

date: 14/5/2020

Q1, Q2, Q3

line: 1.00

module title: ~~Advanced Eng. & Design~~ advanced eng. & design

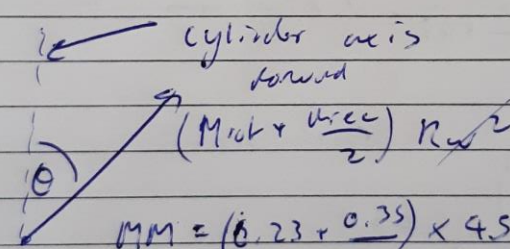
module code: M6X00910

name: Harry Fernhill

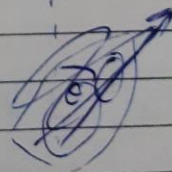
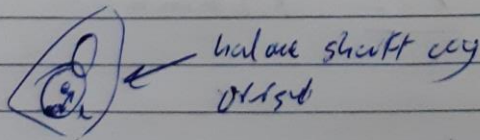
student number: 140876

page 1

- A) pin mass = 240gms $M_{rec} = 240 + \frac{1}{3} \times 330 = 0.35 \text{ kg}$
rod mass = 330gms
big end = 20gms $M_{rot} = \frac{2}{3} \times 330 + 20 = 0.23 \text{ kg}$
 $R = \frac{90}{2} = 45 \text{gms}$
 ω
moment = 5kg
rod length = 140mm

- a) 
 $MM = (0.23 + \frac{0.35}{2}) \times 45$
 $MM = 18.22 \text{ kg} \cdot \text{mm}$

- b) $M_{dynamic} \times r = (M_{rot} + \frac{M_{rec}}{2}) \times R \times \omega^2$
 $\lambda = \frac{18.22}{5} = 3.645 \text{ mm offset}$



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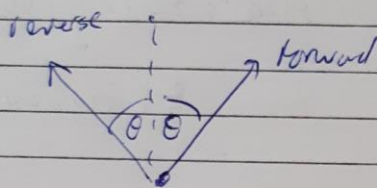
module code: M6X00410

Name: Harry Fernhill

student number: 145376

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c)

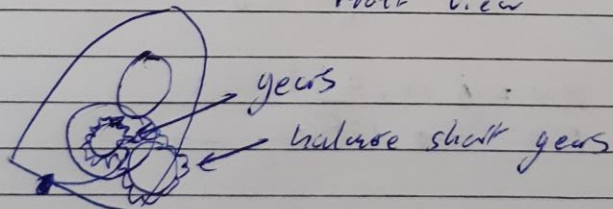


$$\text{reverse} = \frac{M_{rec}}{2} \times \frac{1}{r^2}$$

$$MM = \frac{0.35}{2} \times 45 = 7.87 \text{ kg} \cdot \text{mm}$$

d)

front view

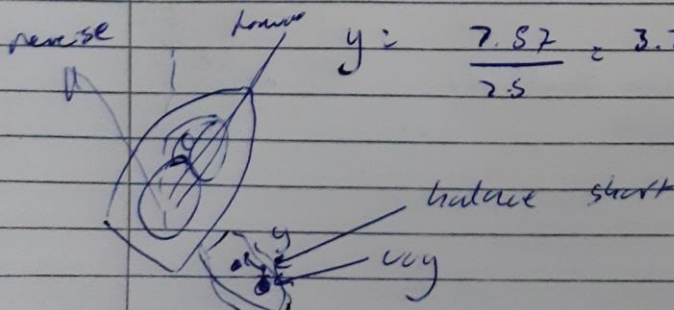


e)

$$\text{mass} = 2.5 \text{ kg}$$

$$\text{moment } y \omega^2 = \frac{m_{rec}}{2} \times \frac{1}{r^2}$$

$$y = \frac{7.87}{2.5} = 3.148 \text{ mm}$$



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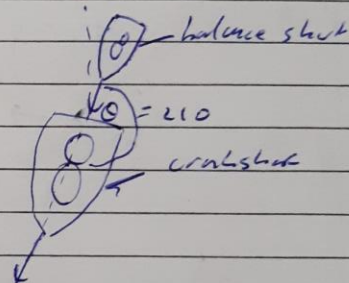
student number: 148876

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c)

TDC

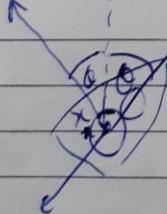
rotate 200°



g) create a horizontal line to cancel vertical vibrations

reverse cylinder axis forward

$$\left(\frac{m_{rec}}{2}\right) \omega^2$$



$$(M_{rot} + \frac{m_{rec}}{2}) \omega^2$$

$$M_{unb} x = (M_{rot} + \frac{m_{rec}}{2}) r + \frac{m_{rec}}{2} r$$

$$M_{unb} x = (0.23 + \frac{0.35}{2}) 45 + (\frac{0.35}{2} \times 45)$$

$$M_{unb} x = 19.23 + 7.88$$

$$M_{unb} x = 26.11 \text{ kg. mm}$$

date: 19/5/2020

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module title: advanced engine design

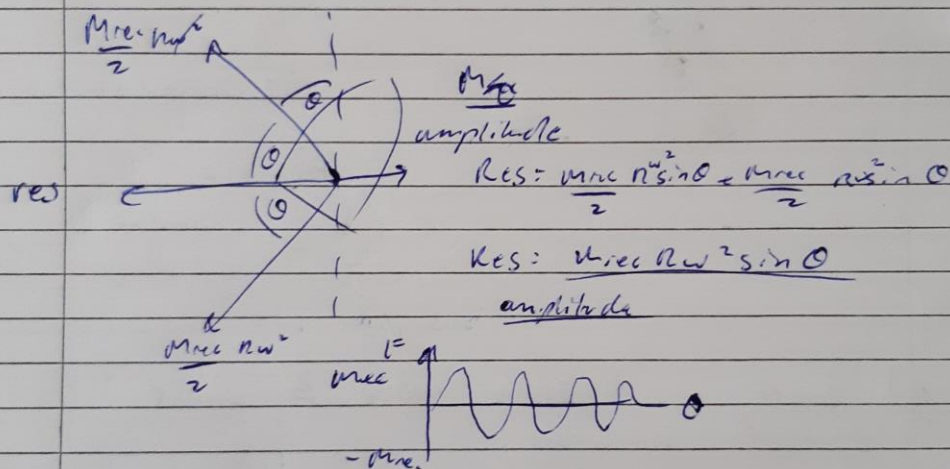
module code: MEX00410

name: Mary Fernhill

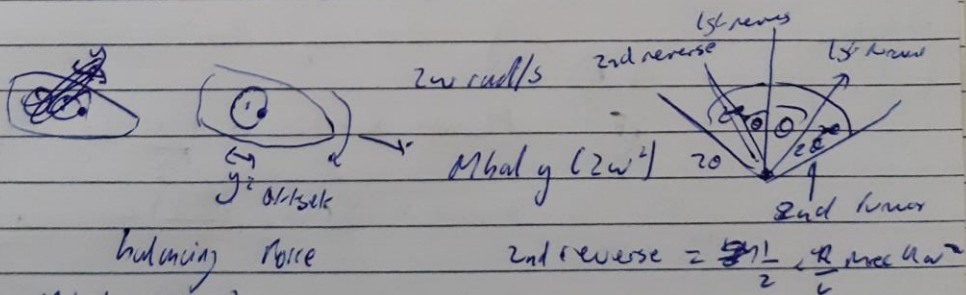
student number: 148876

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resultant force



b) balance 2nd order vector



balancing force

$$= M_{bal} y \omega^2$$

$$= M_{bal} y \omega^2 = M M y \omega^2$$

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date: 14/5/20

time: 1:00

module title: advanced engine design

module code: M6100410

name: Henry Fernhill

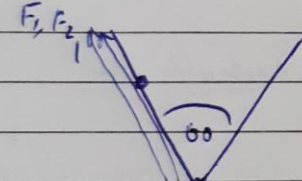
student number: 145876

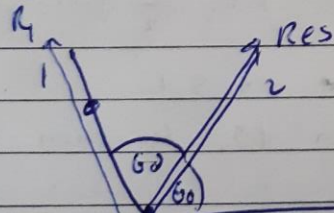
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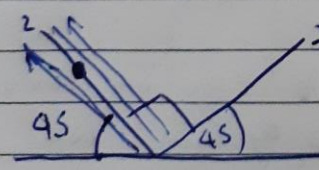
f2) $M_{rec} = 240 \times \frac{1}{2} \times 360 = 0.36 \text{ kg}$
 $M_{rot} = \frac{2}{3} \times 360 = 0.24 \text{ kg}$

$$R = \frac{80}{2} = 40$$

$$\text{Length} = 140 \text{ mm}$$

a) 
$$= 2(M_{rot} + M_{rec}) R \sin 60$$
$$= 2 \times 16.8 \times 40 \times \frac{\sqrt{3}}{2}$$
$$= 33.6 \text{ kg} \cdot \text{mm}$$

b) 
$$RES = \left(\frac{M_{rec}}{2} \times R \cos 60 \right) + \left(\frac{M_{rot}}{2} \times R \cos 60 \right)$$
$$RES = 2.4 + 2.4$$
$$R_{RES} = 4.8 \text{ kg} \cdot \text{mm}$$

c) 
$$RES = 4(M_{rot} + M_{rec}) R \sin 45$$
$$= 4 \times 16.8 \times 40 \times \frac{\sqrt{2}}{2}$$
$$RES = 67.2 \text{ kg} \cdot \text{mm}$$

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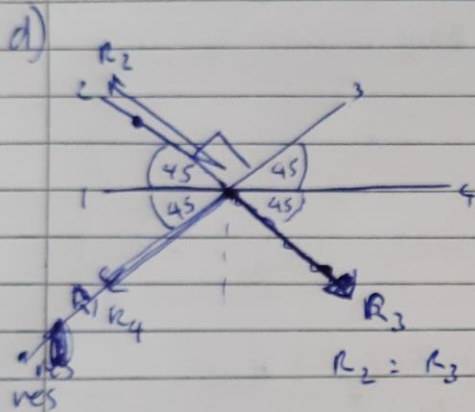
module 14Hr: advanced engine design

module code: m6100410

name: Henry Perahia

student number: 148976

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$$M_{rec} = 0.36$$

$$M_{rot} = 0.29$$

$$R = 40$$

$$L = 140$$

$R_2 = R_3 = \text{cancel each other out}$

$$R_{es} = R_1 - R_4 \text{ (2 down)}$$

$$R_{es} = \left(\frac{M_{rec} R \cos 45}{2} \right) + \left(\frac{M_{rec} R \cos 45}{2} \right)$$

$$R_{es} = 5.1 + 5.1$$

$$R_{es} = 10.2 \text{ kg} \cdot \text{mm} \text{ down}$$

e) balance shaft to cancel the first order vectors by using a crankshaft with a 180 degree offset.

$$\text{Crank shaft moment} = 67.2 \text{ kg} \cdot \text{mm} \cdot \omega$$

$$\text{balance shaft moment} = 10.2 \text{ kg} \cdot \text{mm} \cdot \omega$$

balance shaft resultant vector = adding balance shaft

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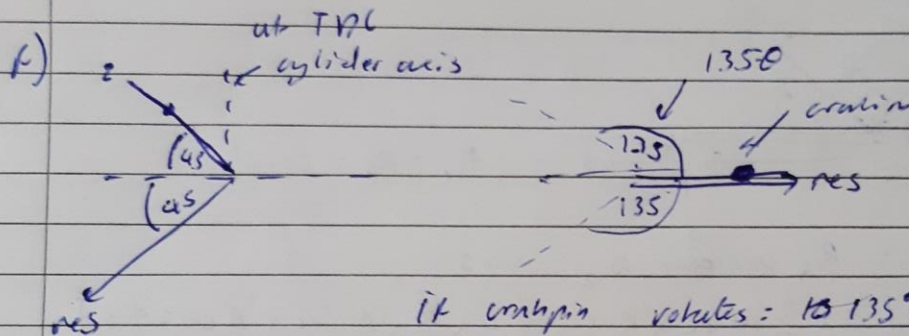
module title: advanced engine design

module code: MBX00910

name: Mervyn Farnham

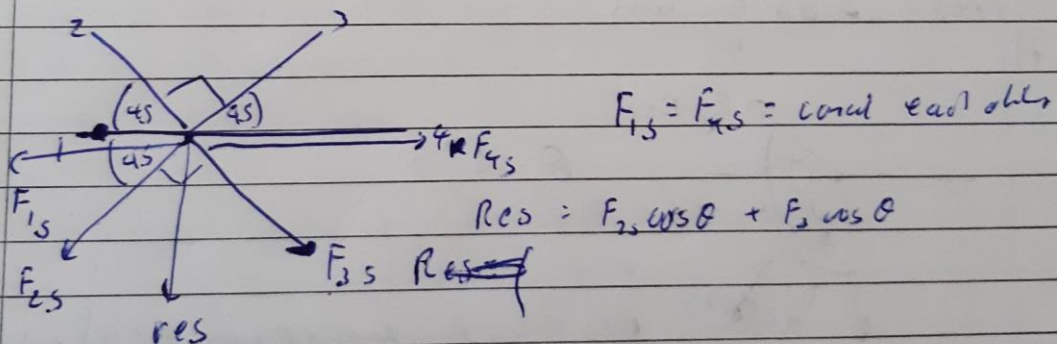
student number: 148876

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if crankpin rotates: 135° clockwise
Resultant reverse vector rotates: 135° anticlockwise

g)



$$\text{Res} = \left(\frac{1}{2} \times \frac{R}{L} \times m_{\text{rec}} \times R \cos 45 \right) + \left(\frac{1}{2} \times \frac{R}{L} \times m_{\text{rec}} \times R \cos 45 \right)$$

$$\text{res} = 2 \left(\frac{1}{2} \times \frac{40}{140} \times 0.36 \times 40 \cos 45 \right)$$

$$\text{res} = 2 (1.45 \text{ kg} \cdot \text{mm})$$

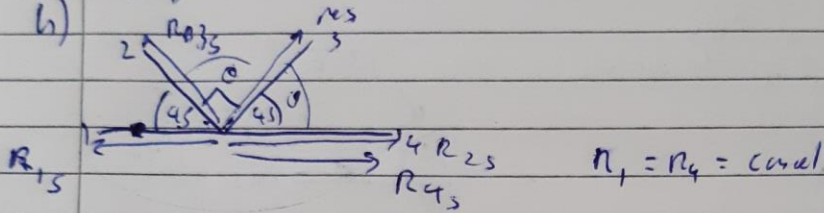
$$\text{res} = 2.9 \text{ kg} \cdot \text{mm}$$

Time: 1:00

module code: mx00910

Student number: 148876

b)



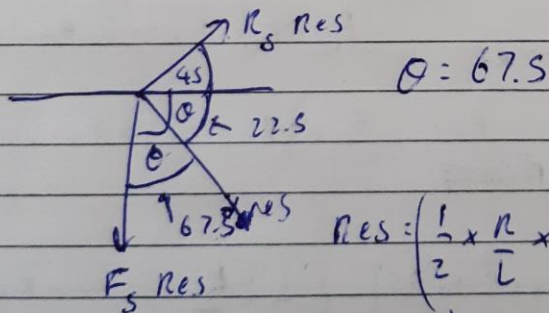
$$R_{es} = R_3 \cos 45^\circ + R_2 \sin 45^\circ$$

$$Res = \left(\frac{1}{2} \times \frac{R}{L} \mu_{rec} \times R \right) + \left(\frac{1}{2} \times \frac{R}{L} \times \mu_{rec} \times n_{users} \right)$$

$$n_{ES} = 2.1 + 1.46$$

$res = 3.56 \text{ kg/mm}$

i)



$$Res = \left(\frac{1}{2} \times \frac{R}{L} \times \mu_{rec} \times R \times \cos 87.5 \right) \times 2$$

$$R_{ES} = \left(\frac{1}{2} \times \frac{40}{140} \times 0.36 + 40 \times \cos 67.5^\circ \right) \times 2$$

$$res^2 = 0.78 + 0.78$$

2nd order $\text{res} = 0.70 + 0.70$
~~first~~ $\text{res} = 1.57 \text{ kg/mm}$

20 at the crash rotation

date: 14/5/2020

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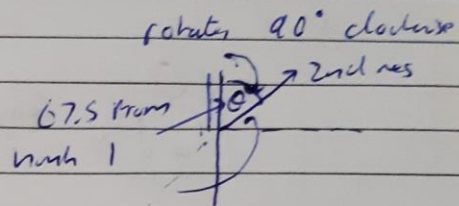
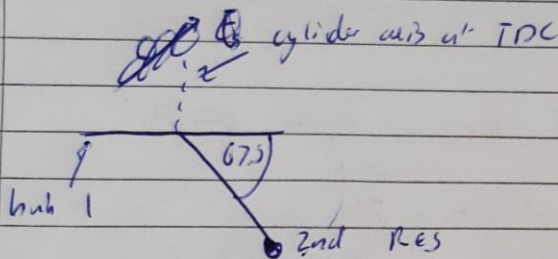
module title: advanced engine design

module code: 276100410

Name: Gary Forster

Student number: 148326

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second order rotates 20
anti clockwise

3)

~~problem~~

$$M_{rec} = 240 + \frac{1}{2} \times 270 = 0.33 \text{ kg}$$

$$M_{rot} = \frac{2}{3} \times 270 = 0.18$$

$$R = \frac{85}{2} = 42.5$$

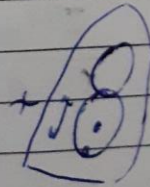
$$\text{lip per crank} = \text{1st order moment} \\ \left(M_{rot} + \frac{M_{rec}}{2} \right) R$$

$$= \left(0.18 + \frac{0.33}{2} \right) \times 42.5 = 14.67 \text{ kg mm}$$

$$b) \text{ 1st order moment} = 3 \text{ kg}$$

$$M_{crank} \text{ at } 180^\circ = \frac{M_{rot} + M_{rec}}{2} R$$

$$x = \frac{14.67}{3} = 4.89 \text{ mm offset}$$



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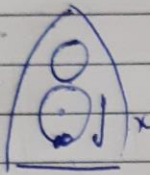
module code: MEX00910

name: Harry Farnhill

student number: 148076

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c)



kingston has a higher density

$$\text{density} = \begin{aligned} \rho_{\text{steel}} &= 7800 \text{ kg/m}^3 \\ \rho_{\text{kingston}} &= 19300 \text{ kg/m}^3 \end{aligned}$$

kingston is denser allowing a closer distance reducing offset

$$M_{\text{kingston}} \times \text{kingston} = M_{\text{steel}} \times \text{steel}$$

$$2 \times M_{\text{steel}} - (1)$$

$$\times \text{kingston} = 0.5 \times \text{steel} - (2)$$

moment of inertia kingston: I

$$I_{\text{kingston}} \times \text{kingston}^2$$

$$\text{moment of inertia steel } I = M_{\text{steel}} \times \text{steel}^2$$

$$\frac{M_{\text{kingston}} \times \text{kingston}^2}{M_{\text{steel}} \times \text{steel}^2}$$

$$\frac{2 M_{\text{steel}} (0.5 \times \text{steel})^2}{M_{\text{steel}} \times 0.5 \times \text{steel}^2} = 2 \times 0.5 \times 0.5$$

$$\frac{2 \times 0.5 \times 0.5 \times \text{steel}^2}{M_{\text{steel}} \times 0.5 \times \text{steel}^2} = 0.5 - \text{half the mass of inertia of steel}$$

increase engine torque from reduced mass
increasing acceleration

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module code: ME100100 410

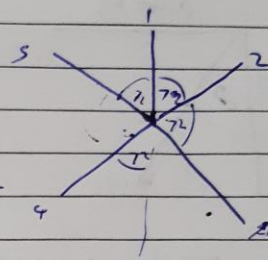
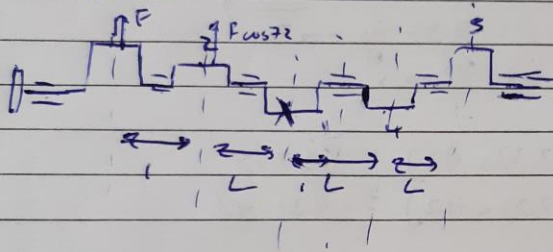
name: Henry Fernhill

Student number: 148876

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part 2

side view vertical



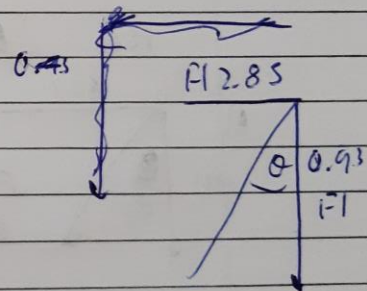
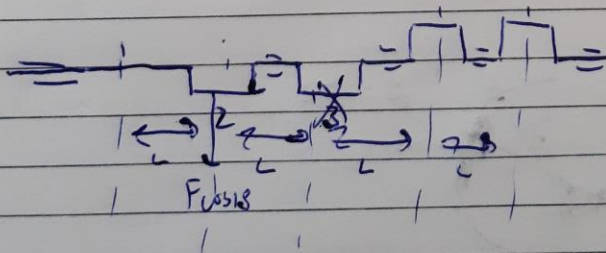
left = right

$$FL + F\cos 72L = F\cos 72FL + F\cos 72L$$

$$0.31FL = FL(0.31) + FL(0.31)$$

$$0.93FL$$

top view



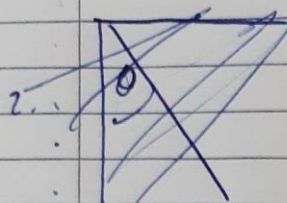
$$90 - 72 = 18$$



left = right

$$F\cos 18L = FL\cos 18 + F\cos 18$$

$$= FL 2.85$$



date: 14/5/2020

time: 1:00

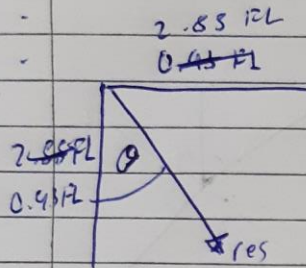
module title: advanced engine design

module code: M6800460

sk name: blusy Perakli

student number: 148876

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$F = 50\%$ balance

$$F = 0.5 (m_{rot} + m_{ce}) \times r$$

$$F = 0.5 (0.18 + 0.33) \times 92.5$$

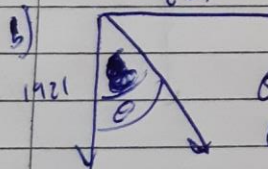
$$F = 7.33 \text{ kg} \cdot \text{mm}^2$$

$$L = 92 \text{ mm}$$

$$V_{ert} = 0.43 (7.33 \times 92) = 627.15$$

$$hor = 2.85 \times (7.33 \times 92) = 1921.93$$

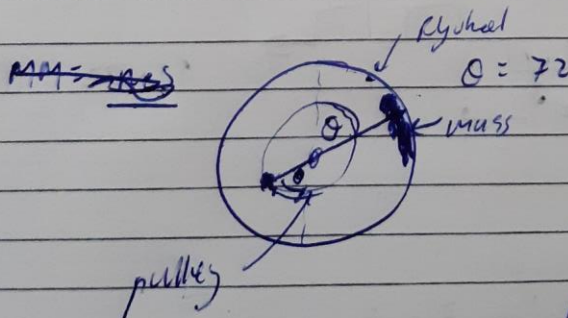
$$Res = \sqrt{627.15^2 + 1921.93^2} = 2021.65 \text{ kg} \cdot \text{mm}$$



$$\theta = \tan^{-1} \left(\frac{627}{1921} \right) = 18.0^\circ$$

$$\theta = \tan^{-1} \left(\frac{1921}{627} \right) = 72^\circ$$

c)



d)

$$MM = 2021.65$$

length from pulley
to flywheel

first order overall balance

$$MM = \frac{2021.65}{480} = 4.21 \text{ kg} \cdot \text{mm}$$