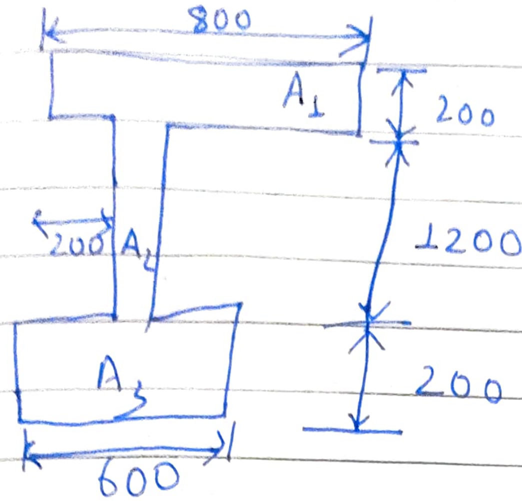
Name:- Swaraj Bandhu Prasad Kalwar ; Reg no:- 12111470
Rollno:- RK21YKB61 ;

Q1)



Rectangle A_1 =

$$\text{area} = 200 \times 800$$
$$= 160000\,mm^2$$
$$\text{centroid} = \left[400, \left[\frac{200}{2} + 1400\right]\right]$$
$$= [400, 1500]$$

Rectangle A_2 =

$$\text{Area} = 1200 \times 200$$
$$= 240000\,mm^2$$
$$\text{centroid} = (300, 800)$$

Rectangle A_3 =

$$\text{Area} = 200 \times 600 = 120000\,mm^2$$
$$\text{centroid} = (300, 100)$$

$$\bar{x} = \frac{x_1 A_1 + x_2 A_2 + x_3 A_3}{A_{total}}$$

PAGE

$$= \frac{16\times4\times10^6 + 24\times3\times10^6 + 12\times3\times10^6}{52\times10^4}$$

$$= \frac{172}{52}\times10^2$$

$$X_{cm} = 3.30\times10^2$$
$$= 330mm$$

$$Y_c = \frac{A_1Y_1 + A_2Y_2 + A_3Y_3}{\text{total Area}}$$

$$= \frac{16\times15\times10^6 + 24\times8\times10^6 + 12\times\cancel{1}\times10^6}{52\times10^4}$$

$$= \frac{444}{52}\times10^2 = 8.53\times10^2$$
$$= 853mm$$

Now

For x

Rectangle A

$$I_x = \frac{1}{12}bh^3 = \frac{1}{12}\times800\times(200)^3$$

$$= \frac{8\times2^3}{12}\times10^8\ mm^4$$

$$= \frac{64}{12}\times10^8\ mm^4$$

$$= 5.33\times10^8\ mm^4$$

$$I_{x,\bar{x}} = I_{x_1} + Al^2$$
$$= 5.33\times10^8 + 16\times10^4\times70\times70$$
$$= 533\times10^6 + 16\times49\times10^6$$
$$I_{x\bar{x}} = (533+754)\times10^6$$
$$= 1317\times10^6\ mm^4$$

DATE

Rectangle A_2

$$Ix_2 = \frac{1}{12} bh^3 = \frac{1}{12} \times 200 \times (1200)^3$$

$$= 288 \times 10^8 \, mm^4$$

$$Ix_2\bar{x} = Ix_2 + A_2 d^2$$

$$= 288 \times 10^8 + (30)^2 \times 24 \times 10^4$$

$$= (288 + 24 \times 9)$$

$$= 216 + 28800) \times 10^6$$

$$= 29016 \times 10^6$$

Rectangle A_2

$$IX32 \quad \frac{1}{12} bh^3 \Rightarrow \frac{1}{12} \times 600 \times (200)^3$$

$$= \frac{8 \times 6}{12} \times 10^8$$

$$Ix_3\bar{x} = 4 \times 10^8 + 120000 \times (30)^2$$

$$= 4 \times 10^8 + 12 \times 9 \times 10^6$$

$$= (400 + 108) \, 10^6 \, mm^4$$

$$= 508 \times 10^6 \, mm^4$$

Now

$$I_x = (508 + 29016 + 1317) \, 10^6$$

$$= 30841 \times 10^6 \, mm^4$$

For Y

$$I_{Y_2} Y' = \frac{1}{12} hb^3 + A_1 d^2$$

$$= \frac{1}{12} \times 200 \times (800)^3 + 160000 (647)^2$$

$$= \frac{1024}{12} \times 10^8 + 16 \times 10^{14}$$

$= 85.3333 \times 10^8 + 418609 \times 16 \times 10^4$

$= (853333 + 6697744)\, 10^4$

$= 7551077 \times 10^4 \, mm^4$

$\underline{I_{Y_2 Y'}}$

$\Rightarrow \frac{1}{12} h b^3 + A_2 d^2$

$= \frac{1}{12} \times 1200 \times (200)^3 + 24 \times 10^4 + (53)^2$

$= 8 \times 10^8 + 24 \times (53)^2 \times 10^4$

$= 80000 + 67416$

$\Rightarrow 147416 \times 10^4 \, mm^2$

$\underline{I_{Y_3 Y'}}$

$\Rightarrow \frac{1}{12} h b^3 + A_3 d^2$

$\Rightarrow \frac{1}{12} \times 200 \times (300)^3 + 12 \times 10^4 \times (753)^2$

$\Rightarrow 4.5 \times 10^8 + 680\cancel{8}4108 \times 10^{\cancel{8}4}$

$\Rightarrow 48000 \times 10^4 + 6804108 \times 10^4$

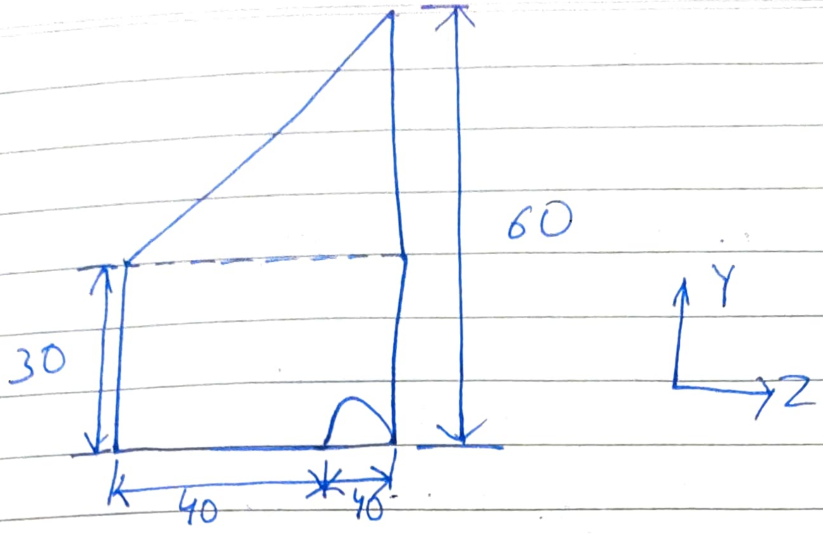
$\Rightarrow 6849108 \times 10^4$

$I_Y = (6849108 + 147416 + 7851077)\, 10^4$

$14547601 \times 10^4 \, mm^4$

$I_{x_1}, I_y = (30841 \times 10^6, 14547601 \times 10^4)\, mm^4$

(2)



* Area of triangle $\frac{1}{2} \times b \times h = \frac{1}{2} \times 30 \times 80$

$= 1200 mm^2$

centroid $= \left(\frac{80}{3}, \frac{30}{3} + 10\right)$

$= (26.66, 40) mm$

* Area of rectangle $= b \times h = 30 \times 80$

$= 2400 mm^2$

centroid $= \left(\frac{80}{2}, \frac{30}{2}\right) = (40, 15).$

* Area of semi circle $= \frac{\pi r^2}{2}$

$= \frac{3.14 \times (20)^2}{2}$

$= \frac{3.14 \times 20 \times 20}{2}$

$\Rightarrow (2 \times 3.14 \times 100) mm^2$

$\Rightarrow 628 mm^2$

centroid $= \left(60, \frac{4r}{3\pi}\right)$

$= (60, 8.49)$

$$* \quad \bar{X} = \frac{A_1 x_1 + A_2 x_2 + A_3 x_3}{A_{total}}$$

$$\Rightarrow \frac{26.66 \times 1200 + 40 \times 2400 + 621 \times 60}{A_{total}}$$

$$\Rightarrow \frac{31992 + 9600 - 37680}{4228.}$$

$$\Rightarrow \frac{90,312}{4228} = 21.36 mm$$

$$\bar{Y} \Rightarrow \frac{1200 \times 40 + 15 \times 2400 - 625 \times 8.49}{4228}$$

$$= \frac{4800 + 3600 - 5331}{4228}$$

$$= 18.60 mm$$

Triangle

M.O.I about centroids X-axis =

$$I x_1 \bar{X} = \frac{1}{36} bh^3 + A_1 d^2$$

$$= \frac{1}{36} \times 30 \times (80)^3 + 1200 \times (5.3)^2$$

$$= \frac{1}{36} \times 3 \times 5 \times 8 \times 0 \times 10^4 + 12 \times (5.3)^2 \times 10^2$$

$$= 426666 + 33708$$

$$= 460374 \ mm^4$$

$$I Y_1 Y' = \frac{1}{36} bh^3 + A_1 d^2$$

$$= \frac{1}{36} \times 80 \times (30)^3 + 1200 \times (21.4)^2$$

$$= \frac{8 \times 27 \times 10^4}{36} + 549552$$

$= 60000 + 549552$

$= 609,552$

* Rectangle

$$I_{x_2\bar{x}} = \frac{1}{12} bh^3 + A_2 d^2$$

$$\Rightarrow \frac{1}{12} \times 80 \times (30)^3 + 2400 \times (18.64)^2$$

$$\Rightarrow \frac{27 \times 8}{12} \times 10^4 + 2400 \times (18.64)^2$$

$$\Rightarrow 166153 + 833879$$

$$= 1000,032$$

$$I_{Y_2\bar{Y}} = \frac{1}{12} bh^3 + A_2 d^2$$

$$\Rightarrow \frac{1}{12} \times (30)(30)^3 + 2400 \times (3.6)^2$$

$$= \frac{3 \times 8^3}{12} \times 10^4 + 2400 \times 12.96$$

$$= 1280000 + 31,104$$

$$\Rightarrow 1,311,104$$

Semicircle

$$I_{x_3\bar{x}} = \frac{1}{8} \pi r^4 + A_3 (21.36)^2$$

$$\Rightarrow \frac{1}{8} \times 3.14 \times (20)^4 + 625 \times (21.36)^2$$

$$\Rightarrow 62800 + 286524$$

$$\Rightarrow 349,324.\ mm^4$$

$$I_{Y_3}\bar{Y} \Rightarrow \frac{1}{8}\cancel{\pi}\pi r^4 + A_3(10.11)^2$$

$$\Rightarrow 62800 + 64189$$

$$\Rightarrow 126,989\ mm^4$$

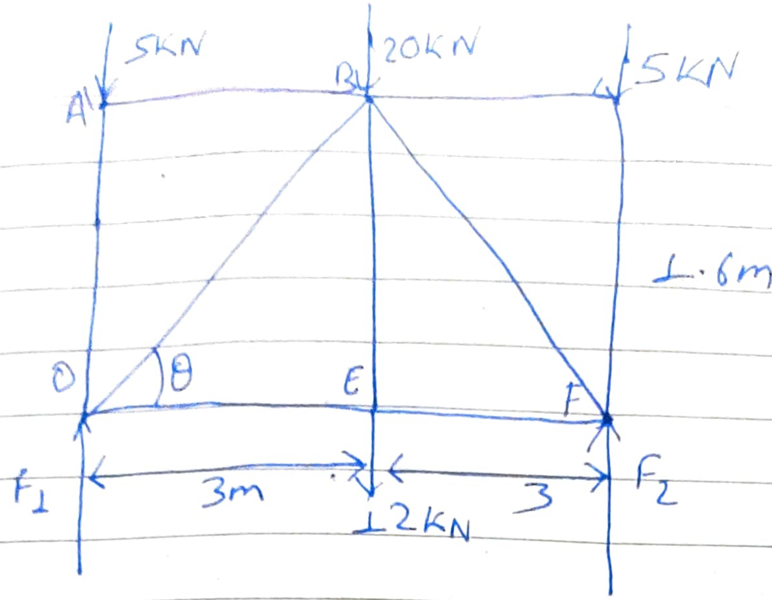
$$M_x \Rightarrow 349324 + 460374 + 1000,032$$

$$\Rightarrow 1809730\ mm^4$$

$$M_y \Rightarrow \cancel{600}\ 609552 + 1311104 + 126,989$$

$$\Rightarrow 2047645\ mm^4$$

3)a)



$\tan\theta = \frac{1.6}{3} \Rightarrow \theta = 28.07$

$F_1 + F_2 = 42$

momentum also F

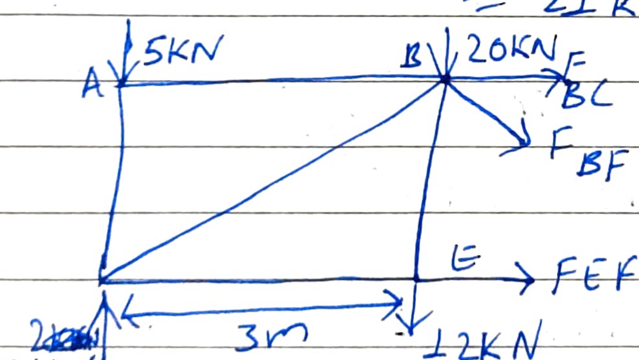
$5\times 6 + 20\times 3 + 12\times 3 - F_1\times 6 = 0$

$-F_1\times 6 = -126$

$F_1 = 21KN$

$\therefore F_2 = (42-21)KN$

$= 21KN$



about point F

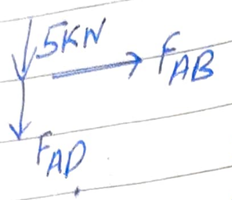
$5\times 6 - 21\times 6 + 12\times 3 + 20\times 3 - F_{BC}\times 3 = 0$

$30 - 126 + 36 + 60 - \cancel{F_{BC}\times 3}\ F_{BC}\times 3 = 0$

$60 + 66 - 126 - F_{BC}\times 3 = 0$

$F_{BC} = 0KN$

at point A

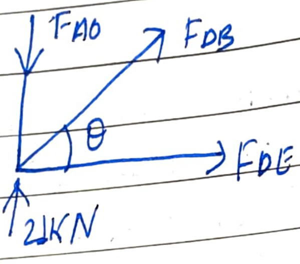


$\Sigma F_y = 0$

$\Sigma F_y = 0$

$F_{AB} = 0KN$ | $F_{AD} = 5KN [C]$

at point D



$F_{DB}\sin\theta + 21 = F_{AD}$

$F_{DB}\sin 26 = 5-21$

$= -16$

$F_{DB} = \frac{-16}{\sin 28} = \frac{-16}{0.46} = -34.78$

$F_{DB} = 34.78 [C]$

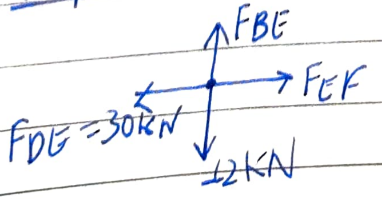
Now

$F_{DE} = F_{DB}\cos 28$ (because DB has cos comp)

$F_{DE} = 34 \times 0.88$

$= 29.98 = 30 [8]$

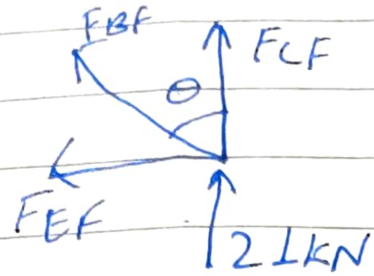
at point E



$F_{BE} = 12KN [T]$

$F_{EF} = 30KN [T]$

at point F,



$FEF + FBF \sin 28 = 0$

$\frac{12}{\sin 28} = -FBF$

$FBF = 25.5$ [comp]

SO FBF has ~~come~~ cosine comp so

$FCF - 121 = FBF \cos 28$

$FCF - 121 = 25.5 \times \cos 28$

$FCF = 22.44$

$FCF = 22.44 - 21$

$= 1.44$ [T]

HERE

$F_{AB} = 0kN$, $F_{AD} = 5kN$ [C]

$F_{DB} = 34.78$ [C]

$F_{DE} = 30$ [T], $F_{BE} = 12kN$ [T]

$FEF = 30kN$ [T], $FBF = 25.5$ [com]

$F_{CF} = 1.44$ [T] and $F_{BC} = 0kN$.