7 questions - 10, 15, 20 marks

no theory involved - only problem solving

centroid, moment of inertia, work and energy, friction, joints & sections (trusses)

2 - 3 qs

big topic

→ Eqs of equilibrium

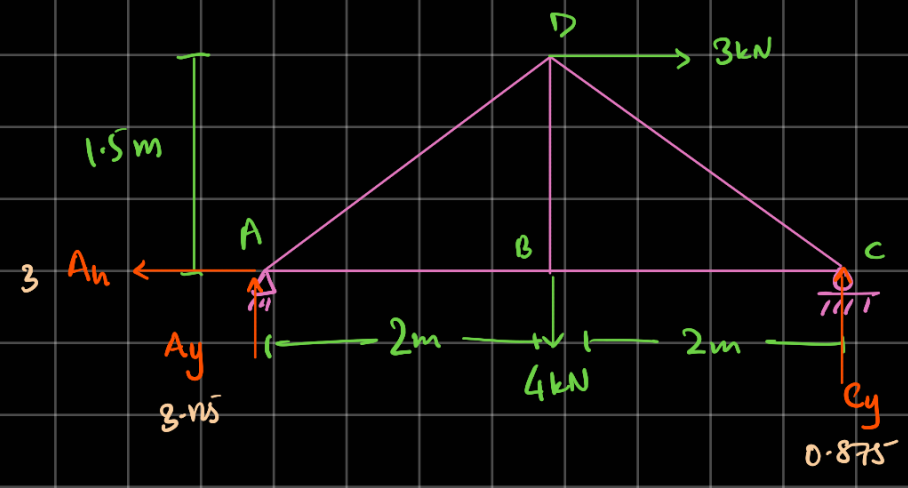
Chapter 3 - 5

→ conversions could be there

Q Find out member forces

Q Find slope of line (diagonal members)

Example



$\Sigma F_x = 0$

$A_x + 3 = 0$

$A_x = -3\,kN$

$\Sigma F_y = 0$

$A_y + C_y = 4$

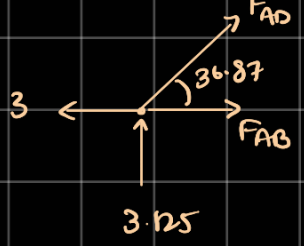
$(+\circlearrowleft) \Sigma M_A = 0$

$-3(1.5) - 4(2) + C_y(4) = 0$

$C_y = 3.125\ kN$

$\therefore A_y = 0.875\ kN$

Joint A



$F_{AD}\,i = F_{AD}\cos(36.87)$

$= F_{AD}(4)$

$$F_{AB}\left(\frac{4}{5}\right)$$

$$F_{AD}\,j = F_{AD}\sin(36.87)$$

$$= F_{AD}\left(\frac{3}{5}\right)$$

$$\Sigma F_x = 0$$

$$F_{AB} + F_{AD}\left(\frac{4}{5}\right) = 3$$

$$\Sigma F_y = 0$$

$$F_{AD}\left(\frac{3}{5}\right) = -0.87J$$

$$F_{AD} = -1.46\ kN\ (T)$$

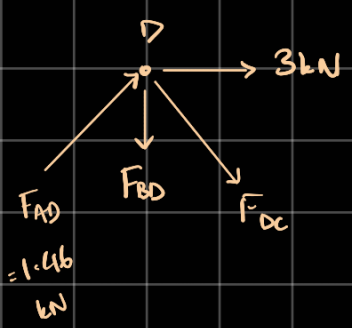
$$= 1.46\ kN\ (C)$$

$$\Sigma F_x = 0$$

$$F_{AB} - 1.46\left(\frac{4}{5}\right) = 3$$

$$F_{AB} = 4.17\ kN\ (T)$$

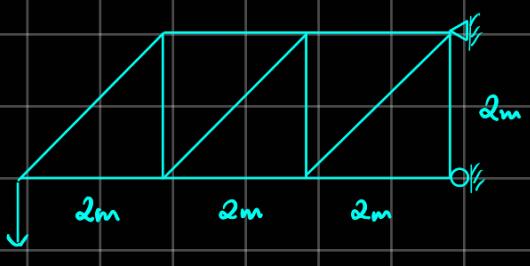
Joint D



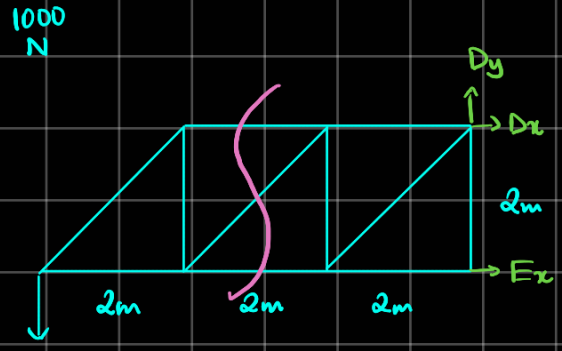
Example

$$\Sigma M_G = 0$$

$$1000\,(2) - F_{BC}\,(2) = 0$$



$F_{BC} = 1000$ N

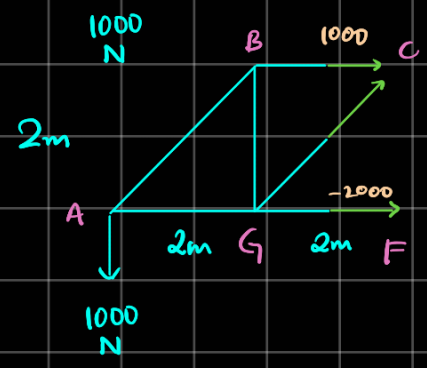


$\sum M_C = 0$

$1000(4) + F_{GE}(2) = 0$

$F_{GE} = -2000$

$= 2000$ N (C)



$\sum F_x = 0$

$F_{BC} + F_{GE} + \frac{F_{GC}}{\sqrt{2}} = 0$

$F_{GC} = (2000 - 1000)\sqrt{2}$

$= 1414$ N

$\sum F_y = 0$

$-1000 + F_{GC} \sin 45 = 0$

$F_{GC} = 1414$ N

$\sum M_A = 0$

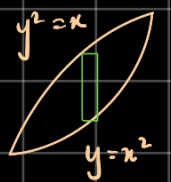
$F_{GC} \sin 45 (2) - F_{BC}(2) = 0$

$F_{GC} = \frac{1000 \times 2}{2 \times 1/\sqrt{2}}$

$= 1414$ N

Centroids

Tutorial Q_2



$y_1 = x^{1/2}$

$y_2 = x^2$

$dA = (y_1 - y_2)\,dx$

$$\frac{h}{2} = \frac{y_1 - y_2}{2}$$

$$\tilde{y} = \frac{h}{2} + y_2$$

$$= \frac{y_1}{2} - \frac{y_2}{2} + y_2$$

$$= \frac{y_1 + y_2}{2}$$

$$\bar{y} = \frac{\int \tilde{y}\, dA}{\int dA}$$

$$= \frac{\int \left(\frac{y_1+y_2}{2}\right)(y_1+y_2)\, dx}{\int \frac{y_1+y_2}{2}\, dx}$$

$$= \frac{\frac{1}{2}\int (y_1+y_2)^2\, dx}{\frac{1}{2}\int y_1+y_2\, dx}$$

$$= \frac{\int x + x^4 + 2x^{3/2}\, dx}{\int x^{1/2} + x^2\, dx}$$

$$= \frac{\frac{x^2}{2} + \frac{x^5}{5} + \frac{4}{5}x^{5/2}}{\frac{2}{3}x^{3/2} + \frac{x^3}{3}}$$

Moment of Inertia

$$I_x = \int_A y^2\, dA$$

$$I_y = \int_A x^2\, dA$$

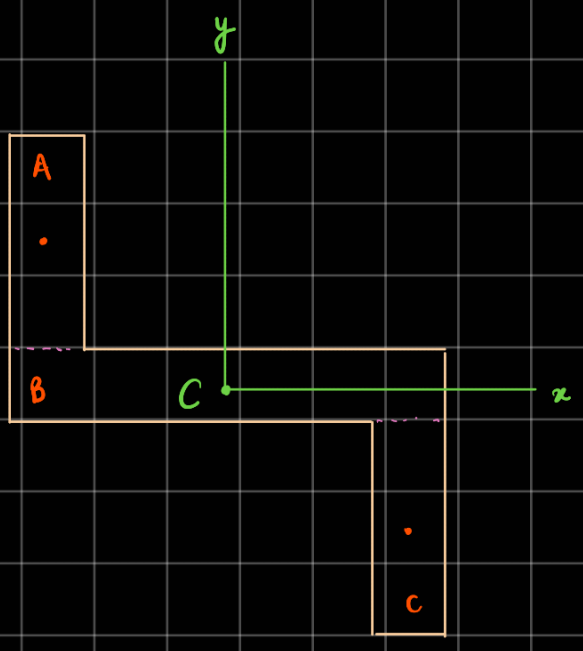
$$I_{x'} = \int_A y^2 \, dA$$

$$dA = b \, dy'$$

$$I_{x'} = \int$$

10.4

Moment of Rectangle - moment of circle



Shape A

$$I_{x'} = I_x + Ad^2$$

$$= \frac{bh^3}{12} + bh \times d^2$$

$$= \frac{100 \times 300^3}{12} + 300 \times 100 \times (200)^2$$

$$= 225{,}000{,}000 + 1\,200\,000\,000$$

$$= 1\,425\,000\,000 \ mm^4$$

Shape B

$$I_x = \frac{bh^3}{12} = \frac{600 \times 100^3}{12}$$

$$= 50\,000\,000 \ mm^4$$

Shape C

$$I_{x'} = I_x + Ad^2$$

$$= \frac{bh^3}{12} + bh \times d^2$$

$$= \frac{100 \times 300^3}{12} + (300 \times 100 \times 200 \times 200)$$

$= 1\ 425\ 000\ 000\ mm^4$

Polar moment-

Sum of all moments

$= 1\ 425\ 000\ 000$

$+ 1\ 425\ 000\ 000$

$50\ 000\ 000$

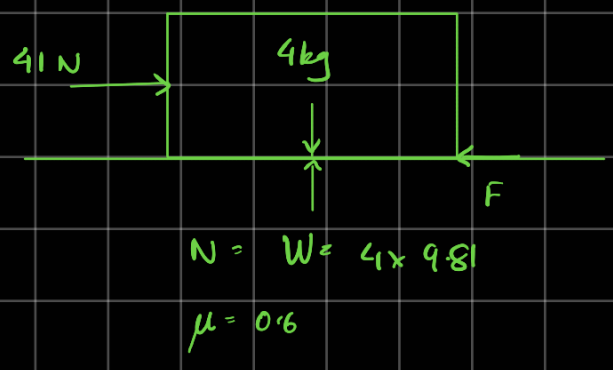
$= 2,900,000,000\ mm^4$

Work & Energy

$W = F d \cos\theta$

$= 41 \times 2 \times \cos 90$

$= 82\ J$



$\Delta E = \Delta KE + E_{thermal}$

$E_{thermal} = \mu_s m g d$

$= 0.6 \times 4 \times 9.81 \times 2$

$= 47.088\ J$

$\Delta E = E_{thermal}$