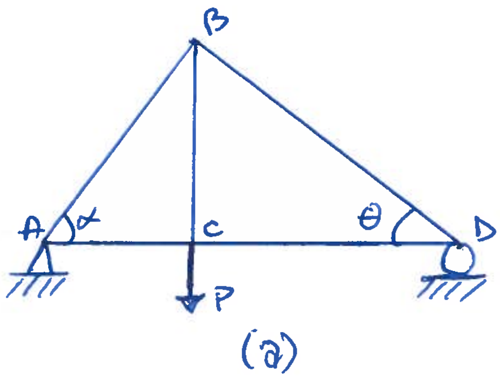
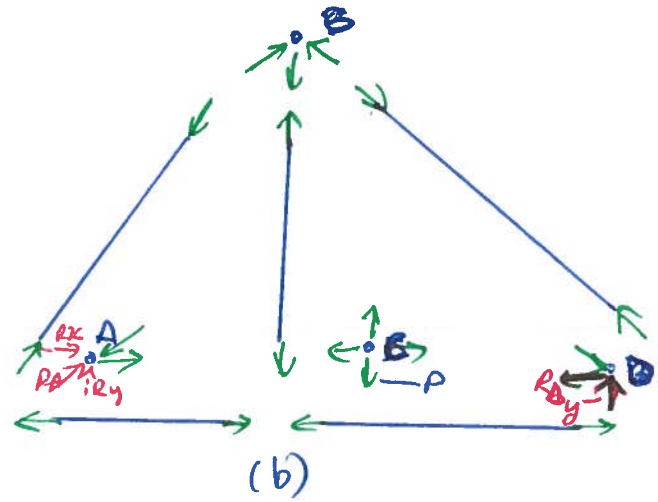
5.3.1 ANALYSIS OF TRUSSES BY THE METHOD OF JOINTS

The lines of actions of all the internal forces in the truss are known, the analysis reduces to finding the magnitude of forces and determining if in "compression" or "tension".



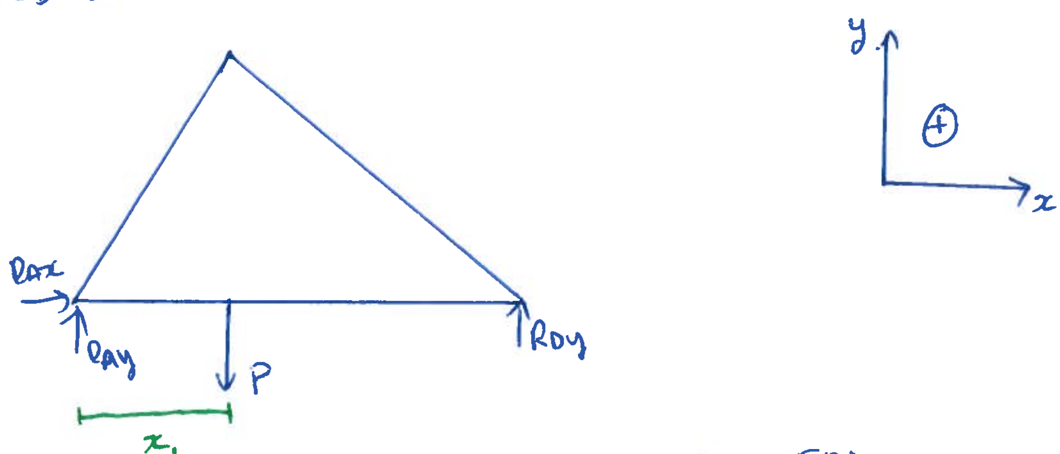
(a)



(b)

STEPS:

1) FBD of the entire truss (analysis truss as a rigid body)



2) Apply equilibrium equation to the previous FBD to find the reaction forces.

$$\sum F_x = 0 = R_{Ax}$$

$$\sum F_y = 0 = R_{Ay} - P + R_{Dy}$$

$$(+) \sum M_A = 0 = -P x_1 + R_{Dy} x_2$$ (could of taken point D)

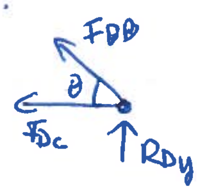
3) Equilibrium at each joint

(refer to drawing (b) on previous page)

Apply the equation of equilibrium at each joint after drawing their respective FBD.

JOINT D

FBD:



$$\Sigma F_x = 0 = -F_{DC} - F_{DB}\cos\theta$$

$$\Sigma F_y = 0 = R_{Dy} + F_{DB}\sin\theta$$

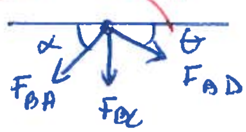
(Don't begin with a joint that has three or more unknowns, since we only have 2 equations (2D particles))

2 equations → 2 unknowns to solve.

JOINT B

FBD:

we do not know the directions so we assume one to start with.



alternate interior angle

$F_{BD} = F_{DB}$

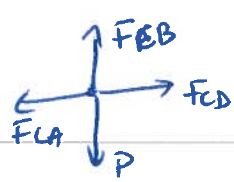
$$\Sigma F_x = 0 = F_{BD}\cos\theta - F_{BA}\cos\alpha$$

$$\Sigma F_y = 0 = -F_{BC} - F_{BA}\sin\alpha - F_{BD}\sin\theta$$

2 equations - 2 unknowns

JOINT C

FBD:



$$\Sigma F_x = 0 = F_{CD} - F_{CA}$$

$$\Sigma F_y = 0 = -P + F_{CB}$$

JOINT A — If we want to verify our results $(0=0)$

FBD:

$\sum F_x = 0 = R_{Ax} + F_{AC} + F_{AB}\cos\alpha$

$\sum F_y = 0 = R_{Ay} + F_{AB}\sin\alpha$

4) Write if the forces are in tension or compression;

Ex: $F_{AC} = Z$ N in T

$F_{BC} = Y$ N in C

~ if all forces are supposed to be in tension initially then with the sign;

$\ominus$ = compression

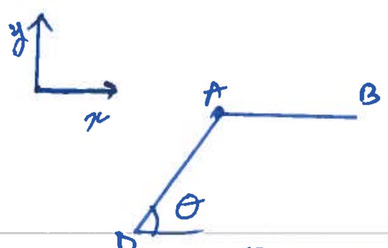
$\oplus$ = tension.

★★★ When you find ~~the~~ direction of a force during the analysis of a joint DO NOT FORGET TO ADJUST THE DIRECTION OF THE KNOWN FORCE AT THE OTHER JOINTS !!!!!

5.3.2 ZERO-FORCE MEMBERS

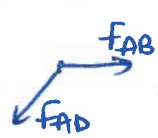
→ (also reaction forces)

1) If we have two members at a joint, no external forces and the two members are not aligned → these two members must be 0.



$F_{AB} = F_{AD} = 0$

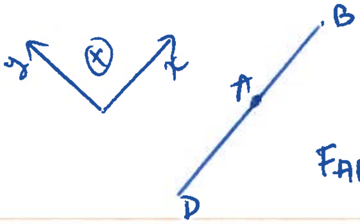
FBD:



$\sum F_x = 0 = F_{AB} - F_{AD}\cos\theta$

$F_{AB} = 0$

$\sum F_y = 0 = -F_{AD}\sin\theta \Rightarrow F_{AD} = 0$



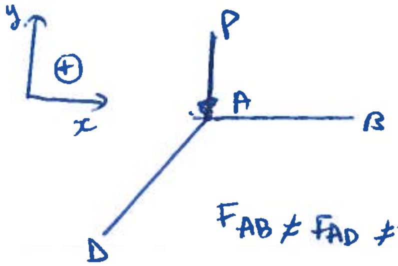
$F_{AB} = F_{AD} \neq 0$

FBD:

$\Sigma F_x = 0 \quad -F_{AD} + F_{AB}$

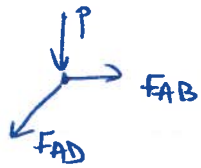
$\Rightarrow F_{AD} = F_{AB}$

$\Sigma F_y = 0.$



$F_{AB} \neq F_{AD} \neq 0$

FBD:



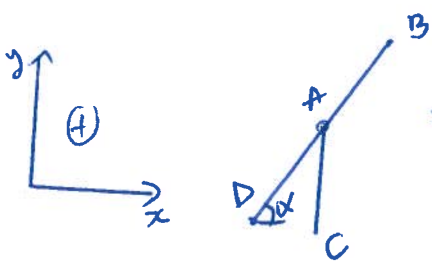
$\Sigma F_x = 0 = F_{AB} - F_{AD}\cos\theta$

$\Sigma F_y = 0 = -P - F_{AD}\sin\theta$

$\Rightarrow$

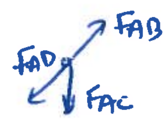
$$F_{AD} = \frac{-P}{\sin\theta}$$

2) If we have 3 members at a joint, no external force and two members are aligned, the third member is a zero-force member.



$F_{AC} = 0$

FBD:

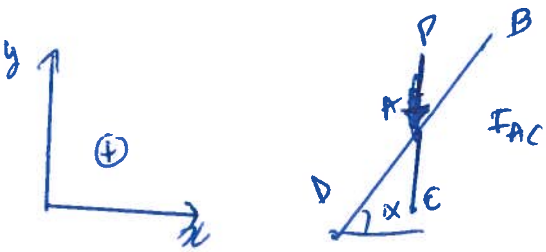


$\Sigma F_x = 0 = F_{AD}\cos\alpha + F_{AB}\cos\alpha$

$\Rightarrow F_{AD} = F_{AB}$

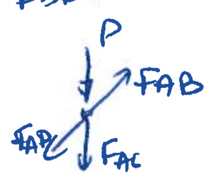
$\Sigma F_y = 0 \quad \underbrace{-F_{AD}\sin\alpha + F_{AB}\sin\alpha}_{=0} - F_{AC}$

$\Rightarrow F_{AC} = 0$



$F_{AC} \neq 0$

FBD:



$\Sigma F_x = 0 = -F_{AD}\cos\alpha + F_{AB}\cos\alpha$

$F_{AD} = F_{AB}$

$\Sigma F_y = 0 = \underbrace{-F_{AD}\sin\alpha + F_{AB}\sin\alpha}_{0} - P - F_{AC}$

$\Rightarrow F_{AC} = -P$