

P 1
of

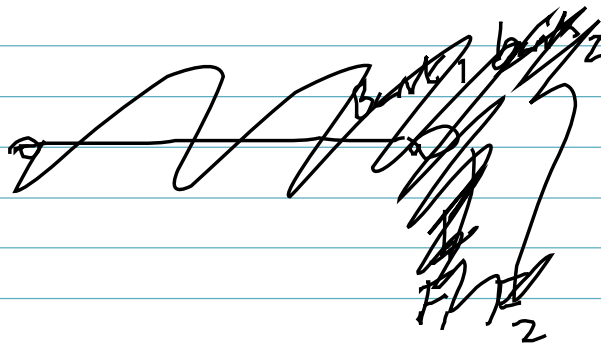
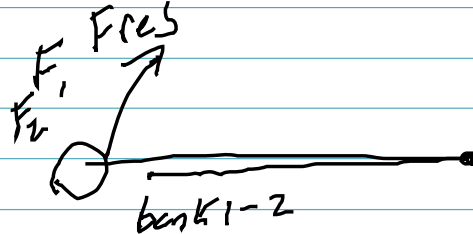
ADVANCED ENGINE DESIGN M6X00410

RYAN JAMES 0751093 14.5.20 1PM

1a)

$$R = 4.5$$
$$L = 140$$
$$m_{rec} = 0.35$$
$$m_{rot} = 0.24$$

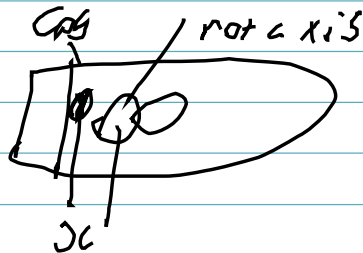
$$M_{crank} = 5$$
$$M_{bal} = 2.5$$



$$MM = 2 \left(m_{rot} + \frac{m_{rec}}{2} \right) \times R = 37.35 \text{ Kg.mm}$$

1b)

$$\alpha = \frac{MM}{M_{crank}} = 7.47 \text{ mm}$$



1c)

$$MM = 2 \left(\frac{m_{rec}}{2} \times R \right) = 15.75 \text{ Kg.mm}$$

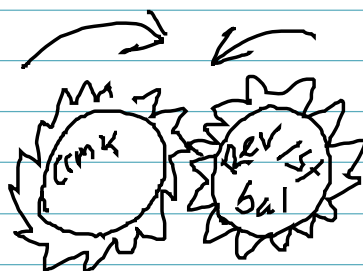
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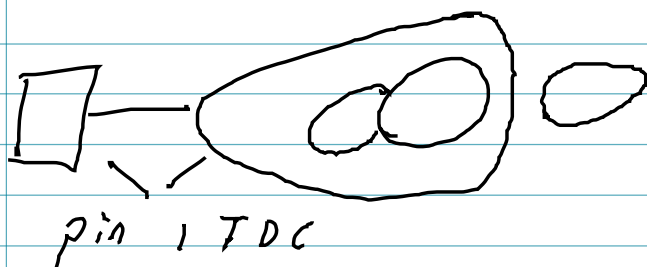
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~~MAN = $\frac{m_{DC}}{2} \times R \approx 7.875 \text{ kg}$~~

1d Gears



Same Size
Same Speed

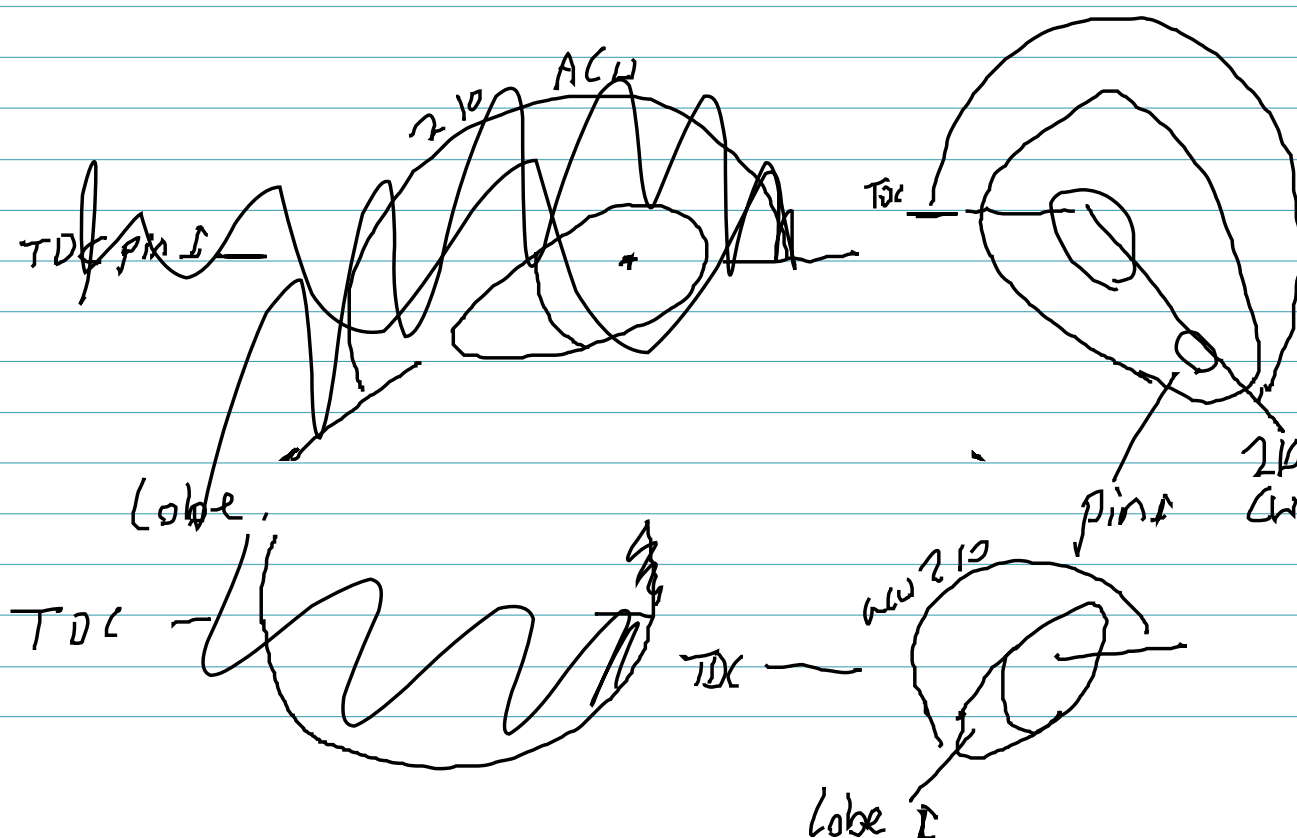


Lobe opposite
to pin at TDC

1e)

$$y = \frac{mm}{m_{bal}} = 3.15 \text{ mm} \quad \times 2 = \underline{\underline{3.3 \text{ mm}}}$$

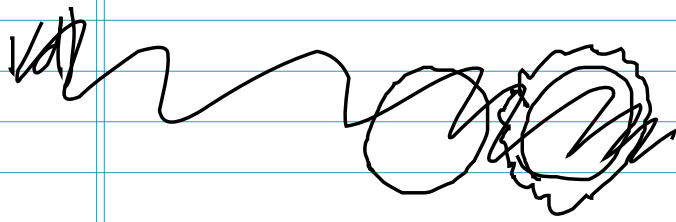
1f)



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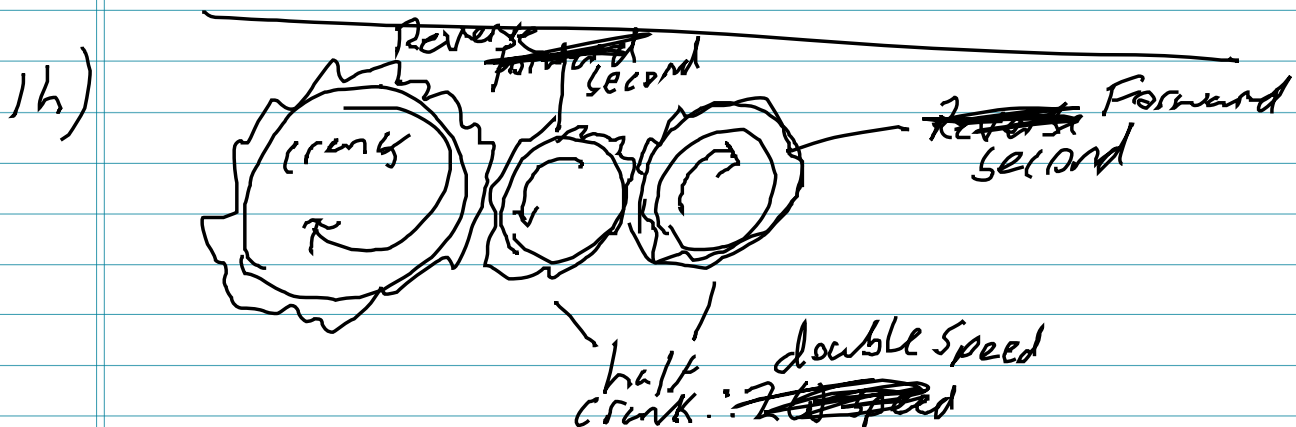
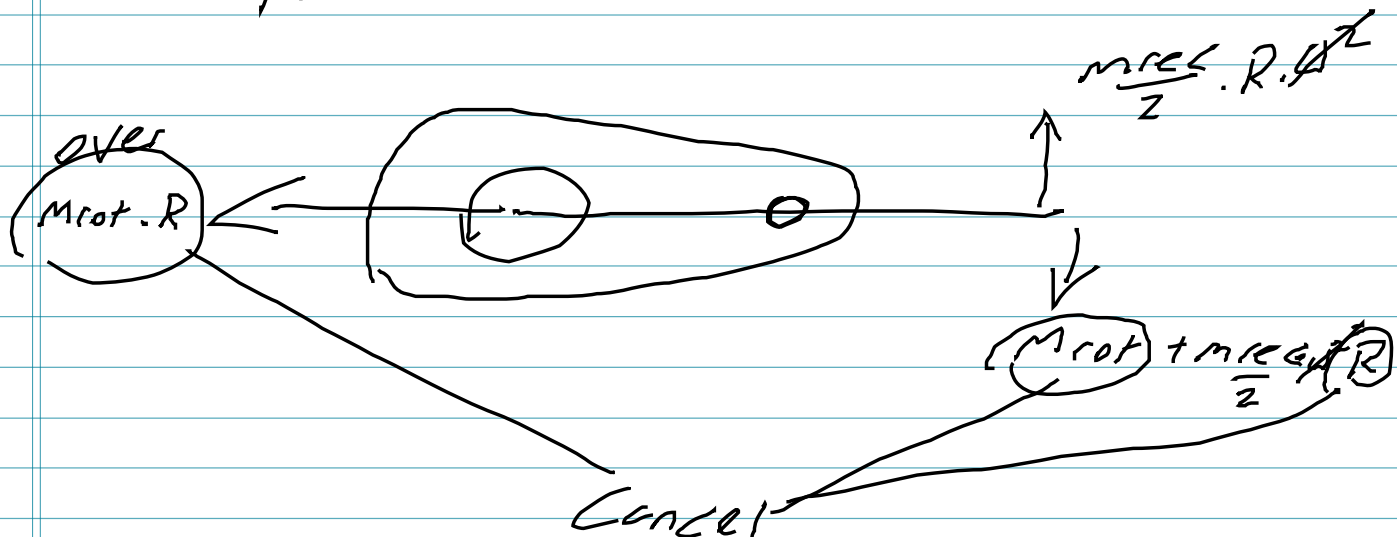
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1g) minimise Vert
under balance as engine hori. Zontal

$$p_{pin} = m m = m_{rot} R = 10.8 \text{ Kg. mm}$$

$$2 \text{ piston} = 10.8 \times 2 = 21.6 \text{ Kg. mm}$$



$$m m = 0.5 \times \frac{R}{L} m_{rec} R \omega^2 = 2.5313 \text{ Kg. mm.}$$

$$\therefore 2 \text{ pistons} = 5.0625 \text{ Kg. mm}$$

per pin

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Q2

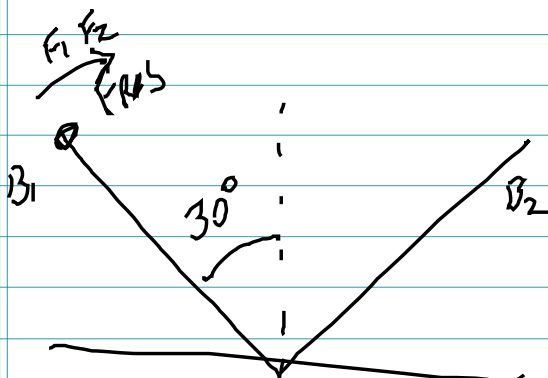
$$R = 40$$

$$L = 140$$

$$m_{rec} = 0.36$$

$$m_{rot} = 0.29$$

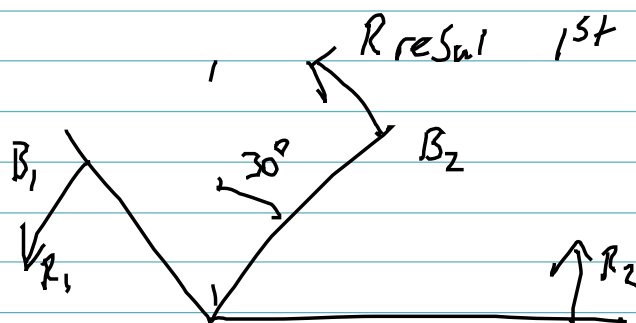
c)



$$2 \left(\left(m_{rot} + \frac{m_{rec}}{2} \right) \times R \right) = 33.6 \text{ kg.m}$$

$$33.6 \text{ kg.m} @ 30^\circ \leftarrow \text{vert}$$

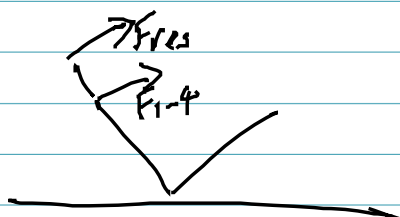
b)



VECTOR RESOLVE
magnitude ↑

$$M_m = \frac{m_{rec}}{2} \times R = 7.2 \text{ kg.m}$$

c)



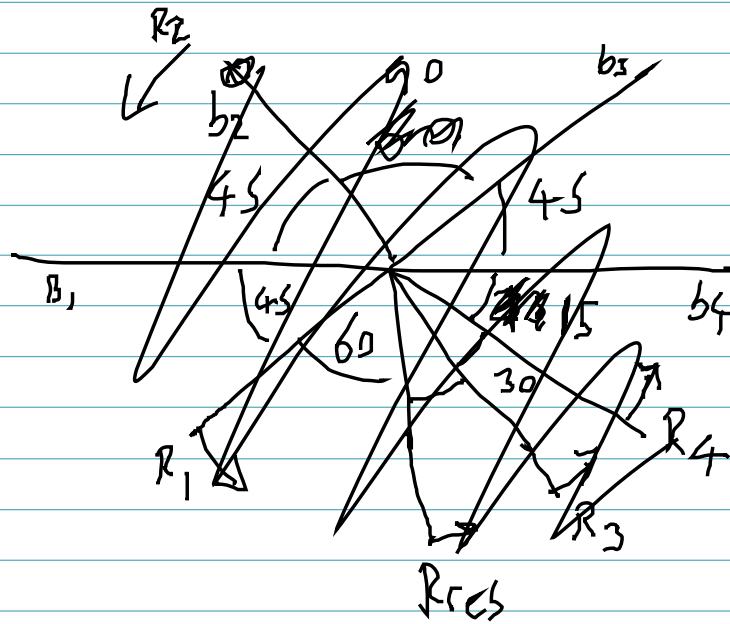
$$4 \left(m_{rot} + \left(\frac{m_{rec}}{2} \right) \right) \times R = 67.2 \text{ kg.m}$$

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of

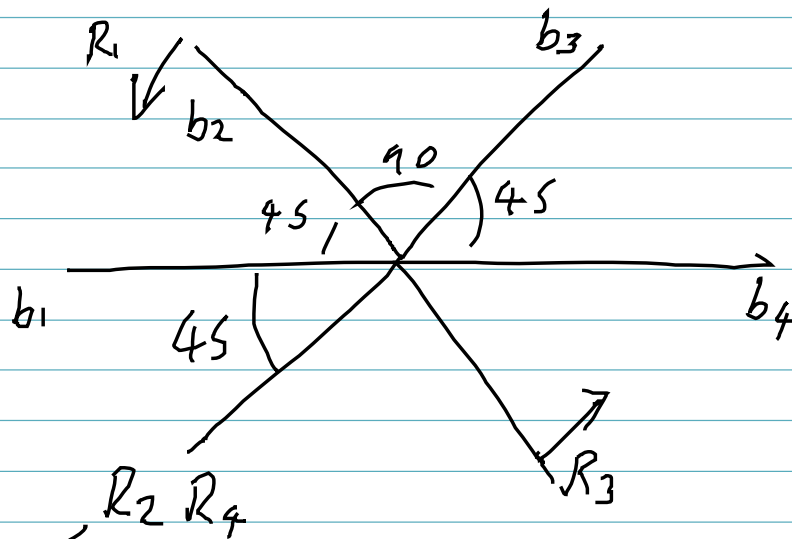
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d)



2d)



$$m_{m \text{ rev}} = 2 \left(\frac{m_{\text{rec}}}{2} \times R \right) = 14.4 \text{ kg}$$

2e)

forward on crank by of set of COG

$$\text{eg offset} = \frac{m \text{ (set forward)}}{m_{\text{crank}}} = \frac{K_s m}{m_{\text{crank}}}$$

Reverse on balance shaft to be with of set COG

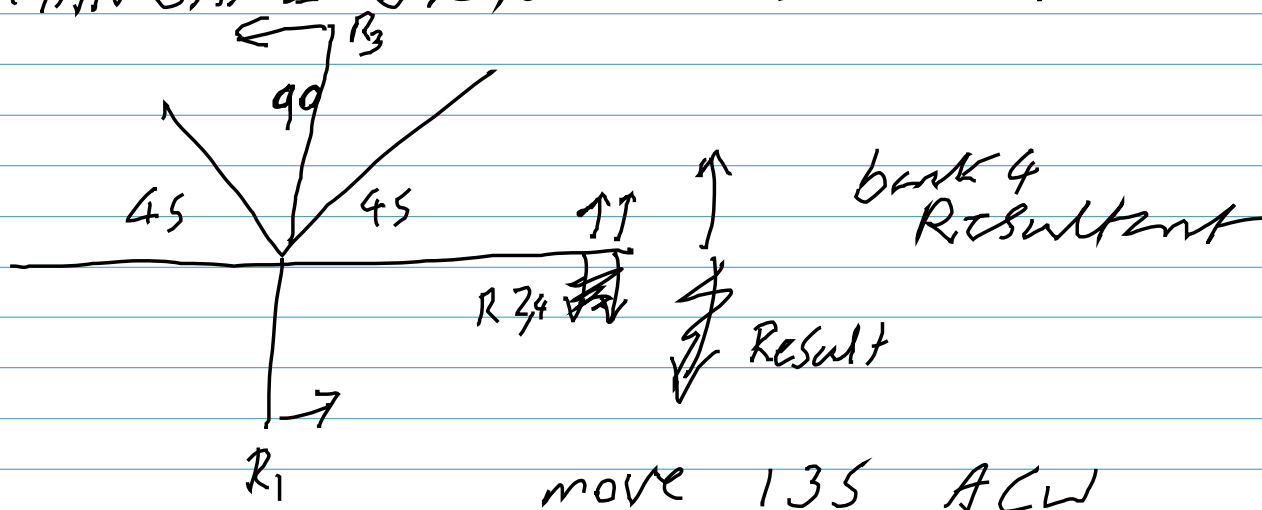
$$\text{eg of set} = \frac{m_{\text{revist}}}{m_{\text{bal}}} \left(\text{counter rotating} \right)$$

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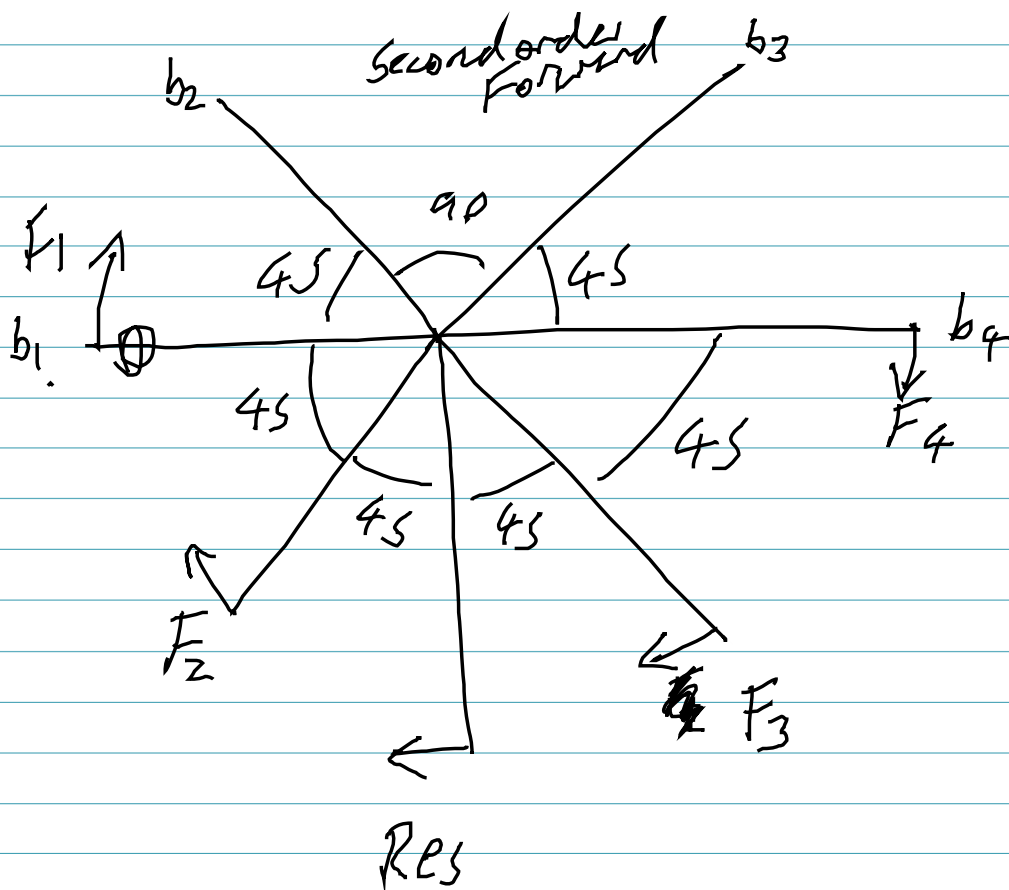
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2f)



2g)



Vertical component of -1.4142

$$m_n = 2 \left(\frac{1}{2} \times \frac{R}{L} \cdot m \cdot \cos 45^\circ \right) \times \cos 45^\circ = 2.9092$$

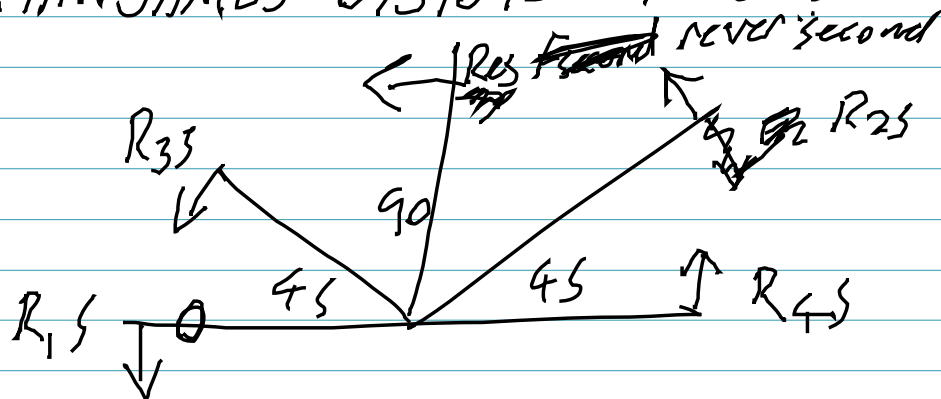
$$= 2.9092 \text{ Kg. mm}$$

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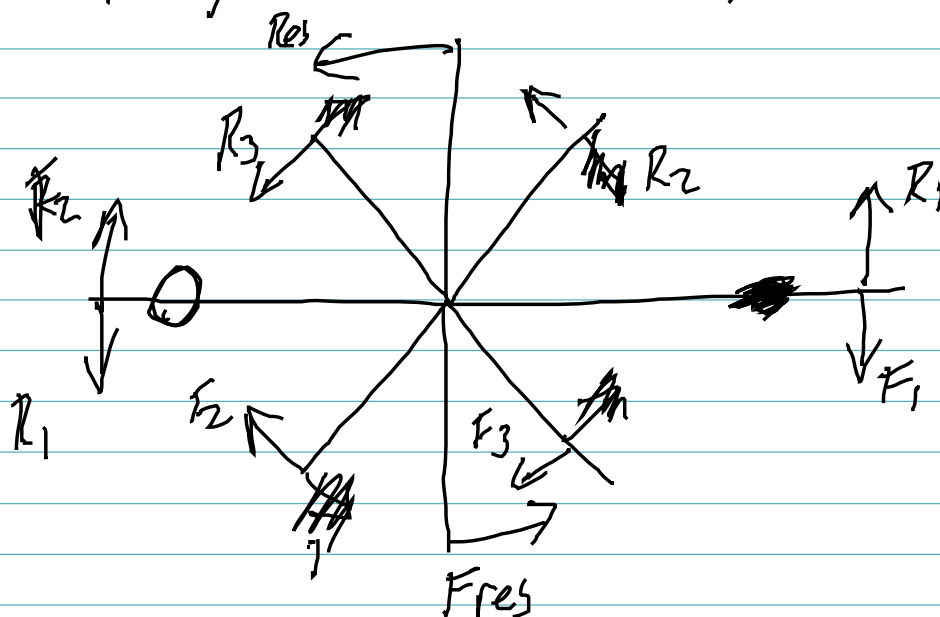
2h)



magn. double 1.4142 vector of $2\cos 45$

$$\therefore M_m = 2.9092 \text{ Kg} \cdot \text{mm}$$

i) forward $\downarrow$ reverse $\uparrow$ $\therefore$ cancel
at p.n on bank 4



Cont

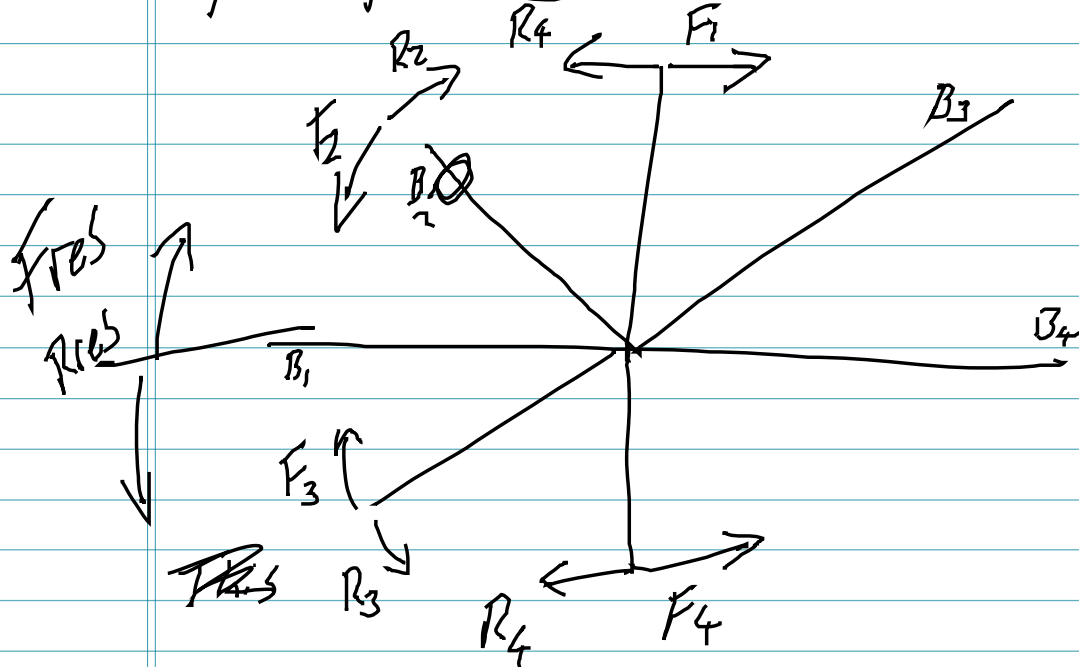
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2 i)

put pin @ bank 2



As one resultant move C.W. and
othe A.C.W they will combine
in some situations also moving
pin 45° moves Resultants
go as moves double
engine speed

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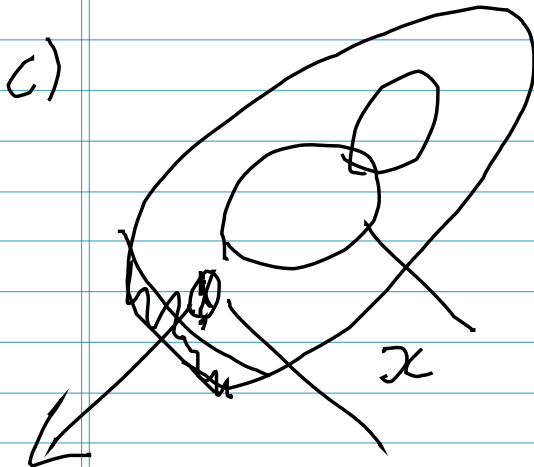
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Q3) $m_{re} = 0.33$ $m_{rot} = 0.18$ $R = 42.5$

$$\therefore mm = \left(\frac{m_{rec}}{2} + m_{rot} \right) \cdot R = \underline{14.6625}$$

$$14.66 \text{ Kg. mm}$$

b) $m_{crank} = \frac{14.66}{3} = 4.89 \text{ mm}$



As Tungsten has greater density than steel

$$\text{dens} = \frac{\text{kg}}{\text{m}^3}$$

Less m d. Stroke out
for same mass moment
reduces α

$$\text{As } I = m\alpha^2 \text{ by reducing}$$

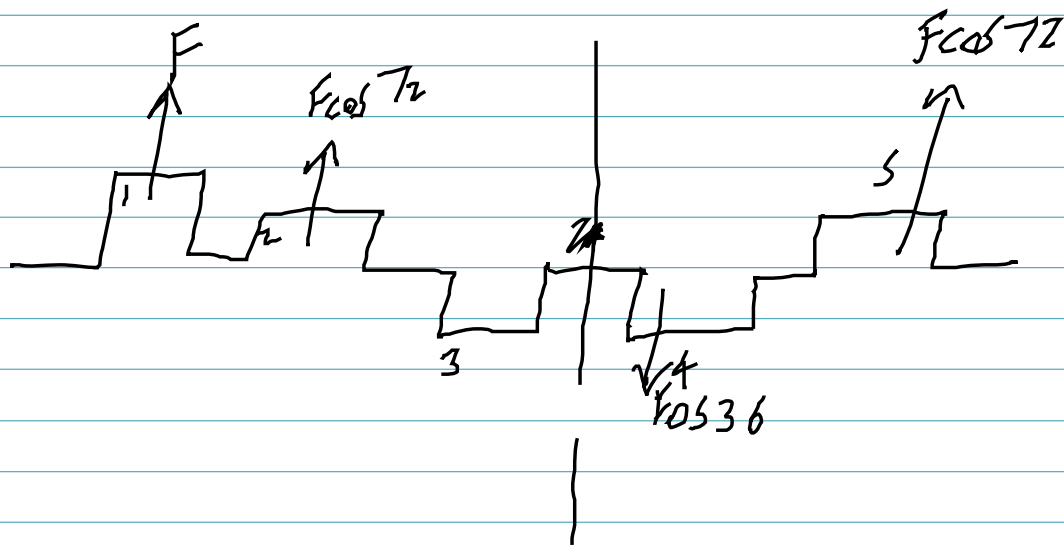
α which is squared this reduces rotational inertia $\therefore$ equivalent mass and easier to spin up.

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RYAN JAMES 0751093 14.5.20 12M

Q3 part 2)



$$F = 0.5 \left(\frac{m_{rec}}{2} + m_{rot} \right) R = 7.33 \text{ Kg.m}$$

Along crank: (clockwise direction)

$$(F \times 2L) + (F \cos 72 \times L) + (F \cos 36 \times L) - (F \cos 72 \times 2L)$$

$$= 2FL - F \cos 72 L + F \cos 36 L \quad (L = 0.092)$$

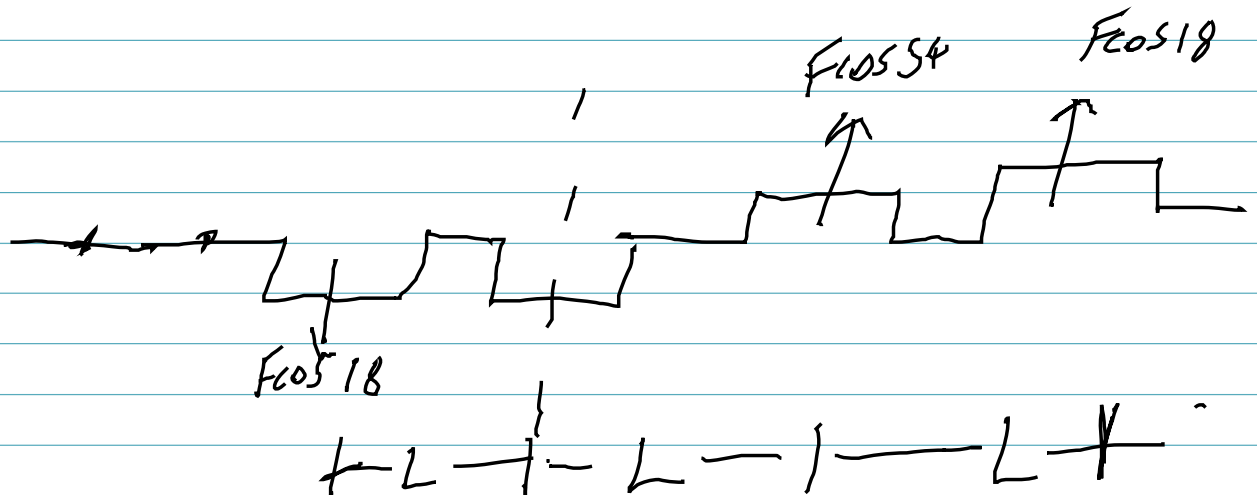
$$= 16685.9 \text{ Kg.m.m} \quad (\text{parallel moment})$$

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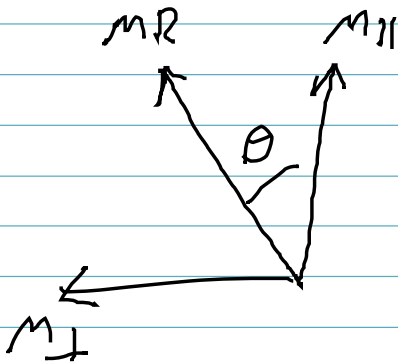
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Part 2
Q3



$$\begin{aligned}\text{moment} &= (F \cos 18 \times L) + (F \cos 54 \times L) + (F \cos 18 \times L) \\ &= 2FL \cos 18 + FL \cos 54 \\ &= 1679.09 \text{ Kg. mm. mm}\end{aligned}$$

b)



$$\begin{aligned}M_R^2 &= M_{\parallel}^2 + M_{\perp}^2 \\ M_R &= \sqrt{M_{\parallel}^2 + M_{\perp}^2} \\ &= 2379.41 \text{ Kg mm. mm.}\end{aligned}$$

$$\tan \theta = \frac{M_{\perp}}{M_{\parallel}}$$

$$= \frac{1679.09}{1685.9}$$

$$\theta = \tan^{-1} \left(\frac{1679.09}{1685.9} \right)$$

$$= 44.88^\circ$$