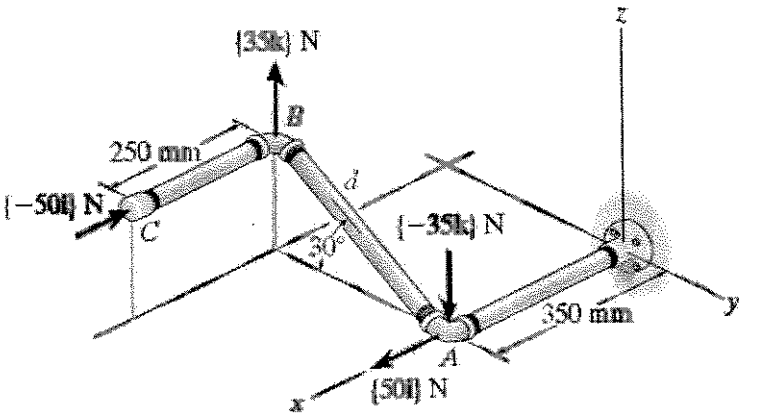
Problem I:



Determine the distance d between A and B so that the resultant couple moment has a magnitude of $M_R = 20$ N.m. *(15points)*

Calculations:

$M_x = -35\, d \cos 30^\circ = -30.31\, d$

$M_y = -50\, d \sin 30^\circ = -25\, d$

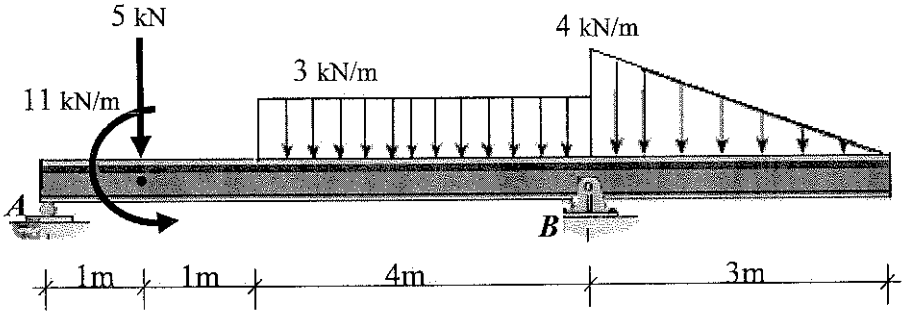
$M_z = -50\, d \cos 30 = -43.3\, d$

$M_R = 20 = \sqrt{M_x^2 + M_y^2 + M_z^2}$

$M_R = 20 = \sqrt{(30.31d)^2 + (-25d^2) + (-43.3d)^2} = \sqrt{3418.59\, d^2}$

$\Rightarrow (20)^2 = 3418.59 d^2 \Rightarrow d = 0.342\ m = 342\ mm$

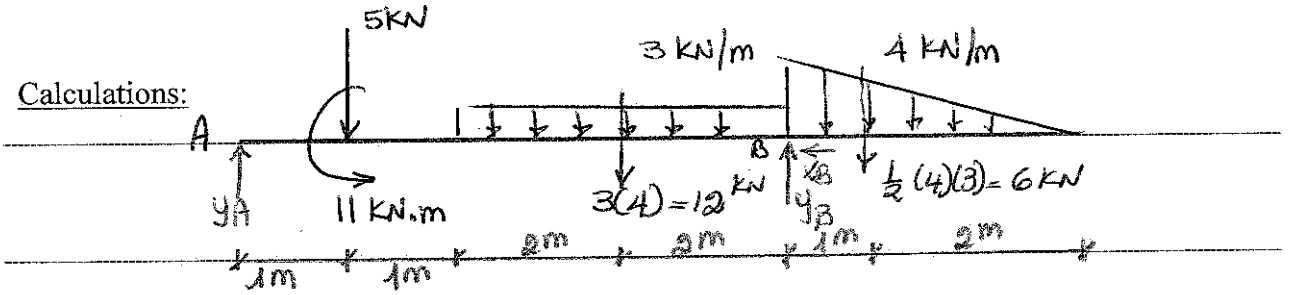
Problem II:



The beam is supported by a roller at A and pin at B. Determine the reactions at support *A* and *B*. *(15 points)*

Note: FBD must be included

Calculations:



$\rightarrow \Sigma F_x = 0 \Rightarrow \boxed{x_B = 0 \text{ kN}}$

$+\circlearrowleft \Sigma M_A = 0 \quad -5(1) + 11 - 12(4) + y_B(6) - 6(7) = 0$

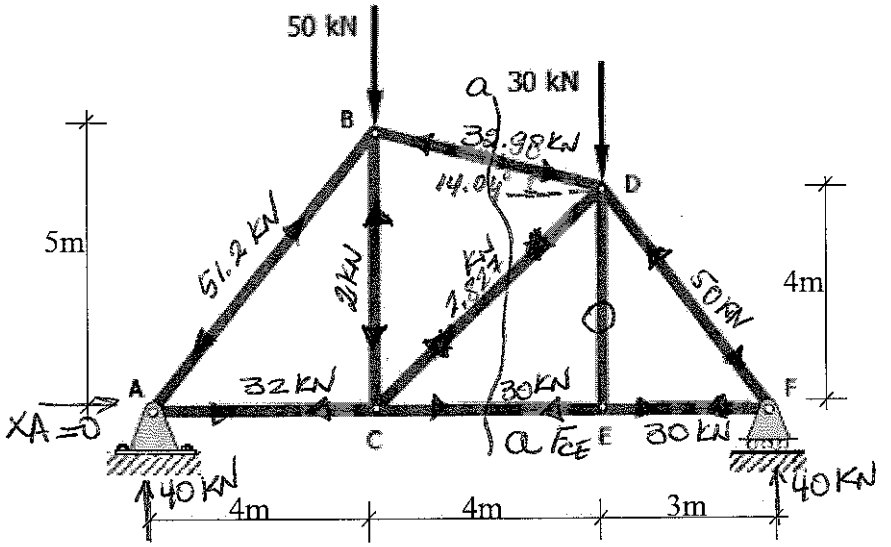
$\Rightarrow \boxed{y_B = 14 \text{ kN} \uparrow}$

$+\circlearrowleft \Sigma M_B = 0 \Rightarrow -y_A(6) + 11 + 5(5) + 12(2) - 6(1) = 0$

$\Rightarrow \boxed{y_A = 9 \text{ kN} \uparrow}$

CHECK: $+\uparrow \Sigma F_y = 0 \quad 9 - 5 - 12 - 6 + 14 = 0 \quad \therefore$ OK.

Problem III:



Determine the force in each member of the truss and state if the members are in tension or compression. *(Use a combination of method of section and joint to solve the truss). (40 points)*

Calculations:

Reactions: $\pm \Sigma F_x = 0 \Rightarrow \boxed{X_A = 0 \text{ kN}}$ ½

$+\circlearrowleft \Sigma M_A = 0 \quad -50(4) - 30(8) + y_F(11) = 0 \Rightarrow \boxed{y_F = 40 \text{ kN} \uparrow}$ (1)

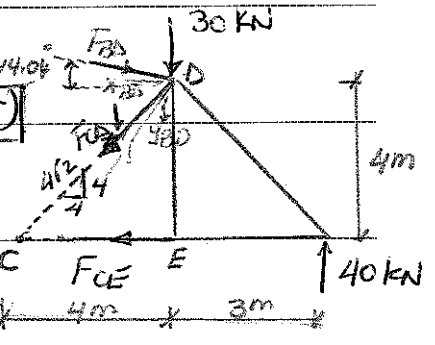
$+\circlearrowleft \Sigma M_F = 0 \quad -y_A(11) + 50(7) + 30(3) = 0 \Rightarrow \boxed{y_A = 40 \text{ kN} \uparrow}$ (1)

CHECK! $+\uparrow \Sigma F_y = 0 \quad 40 - 50 - 30 + 40 = 0$ ∴ o.k.

sec a-a: right.

$+\circlearrowleft \Sigma M_D = 0 \Rightarrow 40(3) - F_{CE}(4) \Rightarrow \boxed{F_{CE} = 30 \text{ kN (T)}}$

$+\circlearrowleft \Sigma M_E = 0 \Rightarrow 40(7) - 30(4) - F_{BD}\cos 14.04(4) - F_{BD}\sin 14.0(4) = 0 \Rightarrow \boxed{F_{BD} = 32.98 \text{ kN (C)}}$



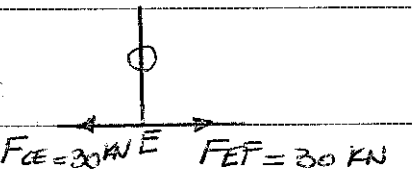
$+\uparrow \Sigma F_y = 0 \quad 40 - 30 - 32.98 \sin 14.04 - F_{CA}\frac{4}{4\sqrt{2}} = 0$

$\Rightarrow \boxed{F_{CA} = 2.827 \text{ KN (T)}}$

Member ED is a Zero Force member. $\boxed{F_{ED} = 0 \text{ KN}}$

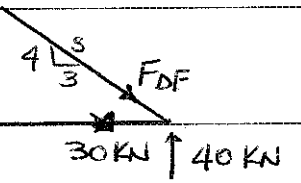
Equilibrium of joint E:

$\pm \Sigma F_x = 0 \quad -30 + F_{EF} = 0 \Rightarrow \boxed{F_{EF} = 30 \text{KN (T)}}$



Joint F

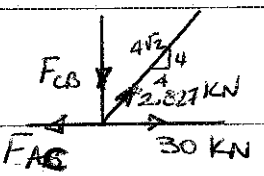
$\Sigma F_x = 0 \Rightarrow -30 + F_{DF}\frac{3}{5} = 0 \Rightarrow \boxed{F_{DF} = 50 \text{KN (C)}}$



Check for $F_y = 0 \Rightarrow 40 - 50\left(\frac{4}{5}\right) = 0$ ∴ OK.

Joint C:

$+\uparrow \Sigma F_y = 0 \Rightarrow F_{CB} - \frac{2.827 \times 4}{4\sqrt{2}} = 0$

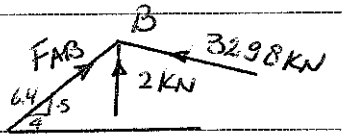


$\Rightarrow \boxed{F_{CB} = 2 \text{ KN (C)}}$

$\pm \Sigma F_x = 0 \Rightarrow -F_{AB} + 2.827 \times \frac{4}{4\sqrt{2}} + 30 = 0 \Rightarrow \boxed{F_{AC} = 32 \text{KN (T)}}$

Joint B

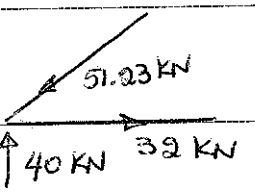
$\pm \Sigma F_x = 0 \quad F_{AB}\frac{4}{6.4} - 32.98 \cos 14.04 = 0$



$\Rightarrow \boxed{F_{AB} = 51.2 \text{ KN (C)}}$

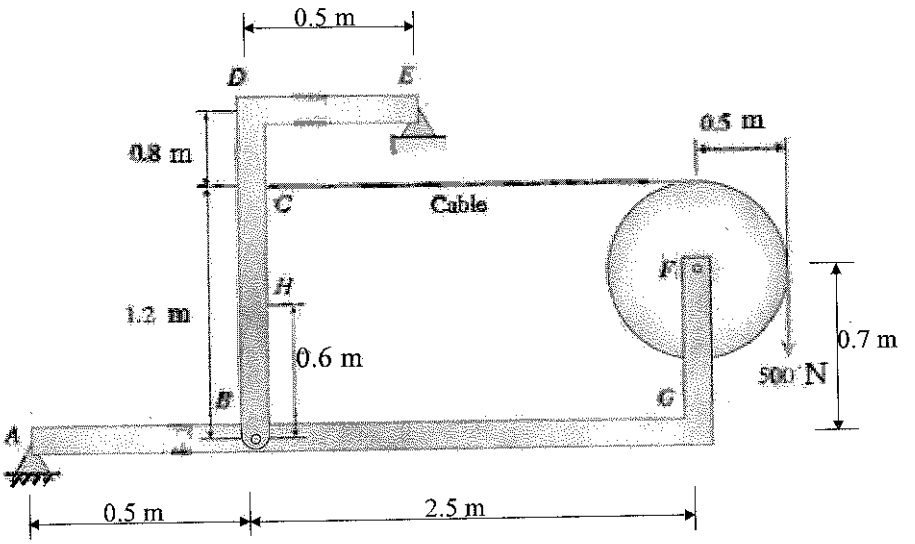
Joint A

check for equilibrium $\Sigma F_x = 0$ or $\Sigma F_y = 0$



$+\uparrow \Sigma F_y = 0 \rightarrow 40 - 51.2 \frac{5}{6.4} = 0$

Problem IV:

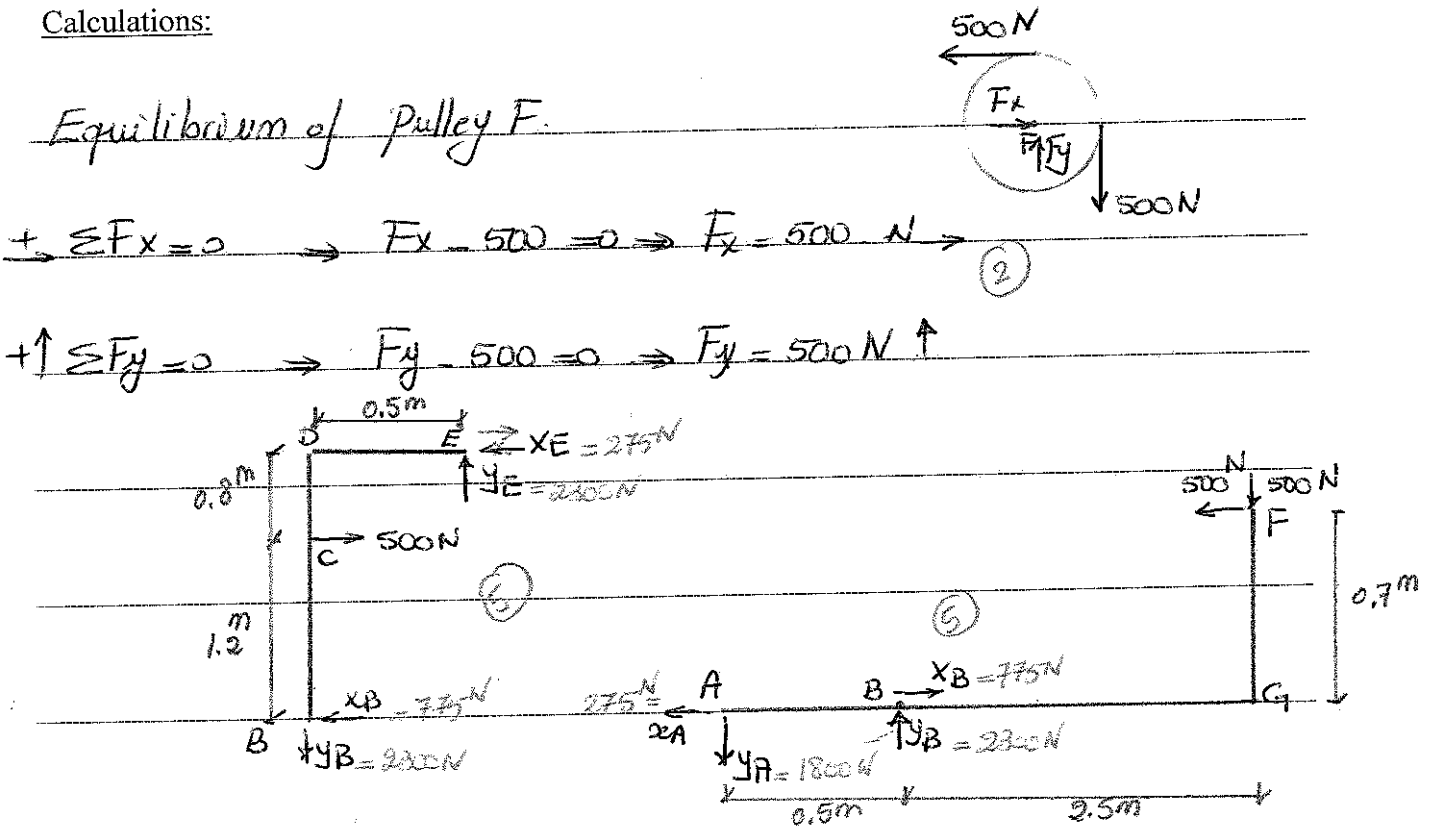


A plane frame with a pin support at A and pin support at E has a cable attached at C which runs over a frictionless pulley at F. The cable force is known to be 500 N.

(a) Find reactions at supports A and E. *(30 points)*

Note: FBD must be included

Calculations:



Part AF:

$+\circlearrowleft \Sigma M_A = 0 \Rightarrow y_B(0.5) + 500(0.7) - 500(3) \Rightarrow \boxed{y_B = 2300\ N \uparrow}$

$+\uparrow \Sigma F_y = 0 \Rightarrow -y_A + 2300 - 500 = 0 \Rightarrow \boxed{y_A = 1800\ N \downarrow}$

Part BE:

$+\uparrow \Sigma F_y = 0 \Rightarrow -2300 + y_E = 0 \Rightarrow \boxed{y_E = 2300\ N \uparrow}$

$+\circlearrowleft \Sigma M_E = 0 \Rightarrow 2300(0.5) - x_B(2) + 500(0.8) = 0 \Rightarrow \boxed{x_B = 775\ N \leftarrow}$

$\pm \Sigma F_x = 0 \Rightarrow -775 + 500 - x_E = 0 \Rightarrow \boxed{x_E = -275\ N = 275\ N \rightarrow}$

6×3

Part AF:

$\pm \Sigma F_x = 0 \quad -x_A + 775 - 500 = 0 \Rightarrow \boxed{x_A = 275\ N \leftarrow}$

Good Luck!