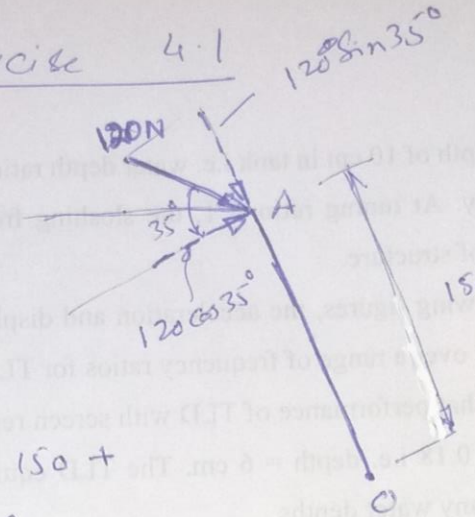
Exercise 4.1

Prob. 1

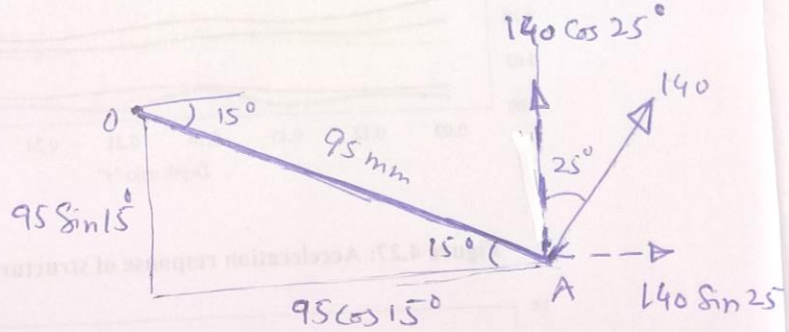


$$M_O = 120 \cos 35^\circ \times 150 + 120 \sin 35^\circ \times 0$$

$$= 14745 \text{ N·mm}$$

$$= 14.75 \text{ N·m} \quad (\circlearrowright)$$

prob 2

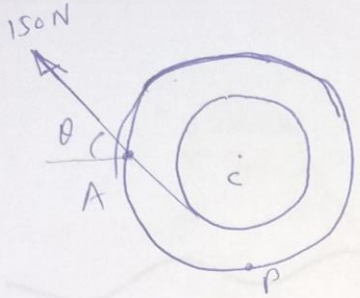


$$M_O = -140 \cos 25^\circ \times 95 \cos 15^\circ - 140 \sin 25^\circ \times 95 \sin 15^\circ$$

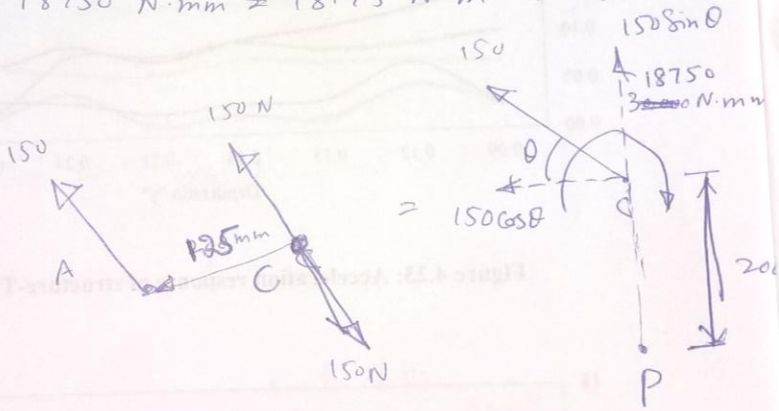
$$= -13098 \text{ N·mm}$$

$$= 13.1 \text{ N·m} \quad (\circlearrowleft)$$

Prob. 3



$M_C = 150 \times 125 = 18750\ N\cdot mm = 18.75\ N\cdot m$ (↻)



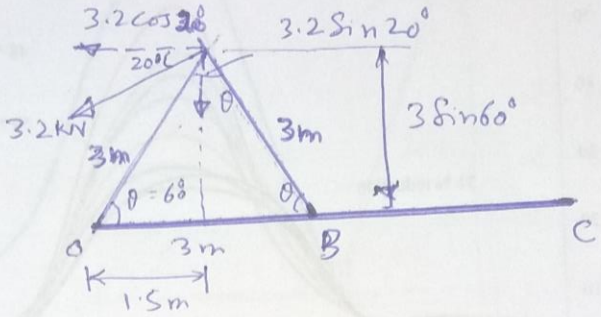
$M_P = 0 = 18750 + 150\sin\theta \times 0 - 150\cos\theta \times 200$

$\Rightarrow \quad 30000\cos\theta = 18750$

$\theta = 51.32^\circ$

Excercise 4.1

Problem 4

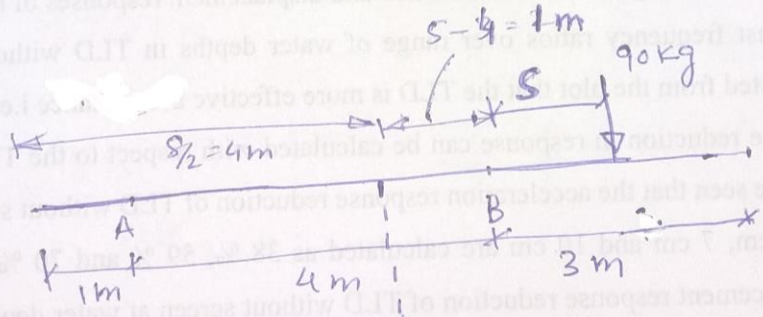


$\theta = 60^\circ$ in Equilateral triangle

$$M_O = -3.2\cos 20^\circ \times 3\sin 60^\circ + 3.2\sin 20^\circ \times 1.5$$

$$M_O = -6.18\ KN.m = 6.18\ KN.m\ (\curvearrowleft)$$

Prob 5



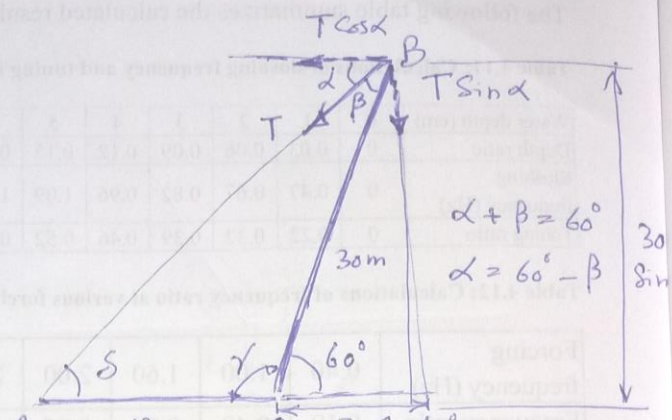
$$R = (28\times g)\times 8$$

$$M_B = 0 = (90\times g)\times S - [(28\times g)\times 8]\times 1$$

$$\Rightarrow S = 2.49\ m$$

Problem 6

Excercise 4.1



$\frac{\sin\beta}{12} = \frac{\sin\gamma}{AB} = \frac{\sin\delta}{30}$

$\gamma = 180° - 60° = 120°$

Not applicable

$(AB)^2 = 12^2 + 30^2 - 2\times12\times30\times\cos 120°$

$AB = 37.47\ m$

$\frac{\sin\beta}{12} = \frac{\sin 120°}{37.47} \Rightarrow \beta = 16.1°$

$\alpha = 60 - \beta = 60 - 16.1 = 43.9°$

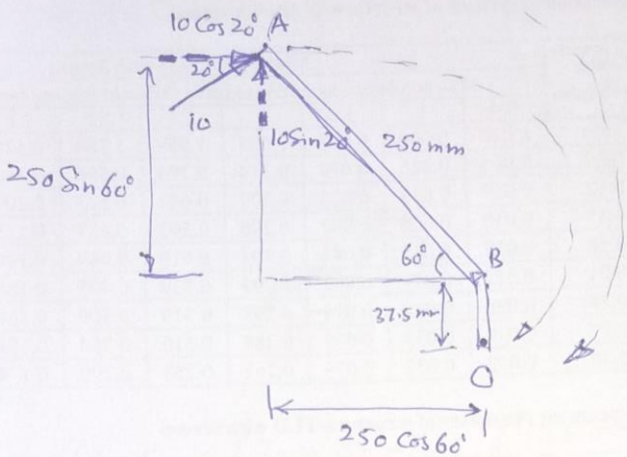
$M_o = -T\cos 43.9° \times 30\sin 60° + T\sin 43.9° \times 30\cos 60°$

$= -72$

$\Rightarrow T = \frac{-72}{-8.32} = 8.65\ KN$

Prob 7

Excercise 4.1

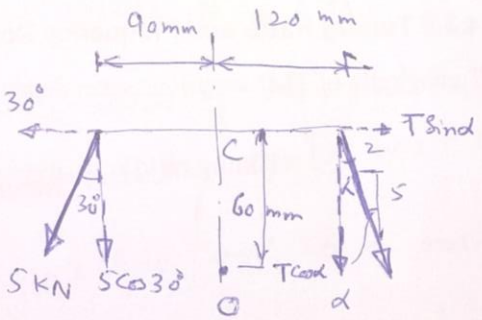


$M_0 = 10 \sin 20^\circ \times 250 \cos 60^\circ + 10 \cos 20^\circ \times (250 \sin 60^\circ + 37.5)$

$M_0 = 2814 \text{ N·mm}$ ↻

$= 2.81 \text{ N·m}$ (↻)

Prob 8



$M_0 = T\sin\alpha^{21.8^\circ} \times 60 + T\cos\alpha^{21.8^\circ} \times 120$

$- 5 \sin 30^\circ \times 60 - 5 \cos 30^\circ \times 90 = 0$

$\Rightarrow 133.7\,T = 539.7$

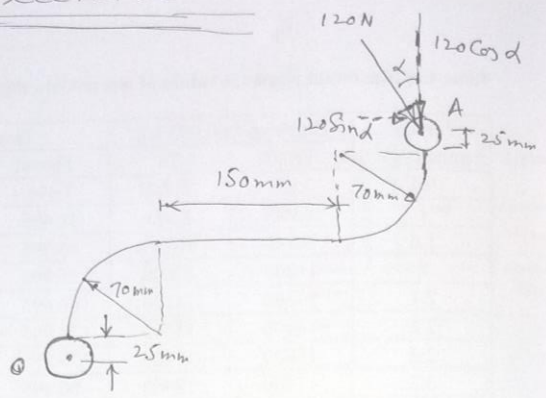
$T \simeq 4.04 \text{ KN}$

$\alpha = \tan^{-1}(2/5)$

$= 21.8^\circ$

Excercise 4.1

Prob 9



$$M_o = 120\cos\alpha\,(70+150+70) + 120\sin\alpha\,(25+70+70+25)$$

$$= 34800\cos\alpha + 22800\sin\alpha \quad \text{— (I)}$$

$\alpha = 30^\circ$

$$M_o = 34800\cos 30^\circ + 22800\sin 30^\circ$$

$$= 41537 \text{ N·mm} = 41.54 \text{ N·m } (\curvearrowright)$$

Inorder to calculate max value of M_o, find the corresponding angle by differentiating eqn (I) w.r.t θ

$$\frac{dM_o}{d\theta} = -34800\sin\alpha + 22800\cos\alpha = 0$$

$$\tan\alpha = 0.655 \Rightarrow \alpha = 33.23^\circ$$

(I) $\Rightarrow$ $(M_o)_{max} = 34800 \times \cos 33.23^\circ + 22800\sin 33.23^\circ$

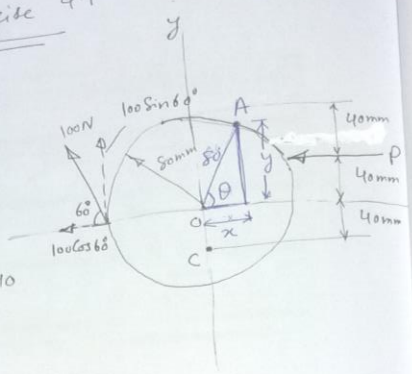
$$= 41604 = 41.6 \text{ N·m } (\curvearrowright)$$

Excercise 4.1

Prob 10

$M_c = 0$

(a) $P = ?$



$M_c = -P \times 80 - 100\cos 60^\circ \times 40 + 100 \sin 60^\circ \times 80 = 0$

$P = 61.6\ N$

(b) $R = ?$ $\quad R_x = \Sigma F_x = -61.6 - 100\cos 60^\circ = -111.6\ N$

$R_y = \Sigma F_y = 100 \sin 60^\circ = 86.6\ N$

(c) Assuming point A is first quadrant

$M_A = 100\sin 60^\circ \times (80 + x) + 100\cos 60^\circ \times y + P \times (y - 40)$

$x = 80\cos\theta \;\&\; y = 80\sin\theta$

$M_A = 86.6(80 + 80\cos\theta) + 50 \times 80\sin\theta + 61.6 \times (80\sin\theta - 40)$

$= 6928 + 6928\cos\theta + 4000\sin\theta + 4928\sin\theta - 2464$

$= 4464 + 8928\sin\theta + 6928\cos\theta$

$\frac{dM_A}{d\theta} = 8928\cos\theta - 6928\sin\theta = 0$

$\Rightarrow \tan\theta = 1.29 \Rightarrow \theta = 52.21^\circ$

$x = 80\cos\theta = 80 \times \cos 52.21^\circ = 49\ mm$

$y = 80\sin\theta = 80 \times \sin 52.21^\circ = 63.2\ mm$

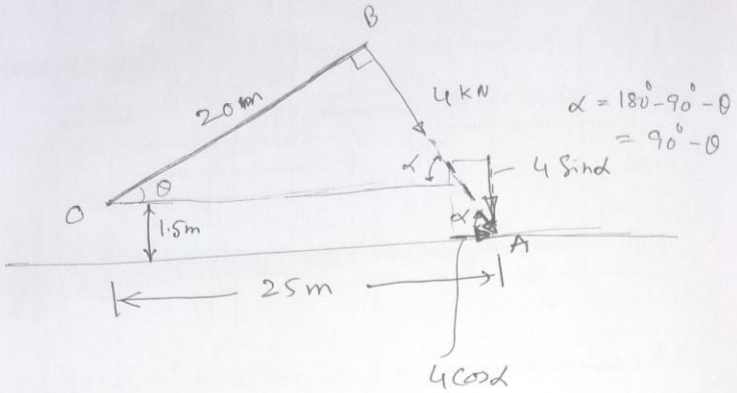
+ve Sign of both x & y indicates that assumed location of x- & y- coordinates are correct.

$M_A = 4464 + 8928\sin 52.21^\circ + 6928\cos 52.21^\circ = 15.67\ Nm$ ↻

Excercise 4.1

Prob. 11

Max $M_o = 4 \times 20$
$= 80\ kN.m$



$$M_o = 4\sin\alpha \times 25 - 4\cos\alpha \times 1.5$$
$$= 100\sin\alpha - 6\cos\alpha \quad \text{— (I)}$$

$$\frac{dM_o}{d\alpha} = 100\cos\alpha + 6\sin\alpha = 0$$

For Max M_o

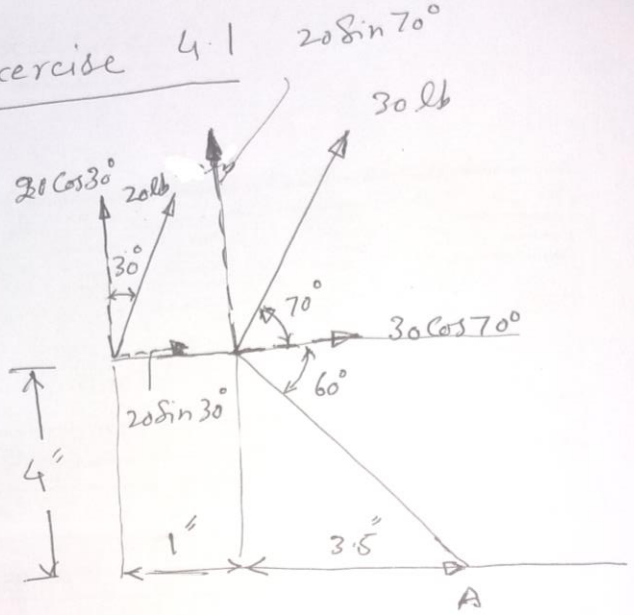
$$80 = 100\sin\alpha - 6\cos\alpha$$
$$0.8 = \sin\alpha - 0.06\sqrt{1-\sin^2\alpha}$$
$$0.8 = x - 0.06\sqrt{1-x^2}$$

By solving quadratic eqn.

$$x = 0.833,\ 0.761$$
$$\sin\alpha = 0.833,\ 0.761$$
$$\alpha = 56.41^\circ,\ 49.55^\circ$$
$$\theta = 180^\circ - 90^\circ - \alpha = 90^\circ - \alpha$$
$$\theta = 33.59^\circ,\ 50.45^\circ$$

Prob 12

Excercise 4.1



$$M_A = (30\cos 70^\circ + 20\sin 30^\circ) \times 4 + 20\sin 70^\circ \times 3.5 + 20\cos 30^\circ \times 4.5$$

$$M_A = 257.6 \text{ in.lb}$$