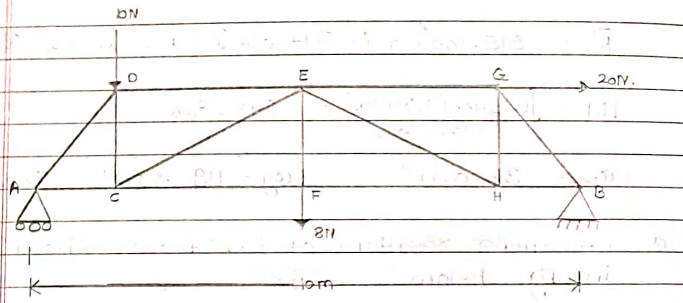
* Truss.

• Analysis of Truss :-



Truss is rigid structure formed by connecting numbers of members with the help of riveting, Bolting or welding trusses are used to support roof of the structure.

Trusses are used in workshops, industrial Shades, factory, railway station, forging, godowns, bridges, etc.

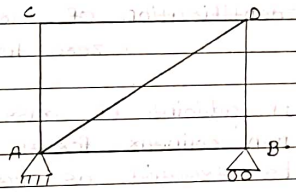
* classification of Truss's :-

① perfect Truss Imperfect truss

Redundant Truss. Defficient Truss.

In the truss shown in above fig. 10N, 8N, 20N, are called as external forces.
AD, AC, AE, DE, CF, EG etc are members of Truss.
and points A, B, C, D, E, F etc are joints of Truss.

① perfect Truss :-



The Truss which obey's / follows following eqn is known as perfect Truss.

$n = 2j - r$

n = no. of members
j = no. of joints.
r = no. of Reaction (3). (1 hinge & roller).

$5 = 2(4) - 3$
$5 = 8 - 3$
$5 = 5$

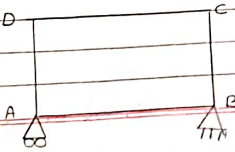
② Imperfect Truss :-

The Truss in which $n \neq 2j - r$ is known as Imperfect Truss.

i) Defficient Truss :-

The Truss where $n < 2j - r$ is known as Defficient Truss.

Ex:- $4 < 5$.
Imperfect defficient Truss.

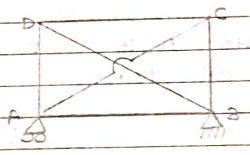


ii) Redundant Truss :-

The truss where $n > 2j-3$ is known as Redundant truss.

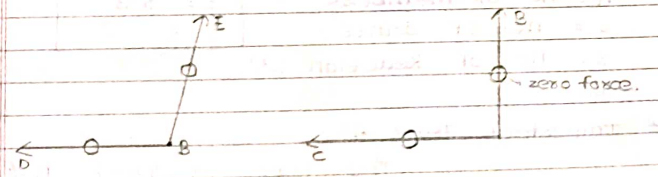
Ex: $6 > 5$

Imperfect Redundant Truss.

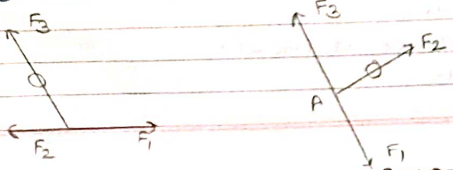


Identification of zero force members.
(zero forces by observation).

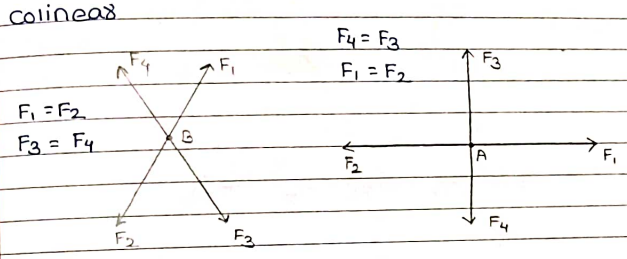
If adjoint of truss carry's only two non colinear forces the both forces can be treated as zero force members or zero forces. (No external force acting at joint).

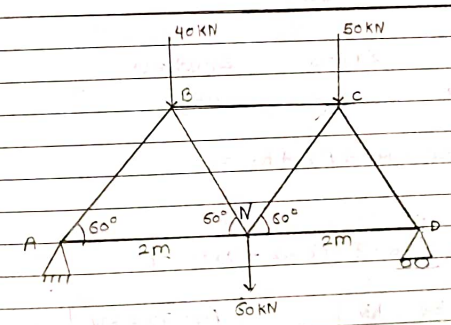


If at a peticular joint of truss, three forces are acting in such a way that two out of them are colinear, then the non-colinear force can be treated as zero force member.



If 4 forces are acting at a joint of truss in such way that two pairs are colinear





Determine the forces in each members.

(Step - I) → Verify wheather the truss is perfect or not.

$n = 2j - 3$

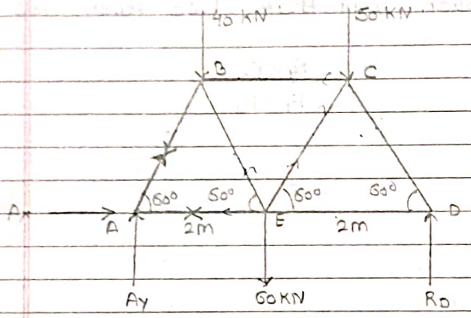
$n = 7, \quad j = 5, \quad 3 = 3$

$7 = 2(5) - 3$

$7 = 7.$

So Given Truss is perfect truss.

Step :② Find out external reactions.



$\Sigma f_x = 0$ $\Sigma f_y = 0$ $\Sigma m@ = 0$

$A_x = 0$.

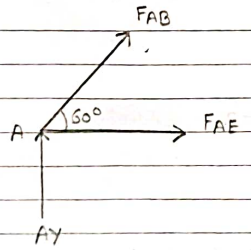
$-40 - 50 - 60 + A_y + R_D = 0$

$\Sigma M@A = 0$

$4R_D - 50 \times 3 - 60 \times 2 - 40 \times 1 = 0$

$\boxed{R_D = 77.5 \text{ kN}}$ $\boxed{A_y = 72.5 \text{ kN}}$

Step ③:- consider equilibrium of joint 'A'



$\Sigma F_y = 0$

$A_y + F_{AB} \sin 60° = 0$

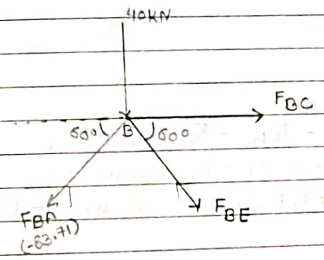
$72.5 + F_{AB}\ 0.866 = 0$

$\therefore F_{AB} = \frac{-72.5}{0.866} = 83.718$ (Compressive)

$\Sigma F_x = 0$

$F_{AE} + F_{AB} \cos 60° = 0$ $\boxed{\therefore F_{AE} = 41.85 \text{ kN}}$

Joint 'B'.



$\Sigma F_x = 0$

$-F_{BA} \cos 60° + F_{BC} + F_{BE} \cos 60°$

$-(-83.715) \times 0.5 + F_{BC} + F_{BE}\ 0.5 = 0$

$41.857 + F_{BC} + 0.5\ F_{BE} = 0.$

$\therefore \boxed{F_{BC} = -60.61 \text{ KN}}$

$\Sigma F_y = 0$

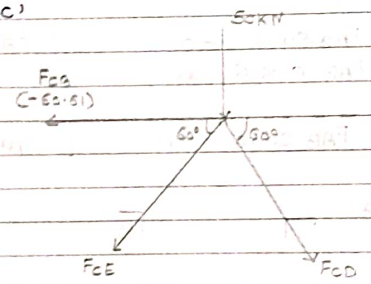
$-F_{BA} \sin 60° - F_{BE} \sin 60° - 40 = 0$

$-(83.715) \times 0.866 - F_{BE} \sin 60° - 40 = 0$

$F_{BE} = \frac{32.497}{\sin 60°}$

$\boxed{F_{BE} = 37.525}$

Joint 'C'



$\Sigma F_x = 0$

$+F_{CD}\cos 60° - F_{CB} - F_{CE}\cos 60° = 0$

$F_{CD}\cos 60° + 60.61 - F_{CE}\cos 60° = 0$

$-F_{CD}\cos 60° + F_{CE}\cos 60° = 60.61 \quad -①$

$\Sigma F_y = 0$

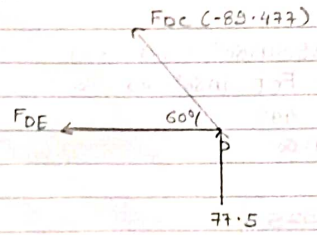
$-50 - F_{CD}\sin 60° - F_{CE}\sin 60° = 0$

$-F_{CD}\sin 60° - F_{CE}\sin 60° = 50 \quad -②$

$F_{CD} = +89.477$ KN (C) $= -89.477$ KN

$F_{CE} = +31.742$ KN (T)

At Joint 'D'



$\Sigma f_y = 0$

$F_{DC}\sin 60° + 77.5 = 0$

$F_{DC} = -89.4892$

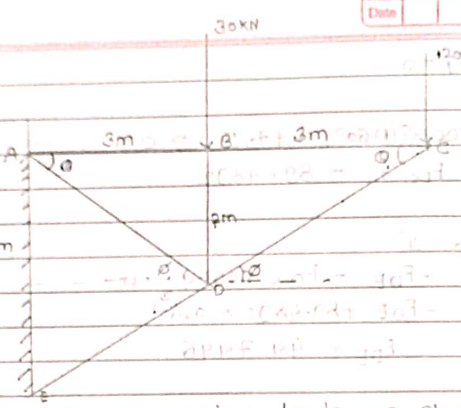
$\Sigma F_x = 0$

$-F_{DE} - F_{DC}\cos 60° = 0$

$-F_{DE} + 89.4892 \times \cos 60° =$

$F_{DE} = 44.7446.$

Sr.No.	Force	Nature	magnitude
①	F_{BC}	compressive	60.61KN.
②	F_{CE}	Tensile	31.76 KN
③	F_{CD}	C	89.48 KN
④	F_{DE}	T	44.74 KN
⑤	F_{AB}	C	83.71 KN.



The truss supports vertical loads as shown in fig. above determine the forces in each member of truss & also state the nature of the forces in Ea tabular form

→ Calculate angle θ as shown in fig.

$\tan\theta = \frac{4}{6}$ $\quad \theta = 33.69°$.

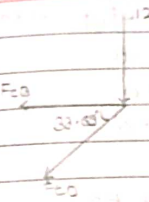
ΔAEC & ΔBCD ... using properties of similar triangle.

$\frac{AC}{BC} = \frac{AE}{BD}$ $\quad \therefore \frac{6}{3} = \frac{4}{BD}$

$\therefore BD = \frac{4}{2}$ $\quad \boxed{\therefore BD = 2m.}$

$\therefore \tan\phi = \frac{2}{3}$ $\quad \therefore \boxed{\phi = 33.69°}$

Consider equilibrium of point 'C'



$-F_{CB} - F_{CD}\cos 33.69° = 0$

$-120 - F_{CD}\sin 33.69 = 0$

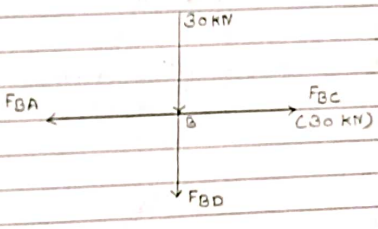
$-F_{CD} = \frac{120}{\sin 33.69}$

$F_{CD} = -216.333.36.055\ kN$

$\therefore -F_{CB} + 36.055 \times \cos 33.69 = 0$

$\therefore \boxed{F_{CB} = 29.999}$

Joint 'B'



$F_y = 0$

$-30 - F_{BD} = 0$

$\boxed{F_{BD} = -30}$

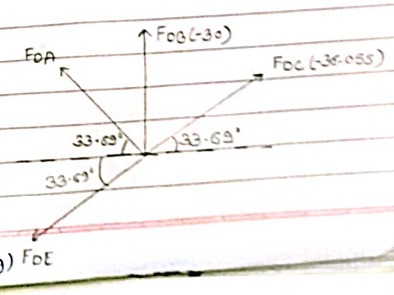
$F_x = 0$

$F_{BC} - F_{BA} = 0$

$-F_{BA} = -30$

$\boxed{F_{BA} = 30}$

At joint 'D'



$F_{DB} + F_{DC}\sin(33.69) + F_{DA}\sin(33.69)$

$- + F_{DE}\sin(33.69) = 0$

$-30 + (-36.055)\sin(33.69) +$

$F_{DA}\sin(33.69) \pm F_{DE}\sin(33.69)\ F_{DE}$

$F_x = 0$

$F_{DC}\cos(33.69) - F_{DA}\cos(33.69) - F_{DE}\cos(33.69)$

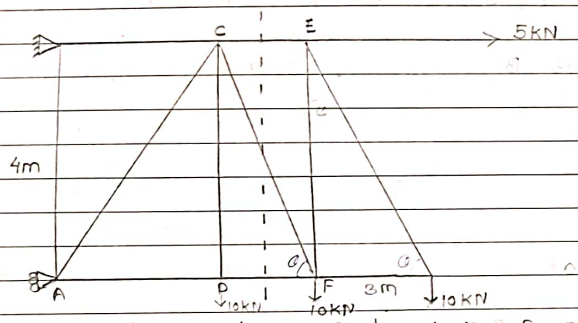
$-29.99 - 0.83\,F_{DA} - 0.83\,F_{DE} = 0$

$-0.83\,F_{DA} - 0.83\,F_{DE} - 29.99 = 0$

$+0.55\,F_{DA} - 0.55\,F_{DE} - 49.999 = 0$

$\therefore F_{DA} = -27.381$ (signs) $F_{DE} = 63.525$

Q. Find out forces in the member 'CE', 'CF'



when it is asked to find out the forces in particular members of of truss then method of section is used.

In this method take a section or cut passing through the force members which asked to be calculated.

while takeing section we have to take care that it should not pass through more than 3 members.

Then consider either equilibrium of either LHS or RHS of Section.

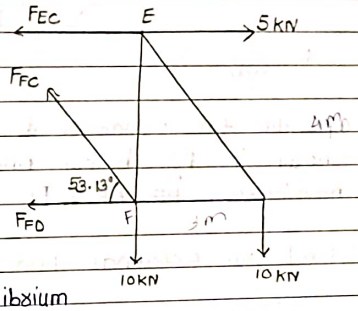
In above numerical take cross-section passing through CE, CF, DF.

consider RHS of the section ①-①.

(Because All forces are known).

$\tan\theta = \frac{4}{3}$

$\therefore \theta = 53.13°$.



Apply All the equilibrium to RHS system.

$\Sigma F_y = 0$

$F_{FC}\sin 53.13° - 20 = 0$

$\therefore \boxed{F_{FC} = 25}$ (T)

$\Sigma m@F = 0$

$-10\times3 - 5\times4 + F_{EC}\times4 = 0$

$\boxed{F_{EC} = 12.5\ kN}$ (T)

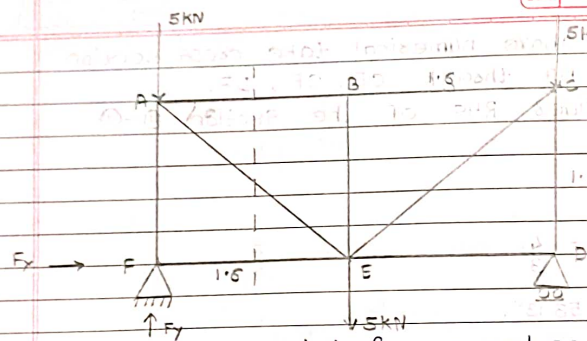
$F_x = 0$

$-F_{EC} + 5 - F_{FD} - F_{FC}\cos 53.13° = 0$

$-12.5 + 5 - F_{FD} - 25\cos 53.13 = 0$

$-7.5 - F_{FD} - 15 = 0$

$\boxed{+F_{FD} = -22.5\ kN\ (C)}$



For the truss loaded & supported as shown in fig. below find out forces in membere AB, AE & FE.

→

Find out external Reactions.

$\Sigma F_y = 0$

$-5 - 5 - 5 + D_y + F_y = 0$

$\Sigma f_x = 0$

$F_x = 0.$

$\Sigma m @ F = 0$

$D_y \times 3.2 - 5 \times 3.2 - 5 \times 1.6 = 0$

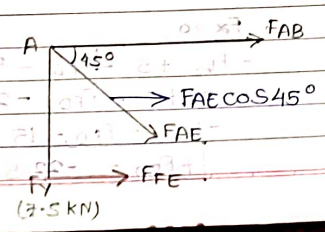
$D_y = \frac{40}{7.5}$

LHS of the section ①-①

$\Sigma m @ A = 0$

$+F_{FE} \times 1.6 = 0$

$\boxed{F_{FE} = 0}$



$\Sigma F_y = 0$

$-5 + F_y - F_{AE} \sin 45° = 0$

$-5 + 7.5 - F_{AE} \sin 45° = 0$

$F_{AE} = 3.5$ KN.

$\Sigma f_x = 0$

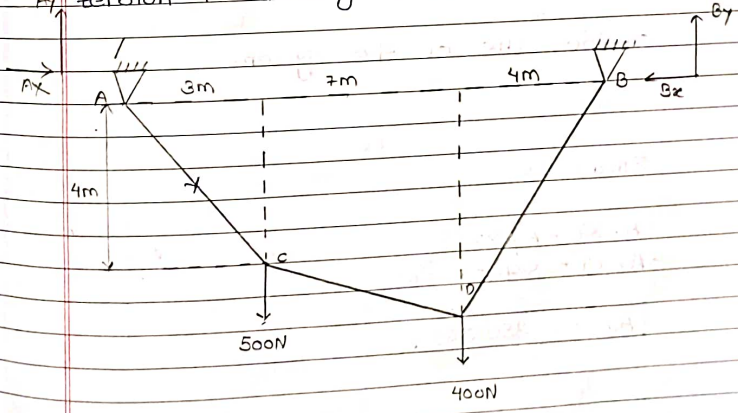
$+F_{FE} + F_{AB} + F_{AE} \cos 45° = 0$

$0 + F_{AB} + 3.5 \cos 45° = 0$

$\boxed{F_{AB} = 2.474}$ KN

* Analysis of cables :-

The cable segment ACDB is supported as shown in fig. below. determine support reactions & maximum tension in the segment of the cable.



Step - I :- External Reactions

$+A_x - B_x = 0$

$\therefore \boxed{A_x = B_x}$

$\Sigma F_y = 0$

$+A_y + B_y - 500 - 400 = 0$

$\therefore \boxed{A_y + B_y = 900}$

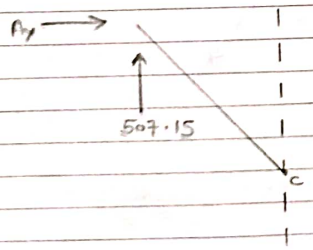
$\Sigma m@A = 0$

$+B_y \times 14 - 400 \times 10 - 500 \times 3 = 0$

$\boxed{B_y = 392.85 \text{ KN}}$

$\therefore \boxed{A_y = 507.15}$

consider LHS of the system

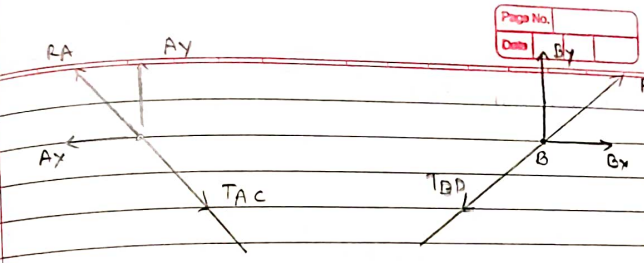


$\Sigma m@C = 0$

$-A_x \times 4 - A_y \times 3 = 0$

$-A_x \times 4 - 507.15 \times 3 = 0$

$\boxed{A_x = -380.362}$



$R_A = \sqrt{A_x^2 + A_y^2} = 633.93 \text{ KN}$

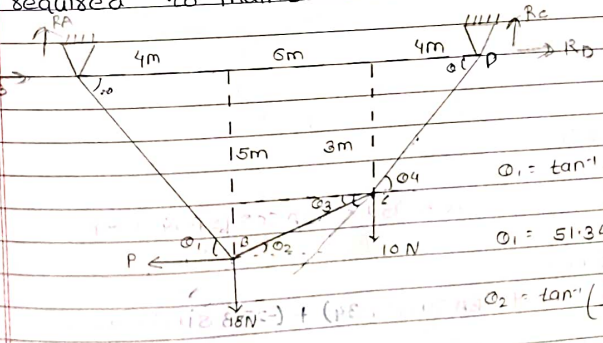
$R_B = \sqrt{B_x^2 + B_y^2} = 546.81$

as $R_A > R_B$

T_{AC} is more than T_{BD}

$\therefore$ max tension in the cable 633.93 KN.

Q. Knowing that force of 180 N & 10N are acting at pt B & pt. C respectively find out magnitude of force P. required to maintain equilibrium



$\theta_1 = \tan^{-1}\left(\frac{5}{4}\right)$

$\theta_1 = 51.34°$

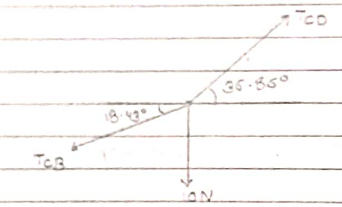
$\theta_2 = \tan^{-1}\left(\frac{2}{6}\right)$

$\theta_2 = 18.434°$

$\theta_3 = 18.434°$

$\theta_4 = \tan^{-1}\left(\frac{3}{4}\right) = 36.869°$

Equilibrium @C:



$T_{CD} = \frac{T_{CB}\cos 0.94}{0.8}$

$T_{CD} = 1.175\,T_{CB}$

$\Sigma F_x = 0$

$T_{CD}\cos(36.86) - T_{CB}\cos(18.43) = 0$

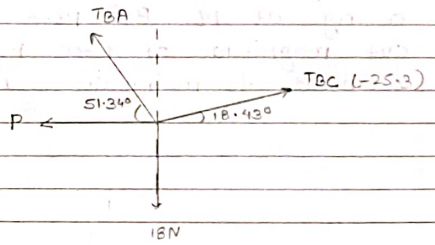
$0.800 \qquad 0.948$

$\Sigma F_y = 0$

$-10 + T_{CD}\sin(36.86) - T_{CB}\sin 18.43 = 0$

$0.7\,T_{CB} - 0.315\,T_{CB} = 10$

$T_{CD} = +30 \qquad T_{CB} = +25.3 \qquad T_{CB} = 26$



$\Sigma F_x = 0$

$\frac{-25.3\cos(18.43)}{24} - \frac{T_{BA}\cos(51.34°)}{20.798} - P = 0$

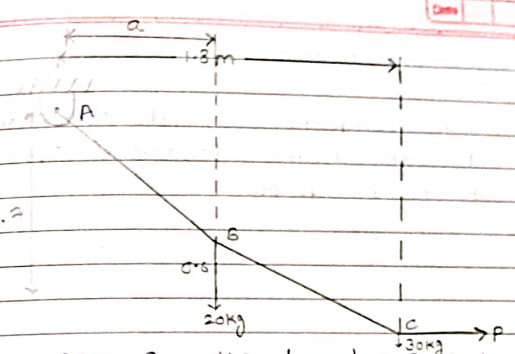
$P = -44.750$

$\Sigma F_y = 0$

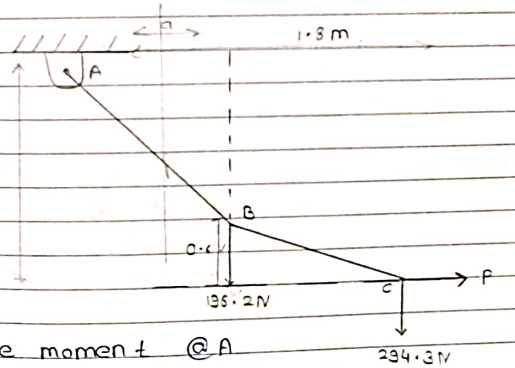
$-18 + T_{BA}\sin(51.34) + (-25.3\sin 18.43) = 0$

$T_{BA} = 33.293$

9.



cable ABC supports two boxes 20 kg at B & 30 kg at C knowing that b = 2.7m determine required magnitude of horizontal force P & corresponding dist. a.



Take moment @A

$2.7P - 294.3 \times 1.8 - 196.2 \times a = 0 \quad -①$

$2.7P - 529.74 - 196.2a = 0$

Consider RHS of the section ①-①

$\Sigma M_{@B} = 0$

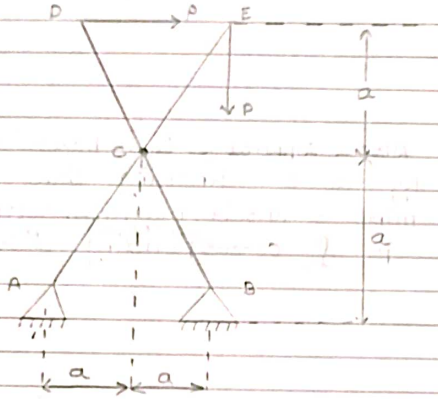
$0.6P - 294.3(1.8 - a) = 0$

$0.6P - 529.74 + 294.3a = 0 \quad -②$

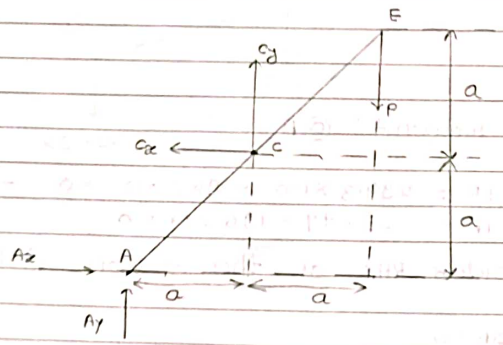
$P = 284.806\,N \qquad a = 1.219\,m$

Analysis of frames :

Q. Determine components of the reaction at 'C' for the frame loaded & supported as shown in below.



consider part FBD of 'ACE'



at this decide the reaction of yourself for next step take app. reactions

we have to find forces of 'C' so take moment (A). at E not useful only

frame P-0

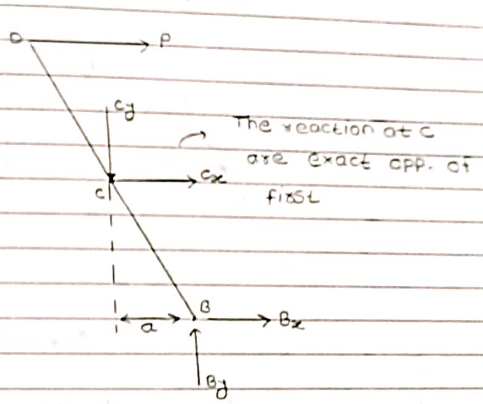
$\Sigma M@A = 0$

$-P \times 2a + C_y \times a + C_x a = 0$

$a[C_x + C_y] = P2a$

$\therefore C_x + C_y = 2P \quad -①$

consider FBD of DCB..



$\Sigma M@B = 0$

$-C_x \times a + C_y \times a - P \times 2a = 0$

$a[C_y - C_x] = P2a$

$\boxed{C_y - C_x = 2P} \quad -①$

$2C_y = 4P$

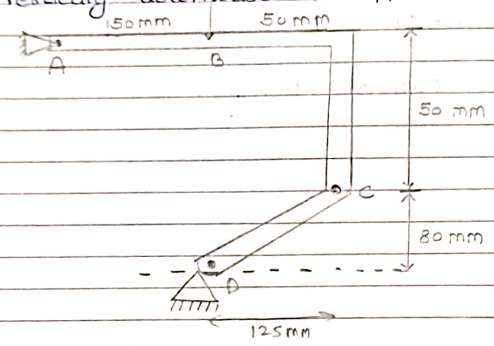
$C_y = 2P$

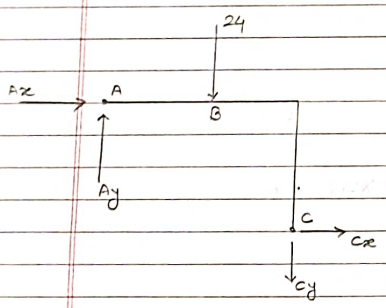
Put in ①

$2P - C_x = 2P$ $\quad \therefore \boxed{C_x = 0}$

$\therefore \boxed{C_y = 2P}$ $\boxed{C_x = 0}$

Q. Determine the components of reaction at pt A & D when the force of 24 KN directed vertically downward is applied at pt. B





$\Sigma F_x = 0$

$A_x + C_x = 0$

$A_x = -20.22$

$\Sigma F_y = 0$

$A_y - 24 - C_y = 0$

$A_y - 24 + 12.94 = 0$

$A_y = 11.06.$

$\Sigma m@C = 0$

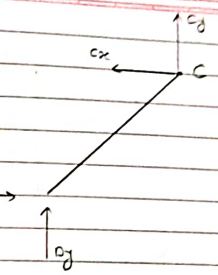
$-A_x \times 50 - A_y \times 200 + 24 \times 50 = 0$

$50A_x + 200A_y = 1200$

$A_x + 4A_y = 24 \quad -(1)$

$\Sigma m@D = 0$

$C_y \times 125 + C_x \times 80 = 0$



$\Sigma m@A = 0$

$-C_y \times 200 + C_x \times 50 - 24 \times 150 = 0$

$C_x - 4C_y = 72 \quad -(2)$

$C_x = 20.22 \qquad C_y = -12.943$

$\Sigma F_x = 0$

$D_x - C_x = 0$

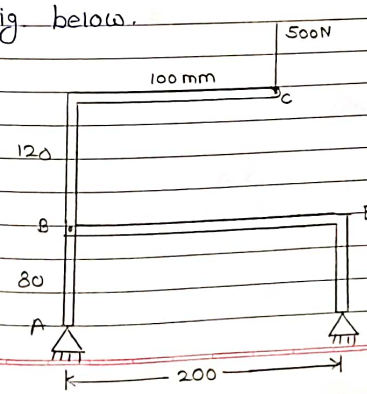
$D_x = 20.22$

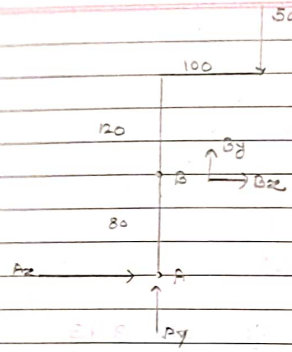
$\Sigma F_y = 0$

$C_y + D_y = 0$

$D_y = 12.943.$

Q. Determine components of forces exerted at pin 'B' on member BED for the frame loaded & supported as shown in fig. below.





$\Sigma M_{@A} = 0$

$-B_x \times 80 - 500 \times 100 = 0$

$B_x = \frac{-500 \times 100}{80} = -625.$

Find out Reactions at support & forces in all membexs of Truss.