Plane Trusses
(case of equ^m)

Truss → Truss is a rigid structure in which member are subjected to either axial tensile or axial compresive only & bending moment is zero in every where in the structure.

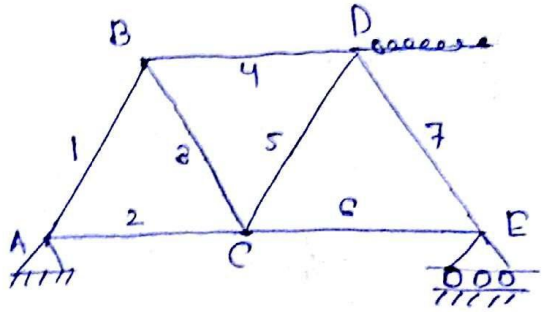
Conditions –

i) All the members should be pin jointed only at the end (Hinged)

ii) only Concentrated point loads are applied

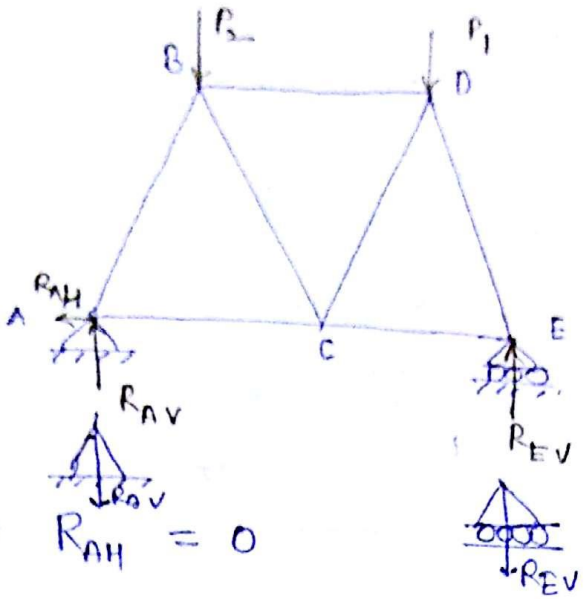
iii) Load should be applied at the joint only

Truss system :-



truss system = members + Pins/joints

→ Truss system alway in equ^m



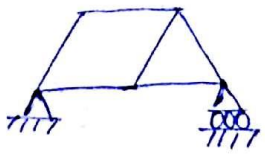
$\Rightarrow R_{AH} = 0$

$\Rightarrow R_{AV} + R_{EV} = P_1 + P_2$

Types

Plane truss [2D only]

Stable truss 'or' Perfect	Collapsible 'or' Destructive	Indestructive truss or Redundant
$m = 2j - 3$	$m < 2j - 3$	$m > 2j - 3$
m → no. of member's		# of m > required
j → # joints		



Analysis of Trusses :-

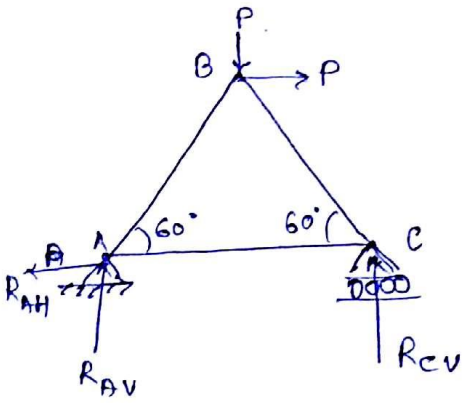
- method of Joints
- method of section

Determination of Reaction

Concept :-

By considering equ^{m} of entire truss we can find out rxn at the support.

Pb.1



Rxn at the support = ?

considering equ^{n}

$\Sigma F_H = 0$

$R_{AH} = P (\leftarrow)$

$\Sigma F_V = 0$

$R_{AV} + R_{CV} = P$

So By Considering

$\Sigma M_A = \Sigma M_C = 0$

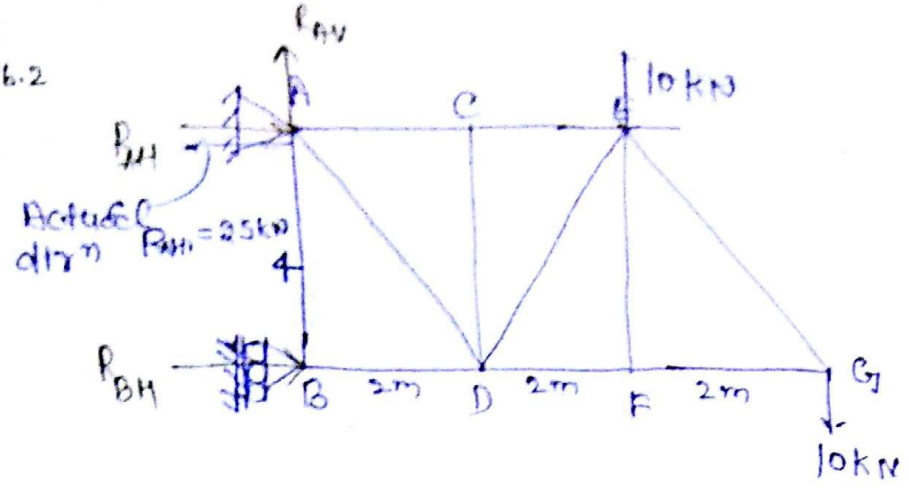
$R_{AV} = R_{CV} = \frac{P}{2} (\uparrow)$

So Rxn

$R_{AH} = P (\leftarrow)$

$R_{AV} = R_{CV} = \frac{P}{2} (\uparrow)$

Pb.2



By Considering equ^{m} of entire truss

$$\Sigma \vec{F}_V = 0$$

$$R_{AV} - 10 - 10 = 0$$

$$\Rightarrow \quad R_{AV} = 20\ kN\ (\uparrow)$$

$$\Sigma \vec{F}_H = 0$$

$$R_{AH} + R_{BH} = 0$$

$$R_{AH} = -R_{BH}$$

$$\Sigma M_A = 0$$

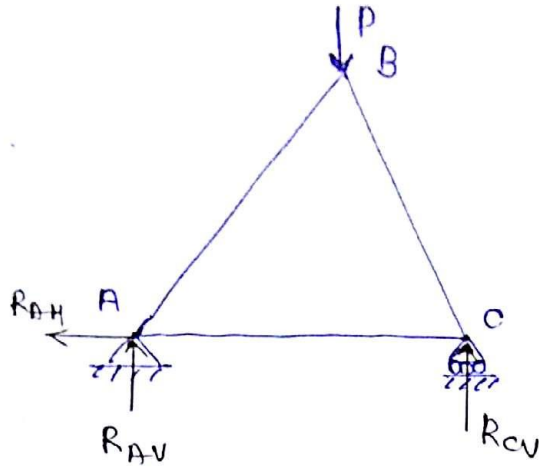
$$10 \times 4 + 10 \times 6 - R_{BH} \times 4 = 0$$

$$R_{BH} = 25\ kN\ (\rightarrow)$$

$$R_{AH} = -25\ kN$$

$\downarrow$ dirn Horizontal backward

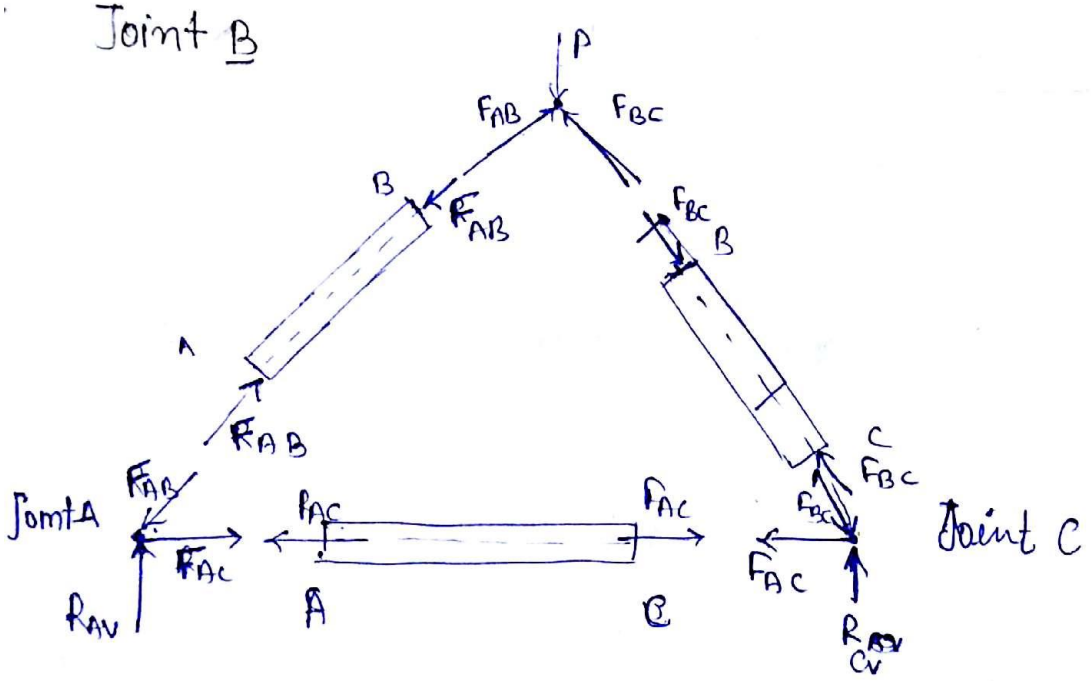
Interaction of active, Reactive & Internal Forces →

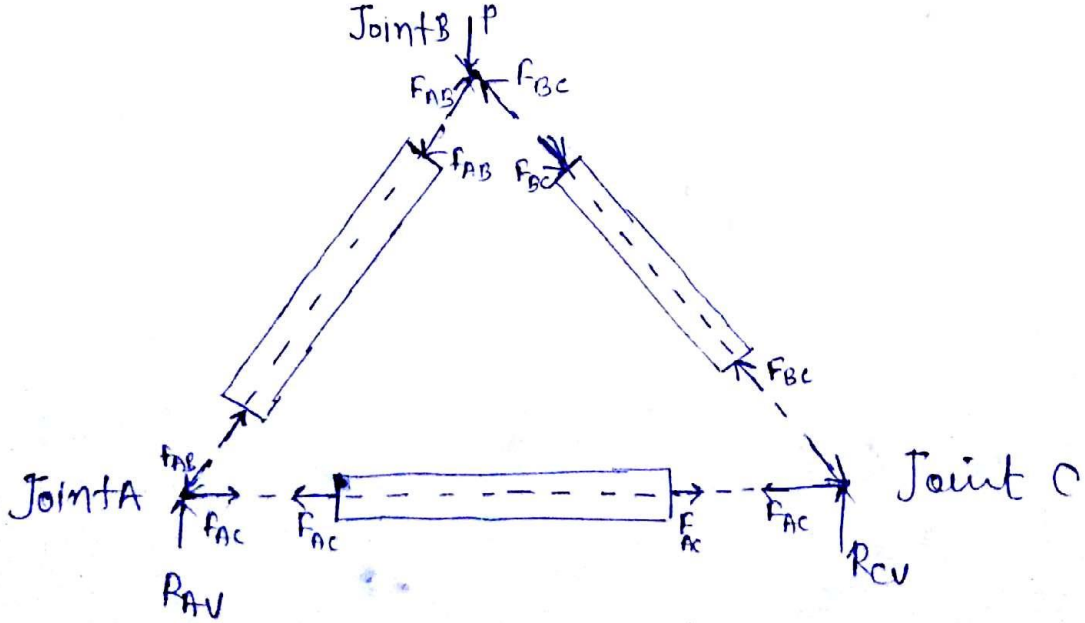


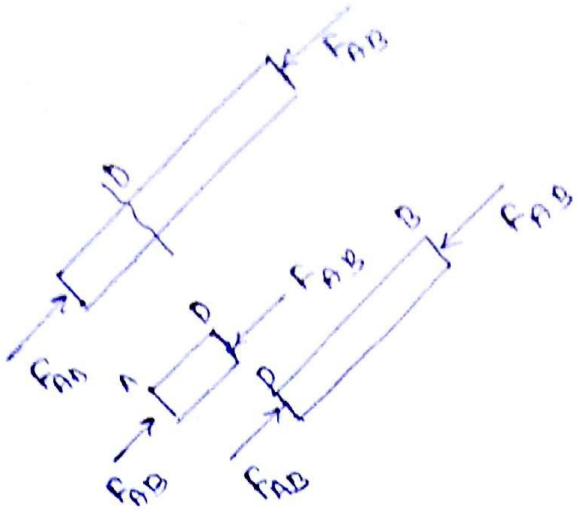
$$R_{AV} + R_{CV} = P$$

$$R_{AH} = 0$$

Joint B





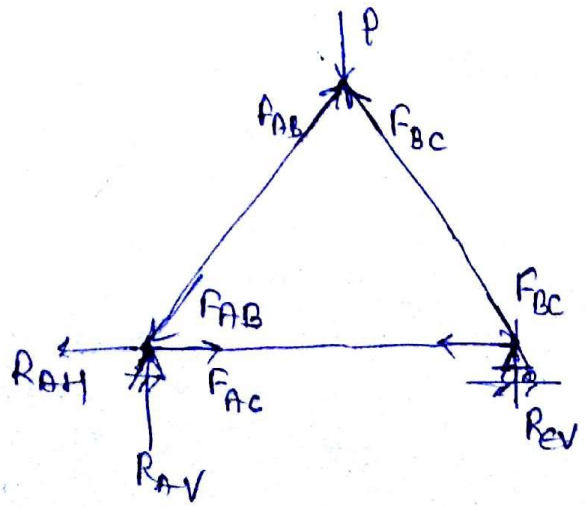


Method of Joint

Concept: equm of a joint is considered in method of joint.

Procedure:-

1. Find support rxn considering equm of the entire truss.
2. Consider equm of a joint where only two unknown members are meeting and use $\sum \vec{F_x} = \sum \vec{F_y} = 0$ to find the unknowns.

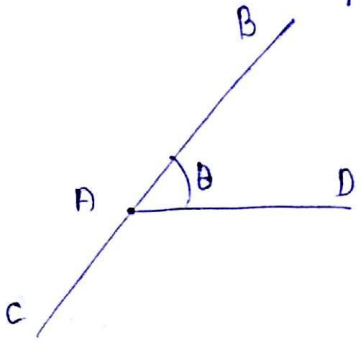


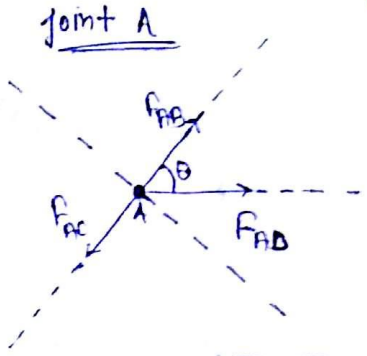
Note:)

① If a member pushes a joint then the member it self will be in Compresion with the same intensity.

② If a member pulls a joint then the member it self will be in tension with the same intensity

③ If a joint three members are meeting and two are collinear then the force in third member will be zero if their is no load or rxn applied at that joint.





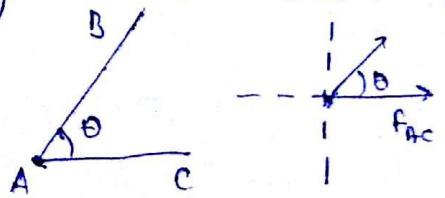
$F_{AD} \sin\theta = 0$

$\sin\theta \neq 0$

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

$\boxed{F_{AC} = F_{AB}}$

④ If at a joint two members are meeting and they are non collinear then the force in both the member will be zero (if there is no load for Rxn at that joint)

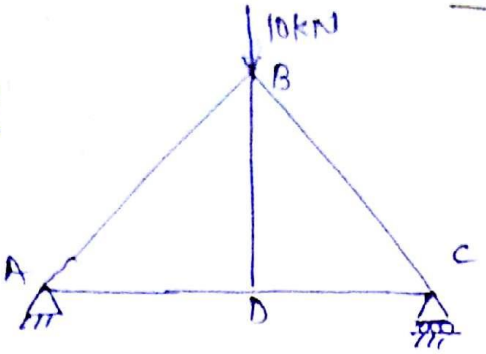


$F_{AB} \sin\theta = 0 \Rightarrow \boxed{F_{AB} = 0}$

$F_{AC} + F_{AB} \cos\theta = 0 \Rightarrow \boxed{F_{AC} = 0}$

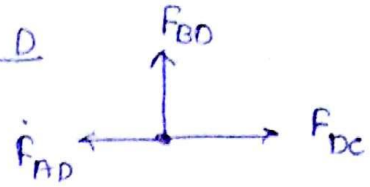
Problem 1

$F_{BD} = ?$



Soln

joint D

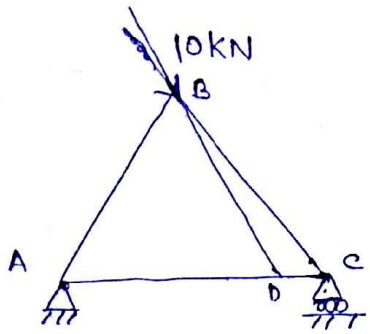


$F_{BD} = 0$

two are collinear

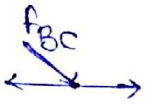
Problem 2

$F_{BD} = ?$



Soln joint D

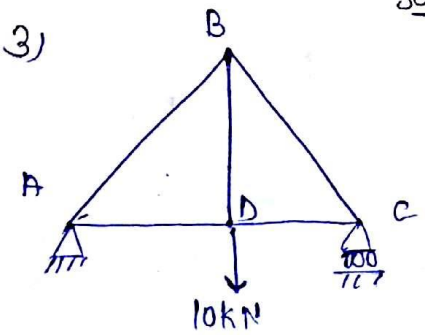
$F_{BD} = 0$



two are collinear

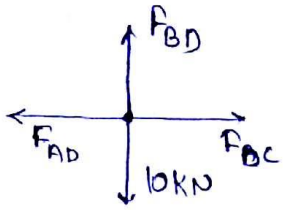
Problem 3)

$F_{BD} = ?$



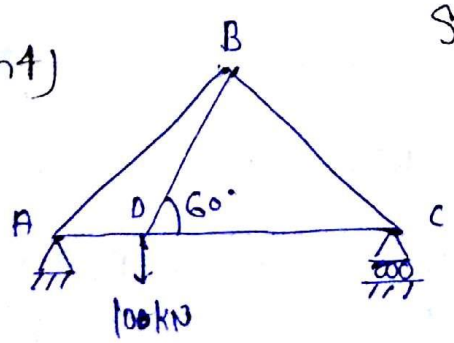
Soln

joint D



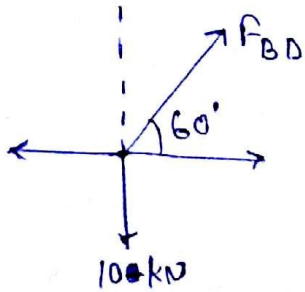
$F_{BD} = 10$ KN (tensile)

Problem 4)



Soln

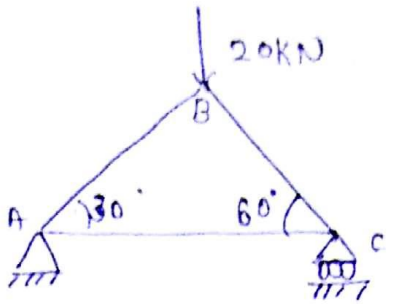
joint D



$F_{BD} \sin 60^\circ = 10$

$F_{BD} = 11.54$ KN (tensile)

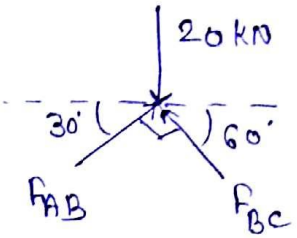
Problem 5)



$F_{AC} = ?$

Sol^n

Joint B



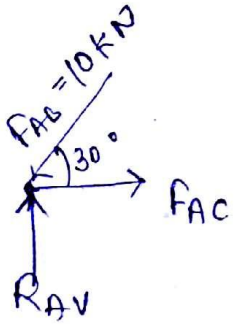
lami's thm

$$\frac{F_{AB}}{\sin(150)} = \frac{20}{\sin(90^\circ)} = \frac{F_{BC}}{\sin(120)}$$

$$F_{AB} = 20 \times \sin 150^\circ = 10 \text{ kN}$$

$$F_{BC} = 20 \sin(120) = 10\sqrt{3} \text{ kN}$$

Joint A



$$F_{AB} \sin 30^\circ = R_{AV} = 5 \text{ kN} (\uparrow)$$

$$F_{AC} = F_{AB} \cos 30^\circ = 5\sqrt{3} \text{ (tensile)}$$

$$R_{AV} + R_{CV} = 20$$

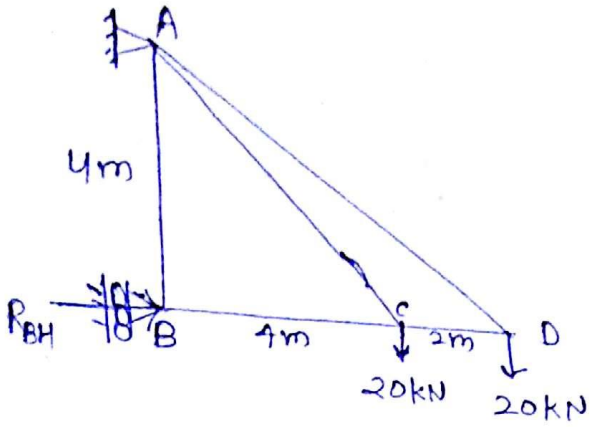
$$R_{CV} = 20 - 5 = 15 \text{ kN} (\uparrow)$$

(H.W. Do with joint C)

Problem 8.5
P.g. 105

$F_{AB} = ?$

$F_{BC} = ?$

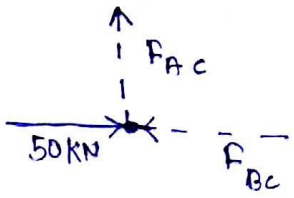


$$\Sigma \vec{M}_A = 0$$

$$20 \times 4 + 20 \times 6 = R_{BH} \times 4$$

$$R_{BH} = 50 \text{ kN}$$

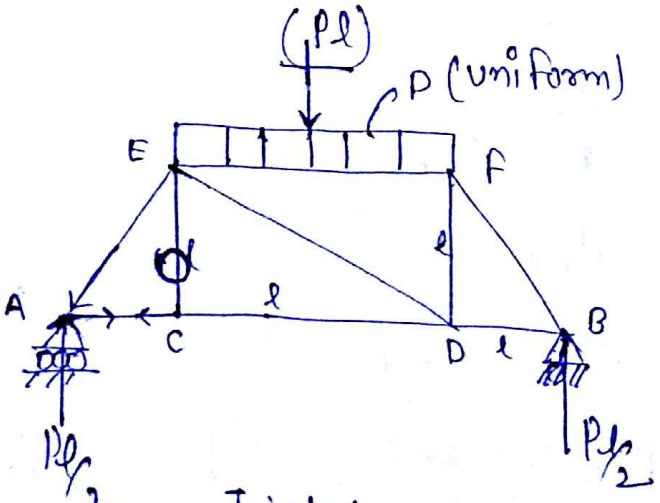
Joint B



$$F_{BC} = 50 \text{ kN} \; ; \quad F_{AC} = 0$$

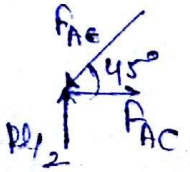
(compo)

Question
Pg. 61
Q.3



$F_{CD} = ?$

Joint A



$$F_{AE} \sin 45^\circ = Pl/2 \quad -(1)$$

$$F_{AE} \cos 45^\circ = Pl/2 \, F_{AC} \quad -(2)$$

(1) & (2)

$$f_{AC} = Pl/2 \quad (\text{tensile})$$

Joint C

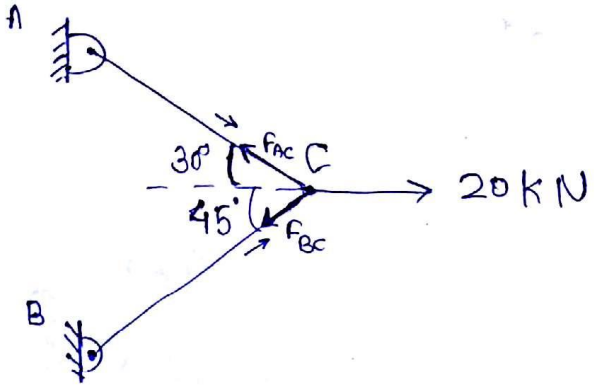
f_{AC} ⟷ F_{CD}

$$F_{AC} = F_{CD}$$

$$F_{CD} = \frac{Pl}{2} \quad (\text{tensile})$$

Problem

Rxn at 'A'



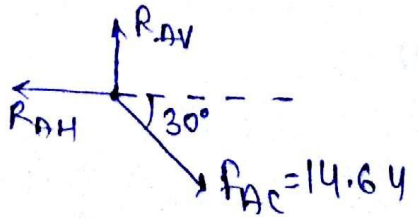
Applying lami's thm

$$\frac{F_{AC}}{\sin(135^\circ)} = \frac{20}{\sin(45)} = \frac{F_{BC}}{\sin(150^\circ)}$$

$F_{AC} = 14.64$ kN (tensile)

$F_{BC} = 10.35$ kN (tensile)

joint A

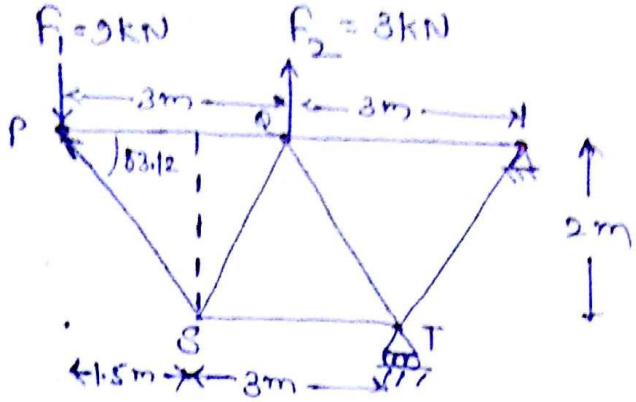


$f_{AM} = f_{AC} \sin 30^\circ = 7.32$

$f_{AH} = f_{BC} \cos 30^\circ = 12.67$ kN (←)

(b)

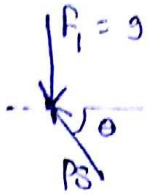
Ques:-



$f_{Q3} = ?$

Solⁿ

at joint P



$\tan\theta = \frac{2}{1.5}$

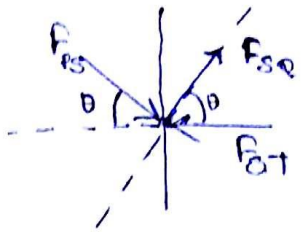
$\theta = 53.13$

$PS \sin(53.13) = 9$

$PS = 11.25\ kN$ (Comp.)

Joint S

$\theta = 53.13$

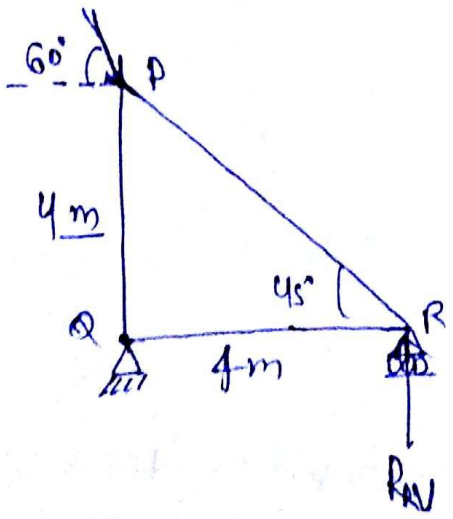


$\theta = 53.13$

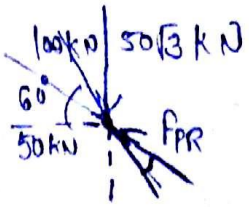
$F_{PS} \sin\theta = F_{SQ} \sin\theta$

$F_{SQ} = 11.25\ kN$ (tensile)

Que.



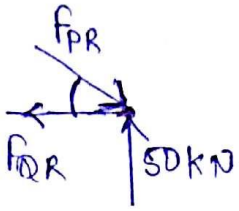
$F_{PR} = ?$ R_{kN} at R



$\Sigma M_P = 0$

$50 \times 4 - R_{RV} \times 4 = 0$

$R_{RV} = 50\,kN(\uparrow)$



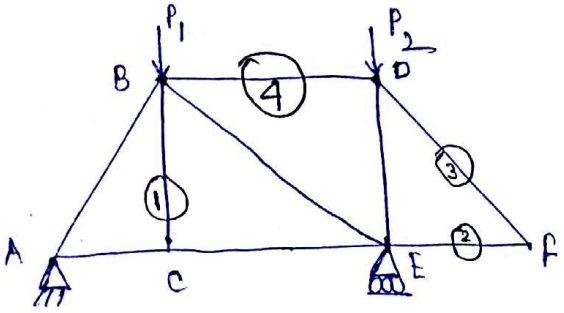
$f_{PR} \sin 45° = 50$

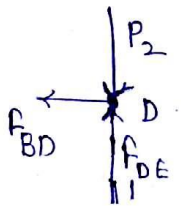
$f_{PR} = \frac{50\sqrt{2}}{2}\,kN$ compressive

$f_{PR} = 50\sqrt{2}\,kN$ $\quad R_{RV} = 50\,kN$

$f_{PR} = 70.71$

Q. Find the member having zero forces in them



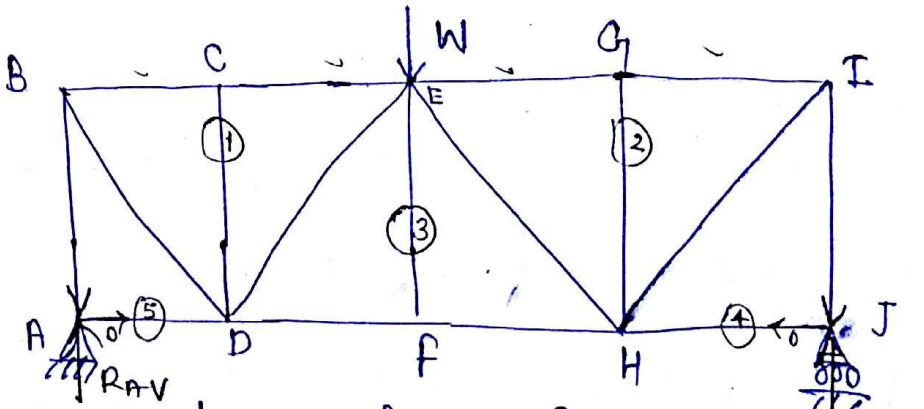


$f_{DE} = P_2$

$f_{BD} = 0$

Total = 4 Ans

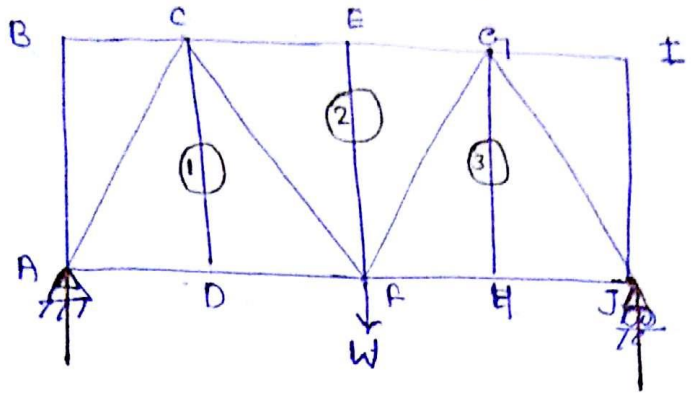
Q.



Find # member having zero forces ?

total = 5

Ques (H.W) Find # member having zero force.



Method of Section :—

Concept :—

① equ^m of a section of a truss considered in method of section.

Procedure

① Find the support rxn considering equ^m of entire truss

② Cut the member (जिसमें force निकालनी है) under consideration by a section

①----------①

and consider equ^m of either LHS or RHS of section ①—① for active, reactive and forces in the cut members. to find the unknown using $\Sigma \vec{F}_x = \Sigma \vec{F}_y = 0$ & $\Sigma \vec{M} = 0$.

Note

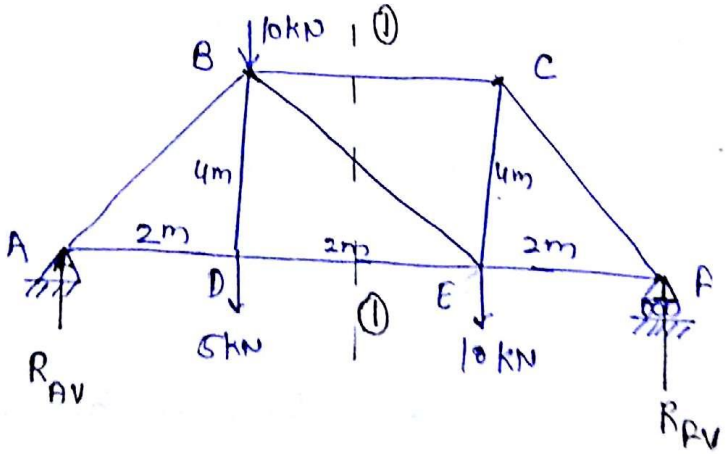
① The advantage of method of section is that force in any intermidiate member can be found directly without calculating force in other members.

② Cut the members such that the entire truss is devided into two seprate part.

③ Refrabaly do not Cut three members bcoz in method of section we have only three equn of equ^m.

④ Cut the members such that all the cut member do not meet a joint (if they meet at one joint then it become method to joint problem.

Pbm



$F_{BC} = ?$

$F_{BE} = ?$

$F_{DE} = ?$

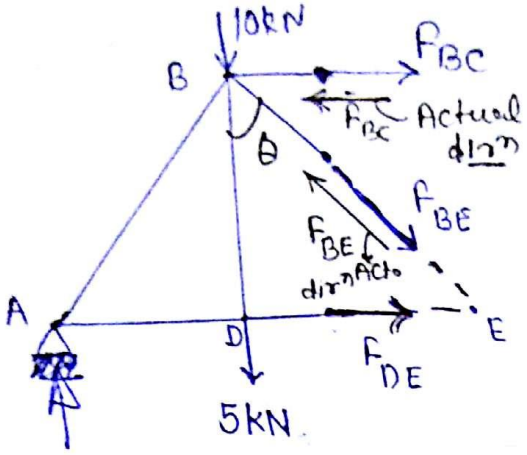
$\Sigma M_F = 0$

$-R_{AV} \times 6 + (10 \times 4) + (5 \times 4) + 10 \times 2 = 0$

$R_{AV} = 13.33\ KN (\uparrow)$

$R_{AV} + R_{FV} = 25 \Rightarrow R_{FV} = 11.67\ KN$

Considering equ^{m} of LHS of Section ①—①



$f_{BE} = ?$

$\Sigma \vec{M}_E = 0$

$13.33 \times 4 + f_{BC} \times 4 = 15 \times 2$

$f_{BC} = -5.83\ kN$

$f_{BC} = 5.83\ kN\ (Compo)$

$f_{DE} = ?$

$\Sigma \vec{M}_B = 0 \quad \curvearrowright 13.33 \times 2 - f_{DE} \times 4 = 0$

$f_{DE} = 6.65\ (tensile)$

$\tan\theta = \frac{2}{4}$

$\theta = 26.56°$

$f_{BE} = ?$

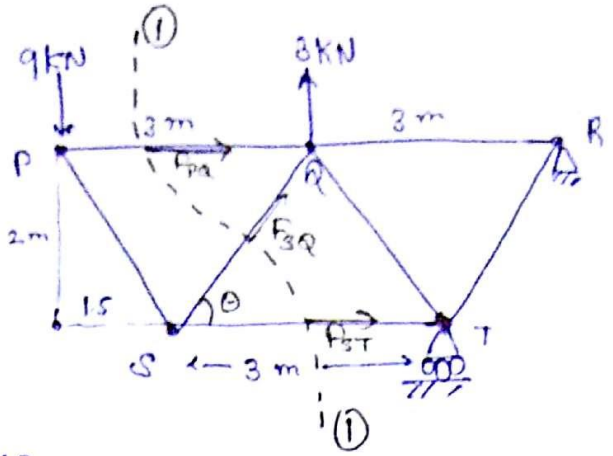
$\Sigma \vec{F}_V = 0$

$13.33 - 10 - 5 - f_{BC} \cos\theta = 0$

$f_{BE} = -1.86\ kN$

$f_{BC} = 1.86\ kN\ (Compo)$

Q.U8



$F_{SQ} = ?$

$\theta = 53.13$

Considering L.H.S.

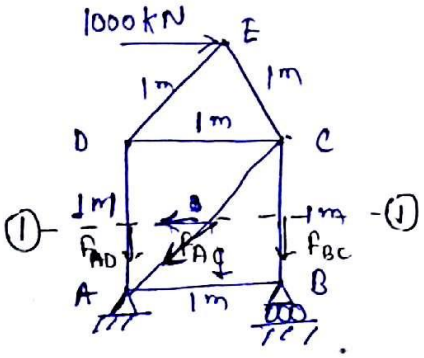
$$\Sigma \vec{F}_V = 0$$

$$-9 + F_{SQ} \sin\theta = 0$$

$$\Rightarrow F_{SQ} = 11.25 \text{ kN (tensile)}$$

Q.8.3
P.9.104

$F_{AC} = ?$



Considering upper side

$$\Sigma \vec{F}_H = 0$$

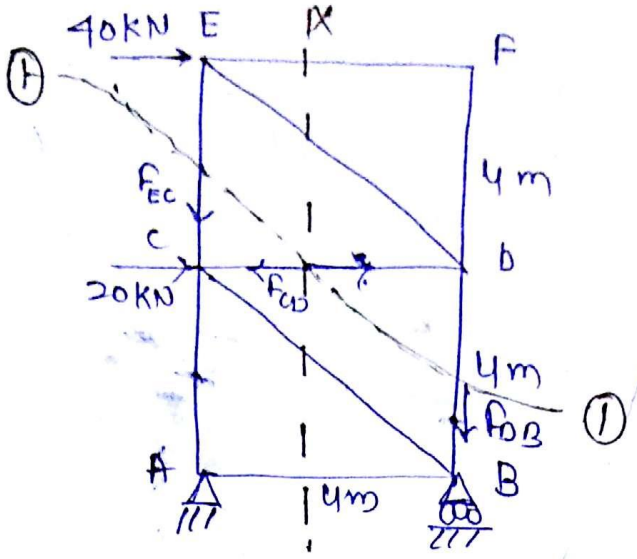
$$1000 - F_{AC}\cos 45^\circ = 0$$

$$F_{AC} = 1000\sqrt{2} \text{ kN (tensile)}$$

$$F_{AC} = 1414 \text{ kN}$$

Q 8.8

P.g.105



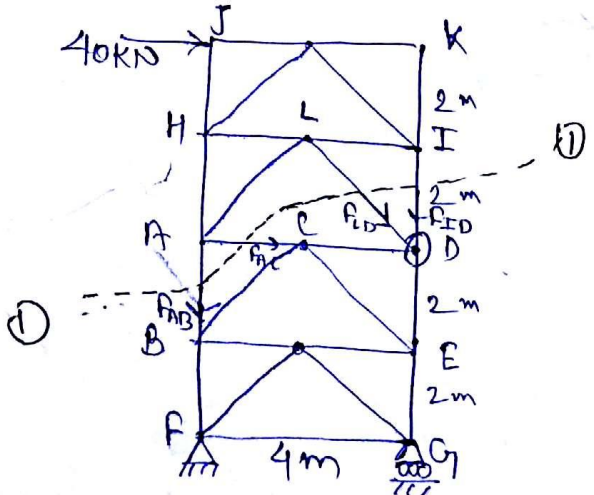
cut by ① -- ①

Considering upper side

$\Sigma \vec{F}_H = 0$

$40 - F_{CD} = 0 \Rightarrow F_{CD} = 40$ kN (tensile)

Ques For the truss shown below find the force in member AB.



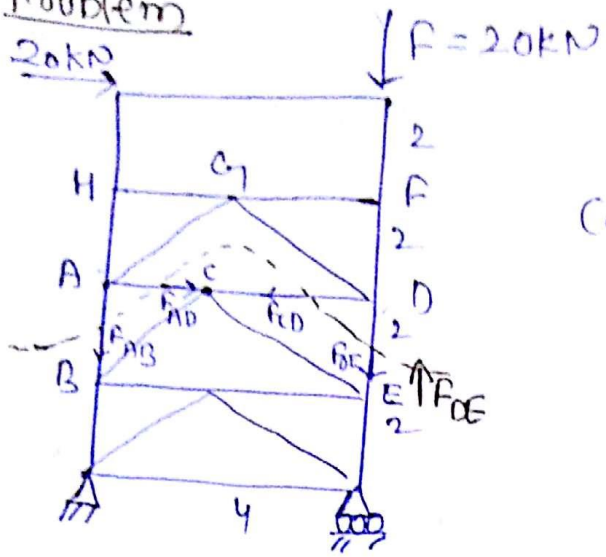
Sol^n Considering upper side ① -- ①

$\Sigma \vec{M}_D = 0$

$\Rightarrow 40 \times 4 - f_{AB} \times 4$

$f_{AB} = 40$ (tensile)

Problem



$F_{DE} = ?$

Consider copper side

$\Sigma M_A = 0$

$20 \times 4 + 20 \times 4 + f_{DE} \times 4 = 0$

$F_{DE} = -40\,kN$

$F_{DE} = 40\,kN$ (Compo)