

Mechanical Principles Exam 2

1.)

$$N = 1800 \text{ RPM}$$

$$d_2 = 0.12 \text{ m}$$

$$d_1 = 0.04 \text{ m}$$

$$\mu = 0.45$$

$$\omega = 900 \text{ N}$$

Q1	10
Q2	10
Q3	9
Q4	3
Q5	7.5
39.5/50	

79%

$$i.) \quad r_2 = \frac{d_2}{2} = \frac{0.12}{2} = 0.06 \text{ m}$$

$$r_1 = \frac{d_1}{2} = \frac{0.04}{2} = 0.02 \text{ m}$$

$$\tau = \frac{2}{3} \mu \omega \frac{(r_2^3 - r_1^3)}{(r_2^2 - r_1^2)}$$

$$\tau = \frac{2}{3} \times 0.45 \times 900 \times \frac{(0.06^3 - 0.02^3)}{(0.06^2 - 0.02^2)}$$

$$\tau = 17.55 \text{ Nm}$$

$$P = \frac{2\pi N \tau}{60} = \frac{2 \times \pi \times 1800 \times 17.55 \text{ Nm}}{60}$$

$$P = 3308.0 \text{ W}$$

ii.)

$$\omega' = \omega - (\omega \times K \times n)$$

$$= 900 - (1.55 \times 25 \times 6)$$

$$\omega' = 667.5 \text{ N}$$

$$\tau = \frac{\mu \times \omega (r_2 + r_1)}{2}$$

$$\tau = \frac{0.45 \times 667.5 (0.06 + 0.02)}{2}$$

$$\tau = 12.015 \text{ Nm}$$

$$P = \frac{2\pi N \tau}{60}$$

$$\frac{2 \times \pi \times 1800 \times 12.015}{60}$$

$$P = 2264.8 \text{ W}$$

19/20

2.)

$$P = 5000 \text{ W}$$

$$N = 2500 \text{ RPM}$$

$$d = 0.13 \text{ m}$$

$$\mu = 0.4$$

$$\theta = 128^\circ \rightarrow \theta = \frac{128 \times \pi}{180} = 2.234 \text{ rad}$$

$$F_i = 250 \text{ N}$$

i.) $V = \omega r$

$$V = \frac{2\pi N}{60} \times \frac{d}{2}$$

$$V = \frac{2 \times \pi \times 2500 \times 0.065}{60}$$

$$V = 17.017 \text{ m/s}$$

ii.) $F_1 + F_2 = \text{Constant}$

$$250 + 250 = \text{Constant}$$

$$F_1 + F_2 = 500$$

$$\frac{F_1}{F_2} = e^{\mu \theta} = e^{0.4 \times 2.234}$$

$$\frac{F_1}{F_2} = 2.444$$

$$F_1 = 2.444 F_2$$

$$F_1 + F_2 = 500$$

$$2.444 F_2 + F_2 = 500$$

$$3.444 F_2 = 500$$

$$F_2 = \frac{500}{3.444}$$

$$= 145.18 \text{ N}$$

$$F_1 = 2.444$$

$$F_1 = 2.444 \times 145.18$$

$$F_1 = 354.82 \text{ N}$$

$$\text{iii) } P = V (F_1 - F_2)$$

$$P = 17.017 (354.82 - 145.18) \checkmark$$

$$P = \underline{3567.44 \text{ W}}$$

$$= 3.5 \text{ Kw} \checkmark$$

iv)

$$n = \frac{\text{Total power}}{\text{Power per belt}}$$

$$= \frac{5000}{3567.44}$$

$$= 1.4 \checkmark$$

$\therefore$ 2 belts $\checkmark$

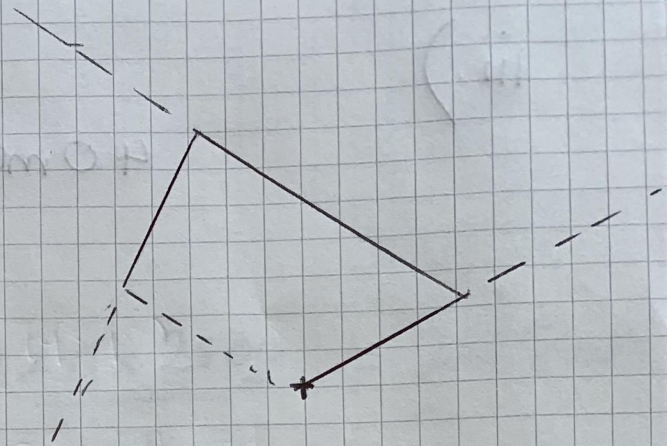
Excellent!

10/10

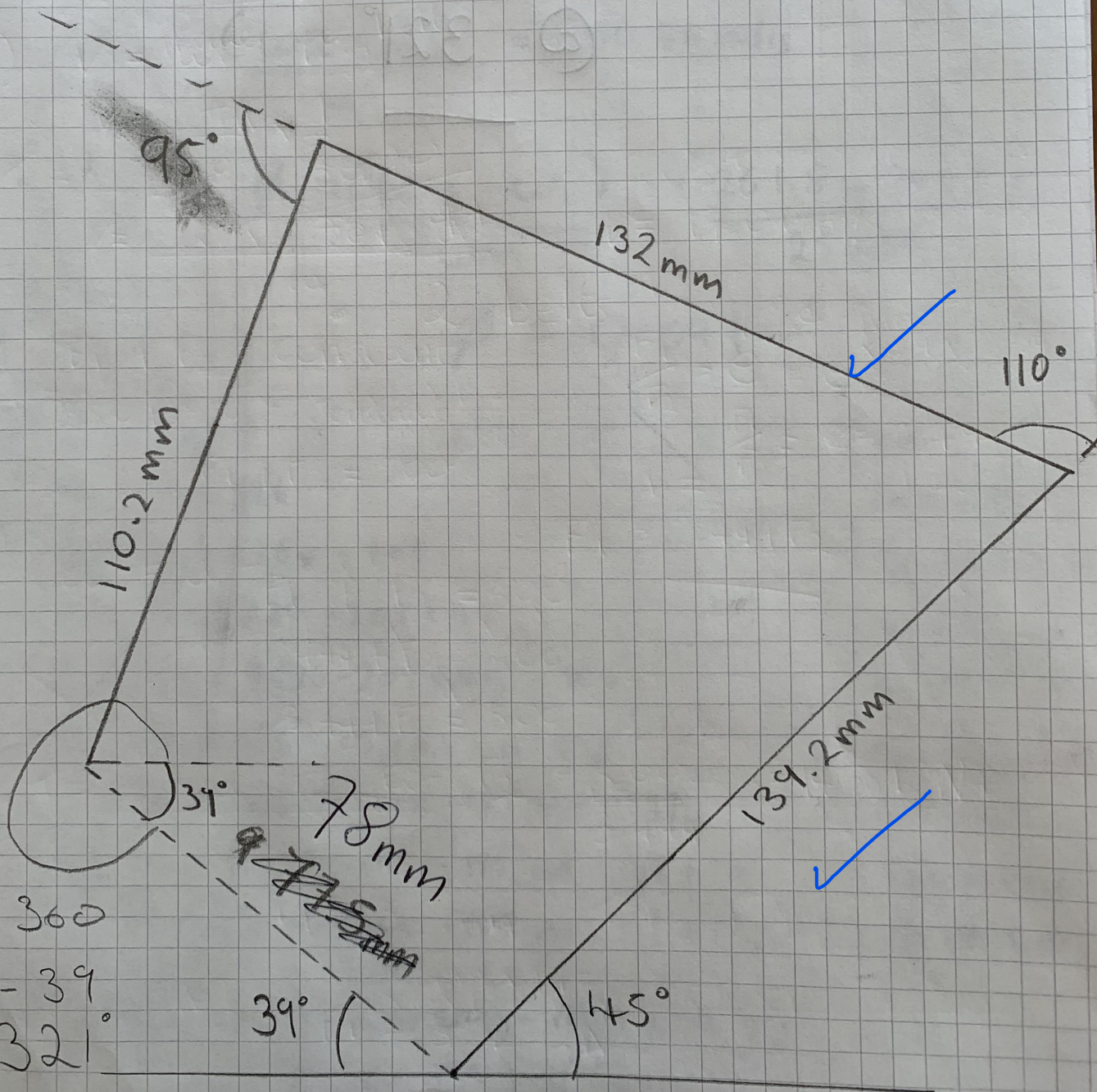
3.) i)

	m	r	mr
A	0.87	80	69.6
B	0.55	120	66
C	0.58	95	55.1
D	md	40	40md

Scale, 1mm = 0.5kgm



ii.)



$$360 - 39 = 321^\circ$$

iii.)

$$40 \text{ md} = \frac{77.8}{2}$$

$$\frac{78}{2} = 39 \text{ kg/mm}$$

$$\text{md} = \frac{39}{40}$$

$$= 0.975 \text{ kg}$$

iv.)

$$① 360 - 39 = 321$$

$$② \underline{321^\circ}$$

accuracy X

9/10

4.)

i.) $N_2 = 2500 \text{ RPM}$
 $N_1 = 2400 \text{ RPM}$

$$\omega_2 = \frac{2\pi N_2}{60} = \frac{2\pi \times 2500}{60} = 261.8 \text{ rad/s}$$

$$\omega_1 = \frac{2\pi N_1}{60} = \frac{2\pi \times 2400}{60} = 251.33 \text{ rad/s}$$

$$\omega_m = \frac{(\omega_2 + \omega_1)}{2} = 256.56 \text{ rad/s}$$

$$\phi = \frac{(\omega_2 - \omega_1)}{\omega_m} = \frac{(261.8 - 251.33)}{256.56}$$

$$\phi = 0.041$$

ii.) $A = \frac{E_a}{E_a}$

$$B = E_a + 526$$

$$C = E_a + 526 - 205$$

$$D = E_a + 526 - 205 + 45$$

$$E = E_a + 526 - 205 + 45 - 185$$

$$F = E_a + 526 - 205 + 45 - 185 + 48$$

$$G = E_a + 526 - 205 + 45 - 185 + 48 - 197$$

$$H = E_a + 526 - 205 + 45 - 185 + 48 - 197 + 10$$

$$I = E_a + 526 - 205 + 45 - 185 + 48 - 197 + 10 - 42$$

$$\begin{array}{l} E_a \\ E_a + 526 \end{array}$$

$$E_a + 321 \text{ min}$$

$$E_a + 366$$

$$E_a + 591$$

$$E_a + 634 \text{ max}$$

$$E_a + 442$$

$$E_a + 452$$

$$E_a + 410$$

Shame

$$\beta W = \text{Max energy} - \text{min energy}$$

$$(E_a + 634) - (E_a + 321)$$

$$\beta W = 960 \text{ J}$$

iii.)

$$I = \frac{Bw}{w m^2 \phi}$$

$$I = \frac{960}{256.56^2 \times 0.041}$$

$$I = 91.26 \text{ Kg m}^2$$

iv.)

$$I = \frac{m r^2}{2}$$

$$91.26 = \frac{m \times 0.15^2}{2}$$

$$m = \frac{2 \times 91.26}{0.15^2}$$

$$m = 8112 \text{ kg}$$

$$I = m r^2$$

$$I = \frac{7850 \times 0.15^2}{2}$$

$$I = 88.31 \text{ Kg m}^2$$

3/10

5.)

$$t_a = 32$$

$$t_b = 64$$

$$t_c = 24$$

$$t_d = 36$$

$$N_1 = 2500 \text{ RPM}$$

$$T_1 = 20 \text{ Nm}$$

$$\eta = 0.85$$

i.) A and B. $\frac{1}{2}$ C and d also

ii.) anticlockwise.

$$GR = \frac{N_1}{N_2} = \frac{t_2}{t_1}$$

$$GR = \frac{t_b}{t_a} \times \frac{t_d}{t_c} = \frac{64}{32} \times \frac{36}{24} =$$

$$GR = 3 \quad \checkmark$$

$$N_2 = \frac{N_1}{GR} \quad \checkmark = \frac{2500}{3} = 833.3 \text{ RPM} \quad \checkmark$$

$$\text{iii.) } P_1 = \frac{2\pi N_1}{60} \times T_1 = \frac{2 \times \pi \times 2500}{60} \times 20 \quad \checkmark$$

$$P_1 = \cancel{261.8 \text{ W}} \quad 5235.98 \text{ W} \quad \checkmark$$

$$P_2 \times \eta = 5235.98 \times 0.85 = 4450.6 \text{ W} \quad \checkmark$$

iv.)

$$T_2 = \frac{60P_2}{2\pi N_2} = \frac{60 \times 4450.6}{2 \times \pi \times 853.3}$$

$$T_2 = 49.81 \text{ Nm}$$

$$T_1 + T_2 + T_3 = 0$$

~~$$T_3 = T_1 - T_2 = 220 - 49.81$$
$$T_3 = 29.81 \text{ Nm}$$~~

$$T_3 = T_1 - T_2 = -(20) - (49.81) \checkmark$$

$$= -29.81 \text{ Nm}$$

$$-29.81 \text{ Nm} \times$$

$\therefore$ anticlockwise

7.5/10