Statics   Topic Rigid Bodies   Date 2/1/14
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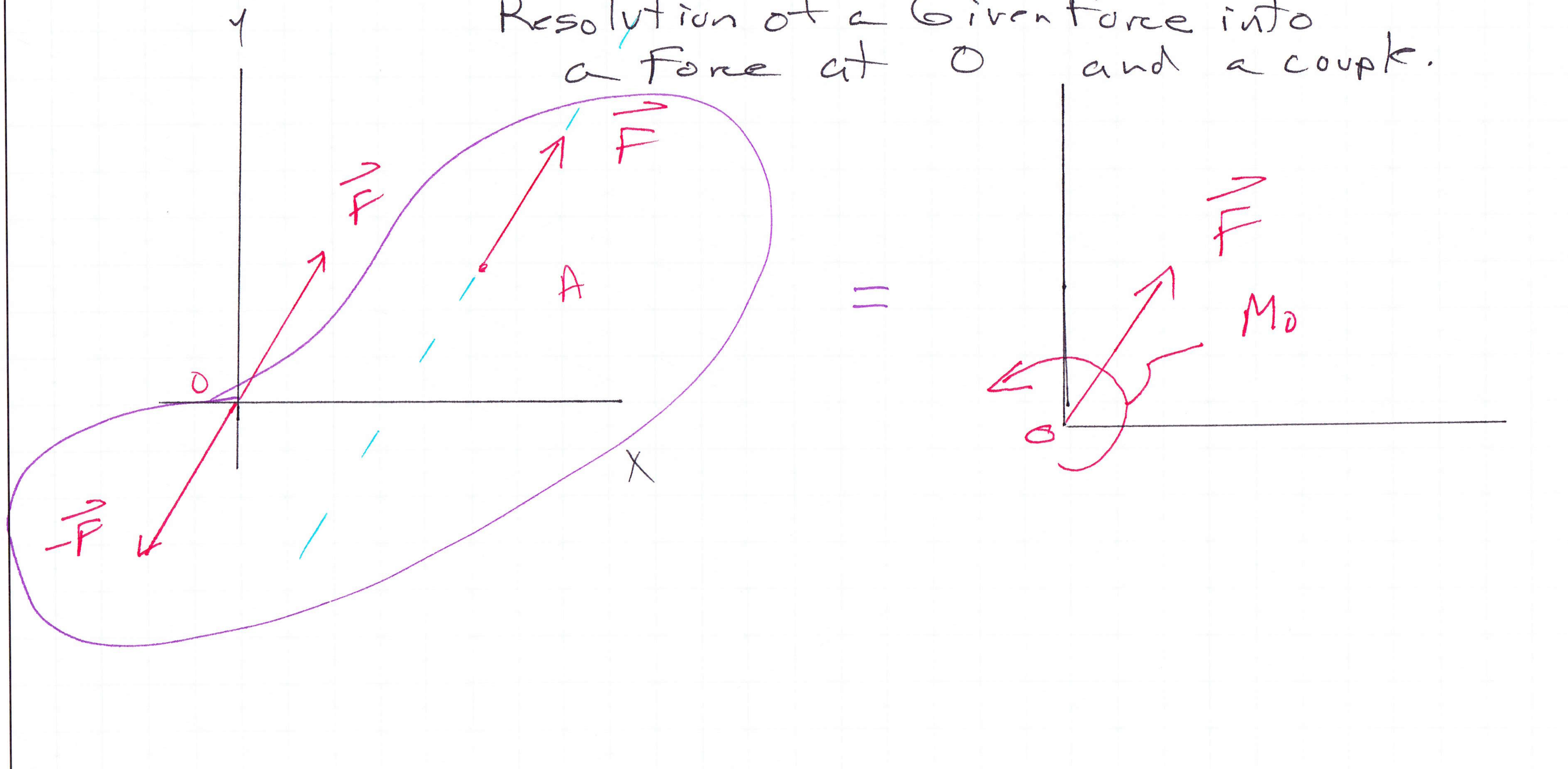
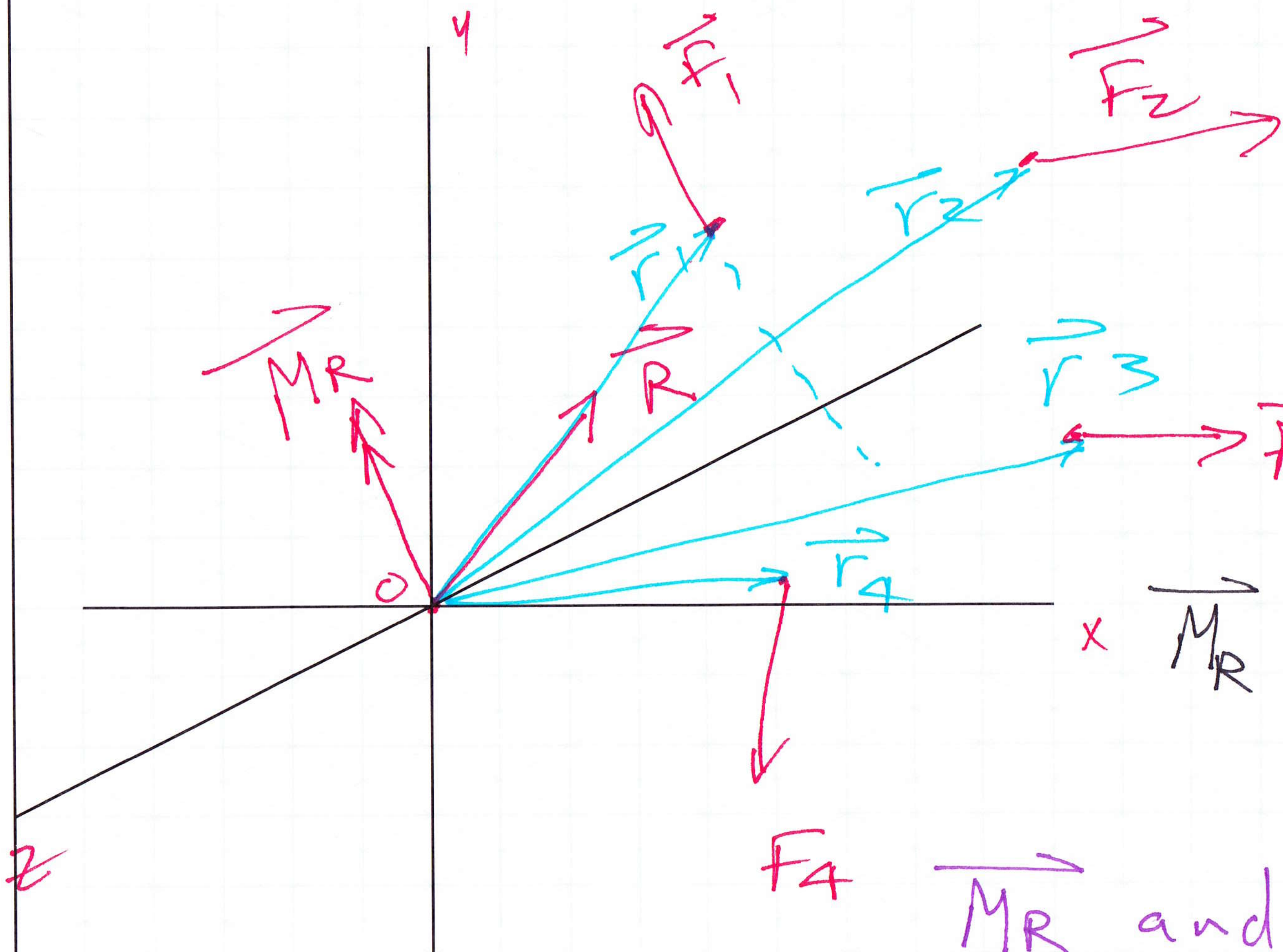
Resolution of a Given Force into a Force at O and a couple.





Simplification of a Force Couple System

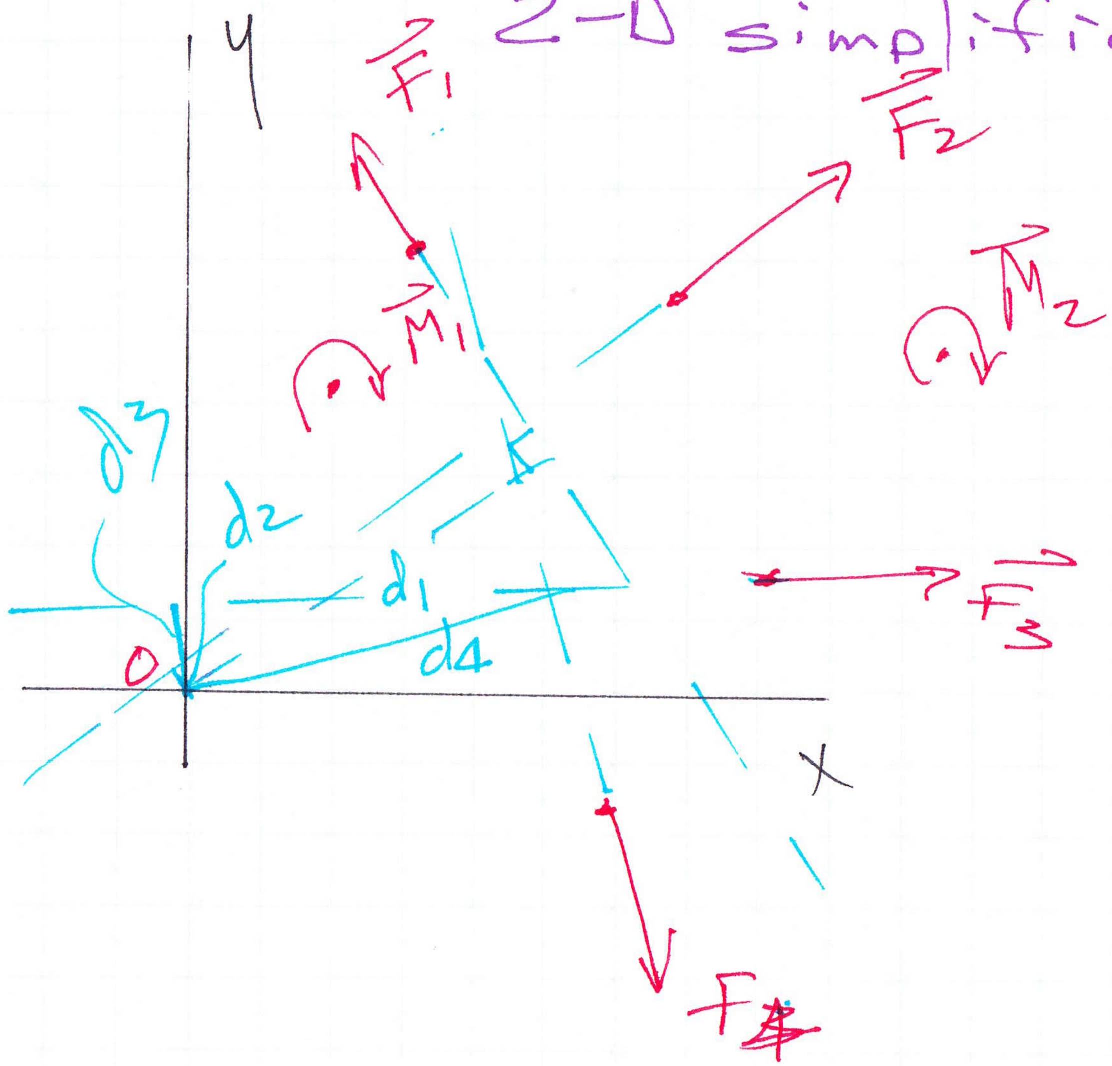
Transfer all forces and moments to the origin.

$$\vec{R} = \vec{F_1} + \vec{F_2} + \vec{F_3} + \vec{F_4}$$

$$\vec{M_R} = \vec{r_1} \times \vec{F_1} + \vec{r_2} \times \vec{F_2} + \vec{r_3} \times \vec{F_3} + \vec{r_4} \times \vec{F_4}$$

$\vec{M_R}$ and $\vec{R}$ — completely represent the original force system.

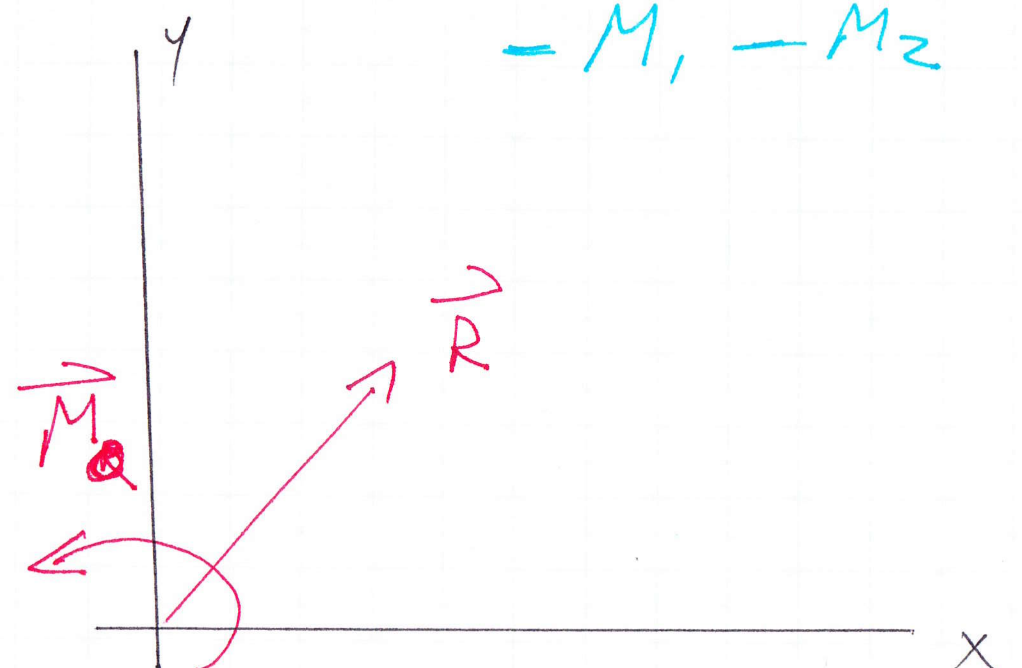
2-D simplification of Force Systems

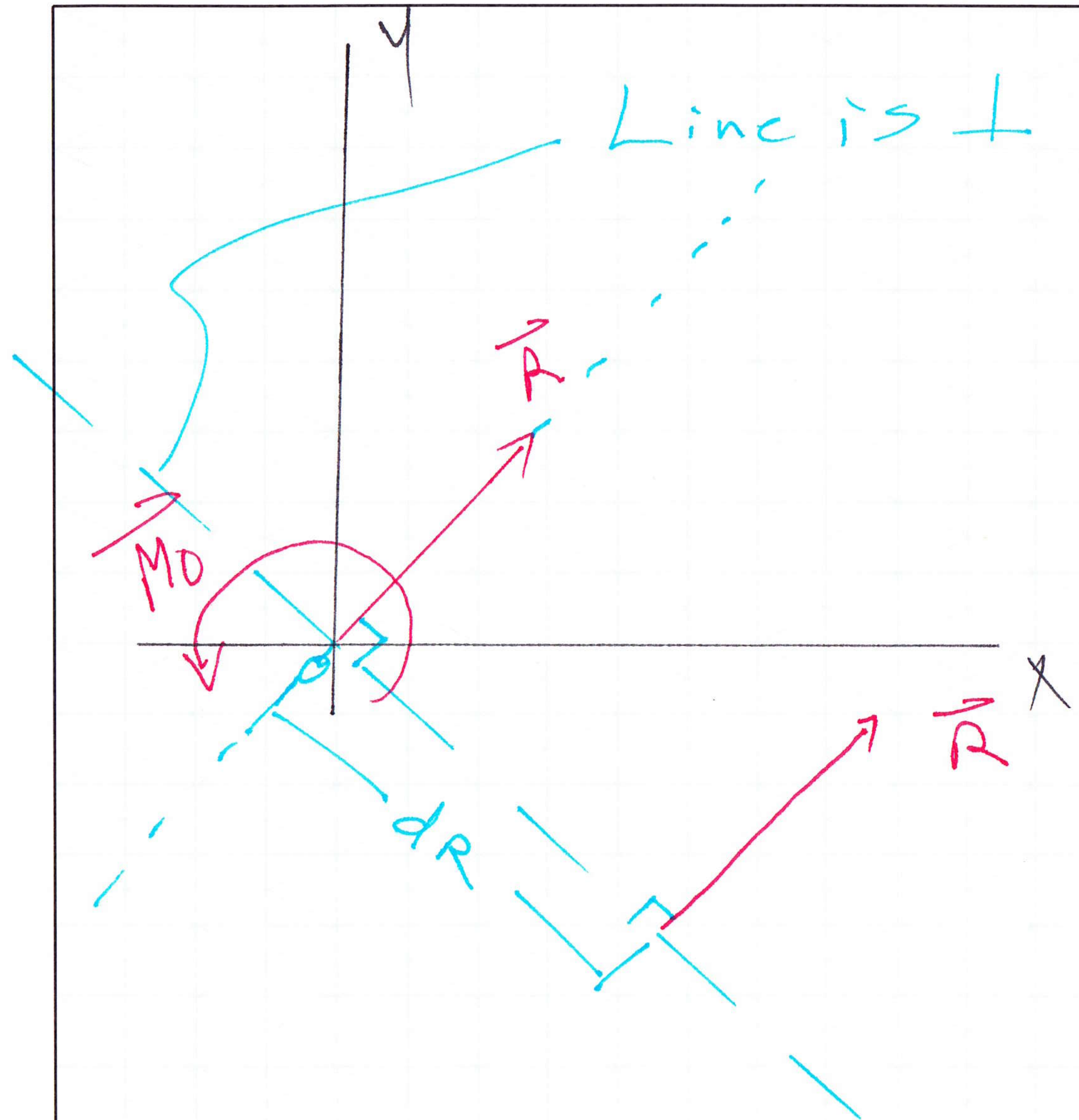


$$\vec{R} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4$$

$$|\vec{R}| = R$$

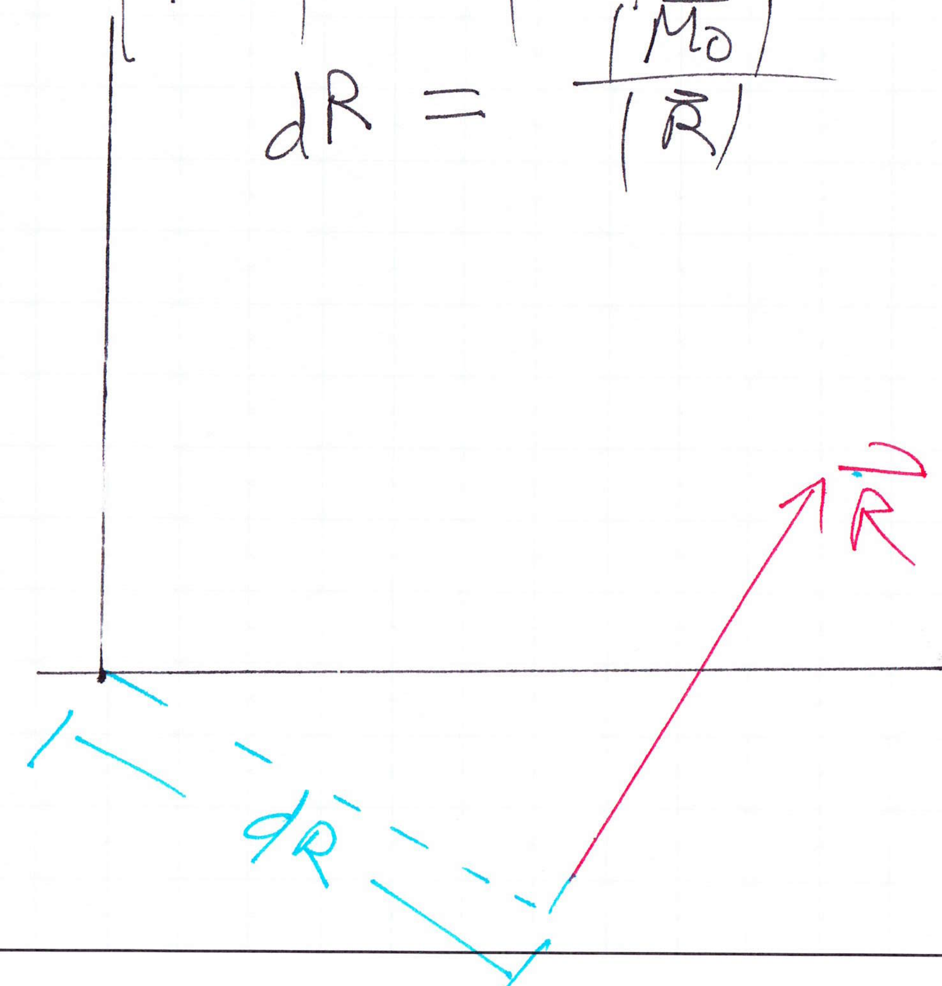
$$|\vec{M}_O| = +F_1 d_1 - F_2 d_2 - F_3 d_3 - F_4 d_4 - M_1 - M_2$$



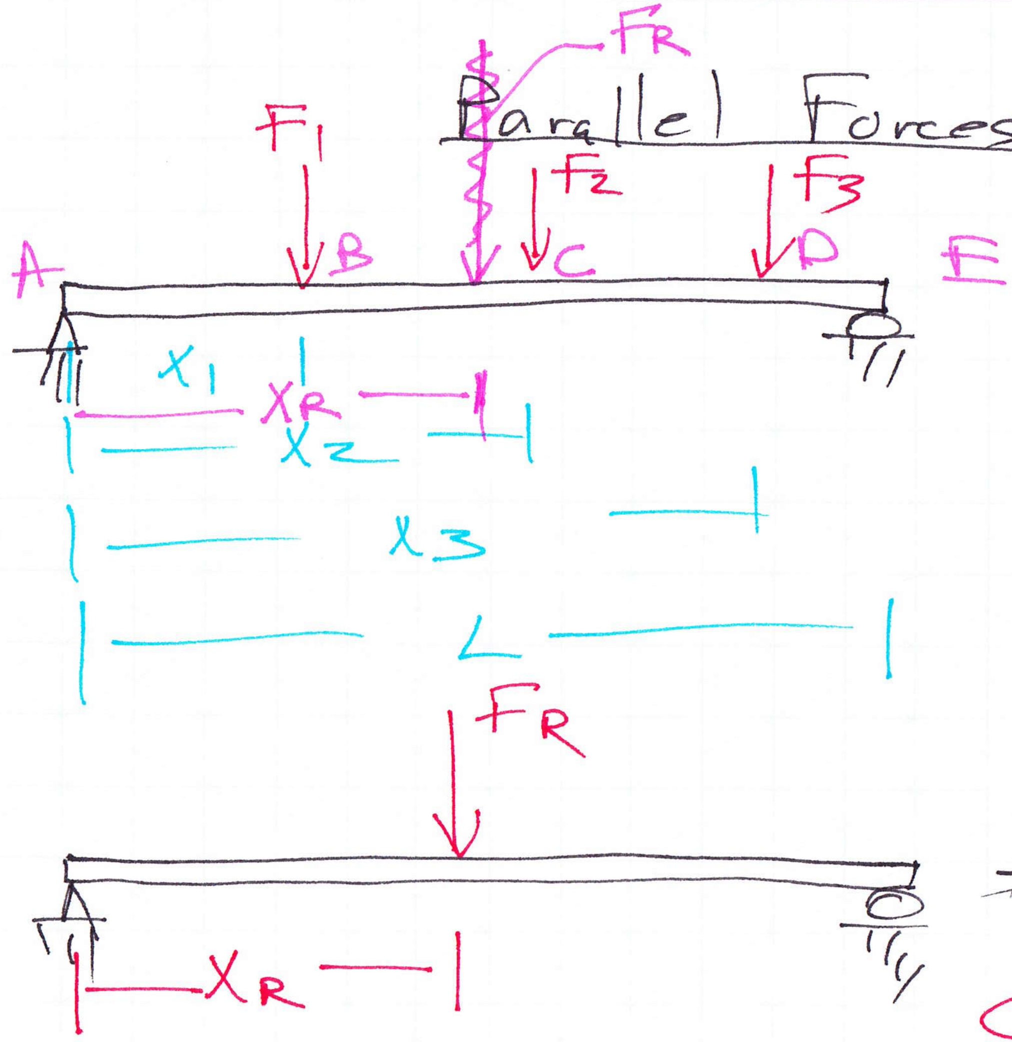


$$|\vec{M_O}| = |\vec{R}|\, dR$$

$$dR = \frac{|\vec{M_O}|}{|\vec{R}|}$$



Parallel Forces on a Beam



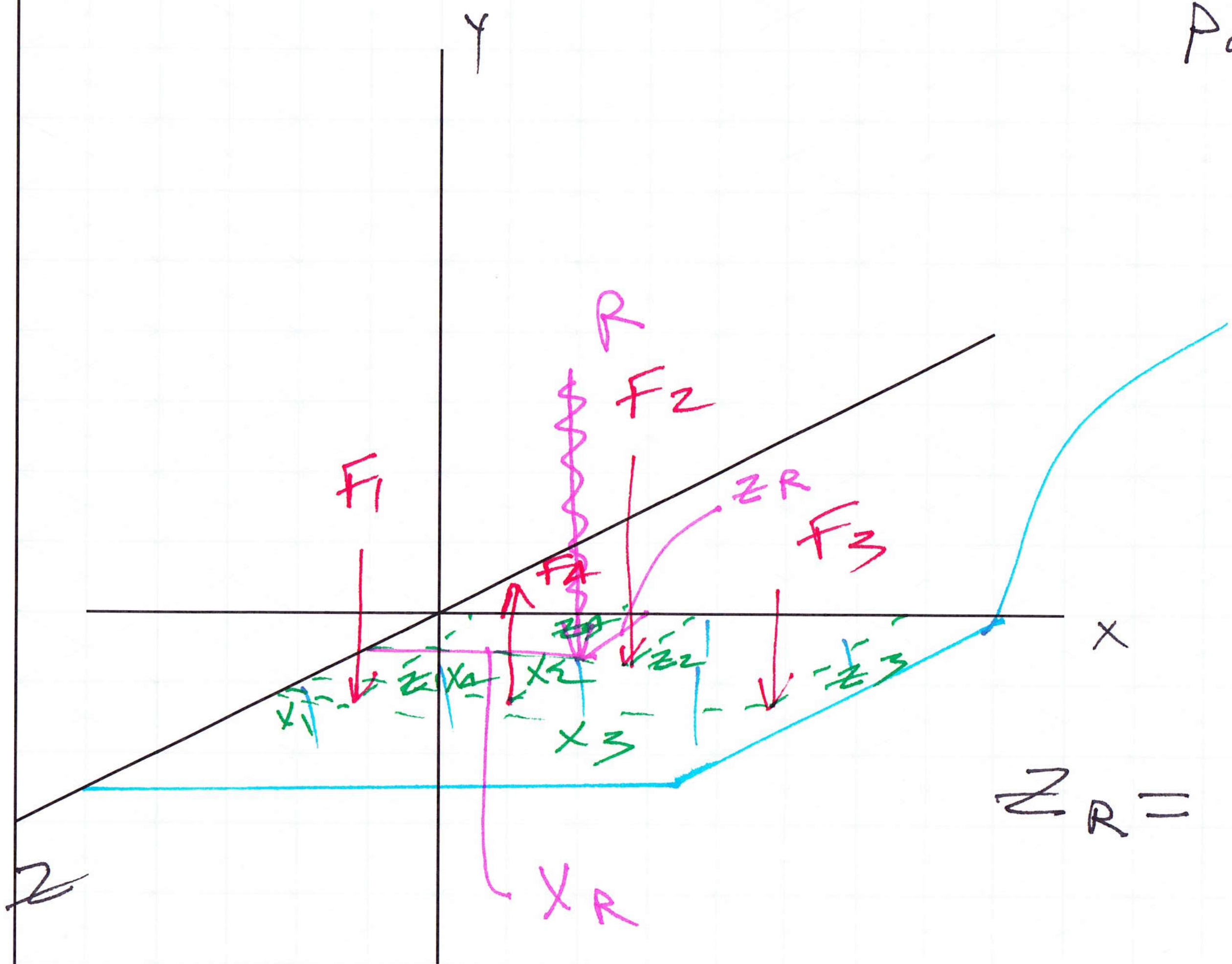
$$F_R = F_1 + F_2 + F_3$$

$$\sum M_A$$

$$F_R X_R = F_1 X_1 + F_2 X_2 + F_3 X_3$$

$$X_R = \frac{F_1 X_1 + F_2 X_2 + F_3 X_3 + F_4 X_4}{F_R}$$

Caution – this is for external support reactions. Be careful when we move to internal forces – Shear and moment

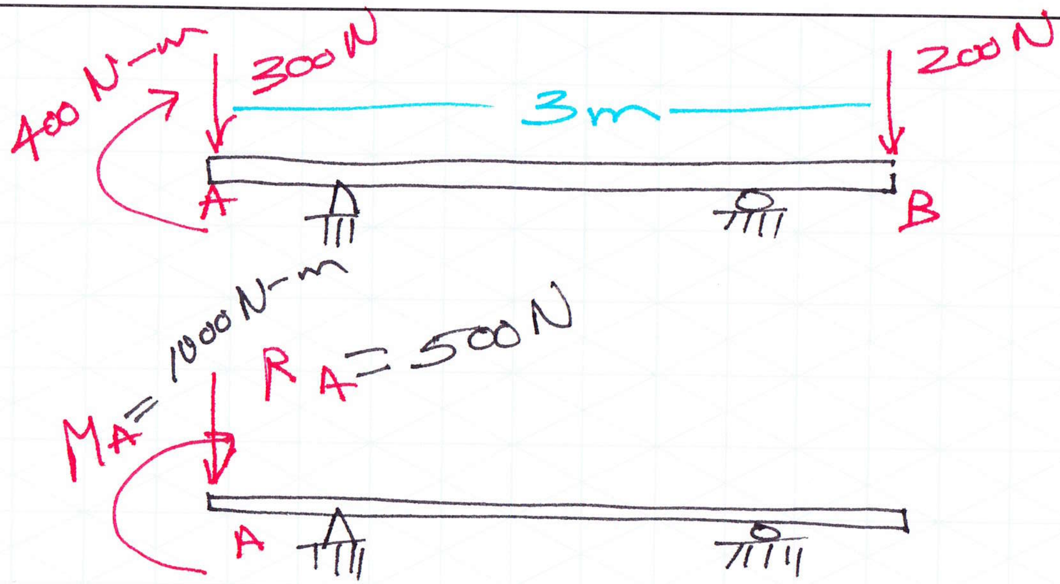


Parallel Forces that are all ⊥ to a plane

$$R = F_1 + F_2 + F_3 - F_4$$

$$X_R = \frac{F_1 X_1 + F_2 X_2 + F_3 X_3 - F_4 X_4}{F_1 + F_2 + F_3 - F_4}$$

$$Z_R = \frac{F_1 Z_1 + F_2 Z_2 + F_3 Z_3 - F_4 Z_4}{F_1 + F_2 + F_3 - F_4}$$

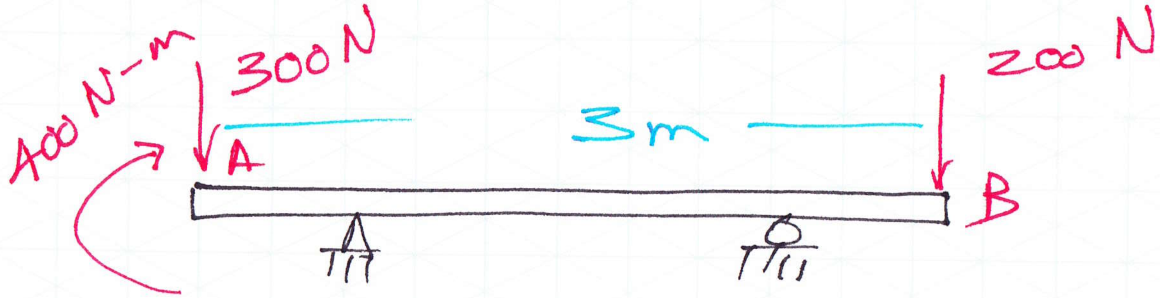


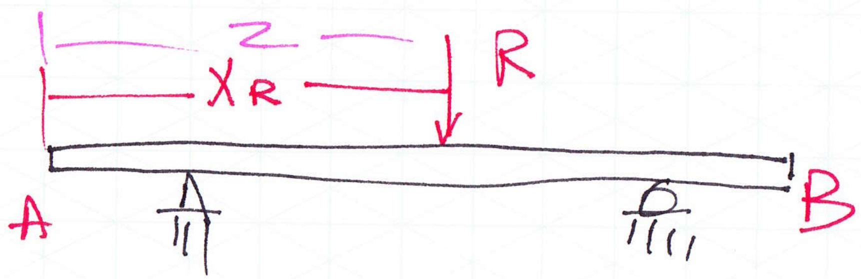
$$R_A = 300 + 200$$

$$R_A = 500\ N \downarrow$$

$$M_A = 400 + 0 + 200(3)$$

$$M_A = 1000\ N\text{-}m \ (+)$$





$R = 300 + 200$

$R = 500\ N \downarrow$

Choose an arbitrary point such as A.

$\Sigma M_A = 400\ cw + 300(0) + 200(3)\ cw$

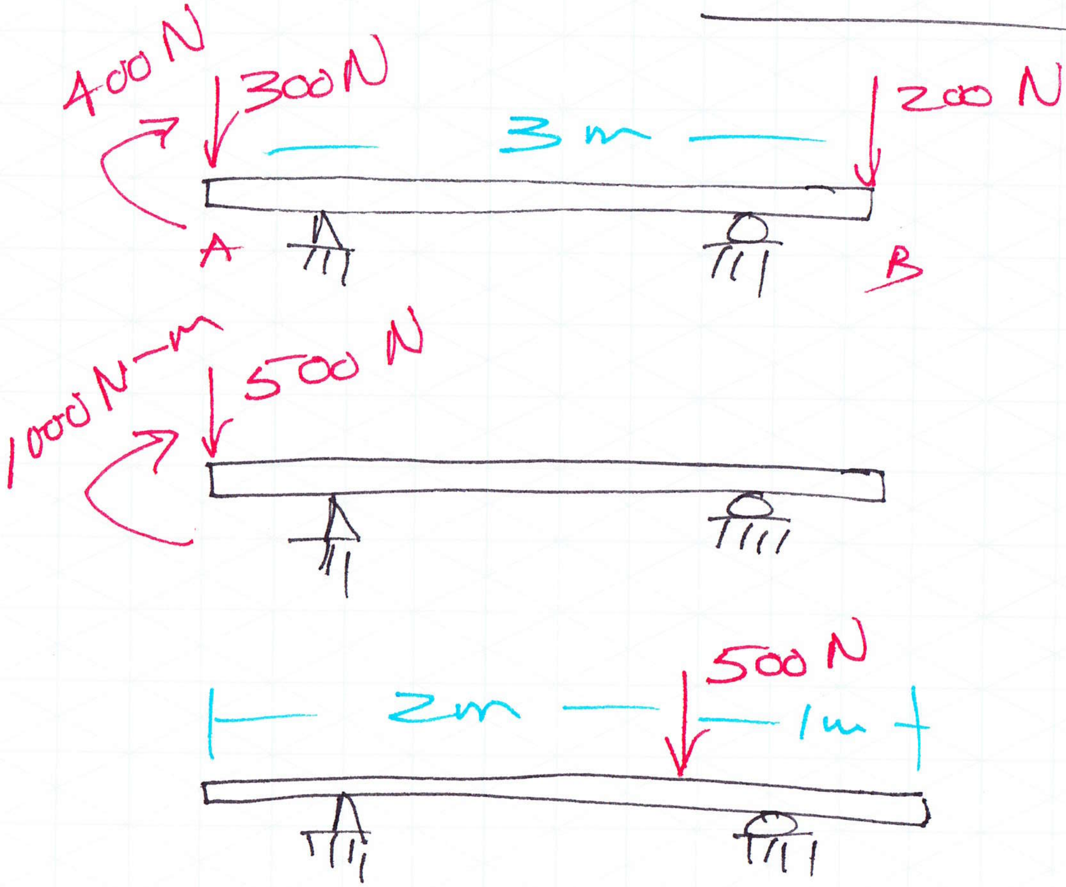
$\Sigma M_A = 1000\ N\text{-}m\ cw$

~~R~~ 500 $X_R = 1000\ N\text{-}m \quad cw$

$X_R = \frac{1000}{500}$

$X_R = 2m$

Summary



All three Force System are equivalent.