pi}{2}[360+240] + \frac{(360-240)^2}{4(900)} + 2(900) \checkmark$$

$$L = 2\ 747 \text{ mm} \checkmark \quad (6)$$

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1.4 $N_B D_B = N_A D_A$

$N_B(0{,}36) = (1\,500)(0{,}24)$✓

$N_B = 1\,000$ r/min✓

$c = \frac{m}{2}[T_C + T_D]$

$320 = \frac{10}{2}[26 + T_D]$✓

$T_D = 38$ teeth✓

$N_D T_D = N_C T_C$

$N_D(38) = (1\,000)(26)$✓

$N_D = 684{,}21$ r/min✓

$c = \frac{m}{2}[T_D + T_E]$

$450 = \frac{10}{2}[38 + T_E]$✓

$T_E = 52$ teeth✓

$N_E T_E = N_D T_D$

$N_E(52) = (684{,}21)(38)$✓

$N_E = 500$ r/min✓ (10)

1.5 $PCD_D = mT_D$

$PCD_D = 10 \times 38 = 380$ mm✓

$PCD_E = mT_E$

$PCD_E = 10 \times 52 = 520$ mm✓

Checking interference between gear C and D:

$R_{AMAX} = \sqrt{R^2 + 2R \times r \times sin^2 4 + r^2 \times sin^2 4}$

$= \sqrt{(190)^2 + 2(190)(130)sin^2(20) + (130)^2 sin^2 20°}$✓

$= 209{,}42$ mm✓

$R_{A\ actual} = \frac{380 + 10 + 10}{2} = 200$ mm✓

$R_{A\ MAX}$ is more than $R_{A\ actual}$ thus no interference. ✓

Checking interference between gear D and E:

$R_{A\ MAX} = \sqrt{R^2 + 2R \times r \times sin^2 4 + r^2 \times sin^2 4}$

$= \sqrt{(260)^2 + 2(260)(190)sin^2 20 + (190)^2 sin^2(20)}$✓

$= 288{,}76$ mm✓

$R_{A\ actual} = \frac{520 + 10 + 10}{2} = 270$ mm✓

$R_{A\ MAX}$ is more than $R_{A\ actual}$ thus no interference. ✓ (10)

1.6 Should be calculated on smaller gear C:

$C_v = \frac{6}{6+v}$ velocity factor

but $v = \frac{\pi DN}{60}$

$= \frac{\pi(0{,}26)(1\ 000)}{60}$ ✓

$= 13{,}614$ m/s✓

$\therefore C_v = \frac{6}{6 + 13{,}614}$ ✓

$= 0{,}3059$✓

$\sigma_w = C_v \times \sigma_B$ working stress

$= 0{,}3059 \times (50 \times 10^6)$✓

$= 15{,}295$ MPa✓

$Y = 0{,}154 - \frac{0{,}912}{T}$ form factor

$= 0{,}154 - \frac{0{,}912}{2{,}6}$ ✓

$= 0{,}119$✓

$F_T = \pi \times m \times b \times y \times \sigma$ face width

$5\ 141{,}93 = \pi(0{,}01)(b)(0{,}119)(15{,}295 \times 10^6)$✓

$b = 89{,}92$ mm✓

$b_{min} = 2{,}5 \times \pi \times m$

$= 2{,}5 \times \pi \times 10$

$= 78{,}54$ mm✓

$b_{MAX} = 4 \times \pi \times m$

$= 4 \times \pi \times 10$

$= 125{,}66$ mm✓

It is suitable as it is within the limits. ✓ (13)

1.7 $P = \frac{2\pi NT}{60}$

$70 \times 10^3 = \frac{2\pi(1\ 000)T}{60}$ ✓

$T = 668{,}45$ Nm✓ (2)

1.8 $F_t = \frac{2T}{PCD}$

$F_t = \frac{2(66{,}45)}{0{,}26}$

$F_t = 514{,}93$ N✓

$F_R = F_t tan\emptyset$

$F_R = 5\ 141{,}93 tan 20°$

$F_R = 1\ 871{,}51$ N✓

Vertical reactions:

$\Sigma cwm = \Sigma Acwm$

$F_R \times 300 + (120 \times 9{,}81)700 = R_R \times 800 + (T_1 + T_2)160$✓

$5\ 6145{,}3 + 1\ 177{,}2 \times 700 = 800R_R + 140\ 475{,}12$

$R_R = -24{,}08$ N✓

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$\Sigma Fup = \Sigma Fdown$

$R_L + R_R = T_1 + T_2 + F_R + w_f$

$R_L + (-24{,}08) = 62\ 46{,}63 + 2\ 533{,}102 + 1\ 871{,}57 + 1\ 177{,}2$✓

$R_L = 11\ 852{,}522$ N✓

Bending at left bearing:

$M_G = -(T_1 + T_2) \times L$

$= -(6\ 246{,}63 + 2\ 533{,}102) \times 0{,}16$✓

$= -1404{,}75$ Nm✓

Bending at gear C:

$M_C = -(T_1 + T_2)L + R_L \times L$

$= -(6\ 246{,}63 + 2\ 533{,}10)0{,}46 + 11\ 852{,}522 \times 0{,}3$✓

$= -482{,}92$ Nm✓

Bending at flywheel:

$M_F = R_R \times L$

$= -24{,}08 \times 0{,}1$✓

$= -2{,}408$ Nm✓

Horizontal reactions:

$\Sigma cwm = \Sigma Acwm$

$R_L \times 800 = F_t \times 500$

$R_L \times 800 = 5\ 141{,}93 \times 500$✓

$R_L = 3\ 213{,}796$ N✓

$\Sigma Fup = \Sigma Fdown$

$R_L + R_R = F_t$

$3\ 213{,}706 + R_R = 5\ 141{,}93$✓

$R_R = 1\ 928{,}223$ N✓

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Bending at gear C:

$M_C = -3\,213{,}706 \times 0{,}3$✓ $= -964{,}112$ Nm✓

Maximum bending is vertical and left bearing G:

$M_G = 1\,404{,}757$ Nm✓ (19)

1.9 $T_e = \sqrt{M^2 + T^2}$

$= \sqrt{(1\,404{,}757)^2 + (668{,}45)^2}$✓

$= 1\,555{,}689$ Nm✓

$T_e = \frac{\pi}{16} D^3 \tau$

$1\,555{,}689 = \frac{\pi}{16} D^3 (60 \times 10^6)$✓

$D = 50{,}92$ mm✓

$\therefore D = 55$ mm✓

$M_e = \frac{1}{2}[M + \sqrt{M^2 + T^2}]$

$= \frac{1}{2}[1\,404{,}757 + \sqrt{1\,404{,}757^2 + 668{,}45^2}]$✓

$= 1\,480{,}223$ Nm✓

$M_e = \frac{\pi}{32} D^3 \sigma_n$

$1\,480{,}233 = \frac{\pi}{32} D^3 (90 \times 10^6)$✓

$D = 55{,}127$ mm✓

$\therefore D = 60$ mm✓

The suitable diameter is 60 mm. ✓ (11)

1.10 Bearing G:

$R_G = \sqrt{{F_V}^2 + {F_H}^2}$

$= \sqrt{(11\,852{,}522)^2 + (3\,213{,}706)^2}$✓

$= 12\,280{,}48$ N✓

Bearing H:

$R_H = \sqrt{{F_V}^2 + {F_H}^2}$

$= \sqrt{(24{,}08)^2 + (1\ 928{,}223)^2}$✓

$= 1\ 928{,}373\ \text{N}$✓ (4)

1.11 $\text{F}_\text{T} = \mu\text{F}_\text{R}$

$= 0{,}08(12\ 280{,}48)$✓

$= 928{,}238\ \text{N}$✓

$\text{T}_\text{f} = \text{F}_\text{T}\text{R}$

$= 928{,}238 \times 0{,}03$✓

$= 27{,}847\ \text{Nm}$✓

$\text{P}_\text{f} = \frac{2\pi\text{NT}_\text{f}}{60}$

$= \frac{2\pi(1\ 000)(27{,}847)}{60}$ ✓

$= 2{,}916\ \text{kW}$✓

$\text{F}_\text{T} = \mu\text{F}_\text{R}$

$= 0{,}08(1\ 928{,}373)$✓

$= 154{,}27\ \text{N}$✓

$\text{T}_\text{f} = \text{F}_\text{T}\text{R}$

$= 154{,}27 \times 0{,}03$✓

$= 4{,}628\ \text{Nm}$✓

$\text{P}_\text{f} = \frac{2\pi\text{NT}_\text{f}}{60}$

$= \frac{2\pi(1\ 000)(4{,}628)}{60}$ ✓

$= 484{,}64\ \text{W}$✓ (12)

1.12 $P = \frac{F_R}{A}$

$= \frac{928{,}238}{(0{,}09)(0{,}06)}$ ✓

$= 171{,}896$ kPa✓

$P = \frac{F_R}{A}$

$= \frac{154{,}27}{(0{,}09)(0{,}06)}$ ✓

$= 28{,}569$ kPa✓ (4)

[100]

TOTAL: 100

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