

Name: James Smith (1801879) Date: 11/05/2020
 Time: 1pm Mechanical Principles (M2X8663)

Question One:

$$D_2 = 120\text{mm} \quad (0.12\text{m})$$

$$D_1 = 40\text{mm} \quad (0.04\text{m})$$

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

$$\mu = 0.45$$

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

$$r_2 = \frac{d_2}{2} = \frac{0.12}{2} = 0.06\text{m}$$

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

i) $T = \frac{2}{3} \mu W \frac{(r_2^3 - r_1^3)}{(r_2^2 - r_1^2)}$ ✓

$$T = \frac{2 \times \mu \times W (r_2^3 - r_1^3)}{3 (r_2^2 - r_1^2)}$$

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

$$T = \underline{17.55 \text{ Nm}}$$
 ✓

$$P = \frac{2\pi NT}{60} = \frac{2\pi \times 1800 \times 17.55}{60}$$
 ✓

$$P = \underline{3308.097 \text{ watts}}$$
 ✓

Q1	10
Q2	10
Q3	7.5
Q4	6
Q5	8
	<u>41.5</u>
	50

83%

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Question One:

ii)

$$x = 1.55 \text{ mm}$$

$$k = 25 \text{ N/mm}$$

$$n = 6$$

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

$$W_1 = W - (x \times k \times n)$$

$$W_1 = 900 - (1.55 \times 25 \times 6)$$

$$W_1 = \underline{667.5 \text{ N}}$$

$$T = \frac{\mu W (r_2 + r_1)}{2}$$

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

$$T = \underline{12.02 \text{ Nm}}$$

Excellent!

$$P = \frac{2\pi NT}{60} = \frac{2\pi \times 1800 \times 12.02}{60}$$

$$P = \underline{2265.72 \text{ watts}}$$

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Question 2:

$$P = 5 \text{ kW (5,000 W)}$$

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

$$d = 130 \text{ mm (0.13 m)}$$

$$\mu = 0.4$$

$$\theta = 128^\circ$$

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

$$\theta = 128^\circ \times \frac{\pi}{180} = \underline{2.23 \text{ radians}}$$

$$r = \frac{d}{2} = \frac{0.13}{2} = \underline{0.065 \text{ m}}$$

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 2500}{60} = \underline{261.8 \text{ rad/s}}$$

A) $v = \omega r$

$$v = 261.8 \times 0.065$$

$$v = \underline{17.02 \text{ m/s}}$$

B)

$$F_1 + F_2 \neq \text{Constant}$$

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

$$F_1 + F_2 \neq 500$$

$$\frac{F_1}{F_2} = e^{\mu\theta} = e^{0.4 \times 2.23} = 2.44$$

$$\frac{F_1}{F_2} = 2.44$$

$$F_1 = 2.44 F_2$$

$$F_1 + F_2 \neq 500$$

$$2.44 F_2 + F_2 \neq 500$$

$$3.44 + F_2 = 500$$

$$\div 3.44 \quad \div 3.44$$

$$F_2 = \underline{145.35 \text{ N}}$$

~~Answer~~

$$F_1 = 2.44 F_2$$

$$F_1 = 2.44 \times 145.35$$

$$F_1 = \underline{354.65 \text{ N}}$$

Minimum belt tension = 145.35 N

Maximum belt tension = 354.65 N

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Question 2:

c) $P = v(F_1 - F_2)$

$P = 17.02 (354.65 - 145.35)$

$P = 3562.29 \text{ watts}$

$P = \underline{3.56 \text{ kW}}$

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

$n = \frac{5000}{3562.29}$

$n = \underline{1.4 \text{ belts}}$

Therefore 2 belts would
be needed

Excellent!

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A) Question 3:

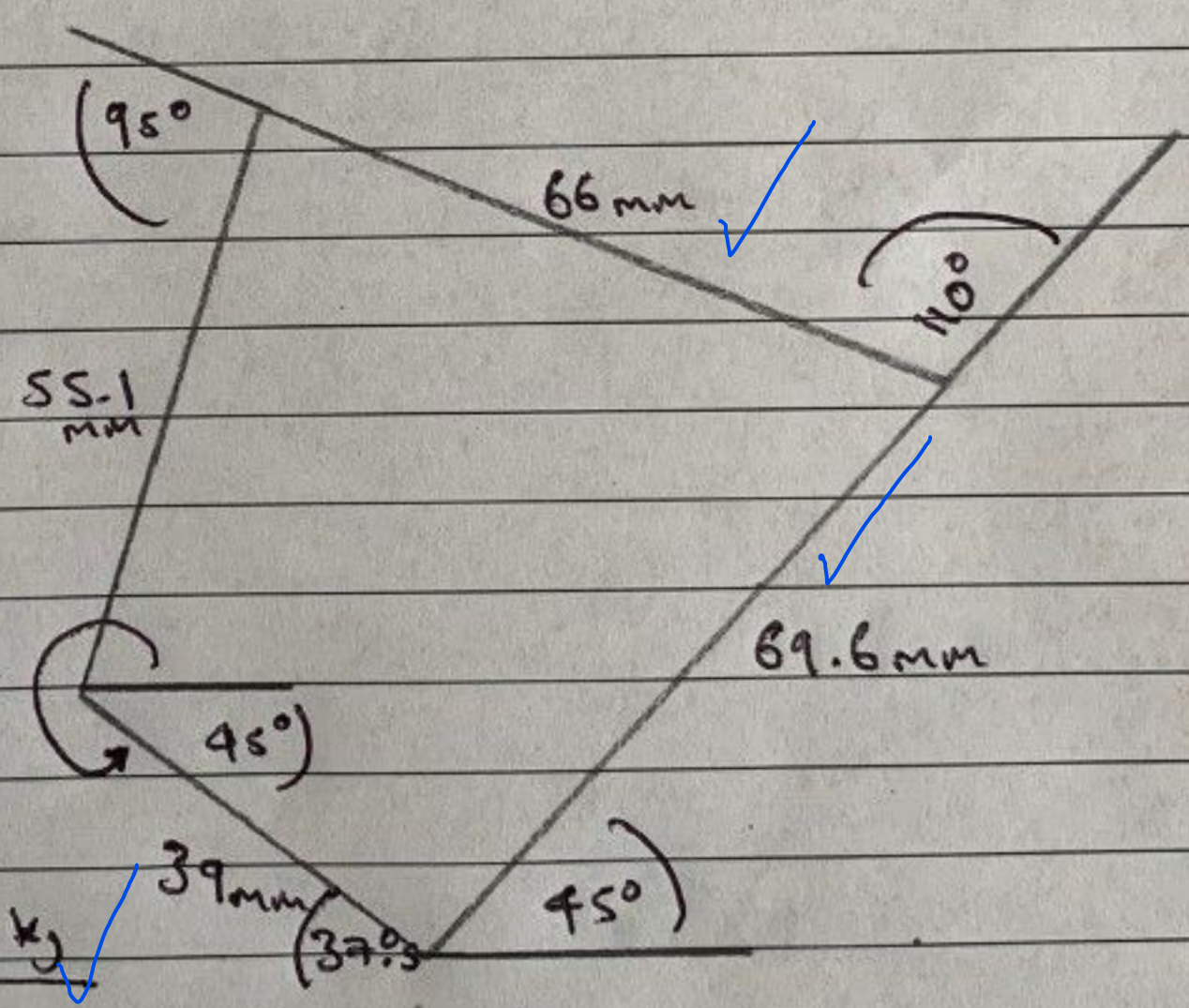
	m	r	mr
A	0.87	80	69.6
B	0.55	120	66
C	0.58	95	55.1
D	md	40	40md

Scale = 1mm = 1kgmm 1/2

Small Scale accuracy

Sketch? X

B)



$40md = \frac{39}{40} = 0.975 \text{ kg}$

Angle = $360 - 37.5 = 322.5^\circ$

X accuracy

- c) Mass of D = 0.975 kg
- d) Angular position = 322.5°

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Question 4c

$$N_2 = 2500 \text{ RPM}$$

$$N_1 = 2400 \text{ RPM}$$

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

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

$$\omega_m = \frac{\omega_1 + \omega_2}{2} = \frac{251.33 + 261.8}{2} = \underline{256.57 \text{ rad/s}}$$

$$\phi = \frac{\omega_2 - \omega_1}{\omega_m} = \frac{261.8 - 251.33}{256.57} = \underline{0.0408} \quad \checkmark$$

B)	Energy	Total
A	EA	EA
B	EA + 526	EA + 526 (MAX)
C	EA + 526 - 205	EA + 321 ✓
D	EA + 526 - 205 + 45	EA + 366
E	EA + 526 - 205 + 45 - 185	EA + 181
F	EA + 526 - 205 + 45 - 185 + 98	EA + 229
G	EA + 526 - 205 + 45 - 185 + 98 - 197	EA + 32 (MIN)
H	EA + 526 - 205 + 45 - 185 + 98 - 197 + 10	EA + 42
I	EA + 526 - 205 + 45 - 185 + 98 - 197 + 10 - 42	EA ✗

$$BW = \text{MAX Energy} - \text{MIN Energy}$$

$$BW = (EA + 526) - (EA + 32)$$

$$BW = \underline{494 \text{ J}} \quad \text{✗}$$

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Time: 2pm Mechanical Principles (M2X8663)

Question 4:

c) $I = \frac{bw}{\omega^2 \phi} = \frac{494}{256.37^2 \times 0.0408} = 0.18 \text{ kgm}^2$

error carried

d) $I = \frac{Mr^2}{2}$ $M = \frac{2 \times 0.18}{0.15^2}$ $r = 150 \text{ mm} \div 1000$
 $\frac{2 \times I}{r^2} = m$ $m = 16 \text{ kg}$ $r = 0.15 \text{ m}$

$I = mk^2$

$k = \sqrt{\frac{I}{m}} = \sqrt{\frac{0.18}{16}} = 0.11 \text{ m}$

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Question 5:

$$t_a = 32 \text{ teeth}$$

$$t_b = 64 \text{ teeth}$$

$$t_c = 24 \text{ teeth}$$

$$t_d = 36 \text{ teeth}$$

$$N_1 = 2500 \text{ RPM (Anti Clockwise)}$$

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

$$R = 85\% (0.85)$$

- A) Gears B and C must have the same module/pitch $\times$
 Gears A and D must have the same module/pitch.
 A and B
 and
 C and D

- B) Clockwise output.

$$GR = \frac{t_b}{t_a} \times \frac{t_d}{t_c} = \frac{64}{32} \times \frac{36}{24} = 3 \checkmark$$

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

- C)

$$P_1 = \frac{2\pi N_1 T_1}{60} = \frac{2\pi \times 2500 \times 20}{60} = 5235.99 \text{ watts} \checkmark$$

$$P_2 = P_1 \times R = 5235.99 \times 0.85 = 4450.59 \text{ watts} \checkmark$$

- D)

$$T_2 = \frac{60 \times P}{2\pi N_2} = \frac{60 \times 4450.59}{2\pi \times 833.3} = 51 \text{ Nm} \checkmark$$

$$T_1 + T_2 + T_3 = 0$$

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

$$T_3 = -(20) - (-51)$$

$$T_3 = -31 \text{ Nm Anti (Anticlockwise)} \times$$