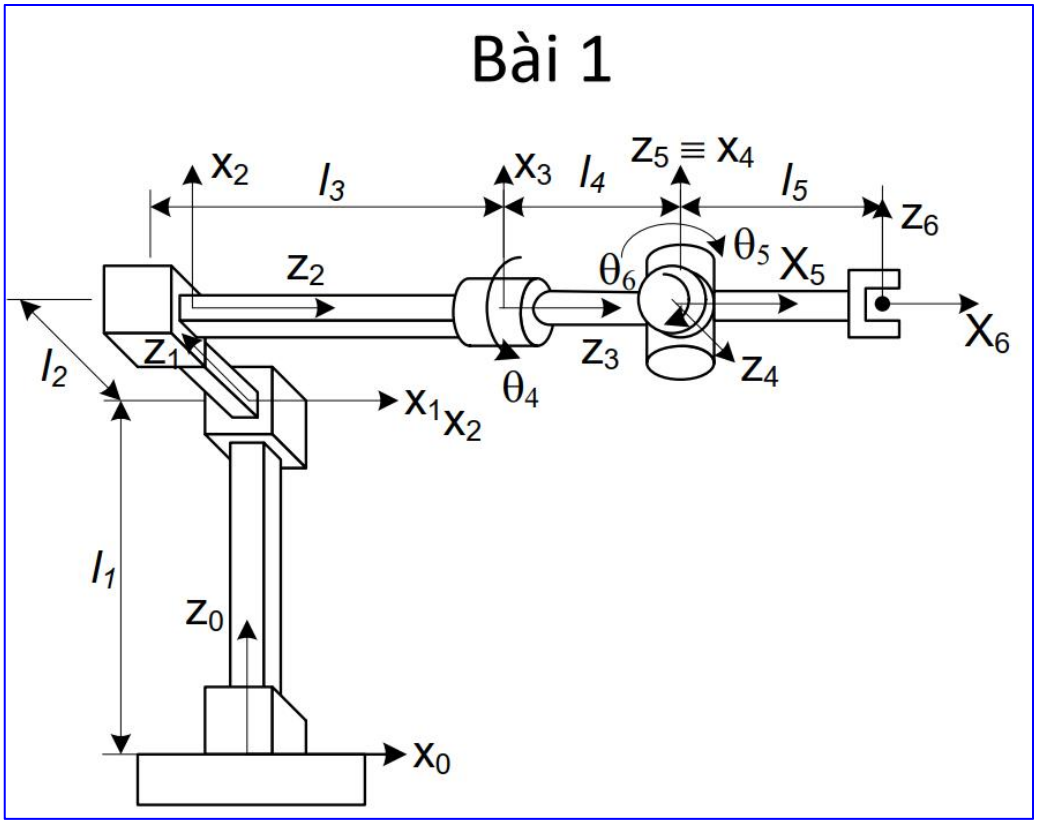


$^{O}P = {}^{O}T_7 \,.\, {}^{7}P$

$= {}^{O}T_1.{}^{1}T_2.{}^{2}T_3.{}^{3}T_4.{}^{4}T_5.{}^{5}T_6.{}^{7}P$

$= T(l_3,l_2,l_1) * R(x,\theta_4) * T(l_4,0,0) * R(z,\theta_5) * R(y,\theta_6) * T(l_5,0,0) * P$

$$= \begin{bmatrix} 1 & 0 & 0 & l3 \\ 0 & 1 & 0 & l2 \\ 0 & 0 & 1 & l1 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta_4 & -\sin\theta_4 & 0 \\ 0 & \sin\theta_4 & \cos\theta_4 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & l4 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x$$

$$\begin{bmatrix} \cos\theta_5 & -\sin\theta_5 & 0 & 0 \\ \sin\theta_5 & \cos\theta_5 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_6 & 0 & \sin\theta_6 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_6 & 0 & \cos\theta_6 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & l5 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} l3 + l4 + l5 * \cos(t5) * \cos(t6) \\ l2 + l5 * (\sin(t4) * \sin(t6) + \cos(t4) * \cos(t6) * \sin(t5)) \\ l1 - l5 * (\cos(t4) * \sin(t6) - \cos(t6) * \sin(t4) * \sin(t5)) \\ 1 \end{bmatrix}$$

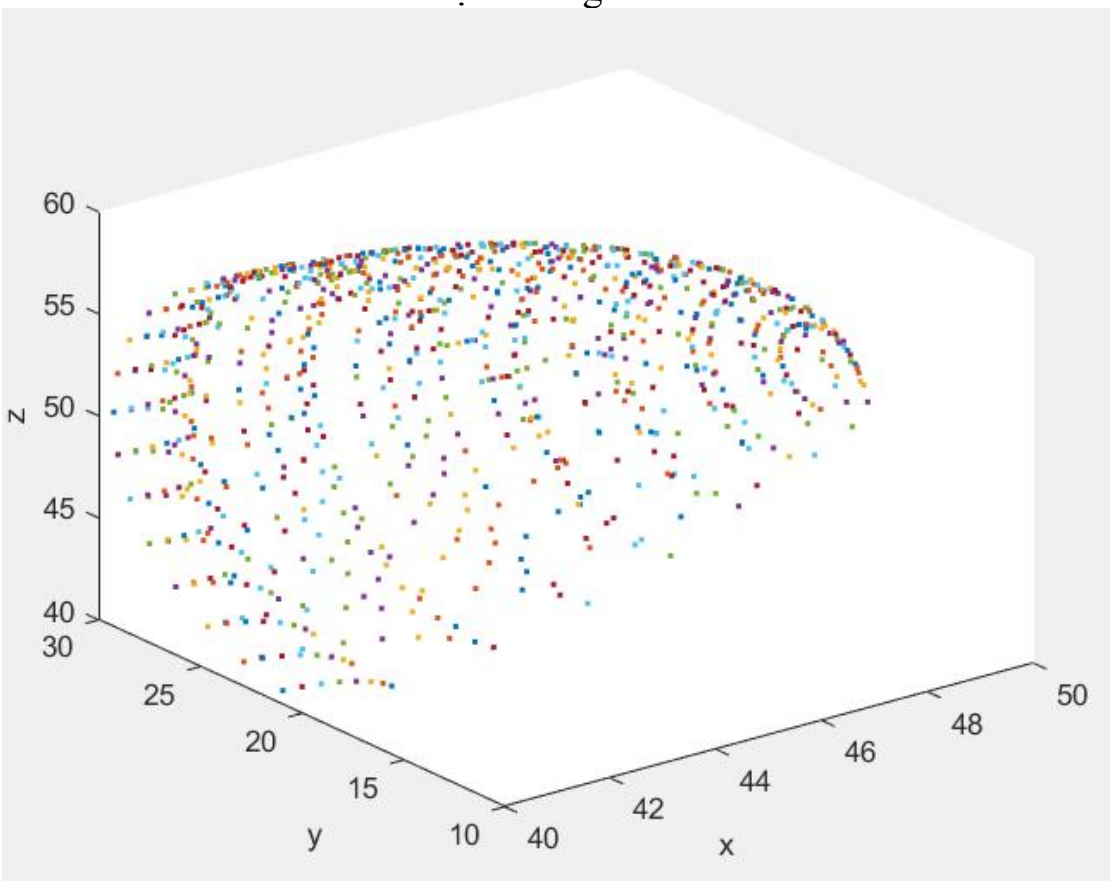
Vậy

$x = l3 + l4 + l5 * \cos(t5) * \cos(t6)$

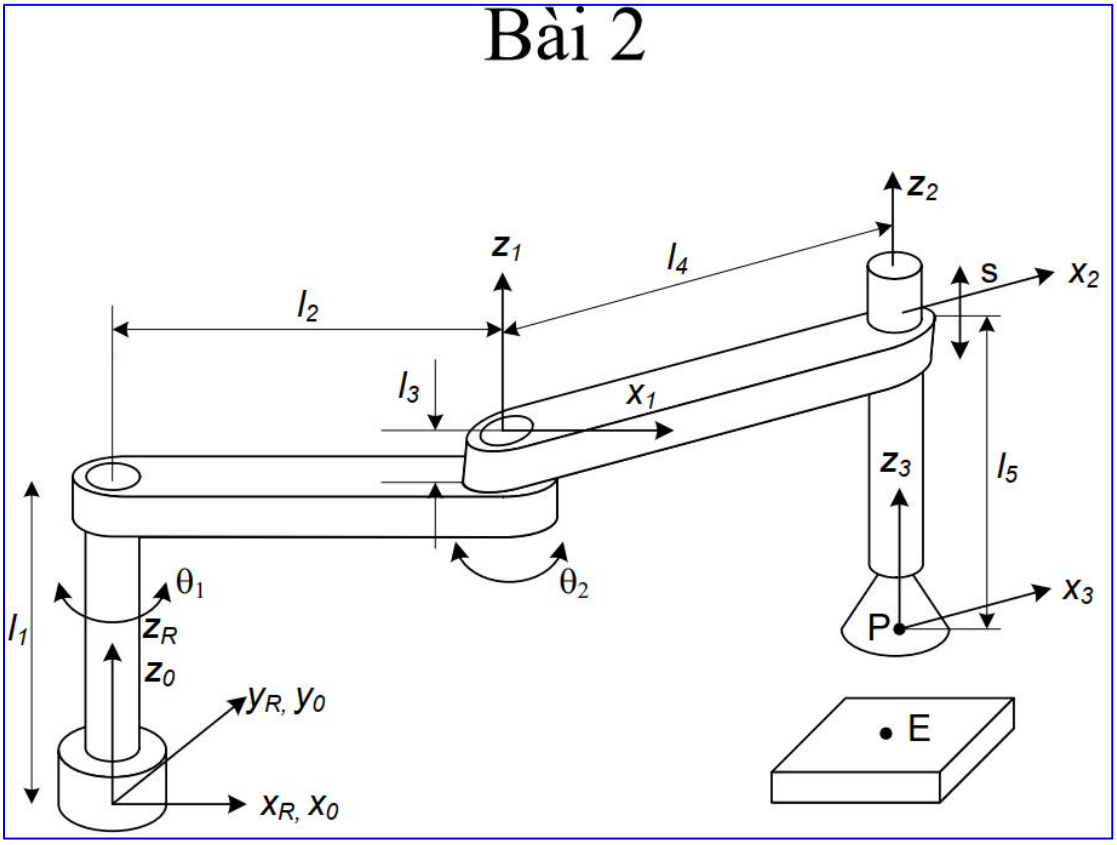
$y = l2 + l5 * (\sin(t4) * \sin(t6) + \cos(t4) * \cos(t6) * \sin(t5))$

$z = l1 - l5 * (\cos(t4) * \sin(t6) - \cos(t6) * \sin(t4) * \sin(t5))$

Đồ thị vẽ bằng Mathlab



Bài 2



$^{O}P = {}^{O}T_4 \,.\, {}^{4}P$

$= {}^{O}T_1.{}^{1}T_2.{}^{2}T_3.{}^{3}T_4.{}^{4}P$

$= R(z,\theta_1) * T(l_2,0,l_1) * R(z,\theta_2) * T(l_4,0,l_3 - l_5 + s) * P$

$$= \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & l2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l1 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_2 & -\sin\theta_2 & 0 & 0 \\ \sin\theta_2 & \cos\theta_2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} 1 & 0 & 0 & l4 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l3 - l5 + s \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} l4 * \cos(t1 + t2) + l2 * \cos(t1) \\ l4 * \sin(t1 + t2) + l2 * \sin(t1) \\ l1 + l3 - l5 + s \\ 1 \end{bmatrix}$$

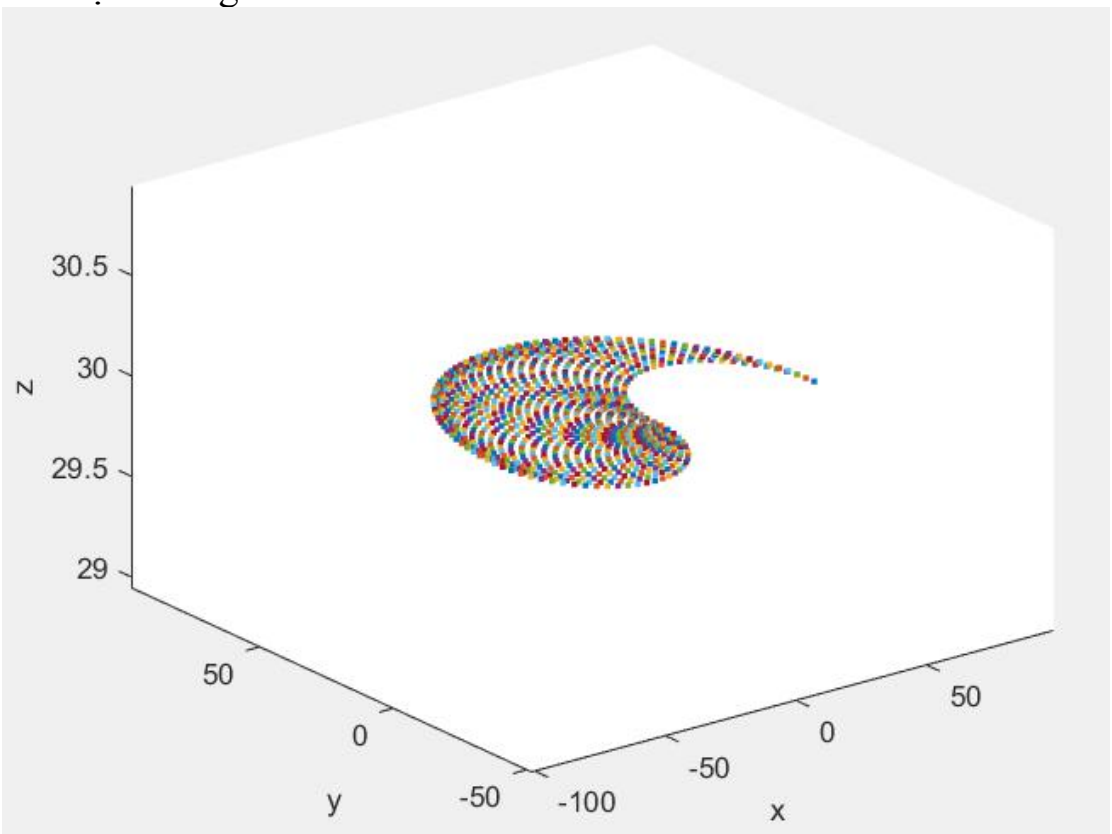
Vậy

$x = l4 * \cos(t1 + t2) + l2 * \cos(t1)$

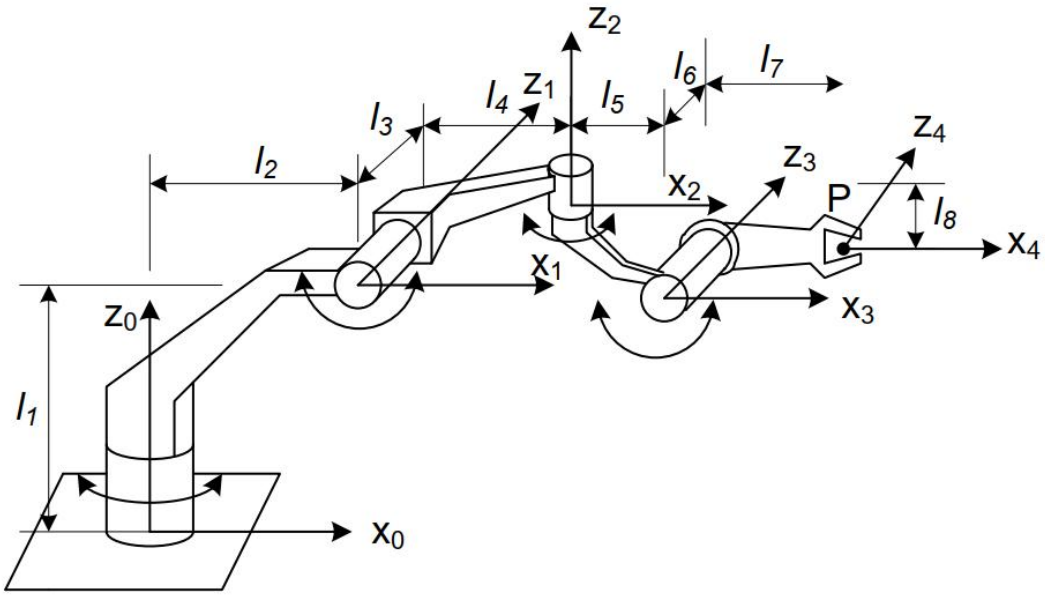
$y = l4 * \sin(t1 + t2) + l2 * \sin(t1)$

$z = l1 + l3 - l5 + s$

Đồ thị vẽ bằng Mathlab



Bài 3



$^{O}P = {}^{O}T_8 . {}^{8}P$

$= {}^{O}T_1 . {}^{1}T_2 . {}^{2}T_3 . {}^{3}T_4 . {}^{4}T_5 . {}^{5}T_6 . {}^{6}T_7 . {}^{7}T_8 . {}^{8}P$

$= R(z,\theta_1) * T(l_2,0,l_1) * R(y,\theta_2) * T(l_4,l_3,0) * R(z,\theta_3) * T(l_5,0,-l_8) * R(y,\theta_4) * T(l_7,l_6,0) * P$

$$= \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & l2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l1 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_2 & 0 & \sin\theta_2 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_2 & 0 & \cos\theta_2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & l4 \\ 0 & 1 & 0 & l3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_3 & -\sin\theta_3 & 0 & 0 \\ \sin\theta_3 & \cos\theta_3 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & l5 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -l8 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} \cos\theta_4 & 0 & \sin\theta_4 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_4 & 0 & \cos\theta_4 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & l7 \\ 0 & 1 & 0 & l6 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

= [l2*cos(t1) - l6*(cos(t3)*sin(t1) + cos(t1)*cos(t2)*sin(t3)) - l5*(sin(t1)*sin(t3) - cos(t1)*cos(t2)*cos(t3)) - l3*sin(t1) - l7*(cos(t4)*(sin(t1)*sin(t3) - cos(t1)*cos(t2)*cos(t3)) + cos(t1)*sin(t2)*sin(t4)) + l4*cos(t1)*cos(t2) - l8*cos(t1)*sin(t2)

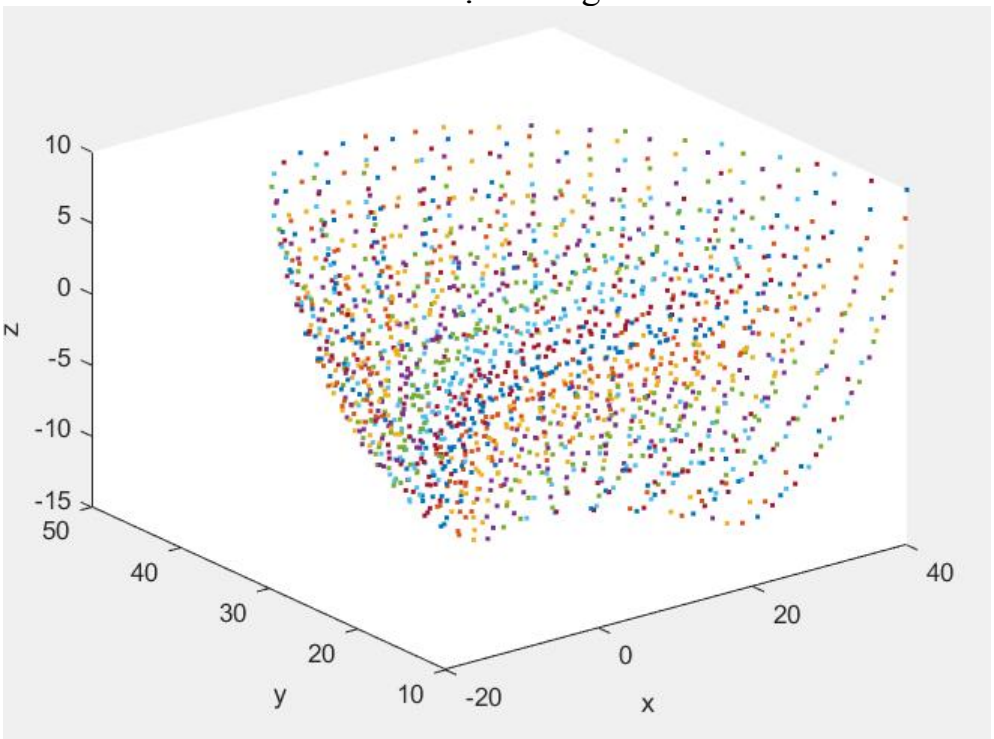
; l5*(cos(t1)*sin(t3) + cos(t2)*cos(t3)*sin(t1)) + l6*(cos(t1)*cos(t3) - cos(t2)*sin(t1)*sin(t3)) + l3*cos(t1) + l2*sin(t1) + l7*(cos(t4)*(cos(t1)*sin(t3) + cos(t2)*cos(t3)*sin(t1)) - sin(t1)*sin(t2)*sin(t4)) + l4*cos(t2)*sin(t1) - l8*sin(t1)*sin(t2)
;
l1 - l7*(cos(t2)*sin(t4) + cos(t3)*cos(t4)*sin(t2)) - l8*cos(t2) - l4*sin(t2) - l5*cos(t3)*sin(t2) + l6*sin(t2)*sin(t3)
;1]

Vậy
x= l2*cos(t1) - l6*(cos(t3)*sin(t1) + cos(t1)*cos(t2)*sin(t3)) - l5*(sin(t1)*sin(t3) - cos(t1)*cos(t2)*cos(t3)) - l3*sin(t1) - l7*(cos(t4)*(sin(t1)*sin(t3) - cos(t1)*cos(t2)*cos(t3)) + cos(t1)*sin(t2)*sin(t4)) + l4*cos(t1)*cos(t2) - l8*cos(t1)*sin(t2)

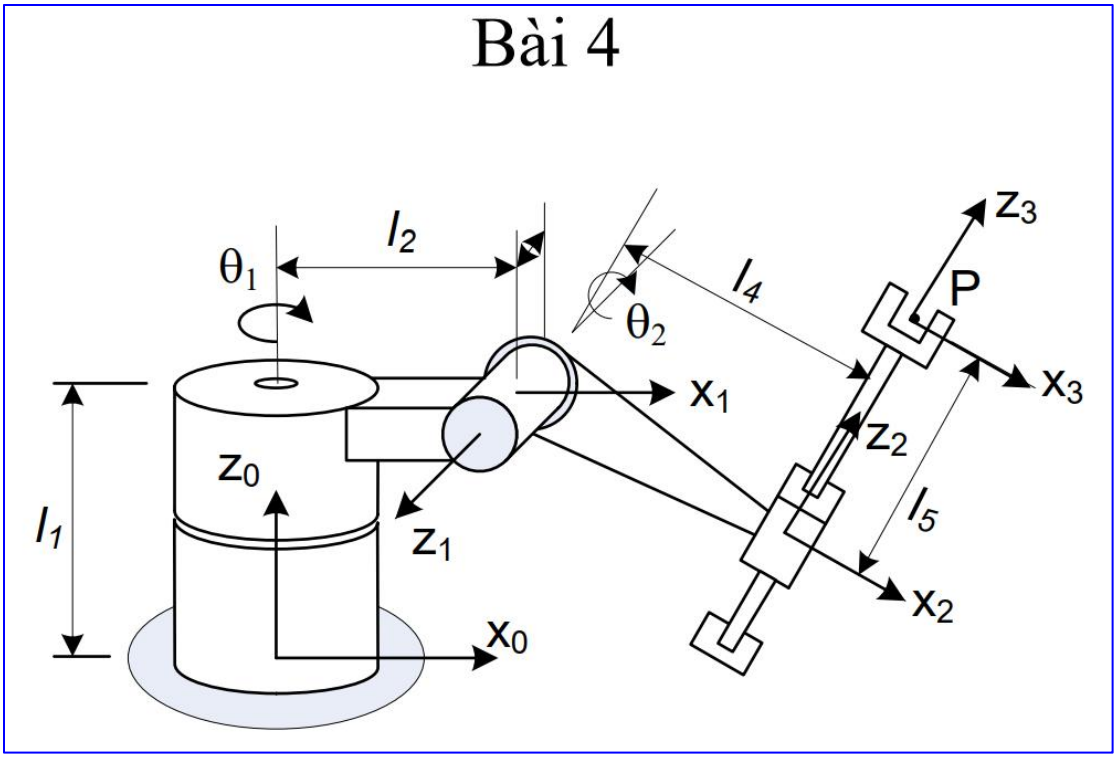
y= l5*(cos(t1)*sin(t3) + cos(t2)*cos(t3)*sin(t1)) + l6*(cos(t1)*cos(t3) - cos(t2)*sin(t1)*sin(t3)) + l3*cos(t1) + l2*sin(t1) + l7*(cos(t4)*(cos(t1)*sin(t3) + cos(t2)*cos(t3)*sin(t1)) - sin(t1)*sin(t2)*sin(t4)) + l4*cos(t2)*sin(t1) - l8*sin(t1)*sin(t2)

z=
l1 - l7*(cos(t2)*sin(t4) + cos(t3)*cos(t4)*sin(t2)) - l8*cos(t2) - l4*sin(t2) - l5*cos(t3)*sin(t2) + l6*sin(t2)*sin(t3)

Đồ thị vẽ bằng Mathlab



Bài 4



$${}^{O}P = {}^{O}T_4 \,.\, {}^{4}P$$

$$= {}^{O}T_1.{}^{1}T_2.{}^{2}T_3.{}^{3}T_4.{}^{4}P$$

$$= R(z,\theta_1) * T(l_2,0,l_1) * R(y,\theta_2) * T(l_4,0,l_5) * P$$

$$= \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & l2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l1 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_2 & 0 & \sin\theta_2 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_2 & 0 & \cos\theta_2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} 1 & 0 & 0 & l4 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l5 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} \cos(t1) * (l2 + l4 * \cos(t2) + l5 * \sin(t2)) \\ \sin(t1) * (l2 + l4 * \cos(t2) + l5 * \sin(t2)) \\ l1 + l5 * \cos(t2) - l4 * \sin(t2) \\ 1 \end{bmatrix}$$

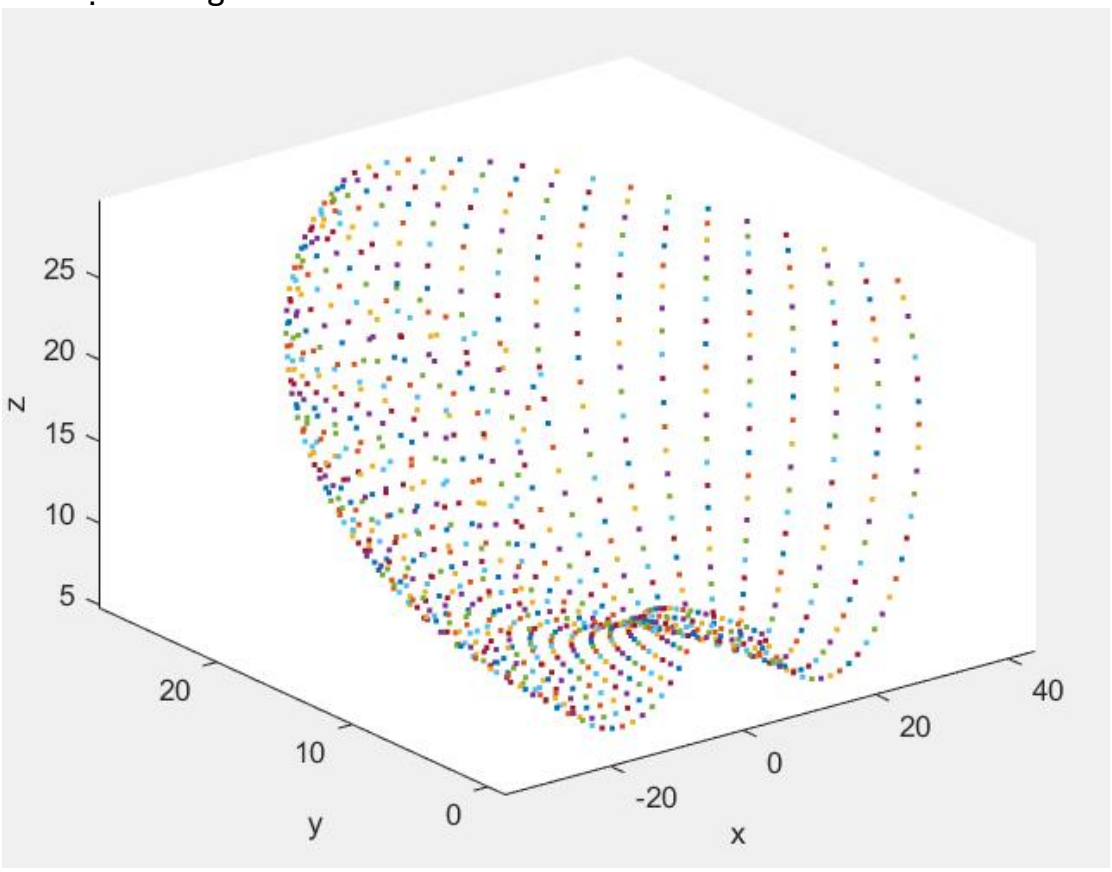
Vậy

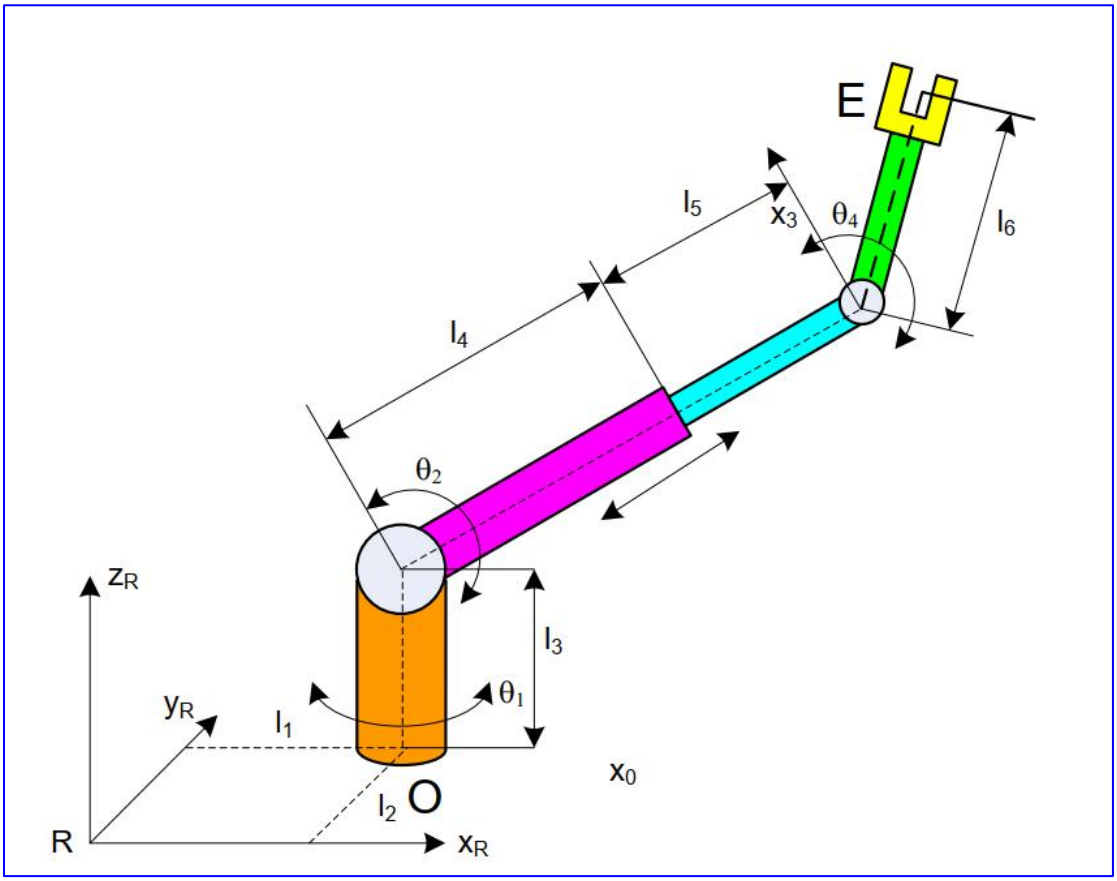
x= cos(t1)*(l2 + l4*cos(t2) + l5*sin(t2))

y= sin(t1)*(l2 + l4*cos(t2) + l5*sin(t2))

z= l1 + l5*cos(t2) - l4*sin(t2)

Đồ thị vẽ bằng Mathlab





${}^{O}P = {}^{O}T_7 \,.\, {}^{7}P$

$= {}^{O}T_1.{}^{1}T_2.{}^{2}T_3.{}^{3}T_4.{}^{4}T_5.{}^{5}T_6.{}^{6}T_7.{}^{7}P$

$= T(l_1,l_2,0)*R(z,\theta_1) * T(0,0,l_3) * R(y,\theta_2)*T(l_4+l_5,0,0)*R(y,\theta_4)$
$*T(l_6,0,0)*P$

$$= \begin{bmatrix} 1 & 0 & 0 & l1 \\ 0 & 1 & 0 & l2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} \cos\theta_2 & 0 & \sin\theta_2 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_2 & 0 & \cos\theta_2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & l4+l5 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_4 & 0 & \sin\theta_4 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_4 & 0 & \cos\theta_4 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} 1 & 0 & 0 & l6 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} l1 + \cos(t1)*\cos(t2)*(l4 + l5) + l6*\cos(t2 + t4)*\cos(t1) \\ l2 + \cos(t2)*\sin(t1)*(l4 + l5) + l6*\cos(t2 + t4)*\sin(t1) \\ l3 - \sin(t2)*(l4 + l5) - l6*\sin(t2 + t4) \\ 1 \end{bmatrix}$$

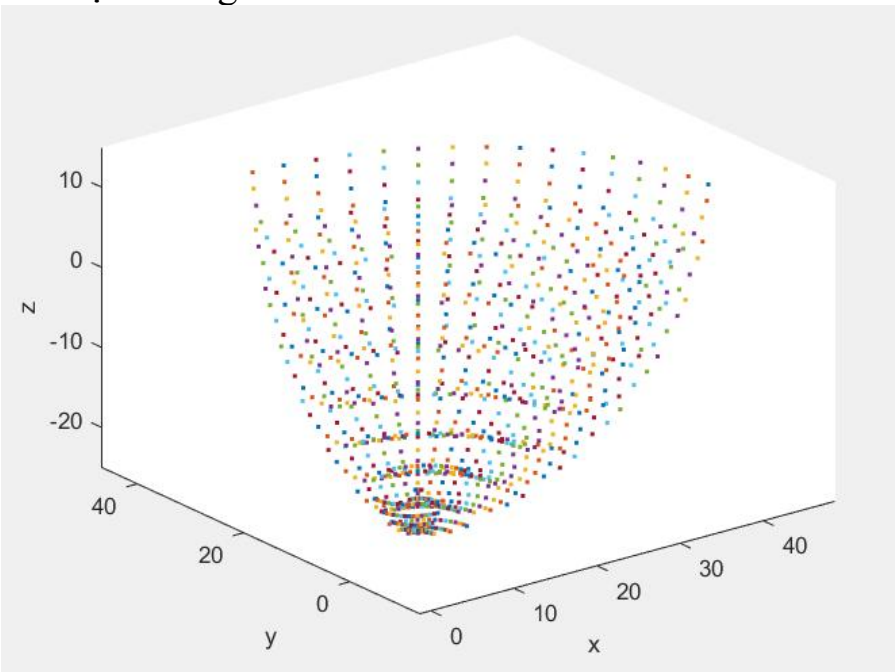
Vậy

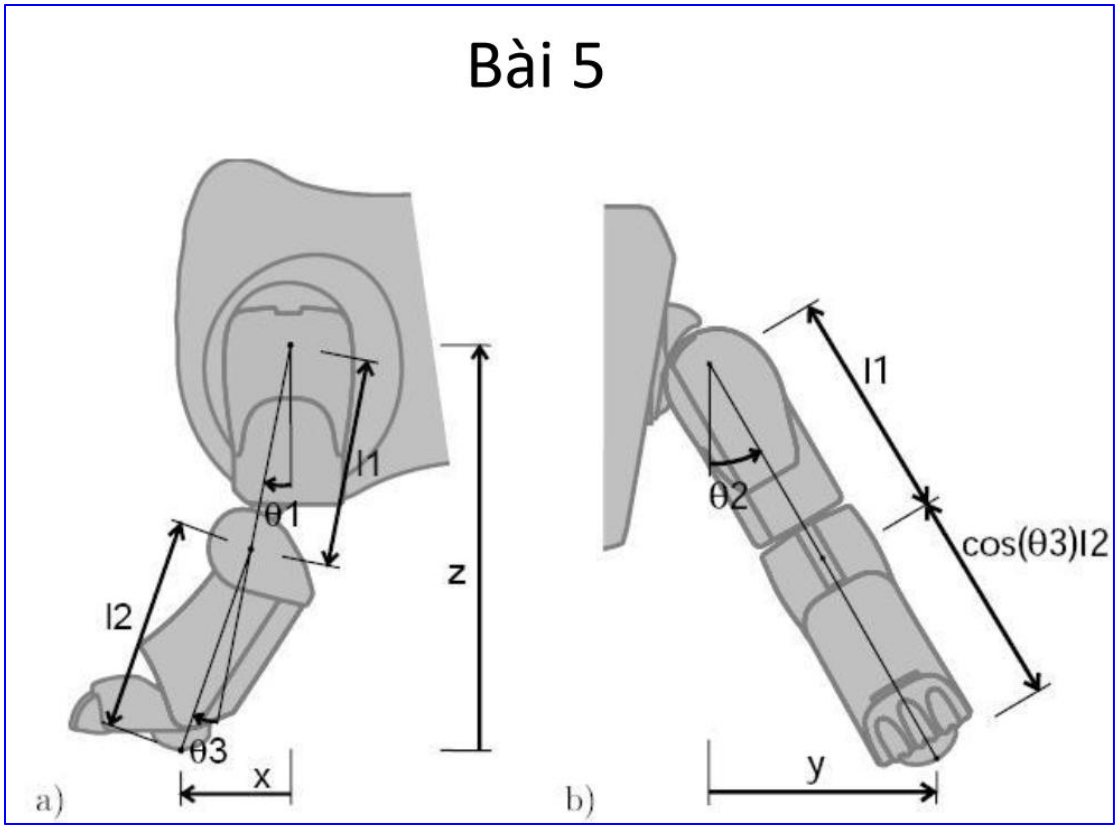
x= l1 + cos(t1)*cos(t2)*(l4 + l5) + l6*cos(t2 + t4)*cos(t1)

y= l2 + cos(t2)*sin(t1)*(l4 + l5) + l6*cos(t2 + t4)*sin(t1)

z= l3 - sin(t2)*(l4 + l5) - l6*sin(t2 + t4)

Đồ thị vẽ bằng Mathlab





Chọn gốc tọa độ ở tâm xoay góc θ_1

${}^{O}P = {}^{O}T_5 \cdot {}^{5}P$

$= {}^{O}T_1.{}^{1}T_2.{}^{2}T_3.{}^{3}T_4.{}^{4}T_5.{}^{5}P$

$= R(y,\theta_1)*R(x,\theta_2) * T(0,0,l_1) * R(y,\theta_3)*T(0,0,l_2)*P$

$$= \begin{bmatrix} \cos\theta_1 & 0 & \sin\theta_1 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_1 & 0 & \cos\theta_1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta_2 & -\sin\theta_2 & 0 \\ 0 & \sin\theta_2 & \cos\theta_2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} \cos\theta_3 & 0 & \sin\theta_3 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_3 & 0 & \cos\theta_3 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l2 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} \cos(t2) * \sin(t1) * (l1 + l2) \\ -\sin(t2) * (l1 + l2) \\ \cos(t1) * \cos(t2) * (l1 + l2) \\ 1 \end{bmatrix}$$

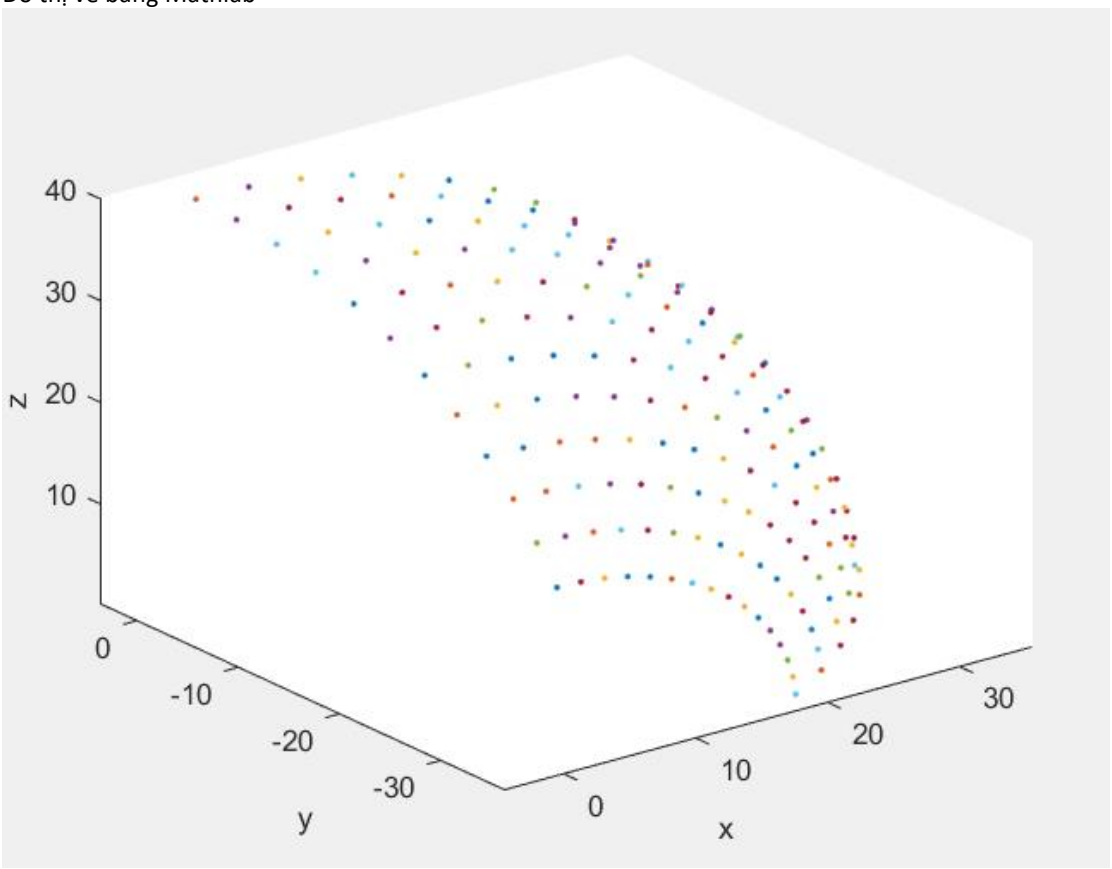
Vậy

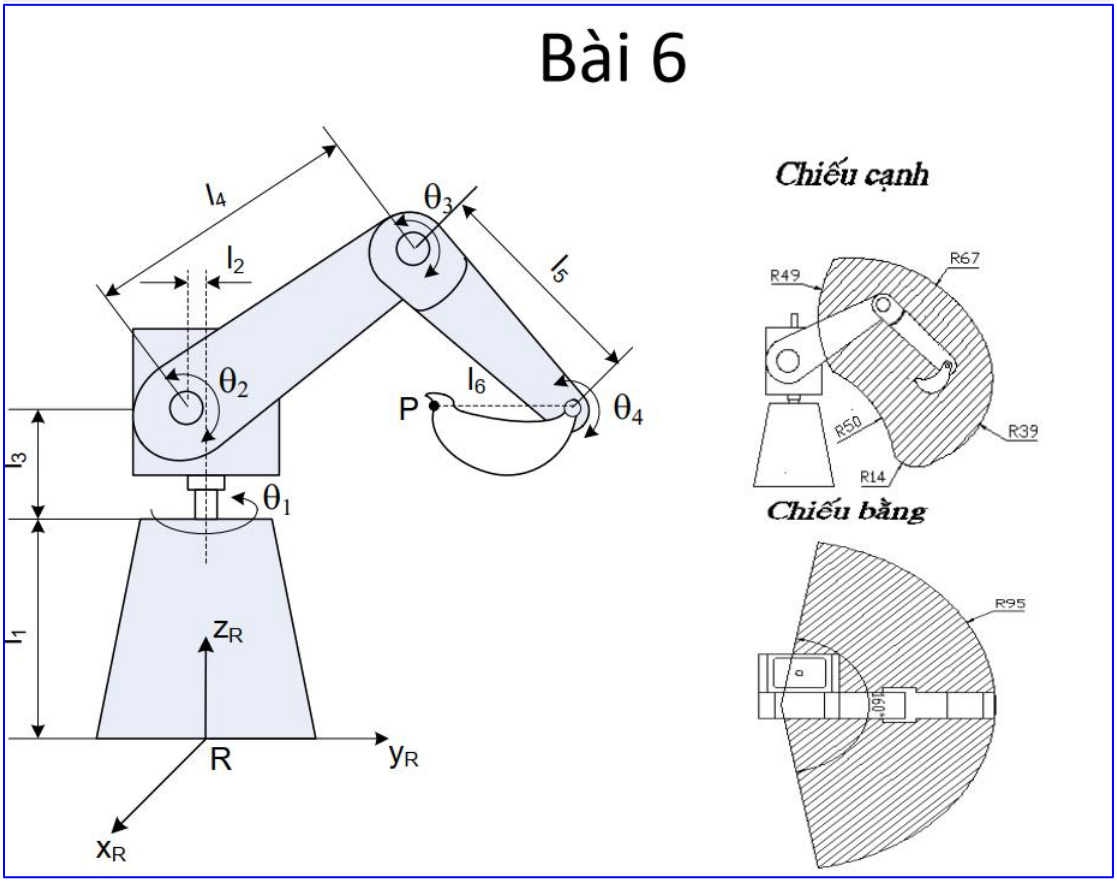
Xx= cos(t2)*sin(t1)*(l1 + l2)

Yy= -sin(t2)*(l1 + l2)

Zz= cos(t1)*cos(t2)*(l1 + l2)

Đồ thị vẽ bằng Mathlab





$^{O}P = {}^{O}T_7 \,.\, {}^{7}P$

$= {}^{O}T_1.{}^{1}T_2.{}^{2}T_3.{}^{3}T_4.{}^{4}T_5.{}^{5}T_6.{}^{6}T_7.{}^{7}P$

$= T(0,0,l_1)*R(z,\theta_1) * T(0,-l_2,l_3) * R(x,\theta_2)*T(0,l_4,0)*R(x,\theta_3)$
$*T(0,l_5,0)*R(x,\theta_4)*T(0,-l_6,0)*P$

$$= \begin{bmatrix} 1 & 0 & 0 & l1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & -l2 \\ 0 & 0 & 1 & l3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} \cos\theta_2 & 0 & \sin\theta_2 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_2 & 0 & \cos\theta_2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & l4 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_3 & 0 & \sin\theta_3 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_3 & 0 & \cos\theta_3 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & l5 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_4 & 0 & \sin\theta_4 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_4 & 0 & \cos\theta_4 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & -l6 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

=

$$\begin{bmatrix} l2 * \sin(t1) + l5 * \sin(t2 + t3) * \cos(t1) + l4 * \cos(t1) * \sin(t2) - l6 * \sin(t2 + t3 + t4) * \cos(t1) \\ l5 * \sin(t2 + t3) * \sin(t1) - l2 * \cos(t1) + l4 * \sin(t1) * \sin(t2) - l6 * \sin(t2 + t3 + t4) * \sin(t1) \\ l1 + l3 + l5 * \cos(t2 + t3) + l4 * \cos(t2) - l6 * \cos(t2 + t3 + t4) \\ 1 \end{bmatrix}$$

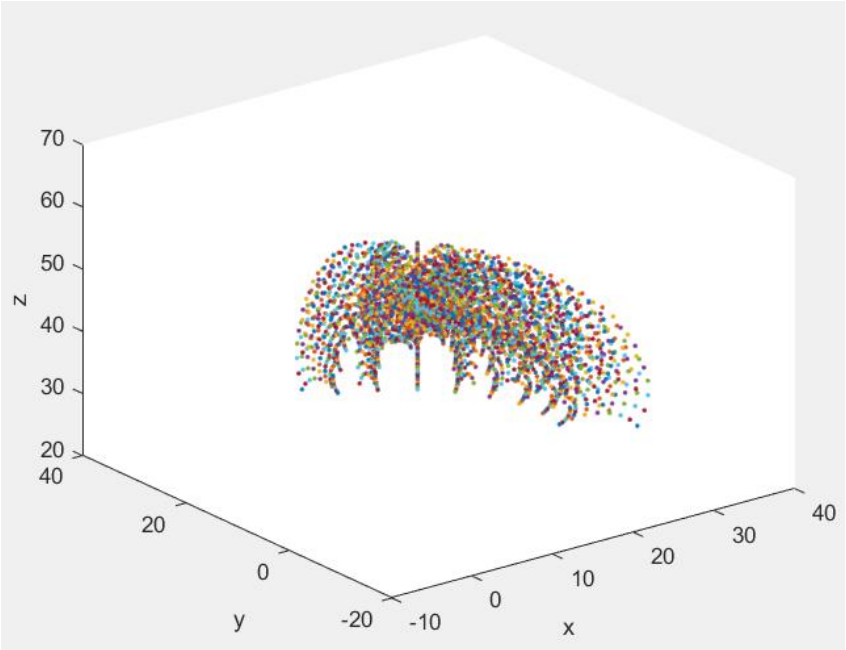
Vậy

x= l2*sin(t1) + l5*sin(t2 + t3)*cos(t1) + l4*cos(t1)*sin(t2) - l6*sin(t2 + t3 + t4)*cos(t1)

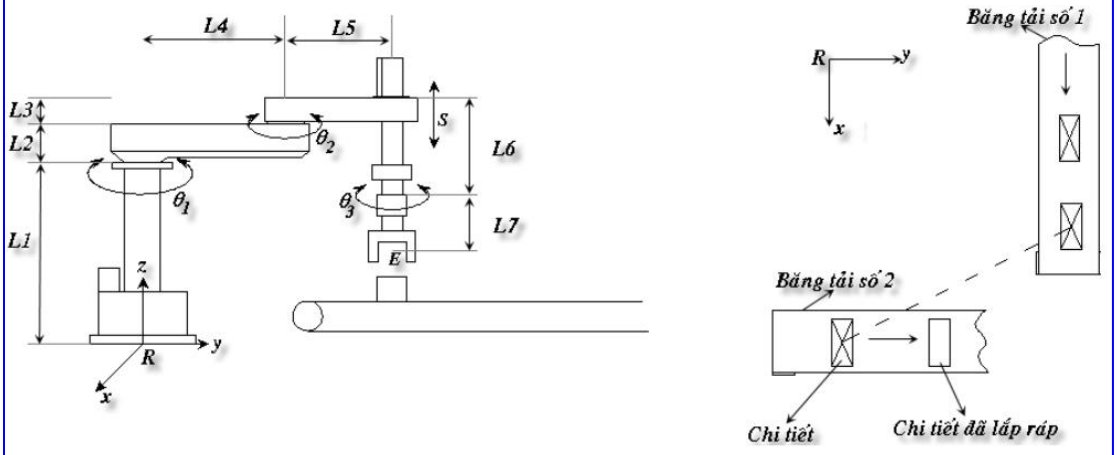
y= l5*sin(t2 + t3)*sin(t1) - l2*cos(t1) + l4*sin(t1)*sin(t2) - l6*sin(t2 + t3 + t4)*sin(t1)

z= l1 + l3 + l5*cos(t2 + t3) + l4*cos(t2) - l6*cos(t2 + t3 + t4)

Đồ thị vẽ bằng Mathlab



Bài 7



$^{O}P = {}^{O}T_7 \,.\, {}^{7}P$

$= {}^{O}T_1.{}^{1}T_2.{}^{2}T_3.{}^{3}T_4.{}^{4}T_5.{}^{5}T_6.{}^{6}T_7.{}^{7}P$

$= T(0,0,l_1)*R(z,\theta_1) * T(0,l_4,l_2) * R(z,\theta_2)*T(0,l_5,l_3-l_6+s)*R(z,\theta_3)$
$*T(0,0,-l_7)*P$

$$= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l1 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & l4 \\ 0 & 0 & 1 & l2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} \cos\theta_2 & -\sin\theta_2 & 0 & 0 \\ \sin\theta_2 & \cos\theta_2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & l5 \\ 0 & 0 & 1 & l3 - l6 + s \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_3 & -\sin\theta_3 & 0 & 0 \\ \sin\theta_3 & \cos\theta_3 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -l7 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} -l5 * \sin(t1 + t2) - l4 * \sin(t1) \\ l5 * \cos(t1 + t2) + l4 * \cos(t1) \\ l1 + l2 + l3 - l6 - l7 + s \\ 1 \end{bmatrix}$$

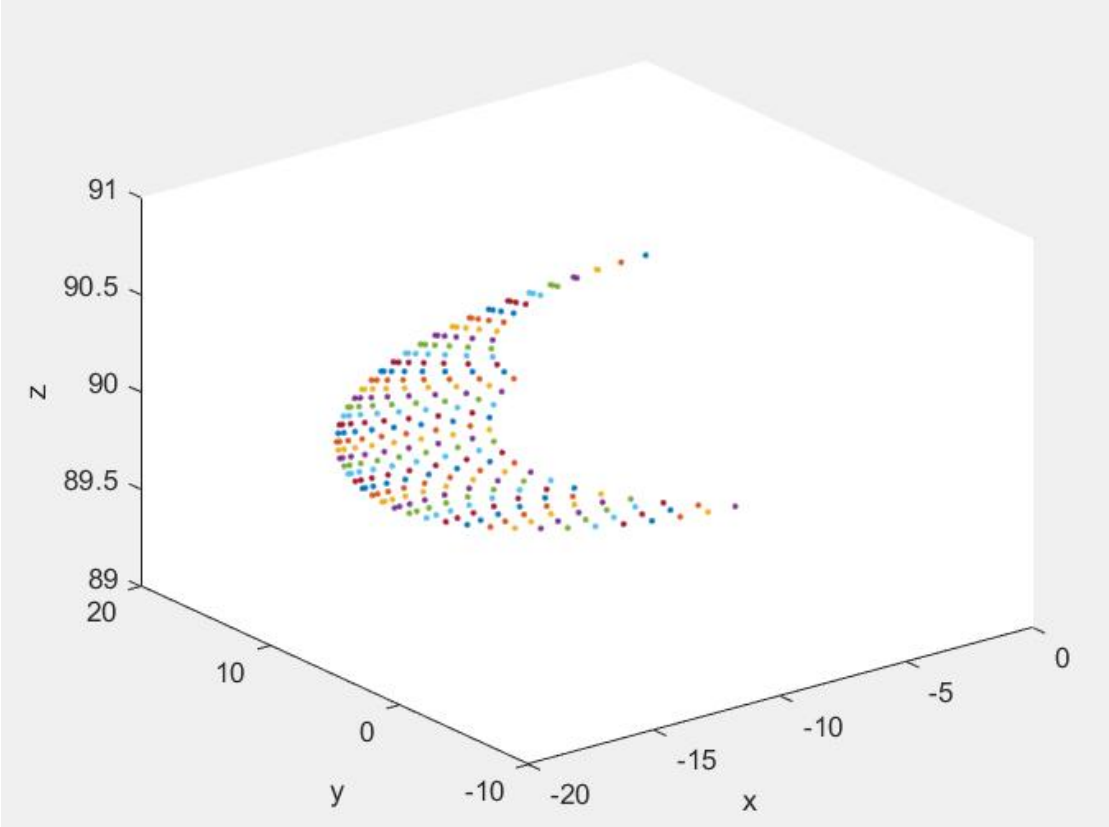
Vậy

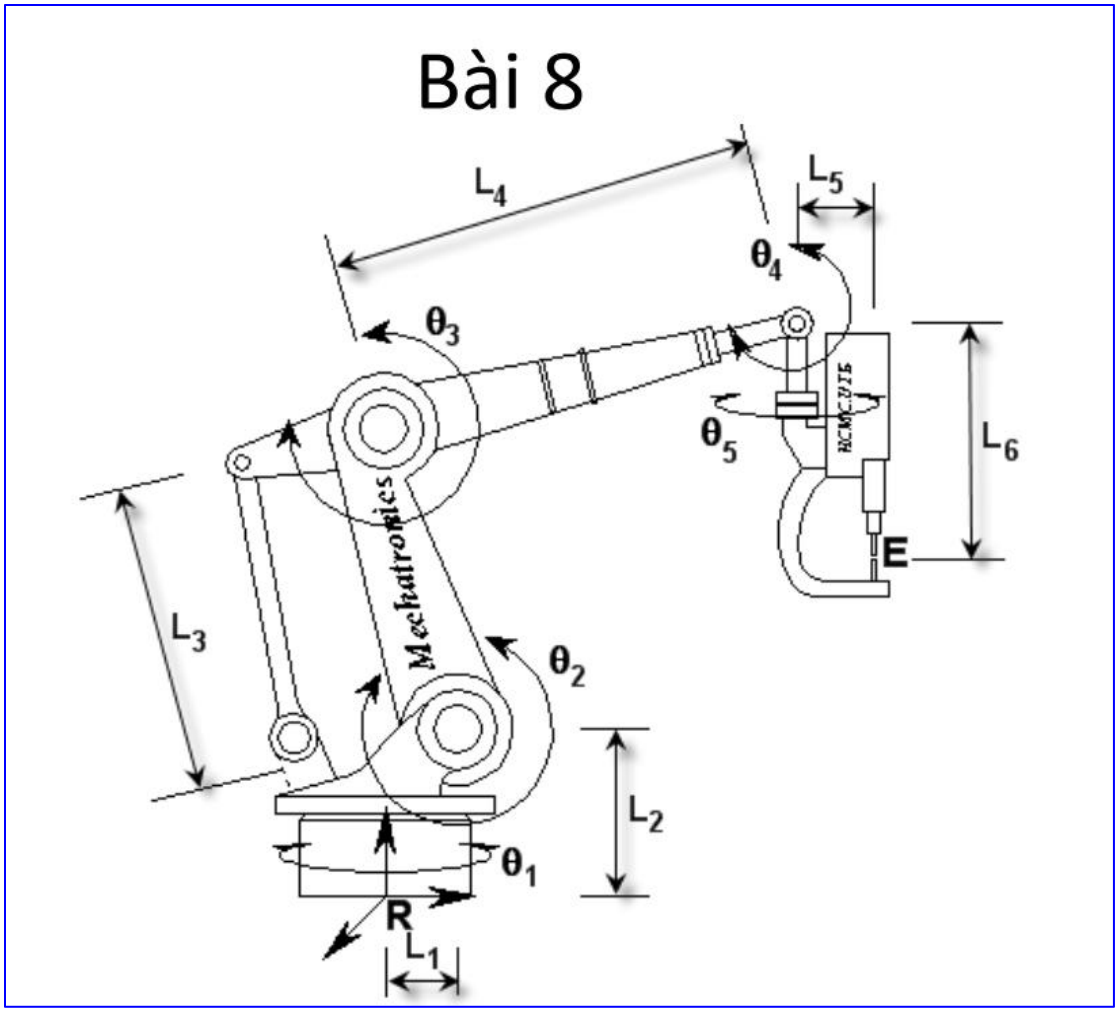
X= - l5*sin(t1 + t2) - l4*sin(t1)

Y= l5*cos(t1 + t2) + l4*cos(t1)

Z= l1 + l2 + l3 - l6 - l7 + s

Đồ thị vẽ bằng Mathlab





${}^{O}P = {}^{O}T_9 \,.\, {}^{9}P$

$= {}^{O}T_1.{}^{1}T_2.{}^{2}T_3.{}^{3}T_4.{}^{4}T_5.{}^{5}T_6.{}^{6}T_7.{}^{7}T_8.{}^{8}T_9.{}^{9}P$

$= R(z,\theta_1) * T(l_1,0,l_2) * R(y,\theta_2) * T(0,0,l_3) * R(y,\theta_3) * T(l_4,0,0) * R(y,\theta_4) * * R(z,\theta_5) * T(l_5,0,l_6) * P$

$$= \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & l1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l2 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_2 & 0 & \sin\theta_2 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_2 & 0 & \cos\theta_2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l3 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_3 & 0 & \sin\theta_3 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_3 & 0 & \cos\theta_3 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & l4 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} \cos\theta_4 & 0 & \sin\theta_4 & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta_4 & 0 & \cos\theta_4 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_5 & -\sin\theta_5 & 0 & 0 \\ \sin\theta_5 & \cos\theta_5 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l6 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

=

$$\begin{bmatrix} l1 + l6 * \sin(t2 + t3) * \cos(t1) + l4 * \cos(t1) * \cos(t2) - l6 * \sin(t2 + t3 + t4) * \cos(t1) \\ \sin(t1) * (l6 * \sin(t2 + t3) + l4 * \cos(t2) - l6 * \sin(t2 + t3 + t4)) \\ l2 + l3 + l6 * \cos(t2 + t3) - l4 * \sin(t2) - l6 * \cos(t2 + t3 + t4) \\ 1 \end{bmatrix}$$

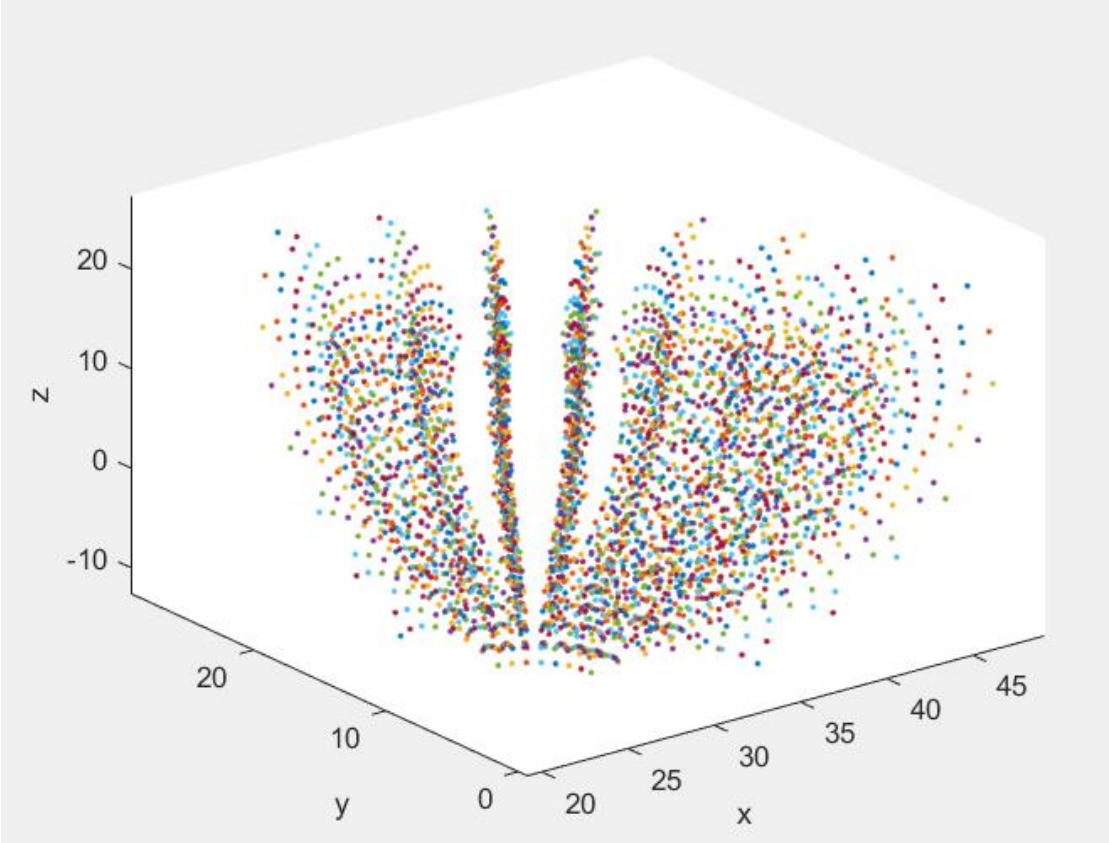
Vậy

X= l1 + l6*sin(t2 + t3)*cos(t1) + l4*cos(t1)*cos(t2) - l6*sin(t2 + t3 + t4)*cos(t1)

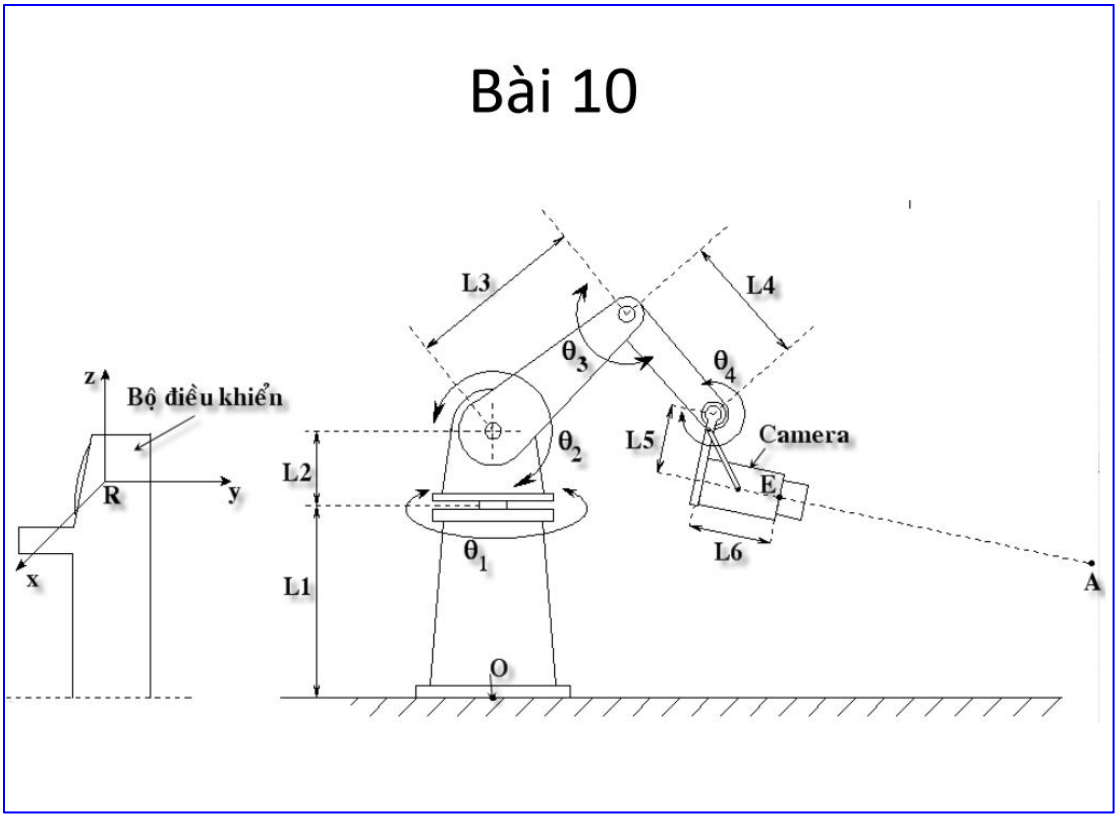
Y= sin(t1)*(l6*sin(t2 + t3) + l4*cos(t2) - l6*sin(t2 + t3 + t4))

Z= l2 + l3 + l6*cos(t2 + t3) - l4*sin(t2) - l6*cos(t2 + t3 + t4)

Đồ thị vẽ bằng Mathlab



Bài 10



$^{O}P = {}^{O}T_9 \,.\, {}^{9}P$

$= {}^{O}T_1.{}^{1}T_2.{}^{2}T_3.{}^{3}T_4.{}^{4}T_5.{}^{5}T_6.{}^{6}T_7.{}^{7}T_8.{}^{8}T_9.{}^{9}P$

$= T(0,0,l_1)*R(z,\theta_1) * T(0,0,l_2) * R(x,\theta_2)*T(0,l_3,0)*R(x,\theta_3)$
$*T(0,l_4,0)* R(x,\theta_4)* T(0,l_6,l_5)*P$

$$= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l1 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & l2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta_2 & -\sin\theta_2 & 0 \\ 0 & \sin\theta_2 & \cos\theta_2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & l3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta_3 & -\sin\theta_3 & 0 \\ 0 & \sin\theta_3 & \cos\theta_3 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & l4 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta_4 & -\sin\theta_4 & 0 \\ 0 & \sin\theta_4 & \cos\theta_4 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & l6 \\ 0 & 0 & 1 & l5 \\ 0 & 0 & 0 & 1 \end{bmatrix} x \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

=

$$\begin{bmatrix} -\sin(t1) * (l4 * \cos(t2 + t3) + l3 * \cos(t2) + l6 * \cos(t2 + t3 + t4) - l5 * \sin(t2 + t3 + t4)) \\ \cos(t1) * (l4 * \cos(t2 + t3) + l3 * \cos(t2) + l6 * \cos(t2 + t3 + t4) - l5 * \sin(t2 + t3 + t4)) \\ l1 + l2 + l4 * \sin(t2 + t3) + l3 * \sin(t2) + l5 * \cos(t2 + t3 + t4) + l6 * \sin(t2 + t3 + t4) \\ 1 \end{bmatrix}$$

Vậy

X= -sin(t1)*(l4*cos(t2 + t3) + l3*cos(t2) + l6*cos(t2 + t3 + t4) - l5*sin(t2 + t3 + t4))

Y= cos(t1)*(l4*cos(t2 + t3) + l3*cos(t2) + l6*cos(t2 + t3 + t4) - l5*sin(t2 + t3 + t4))

Z= l1 + l2 + l4*sin(t2 + t3) + l3*sin(t2) + l5*cos(t2 + t3 + t4) + l6*sin(t2 + t3 + t4)

Đồ thị vẽ bằng Mathlab