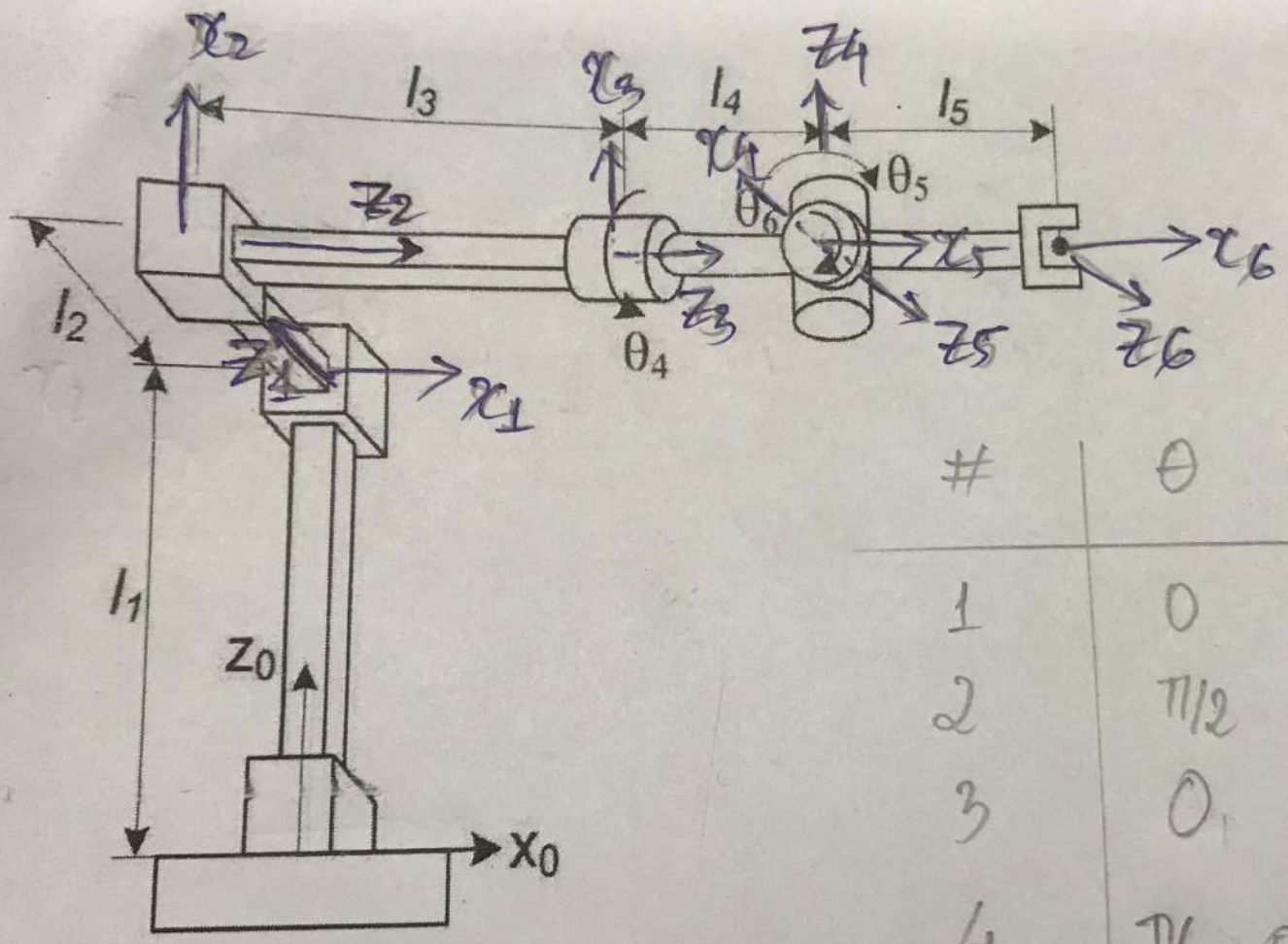
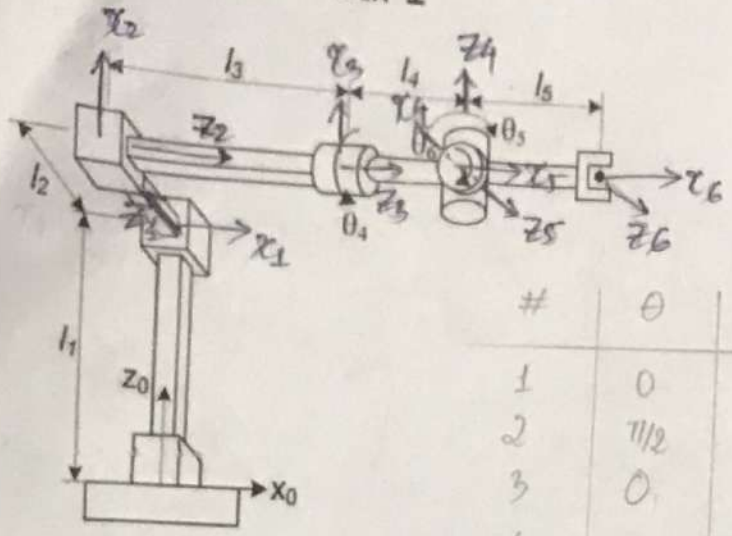
Bài 1



#	θ
1	0
2	π/2
3	O_1
4	π/2 + θ

Bài 1



#	θ	l	α	d	Var
1	0	0	$\pi/2$	l_1	0
2	$\pi/2$	0	$\pi/2$	l_2	0
3	0	0	0	l_3	0
4	$\pi/2+\theta_4$	0	$\pi/2$	l_4	θ_4
5	$\pi/2+\theta_5$	0	$-\pi/2$	0	θ_5
6	θ_6	l_5	0	0	θ_6

$$A_1=\begin{bmatrix}1&0&0&0\\0&0&-1&0\\0&1&0&l_1\\0&0&0&1\end{bmatrix} \quad A_3=\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&l_3\\0&0&0&1\end{bmatrix} \quad A_5=\begin{bmatrix}-\sin(\theta_5)&0&-\cos(\theta_5)&0\\\cos(\theta_5)&0&-\sin(\theta_5)&0\\0&-1&0&0\\0&0&0&1\end{bmatrix}$$

$$A_2=\begin{bmatrix}0&0&1&0\\1&0&0&1\\0&1&0&l_2\\0&0&0&1\end{bmatrix} \quad A_4=\begin{bmatrix}-\sin(\theta_4)&0&\cos(\theta_4)&0\\\cos(\theta_4)&0&-\sin(\theta_4)&0\\0&1&0&l_4\\0&0&0&1\end{bmatrix} \quad A_6=\begin{bmatrix}\cos(\theta_6)&-\sin(\theta_6)&0&l_5\cos(\theta_6)\\\sin(\theta_6)&\cos(\theta_6)&0&l_5\sin(\theta_6)\\0&0&1&0\\0&0&0&1\end{bmatrix}$$

$P=[0;0;0;1]$

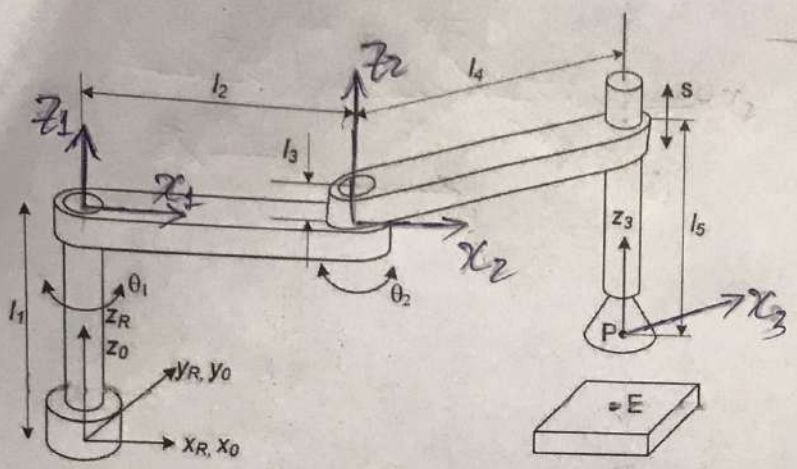
$$\Rightarrow A_1.A_2.A_3.A_4.A_5.A_6=\begin{bmatrix}l_3+l_4+l_5.\cos(\theta_5).\cos(\theta_6)\\l_5.\sin(\theta_4).\sin(\theta_6)-l_2+l_5.\cos(\theta_4).\cos(\theta_6).\sin(\theta_5)\\l_1-l_5.\cos(\theta_4).\sin(\theta_6)+15.\cos(\theta_6).\sin(\theta_4).\sin(\theta_5)\\1\end{bmatrix}$$

Vậy $x=l_3+l_4+l_5.\cos(\theta_5).\cos(\theta_6)$

$y=l_5\sin(\theta_4).\sin(\theta_6)-l_2+l_5.\cos(\theta_4).\cos(\theta_6).\cos(\theta_5)$

$z=l_1-l_5.\cos(\theta_4).\cos(\theta_1)+l_5.\cos(\theta_6).\sin(\theta_4).\sin(\theta_5)$

Bài 2



#	θ	l	α	d
1	θ_1	0	0	l_1
2	θ_2	l_2	0	0
3	θ_2	l_4	0	$-(l_3+s-l_5)$

$$A_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_3 = \begin{bmatrix} \cos(\theta_2) & -\sin(\theta_2) & 0 & l_4\cos(\theta_2) \\ \sin(\theta_2) & \cos(\theta_2) & 0 & l_4\sin(\theta_2) \\ 0 & 0 & 1 & -(l_3+s-l_5) \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} \cos(\theta_1) & -\sin(\theta_1) & 0 & l_2\cos(\theta_1) \\ \sin(\theta_1) & \cos(\theta_1) & 0 & l_2\sin(\theta_1) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$P = [0; 0; 0; 1]$$

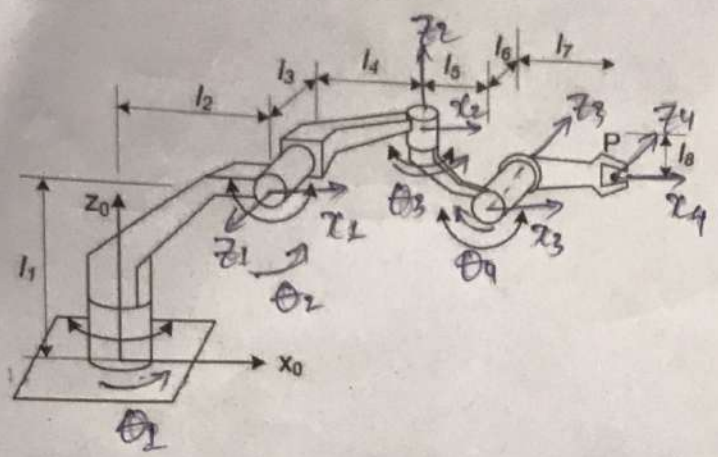
$$\Rightarrow A_1 A_2 A_3 P = \begin{bmatrix} l_4\cos(\theta_1+\theta_2) + l_2\cos(\theta_1) \\ l_4\sin(\theta_1+\theta_2) + l_2\sin(\theta_2) \\ l_1 + l_3 - l_5 - s \\ 1 \end{bmatrix}$$

Vậy $x = l_4\cos(\theta_1+\theta_2) + l_2\cos(\theta_1)$

$y = l_4\sin(\theta_1+\theta_2) + l_2\sin(\theta_2)$

$z = l_1 + l_3 - l_5 - s$

Bài 3



#	θ	l	α	d	var
1	θ_1	l_2	$\pi/2$	l_2	θ_1
2	θ_2	l_4	$-\pi/2$	$-l_3$	θ_2
3	θ_3	l_5	$-\pi/2$	$-l_8$	θ_3
4	θ_4	l_7	0	l_6	θ_4

$$A_1 = \begin{bmatrix} \cos(\theta_1) & 0 & \sin(\theta_1) & l_2\cos(\theta_1) \\ \sin(\theta_1) & 0 & -\cos(\theta_1) & l_2\sin(\theta_1) \\ 0 & 1 & 0 & l_1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad A_2 = \begin{bmatrix} \cos(\theta_3) & 0 & -\sin(\theta_3) & l_5\cos(\theta_3) \\ \sin(\theta_3) & 0 & \cos(\theta_3) & l_5\sin(\theta_3) \\ 0 & -1 & 0 & -l_8 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_3 = \begin{bmatrix} \cos(\theta_2) & 0 & -\sin(\theta_2) & l_4\cos(\theta_2) \\ \sin(\theta_2) & 0 & \cos(\theta_2) & l_4\sin(\theta_2) \\ 0 & -1 & 0 & -l_3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad A_4 = \begin{bmatrix} \cos(\theta_4) & -\sin(\theta_4) & 0 & l_7\cos(\theta_4) \\ \sin(\theta_4) & \cos(\theta_4) & 0 & l_7\sin(\theta_4) \\ 0 & 0 & 1 & l_6 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

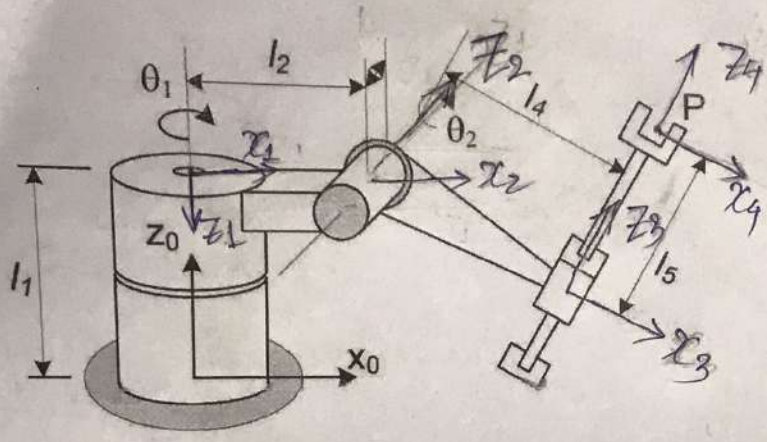
Sau khi nhân lại ta tính được:

$$x = l_2\cos(\theta_1) - l_6[\cos(\theta_2)\sin(\theta_1) + \cos(\theta_1)\cos(\theta_2)\sin(\theta_3)] - l_3\sin(\theta_1) - l_7\cos(\theta_4)[\sin(\theta_1)\sin(\theta_3) - \cos(\theta_1)\cos(\theta_2)\cos(\theta_3)] + l_4\cos(\theta_1)\cos(\theta_2) - l_8\cos\theta_1\cdot\cos(\theta_2) - l_5\sin(\theta_1)\sin(\theta_3) + l_5\cos(\theta_1)\cos(\theta_2)\cos(\theta_3) + l_7\cos(\theta_1)\sin(\theta_2)\sin(\theta_4).$$

$$y = l_6[\cos(\theta_1)\cos(\theta_2) - \cos(\theta_2)\sin(\theta_1)\sin(\theta_3)] + l_3\cos(\theta_1) + l_2\sin(\theta_1) + l_7\cos(\theta_4)[\cos(\theta_1)\sin(\theta_3) + \cos(\theta_3)\cos(\theta_2)\sin(\theta_1)] + l_4\cos(\theta_2)\sin(\theta_1) + l_5\cos(\theta_1)\sin(\theta_3) + l_8\sin(\theta_1)\sin(\theta_2) + l_5\cos(\theta_2)\cos(\theta_3)\sin(\theta_1) + l_7\sin(\theta_1)\sin(\theta_2)\sin(\theta_4).$$

$$z = l_1 - l_8\cos(\theta_2) + l_4\sin(\theta_2) + l_5\cos(\theta_3)\sin(\theta_2) - l_7\cos(\theta_2)\sin(\theta_4) - l_6\sin(\theta_2)\sin(\theta_3) + l_7\cos(\theta_3)\cos(\theta_1)\sin(\theta_2).$$

Bài 4



#	θ	l	α	d	var
1	0	0	π/2	l_1	0
2	θ_1	l_2	π/2	0	θ_2
3	θ_2	l_4	π/2	l_3	θ_3
4	0	0	0	l_5	0

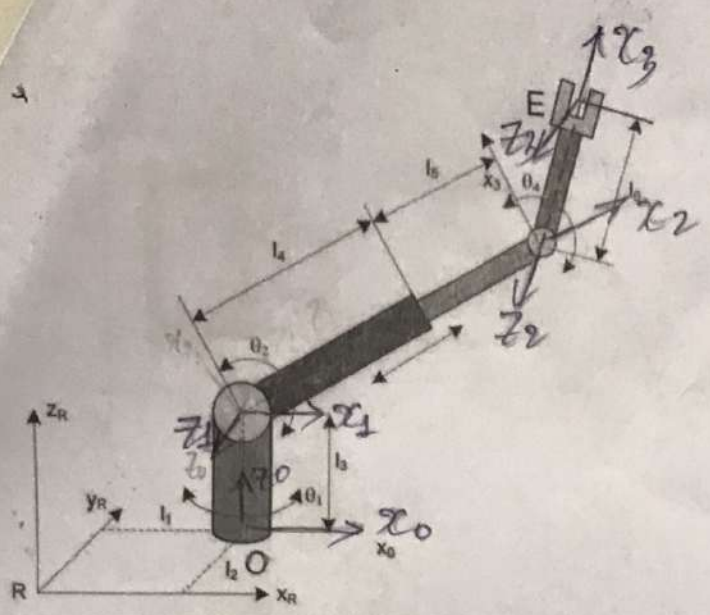
$$A_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad A_3 = \begin{bmatrix} \cos(\theta_2) & 0 & \sin(\theta_2) & l_4\cos(\theta_2) \\ \sin(\theta_2) & 0 & -\cos(\theta_2) & l_4\sin(\theta_2) \\ 0 & 1 & 0 & l_3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} \cos(\theta_1) & 0 & \sin(\theta_1) & l_2\cos(\theta_1) \\ \sin(\theta_1) & 0 & -\cos(\theta_1) & l_2\sin(\theta_1) \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad A_4 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l_5 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$P = [0; 0; 0; 1]$$

$$\Rightarrow A_1 A_2 A_3 A_4 P = \begin{bmatrix} l_2\cos(\theta_1) + l_3\sin(\theta_1) + l_4\cos(\theta_1)\cos(\theta_2) + l_5\cos(\theta_1)\sin(\theta_2) \\ l_3\cos(\theta_1) - l_2\sin(\theta_1) - l_4\cos(\theta_2)\sin(\theta_1) - l_5\sin(\theta_1)\sin(\theta_2) \\ l_1 + l_5\cos(\theta_2) - l_4\sin(\theta_2) \\ 1 \end{bmatrix}$$

Vậy
$$x = l_2\cos(\theta_1) + l_3\sin(\theta_1) + l_4\cos(\theta_1)\cos(\theta_2) + l_5\cos(\theta_1)\sin(\theta_2)$$
$$y = l_3\cos(\theta_1) - l_2\sin(\theta_1) - l_4\cos(\theta_2)\sin(\theta_1) - l_5\sin(\theta_1)\sin(\theta_2)$$
$$z = l_1 + l_5\cos(\theta_2) - l_4\sin(\theta_2)$$



H	θ	l	α	d	var
1	θ_2	0	$\pi/2$	l_3	θ_1
2	θ_2	l_4+l_5	0	0	
3	θ_4	l_6	0	0	

$$A_1 = \begin{bmatrix} \cos(\theta_1) & 0 & \sin(\theta_1) & 0 \\ \sin(\theta_1) & 0 & -\cos(\theta_1) & 0 \\ 0 & 1 & 0 & l_3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_3 = \begin{bmatrix} \cos(\theta_4) & -\sin(\theta_4) & 0 & l_6.\cos(\theta_4) \\ \sin(\theta_4) & \cos(\theta_4) & 0 & l_6.\sin(\theta_4) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} \cos(\theta_2) & -\sin(\theta_2) & 0 & (l_4+l_5)\cos(\theta_2) \\ \sin(\theta_2) & \cos(\theta_2) & 0 & (l_4+l_5).\sin(\theta_2) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$P = [0; 0; 0; 1]$

$\Rightarrow$

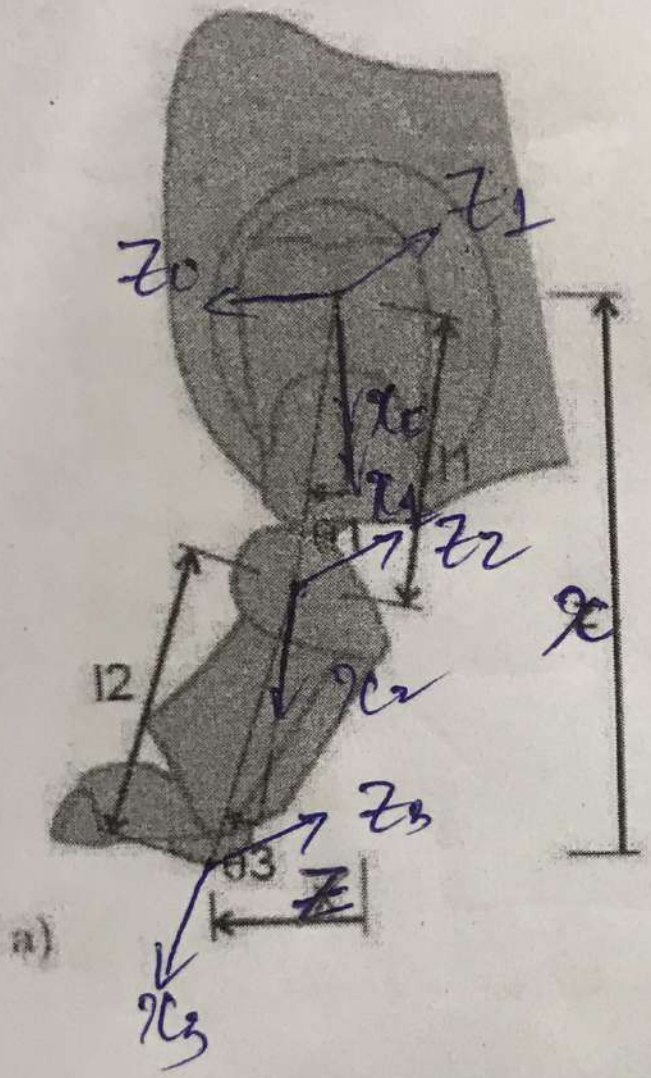
$$A_1.A_2.A_3.P = \begin{bmatrix} \cos(\theta_1)[l_6.\cos(\theta_2+\theta_4) + l_4\cos(\theta_2) + l_5.\cos(\theta_2)] \\ \sin(\theta_1).[l_6.\cos(\theta_2+\theta_4) + (l_4+l_5).\cos(\theta_2)] \\ l_3 + \sin(\theta_2).(l_4+l_5) + l_6.\sin(\theta_2+\theta_4) \\ 1 \end{bmatrix}$$

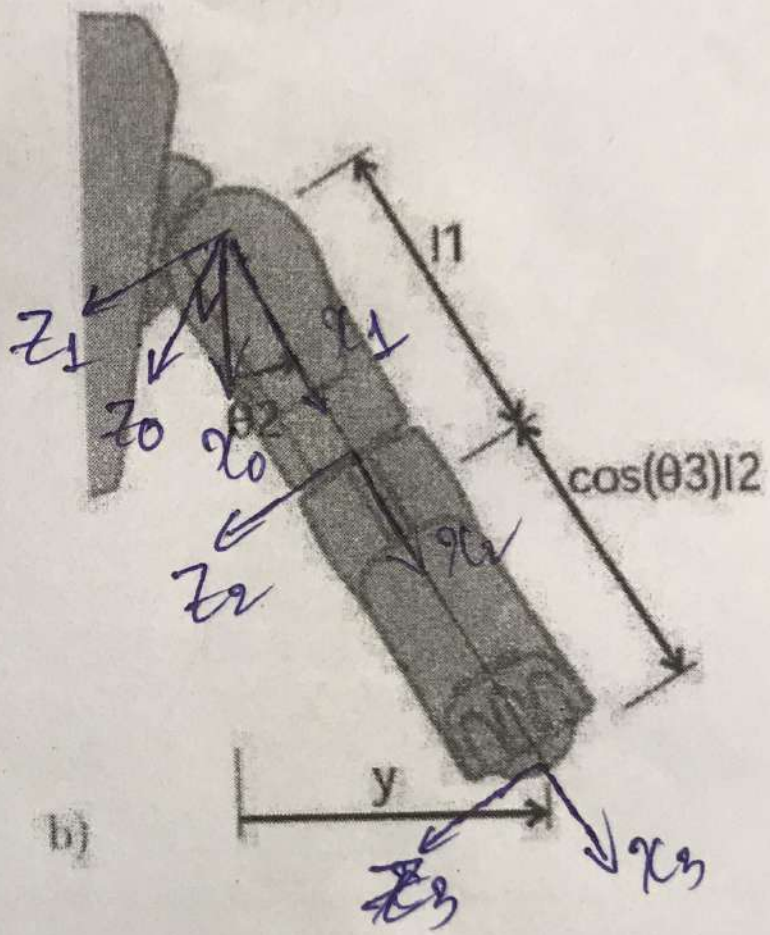
Vậy $x = l_1.\cos(\theta_1)[l_6.\cos(\theta_2+\theta_4) + (l_4+l_5).\cos(\theta_2)]$

$y = l_1.\sin(\theta_1)[l_6.\cos(\theta_2+\theta_4) + (l_4+l_5).\cos(\theta_2)]$

$z = l_3 + \sin(\theta_2).(l_4+l_5) + l_6.\sin(\theta_2+\theta_4)$

Bài 5





#

1

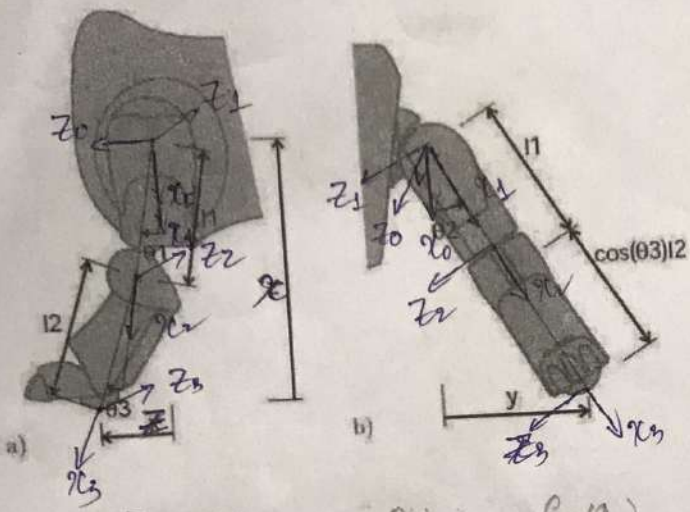
2

3

$$A_1 = \begin{bmatrix} \cos(\theta_2) & - & 0 & \sin(\theta_2) & 0 \\ \sin(\theta_2) & & 0 & -\cos(\theta_2) & 0 \\ 0 & & 1 & 0 & 0 \\ 0 & & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} \cos(\theta_1) & -\sin(\theta_1) & 0 & l_1 \cos(\theta \\ \sin(\theta_1) & \cos(\theta_1) & 0 & l_1 . \sin \\ & & & \end{bmatrix}$$

Bài 5



#	θ	l	α	d	var
1	θ_2	0	$\pi/2$	0	θ_2
2	θ_1	l_1	0	0	θ_1
3	θ_3	l_2	0	0	θ_3

$$A_1 = \begin{bmatrix} \cos(\theta_2) & 0 & \sin(\theta_2) & 0 \\ \sin(\theta_2) & 0 & -\cos(\theta_2) & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} \cos(\theta_1) & -\sin(\theta_1) & 0 & l_1\cos(\theta_1) \\ \sin(\theta_1) & \cos(\theta_1) & 0 & l_1\sin(\theta_1) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_3 = \begin{bmatrix} \cos(\theta_3) & -\sin(\theta_3) & 0 & l_2\cos(\theta_3) \\ \sin(\theta_3) & \cos(\theta_3) & 0 & l_2\sin(\theta_3) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

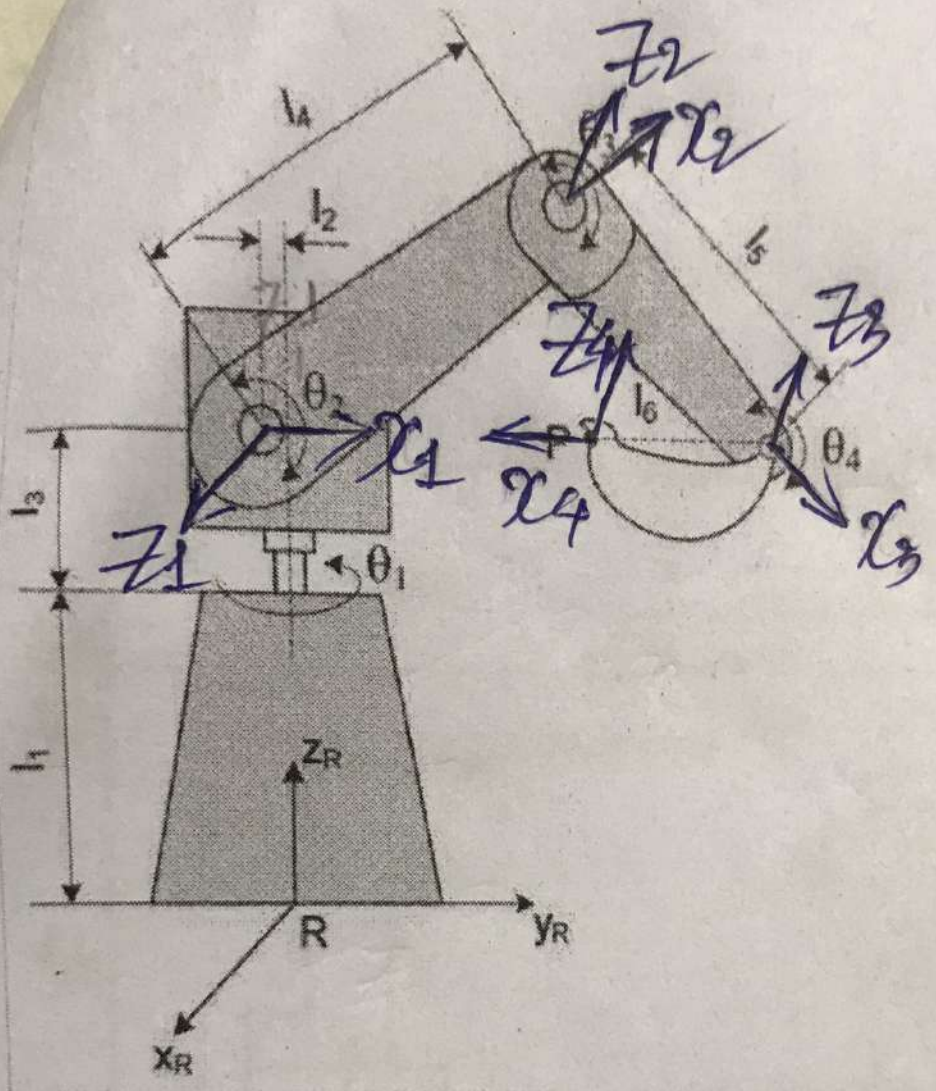
$$P = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} \Rightarrow A_1 A_2 A_3 P = \begin{bmatrix} \cos(\theta_2)[l_2\cos(\theta_1+\theta_3) + l_1\cos(\theta_1)] \\ \sin(\theta_2)[l_2\cos(\theta_1+\theta_3) + l_1\cos(\theta_1)] \\ l_2\sin(\theta_1+\theta_2) + l_1\sin(\theta_1) \\ 1 \end{bmatrix}$$

Vậy $x = \cos(\theta_2)[l_2\cos(\theta_1+\theta_3) + l_1\cos(\theta_1)] \Rightarrow \tan(\theta_2) = \frac{y}{x}$

$y = \sin(\theta_2)[l_2\cos(\theta_1+\theta_3) + l_1\cos(\theta_1)] \Rightarrow \theta_2 = \arctan\left(\frac{y}{x}\right)$

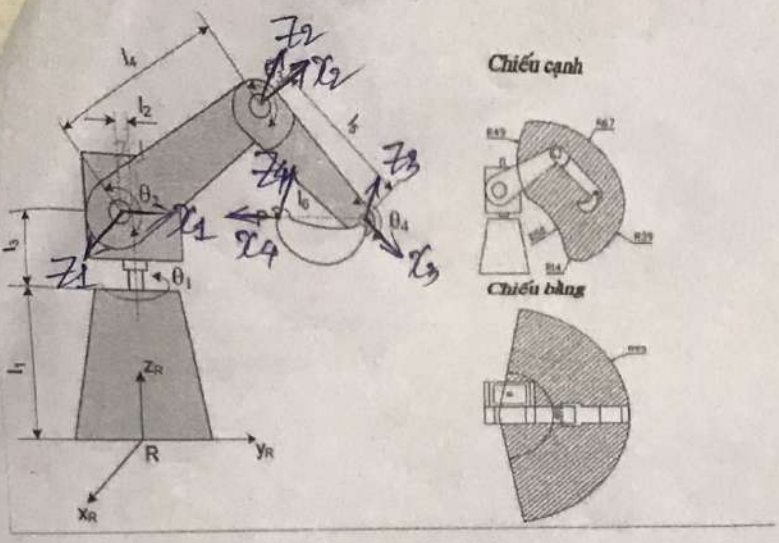
$z = l_2\sin(\theta_1+\theta_2) + l_1\sin(\theta_1)$

Bài 6



$$\Rightarrow A_1 = \begin{bmatrix} -S_1 & 0 & -C_1 & -l_2 \cdot \\ C_1 & 0 & -S_1 & l_2 \\ 0 & 1 & 0 & l_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Bài 6



#	θ	l	α	d	với
1	$\frac{\pi}{2}+\theta_1$	l_2	$\pi/2$	l_1+l_3	θ_1
2	θ_2	l_4	π	0	θ_2
3	θ_3	l_5	0	0	θ_3
4	$-\theta_4$	l_6	0	0	θ_4

$$\Rightarrow A_1 = \begin{bmatrix} -S_1 & 0 & -C_1 & -l_2 S_1 \\ C_1 & 0 & -S_1 & l_2 C_1 \\ 0 & 1 & 0 & l_1 + l_3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad A_3 = \begin{bmatrix} C_3 & -S_3 & 0 & l_5 C_3 \\ S_3 & -C_3 & 0 & l_5 S_3 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} C_2 & -S_2 & 0 & l_4 C_2 \\ S_2 & C_2 & 0 & l_4 S_2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad A_4 = \begin{bmatrix} C_4 & -S_4 & 0 & l_6 C_4 \\ S_4 & C_4 & 0 & l_6 S_4 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Tìm tọa độ x, y, z, ta nhân thêm với ma trận $P = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$

$$\Rightarrow A_1 . A_2 . A_3 . A_4 . P = \begin{bmatrix} -\sin(\theta_1).(l_2 + l_6.\cos(\theta_3 - \theta_2 + \theta_4) + l_4.\cos(\theta_2) + l_5.\cos(\theta_2 - \theta_3)) \\ \cos(\theta_1)(l_2 + l_6\cos(\theta_3 - \theta_2 + \theta_4) + l_4\cos(\theta_2) + l_5.\cos(\theta_2 - \theta_3)) \\ l_1 + l_3 - l_6.\sin(\theta_3 - \theta_2 + \theta_4) + l_4.\sin(\theta_2) + l_5.\sin(\theta_2 - \theta_3) \\ 1 \end{bmatrix}$$

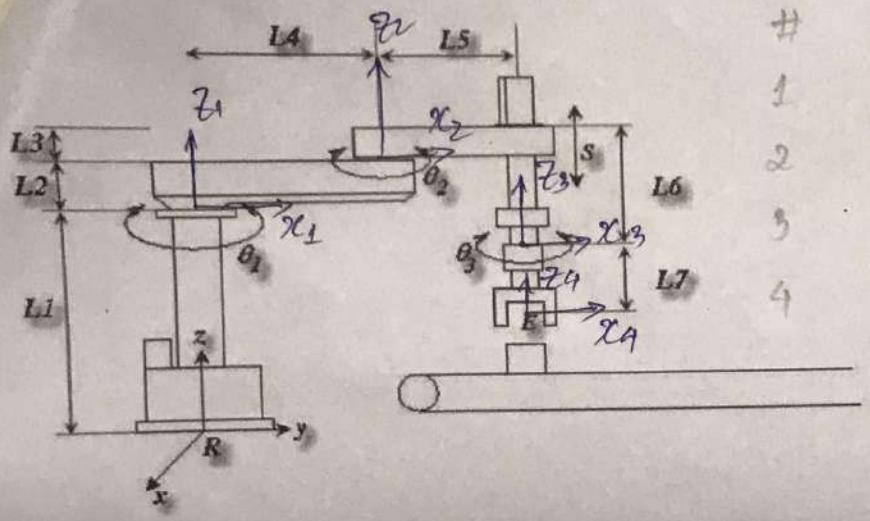
Vậy $x = -\sin(\theta_1).[l_2 + l_6.\cos(\theta_3 - \theta_2 + \theta_4) + l_4.\cos(\theta_2) + l_5.\cos(\theta_2 - \theta_3)]$

$y = \cos(\theta_1).[l_2 + l_6.\cos(\theta_3 - \theta_2 + \theta_4) + l_4\cos(\theta_2) + l_5.\cos(\theta_2 - \theta_3)]$

$z = l_1 + l_3 - l_6.\sin(\theta_3 - \theta_2 + \theta_4) + l_4.\sin(\theta_2) + l_5.\sin(\theta_2 - \theta_3)$

Do có 4 ẩn nhưng chỉ có 3 phương trình nên cần thêm điều kiện để giải

Bài 9 ≡ 7



#	θ	l	α	d	var
1	$\pi/2$	0	0	l_1	θ_1
2	θ_1	l_4	0	l_2	θ_2
3	θ_2	l_5	0	$-(l_6+s-l_3)$	s
4	θ_3	0	0	$-l_7$	θ_3

$$A_1 = \begin{bmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & l_1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad A_3 = \begin{bmatrix} \cos(\theta_2) & \sin(\theta_2) & 0 & l_5\cdot\cos(\theta_2) \\ \sin(\theta_2) & -\cos(\theta_2) & 0 & l_5\cdot\sin(\theta_2) \\ 0 & 0 & -1 & -(l_6+s-l_3) \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} \cos(\theta_1) & -\sin(\theta_1) & 0 & l_4\cdot\cos(\theta_1) \\ \sin(\theta_1) & \cos(\theta_1) & 0 & l_4\cdot\sin(\theta_1) \\ 0 & 0 & 1 & l_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad A_4 = \begin{bmatrix} \cos(\theta_3) & -\sin(\theta_3) & 0 & 0 \\ \sin(\theta_3) & \cos(\theta_3) & 0 & 0 \\ 0 & 0 & 1 & -l_7 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$P = [0; 0; 0; 1]$ >

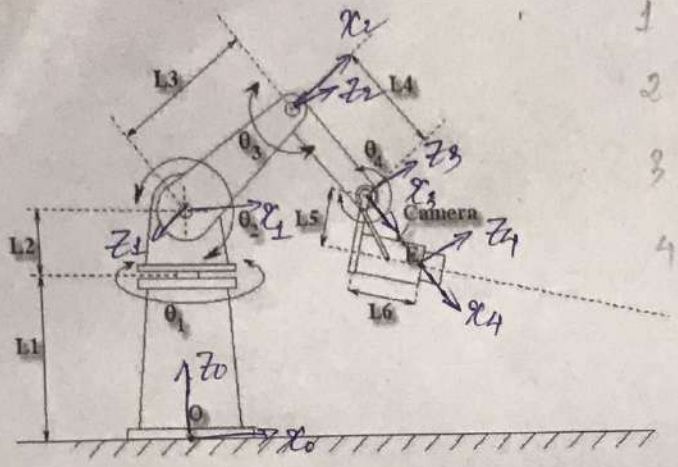
$$\Rightarrow A_1 \cdot A_2 \cdot A_3 \cdot A_4 \cdot P = \begin{bmatrix} -l_5\cdot\sin(\theta_1+\theta_2) - l_4\sin(\theta_1) \\ l_5\cdot\cos(\theta_1+\theta_2) + l_4(\cos(\theta_1)) \\ l_1 + l_2 + l_3 - l_6 - s - l_7 \\ 1 \end{bmatrix}$$

Vậy $x = -l_5\cdot\sin(\theta_1+\theta_2) - l_4\cdot\sin(\theta_1)$

$y = l_5\cdot\cos(\theta_1+\theta_2) + l_4\cdot\cos(\theta_1)$

$z = l_1 + l_2 + l_3 - l_6 - s - l_7$.

Bài 10



#	θ	l	α	d	var
1	θ_1	0	$\pi/2$	l_1+l_2	θ_1
2	θ_2	l_3	π	0	θ_2
3	θ_3	l_4	0	0	θ_3
4	θ_4	$\sqrt{l_5^2+l_6^2}$	0	0	θ_4

$$A_1 = \begin{bmatrix} \cos(\theta_1) & -\sin(\pi/2) & \sin(\theta_1) & 0 \\ \sin(\theta_1) & 0 & -\cos(\theta_1) & 0 \\ 0 & 1 & 0 & l_1+l_2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_3 = \begin{bmatrix} \cos(\theta_3) & -\sin(\theta_3) & 0 & l_4\cos(\theta_3) \\ \sin(\theta_3) & \cos(\theta_3) & 0 & l_4\sin(\theta_3) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} \cos(\theta_2) & \sin(\theta_2) & 0 & l_3\cos(\theta_2) \\ \sin(\theta_2) & -\cos(\theta_2) & 0 & l_3\sin(\theta_2) \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_4 = \begin{bmatrix} \cos(\theta_4) & -\sin(\theta_4) & 0 & \sqrt{l_5^2+l_6^2}\cos(\theta_4) \\ \sin(\theta_4) & \cos(\theta_4) & 0 & \sqrt{l_5^2+l_6^2}\sin(\theta_4) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$P = [0;\ 0;\ 0;\ 1]$$

$$\Rightarrow A_1 A_2 A_3 A_4 P = \begin{bmatrix} \cos(\theta_1)\cdot\left[\sqrt{l_5^2+l_6^2}\cos(\theta_2-\theta_3+\theta_4) + l_3\cos(\theta_2) + l_4\cos(\theta_2-\theta_3)\right] \\ \sin(\theta_1)\cdot\left[\sqrt{l_5^2+l_6^2}\cos(\theta_2-\theta_3+\theta_4) + l_3\cos(\theta_2) + l_4\cos(\theta_2-\theta_3)\right] \\ l_1+l_2-\sqrt{l_5^2+l_6^2}\cdot\sin(\theta_2-\theta_3+\theta_4) + l_3\sin(\theta_2) + l_4\sin(\theta_2-\theta_3) \\ 1 \end{bmatrix}$$

Vậy $x = \cos(\theta_1)\cdot\left[\sqrt{l_5^2+l_6^2}\cos(\theta_2-\theta_3+\theta_4) + l_3\cos(\theta_2) + l_4\cos(\theta_2-\theta_3)\right]$

$y = \sin(\theta_1)\cdot\left[\sqrt{l_5^2+l_6^2}\cos(\theta_2-\theta_3+\theta_4) + l_3\cos(\theta_2) + l_4\cos(\theta_2-\theta_3)\right]$

$z = l_1+l_2-\sqrt{l_5^2+l_6^2}\cdot\sin(\theta_2-\theta_3+\theta_4) + l_3\sin(\theta_2) + l_4\sin(\theta_2-\theta_3)$

4 ẩn 3 phương trình → cần thêm điều kiện