

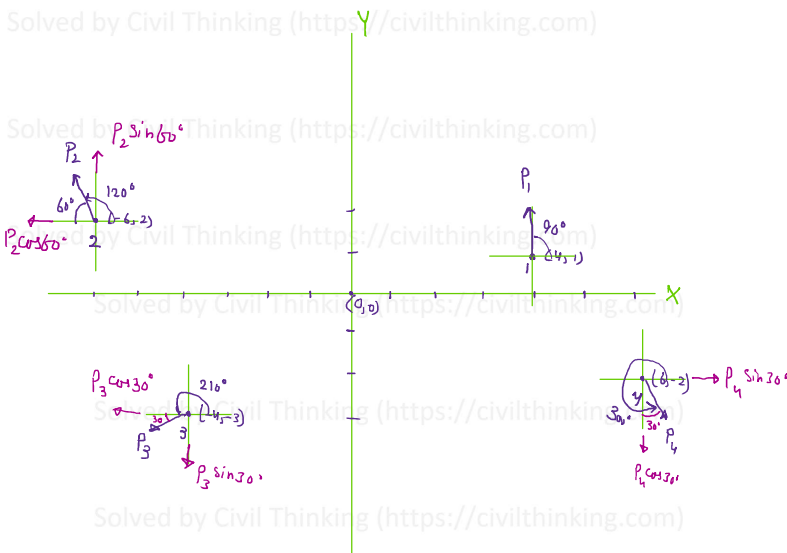
Statics: Force System: **Coplanar Force System** Solved Problem using graphic method and analytical method

Please find the resultant force of the coplanar force system using numerical and graphic methods. Calculate the moment of forces relative to the origin of coordinate system, inclination of the line of action of resultant and its distance from the origin of the coordinate system.

Magnitude of force	Coordinates (x,y) of the point of application of force	Inclination of the force
$P_1 = 100 \text{ kN}$	(4,1)	$\alpha_1 = 90^\circ$
$P_2 = 50 \text{ kN}$	(-6,2)	$\alpha_2 = 120^\circ$
$P_3 = 200 \text{ kN}$	(-4,-3)	$\alpha_3 = 210^\circ$
$P_4 = 150 \text{ kN}$	(6,-2)	$\alpha_4 = 300^\circ$

Solution:

	Magnitude of force	Coordinates (x,y) of the point of application of force	Inclination of the force
1	$P_1 = 100 \text{ kN}$	(4,1)	$\alpha_1 = 90^\circ$
2	$P_2 = 50 \text{ kN}$	(-6,2)	$\alpha_2 = 120^\circ$
3	$P_3 = 200 \text{ kN}$	(-4,-3)	$\alpha_3 = 210^\circ$
4	$P_4 = 150 \text{ kN}$	(6,-2)	$\alpha_4 = 300^\circ$



$$\begin{aligned} \sum F_x &= -P_2 \cos 60^\circ - P_3 \cos 30^\circ + P_4 \sin 30^\circ \\ &= -50 \cdot \cos(60) - 200 \cdot \cos(30) + 150 \cdot \sin(30) \\ &= -123.2050807568878 \end{aligned}$$

$$\begin{aligned} \sum F_y &= P_1 + P_2 \sin 60^\circ - P_3 \sin 30^\circ - P_4 \cos 30^\circ \\ &= 100 + 50 \cdot \sin(60) - 200 \cdot \sin(30) - 150 \cdot \cos(30) \\ &= -86.60254037844385 \end{aligned}$$

$$\begin{aligned} R &= \sqrt{\sum F_x^2 + \sum F_y^2} \\ &= \text{sqrt}(123.205^2 + 86.6^2) = 150.59 \text{ kN} \end{aligned}$$

$$\text{tg}^{-1} \frac{F_y}{F_x} = \alpha \Rightarrow \text{tg}^{-1} \left(\frac{-86.6}{-123.205} \right) = 35.1^\circ$$

$$\begin{aligned} \sum M_o &= (P_2 \sin 60^\circ \times 6) - (P_2 \cos 60^\circ \times 2) + (P_3 \cos 30^\circ \times 3) \\ &\quad - (P_3 \sin 30^\circ \times 4) - (P_4 \sin 30^\circ \times 2) + (P_4 \cos 30^\circ \times 6) \\ &\quad - (P_1 \times 4) \end{aligned}$$

$$\begin{aligned} &= (50 \cdot \sin(60) \cdot 6) - (50 \cdot \cos(60) \cdot 2) + (200 \cdot \cos(30) \cdot 3) - (200 \\ &\quad \cdot \sin(30) \cdot 4) - (150 \cdot \sin(30) \cdot 2) + (150 \cdot \cos(30) \cdot 6) - (100 \cdot 4) \\ &= 558.8457268119897 \text{ kN.m} \end{aligned}$$

Varignon's theorem: $\sum M_o = R \times a$

$$558.84 = 150.59 \times a$$

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$$\Rightarrow a = 558.85/150.59 = 3.7111\text{m}$$

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Graphic Method:

Scale:

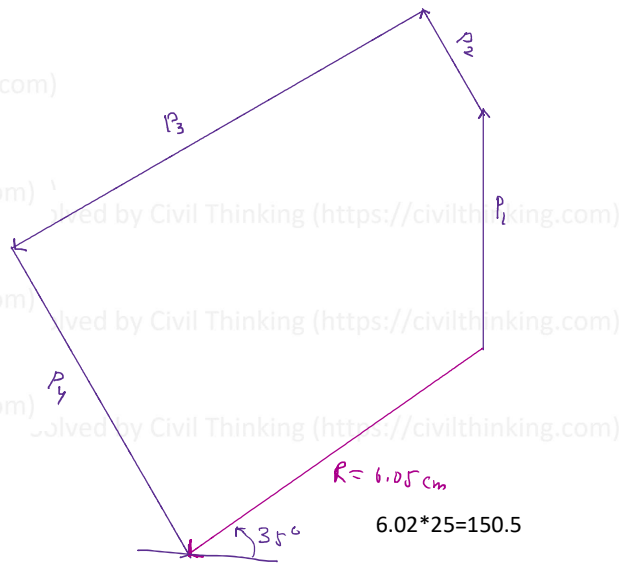
$$4\text{cm} = 100\text{KN} \Rightarrow 1\text{KN} = \frac{4}{100}\text{cm} = \frac{1}{25}\text{cm}$$

$$\rightarrow P_1 = 100\text{KN} = \frac{100}{25} = 4\text{cm}$$

$$\rightarrow P_2 = 50\text{KN} = \frac{50}{25} = 2\text{cm}$$

$$\rightarrow P_3 = 200\text{KN} = \frac{200}{25} = 8\text{cm}$$

$$\rightarrow P_4 = 150\text{KN} = \frac{150}{25} = 6\text{cm}$$

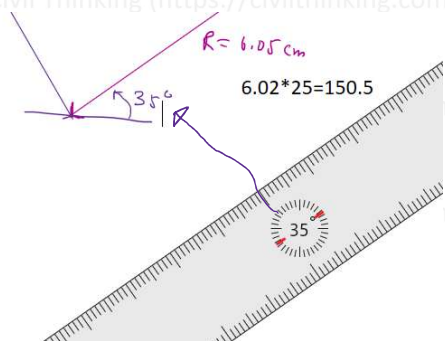


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