



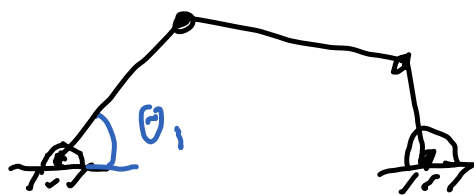
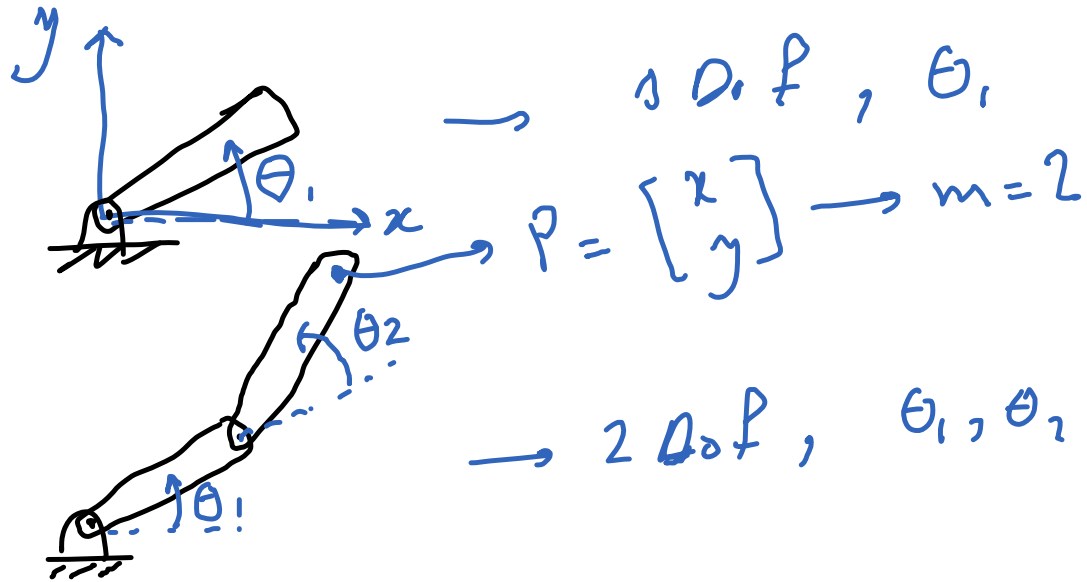
رباتیک پیشرفته

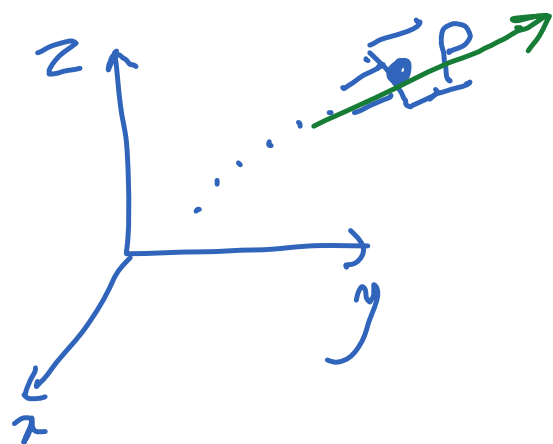
مقدمه، سینماتیک

دکتر امین نیکوبین

دانشگاه سمنان، دانشکده مهندسی مکانیک

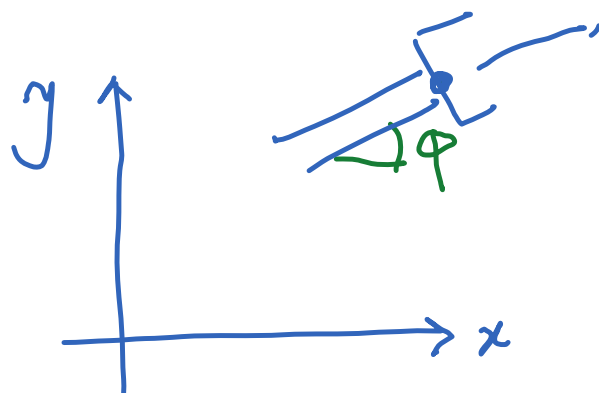
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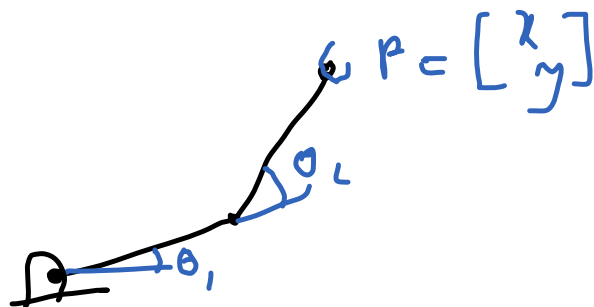
$$P = \begin{bmatrix} x \\ y \\ z \\ \phi \\ \theta \\ \alpha \end{bmatrix}$$

$$m = 6$$



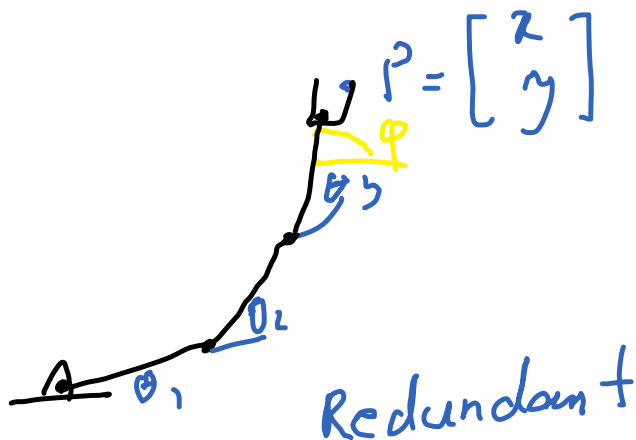
$$P = \begin{bmatrix} x \\ y \\ \phi \end{bmatrix}$$

$$m = 3$$



$$n = 2 \rightarrow n - m = 0$$

$$m = 2$$

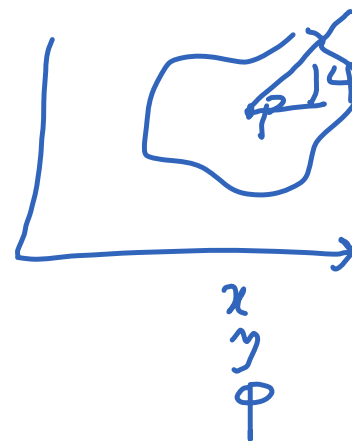
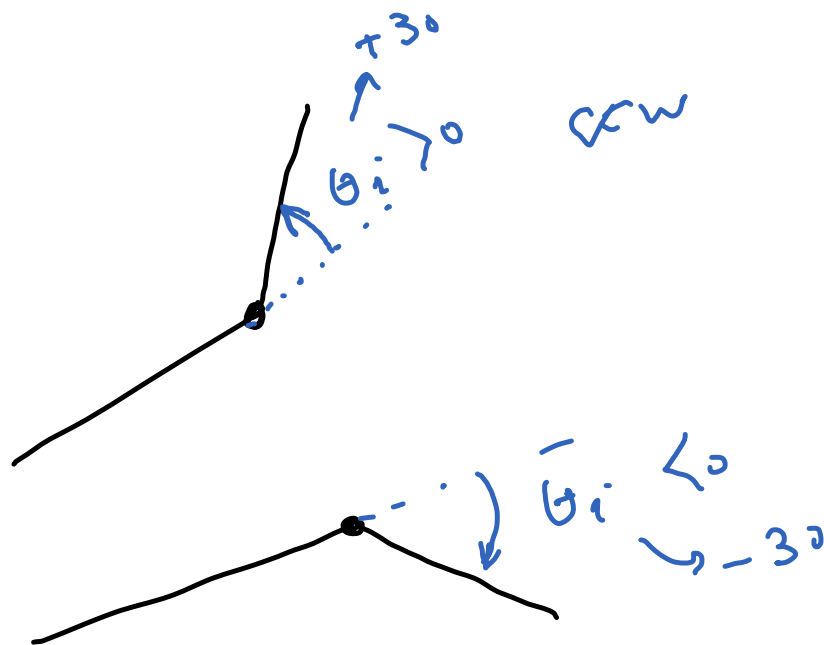


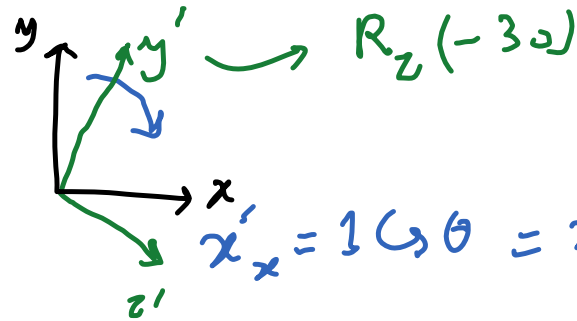
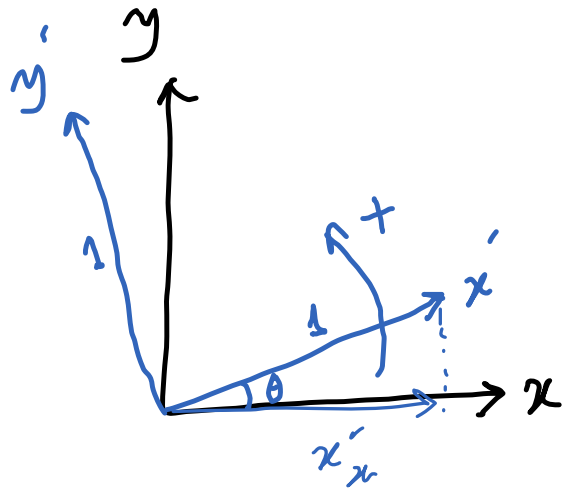
$$n = 3 \rightarrow n - m = 1$$

$$m = 2$$

یک درجه آزادی اضافی دارد

$$P = \begin{bmatrix} x \\ y \\ \varphi \end{bmatrix} \quad \begin{matrix} m = 3 \\ n = 3 \end{matrix} \rightarrow n - m = 1$$





$$x'_x = |x'| \cos \theta = x' \cdot x$$

$$= |x'| |x| \cos \theta = \cos \theta$$

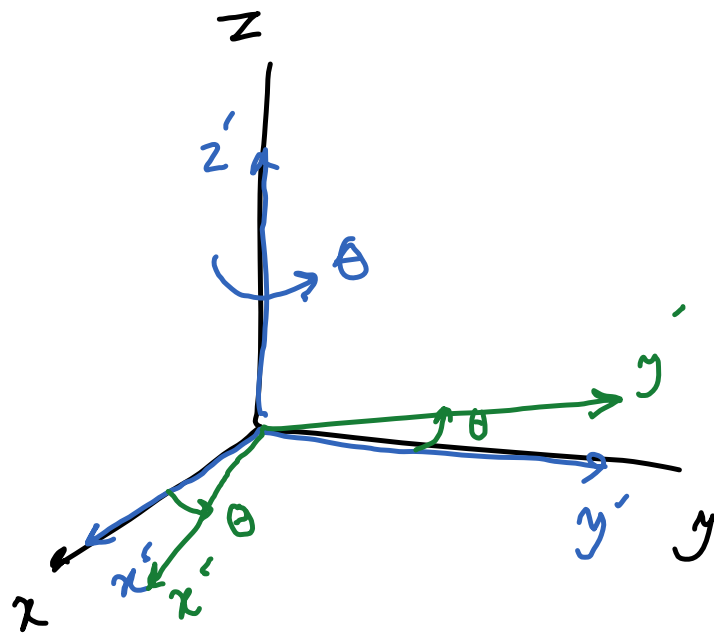
$$x' \cdot x = x'^T x$$

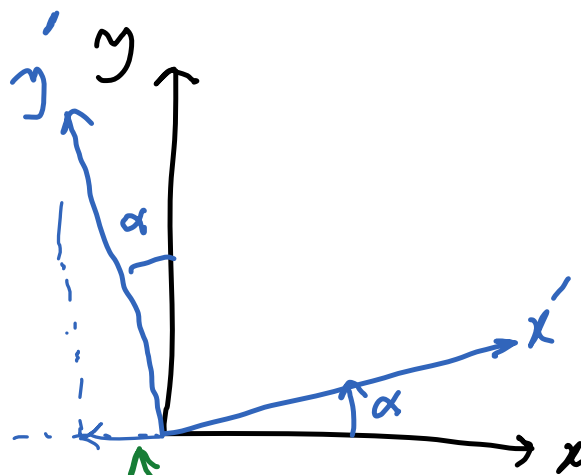
$$a = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix}$$

$$b = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

$$\vec{a} \cdot \vec{b} = a_1 b_1 + a_2 b_2 + a_3 b_3$$

$$a^T b = [a_1 \ a_2 \ a_3] \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} =$$



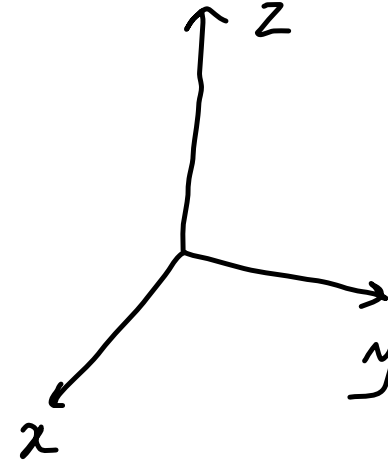
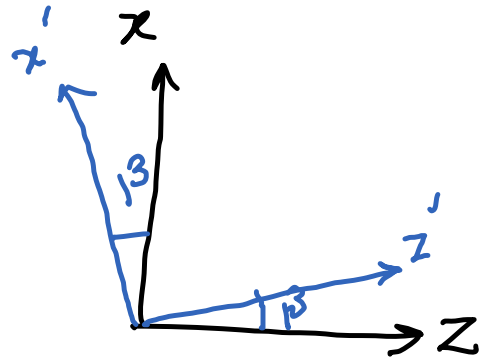


$$x' = \begin{bmatrix} \cos \alpha \\ \sin \alpha \\ 0 \end{bmatrix} \begin{matrix} \leftarrow x \\ \leftarrow y \\ \leftarrow z \end{matrix}$$

$$y' = \begin{bmatrix} -\sin \alpha \\ \cos \alpha \\ 0 \end{bmatrix}$$

$$z' = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

$$R_z(\alpha) = R = \begin{bmatrix} \cos \alpha & -\sin \alpha & 0 \\ \sin \alpha & \cos \alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



$$x' = \begin{bmatrix} \cos \beta \\ 0 \\ -\sin \beta \end{bmatrix} \quad y' = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} \quad z' = \begin{bmatrix} \sin \beta \\ 0 \\ \cos \beta \end{bmatrix}$$

$$R_y(\beta) = \begin{bmatrix} \cos \beta & 0 & \sin \beta \\ 0 & 1 & 0 \\ -\sin \beta & 0 & \cos \beta \end{bmatrix}$$