Bài 2

syms t1 t2 l1 l2 l3 l4 l5

a1=[1 0 0 0;0 1 0 0;0 0 1 l1;0 0 0 1]

a1 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l1]  
[0, 0, 0, 1]

a2=[cos(t1) -sin(t1) 0 0;sin(t1) cos(t1) 0 0;0 0 1 0;0 0 0 1]

a2 =  
   
[cos(t1), -sin(t1), 0, 0]  
[sin(t1), cos(t1), 0, 0]  
[ 0, 0, 1, 0]  
[ 0, 0, 0, 1]

a3=[1 0 0 l2;0 1 0 0;0 0 1 0;0 0 0 1]

a3 =  
   
[1, 0, 0, l2]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]

a4=[1 0 0 0;0 1 0 0;0 0 1 l3;0 0 0 1]

a4 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l3]  
[0, 0, 0, 1]

a5=[cos(t2) -sin(t2) 0 0;sin(t2) cos(t2) 0 0;0 0 1 0;0 0 0 1]

a5 =  
   
[cos(t2), -sin(t2), 0, 0]  
[sin(t2), cos(t2), 0, 0]  
[ 0, 0, 1, 0]  
[ 0, 0, 0, 1]

a6=[1 0 0 l4;0 1 0 0;0 0 1 0;0 0 0 1]

a6 =  
   
[1, 0, 0, l4]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]

a7=[1 0 0 0;0 1 0 0;0 0 1 -l5;0 0 0 1]

a7 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, -l5]  
[0, 0, 0, 1]

a8=[0;0;0;1]

a8 =  
  
 0  
 0  
 0  
 1

k=a1\*a2\*a3\*a4\*a5\*a6\*a7\*a8

k =  
   
l4\*(cos(t1)\*cos(t2) - sin(t1)\*sin(t2)) + l2\*cos(t1)  
l4\*(cos(t1)\*sin(t2) + cos(t2)\*sin(t1)) + l2\*sin(t1)  
 l1 + l3 - l5  
 1

simplify(k)

ans =  
   
l4\*cos(t1 + t2) + l2\*cos(t1)  
l4\*sin(t1 + t2) + l2\*sin(t1)  
 l1 + l3 - l5  
 1

Bài 3

syms t1 t2 t3 t4 l1 l2 l3 l4 l5 l6 l7 l8

q1=[cos(t1) -sin(t1) 0 0;sin(t1) cos(t1) 0 0;0 0 1 0;0 0 0 1]

q2=[1 0 0 0; 0 1 0 0;0 0 1 l1;0 0 0 1]

q3=[1 0 0 l2; 0 1 0 0;0 0 1 0;0 0 0 1]

q4=[cos(t2) 0 sin(t2) 0;0 1 0 0;-sin(t2) 0 cos(t2) 0;0 0 0 1]

q5=[1 0 0 0;0 1 0 -l3;0 0 1 0;0 0 0 1]

q6=[1 0 0 l4;0 1 0 0;0 0 1 0;0 0 0 1]

q7=[cos(t3) 0 sin(t3) 0;0 1 0 0;-sin(t3) 0 cos(t3) 0;0 0 0 1]

q8=[1 0 0 l5;0 1 0 0;0 0 1 0;0 0 0 1]

q9=[cos(t4) 0 sin(t4) 0;0 1 0 0;-sin(t4) 0 cos(t4) 0;0 0 0 1]

q10=[1 0 0 0;0 1 0 -l6;0 0 1 0;0 0 0 1]

q11=[1 0 0 l7;0 1 0 0;0 0 1 0;0 0 0 1]

q12=[1 0 0 0; 0 1 0 0;0 0 1 -l8;0 0 0 1]

q13=[0;0;0;1]

q1 =  
   
[cos(t1), -sin(t1), 0, 0]  
[sin(t1), cos(t1), 0, 0]  
[ 0, 0, 1, 0]  
[ 0, 0, 0, 1]  
   
   
q2 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l1]  
[0, 0, 0, 1]  
   
   
q3 =  
   
[1, 0, 0, l2]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q4 =  
   
[ cos(t2), 0, sin(t2), 0]  
[ 0, 1, 0, 0]  
[-sin(t2), 0, cos(t2), 0]  
[ 0, 0, 0, 1]  
   
   
q5 =  
   
[1, 0, 0, 0]  
[0, 1, 0, -l3]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q6 =  
   
[1, 0, 0, l4]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q7 =  
   
[ cos(t3), 0, sin(t3), 0]  
[ 0, 1, 0, 0]  
[-sin(t3), 0, cos(t3), 0]  
[ 0, 0, 0, 1]  
   
   
q8 =  
   
[1, 0, 0, l5]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q9 =  
   
[ cos(t4), 0, sin(t4), 0]  
[ 0, 1, 0, 0]  
[-sin(t4), 0, cos(t4), 0]  
[ 0, 0, 0, 1]  
   
   
q10 =  
   
[1, 0, 0, 0]  
[0, 1, 0, -l6]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q11 =  
   
[1, 0, 0, l7]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]

q12 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, -l8]  
[0, 0, 0, 1]  
   
  
q13 =  
  
 0  
 0  
 0  
 1

k=q1\*q2\*q3\*q4\*q5\*q6\*q7\*q8\*q9\*q10\*q11\*q12\*q13

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

simplify(k)

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

 k=q1\*q2\*q3\*q4\*q5\*q6\*q7\*q8\*q12\*q9\*q10\*q11\*q13

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

simplify(k)

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

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

l1 - l8\*cos(t2 + t3) - l5\*sin(t2 + t3) - l4\*sin(t2) - l7\*sin(t2 + t3 + t4)  
 1

Bài 4

syms t1 t2 l1 l2 l3 l4 l5

a1=[1 0 0 0;0 1 0 0;0 0 1 l1;0 0 0 1]

a2=[cos(t1) -sin(t1) 0 0;sin(t1) cos(t1) 0 0;0 0 1 0;0 0 0 1]

a3=[1 0 0 l2;0 1 0 0;0 0 1 0;0 0 0 1]

a4=[1 0 0 0;0 1 0 -l3;0 0 1 0;0 0 0 1]

a5=[cos(t2) 0 sin(t2) 0;0 1 0 0;-sin(t2) 0 cos(t2) 0;0 0 0 1]

a6=[1 0 0 l4;0 1 0 0;0 0 1 0;0 0 0 1]

a7=[1 0 0 0;0 1 0 0;0 0 0 l5;0 0 0 1]

a8=[0;0;0;1]

a1 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l1]  
[0, 0, 0, 1]  
   
   
a2 =  
   
[cos(t1), -sin(t1), 0, 0]  
[sin(t1), cos(t1), 0, 0]  
[ 0, 0, 1, 0]  
[ 0, 0, 0, 1]  
   
   
a3 =  
   
[1, 0, 0, l2]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
a4 =  
   
[1, 0, 0, 0]  
[0, 1, 0, -l3]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
a5 =  
   
[ cos(t2), 0, sin(t2), 0]  
[ 0, 1, 0, 0]  
[-sin(t2), 0, cos(t2), 0]  
[ 0, 0, 0, 1]  
   
   
a6 =  
   
[1, 0, 0, l4]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
a7 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 0, l5]  
[0, 0, 0, 1]  
   
  
a8 =  
  
 0  
 0  
 0  
 1

q=a1\*a2\*a3\*a4\*a5\*a6\*a7\*a8

q =  
   
l2\*cos(t1) + l3\*sin(t1) + l4\*cos(t1)\*cos(t2) + l5\*cos(t1)\*sin(t2)  
l2\*sin(t1) - l3\*cos(t1) + l4\*cos(t2)\*sin(t1) + l5\*sin(t1)\*sin(t2)  
 l1 + l5\*cos(t2) - l4\*sin(t2)  
 1

simplify(q)

ans =  
   
l2\*cos(t1) + l3\*sin(t1) + l4\*cos(t1)\*cos(t2) + l5\*cos(t1)\*sin(t2)  
l2\*sin(t1) - l3\*cos(t1) + l4\*cos(t2)\*sin(t1) + l5\*sin(t1)\*sin(t2)  
 l1 + l5\*cos(t2) - l4\*sin(t2)  
 1

Bài 6

syms t1 t2 t3 t4 l1 l2 l3 l4 l5

q1=[1 0 0 0;0 1 0 0;0 0 1 l1;0 0 0 1]

q2=[cos(t1) -sin(t1) 0 0;sin(t1) cos(t1) 0 0;0 0 1 0;0 0 0 1]

q3=[1 0 0 0;0 1 0 0;0 0 1 l3;0 0 0 1]

q4=[1 0 0 0;0 cos(t2) -sin(t2) 0;0 sin(t2) cos(t2) 0;0 0 0 1]

q5=[1 0 0 0;0 1 0 l4;0 0 1 0;0 0 0 1]

q6=[1 0 0 0;0 cos(t3) -sin(t3) 0;0 sin(t3) cos(t3) 0;0 0 0 1]

q7=[1 0 0 0;0 1 0 l5;0 0 1 0;0 0 0 1]

q8=[1 0 0 0;0 cos(t3) -sin(t3) 0;0 sin(t3) cos(t3) 0;0 0 0 1]

q9=[0;0;0;1]

q1 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l1]  
[0, 0, 0, 1]  
   
   
q2 =  
   
[cos(t1), -sin(t1), 0, 0]  
[sin(t1), cos(t1), 0, 0]  
[ 0, 0, 1, 0]  
[ 0, 0, 0, 1]  
   
   
q3 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l3]  
[0, 0, 0, 1]  
   
   
q4 =  
   
[1, 0, 0, 0]  
[0, cos(t2), -sin(t2), 0]  
[0, sin(t2), cos(t2), 0]  
[0, 0, 0, 1]  
   
   
q5 =  
   
[1, 0, 0, 0]  
[0, 1, 0, l4]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q6 =  
   
[1, 0, 0, 0]  
[0, cos(t3), -sin(t3), 0]  
[0, sin(t3), cos(t3), 0]  
[0, 0, 0, 1]  
   
   
q7 =  
   
[1, 0, 0, 0]  
[0, 1, 0, l5]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q8 =  
   
[1, 0, 0, 0]  
[0, cos(t3), -sin(t3), 0]  
[0, sin(t3), cos(t3), 0]  
[0, 0, 0, 1]  
   
  
q9 =  
  
 0  
 0  
 0  
 1

k=q1\*q2\*q3\*q4\*q5\*q6\*q7\*q8\*q9

k =  
   
l5\*(sin(t1)\*sin(t2)\*sin(t3) - cos(t2)\*cos(t3)\*sin(t1)) - l4\*cos(t2)\*sin(t1)  
l4\*cos(t1)\*cos(t2) - l5\*(cos(t1)\*sin(t2)\*sin(t3) - cos(t1)\*cos(t2)\*cos(t3))  
 l1 + l3 + l5\*(cos(t2)\*sin(t3) + cos(t3)\*sin(t2)) + l4\*sin(t2)  
 1

simplify(k)

ans =  
   
-sin(t1)\*(l5\*cos(t2 + t3) + l4\*cos(t2))  
 cos(t1)\*(l5\*cos(t2 + t3) + l4\*cos(t2))  
 l1 + l3 + l5\*sin(t2 + t3) + l4\*sin(t2)  
 1

Bài 7

syms t1 t2 t3 l1 l2 l3 l4 l5 l6 l7

q1=[1 0 0 0;0 1 0 0;0 0 1 l1;0 0 0 1]

q2=[1 0 0 0;0 1 0 0;0 0 1 l2;0 0 0 1]

q3=[cos(t1) -sin(t1) 0 0;sin(t1) cos(t1) 0 0;0 0 1 0;0 0 0 1]

q4=[1 0 0 l4;0 1 0 0;0 0 1 0;0 0 0 1]

q5=[1 0 0 0;0 1 0 0;0 0 1 l3;0 0 0 1]

q6=[cos(t2) -sin(t2) 0 0;sin(t2) cos(t2) 0 0;0 0 1 0;0 0 0 1]

q7=[1 0 0 l5;0 1 0 0;0 0 1 0;0 0 0 1]

q8=[1 0 0 0;0 1 0 0;0 0 1 -l6;0 0 0 1]

q9=[cos(t3) -sin(t3) 0 0;sin(t3) cos(t3) 0 0;0 0 1 0;0 0 0 1]

q10=[1 0 0 0;0 1 0 0;0 0 1 -l7;0 0 0 1]

q11=[0;0;0;1]

q1 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l1]  
[0, 0, 0, 1]  
   
   
q2 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l2]  
[0, 0, 0, 1]  
   
   
q3 =  
   
[cos(t1), -sin(t1), 0, 0]  
[sin(t1), cos(t1), 0, 0]  
[ 0, 0, 1, 0]  
[ 0, 0, 0, 1]  
   
   
q4 =  
   
[1, 0, 0, l4]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q5 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l3]  
[0, 0, 0, 1]  
   
   
q6 =  
   
[cos(t2), -sin(t2), 0, 0]  
[sin(t2), cos(t2), 0, 0]  
[ 0, 0, 1, 0]  
[ 0, 0, 0, 1]  
   
   
q7 =  
   
[1, 0, 0, l5]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]

q8 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, -l6]  
[0, 0, 0, 1]  
   
   
q9 =  
   
[cos(t3), -sin(t3), 0, 0]  
[sin(t3), cos(t3), 0, 0]  
[ 0, 0, 1, 0]  
[ 0, 0, 0, 1]  
   
   
q10 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, -l7]  
[0, 0, 0, 1]  
   
  
q11 =  
  
 0  
 0  
 0  
 1

k=q1\*q2\*q3\*q4\*q5\*q6\*q7\*q8\*q9\*q10\*q11

k =  
   
l5\*(cos(t1)\*cos(t2) - sin(t1)\*sin(t2)) + l4\*cos(t1)  
l5\*(cos(t1)\*sin(t2) + cos(t2)\*sin(t1)) + l4\*sin(t1)  
 l1 + l2 + l3 - l6 - l7  
 1

simplify(k)

ans =  
   
l5\*cos(t1 + t2) + l4\*cos(t1)  
l5\*sin(t1 + t2) + l4\*sin(t1)  
 l1 + l2 + l3 - l6 - l7  
 1

Bài 5

syms t1 t2 t3 l1 l2

q1=[cos(t1) 0 sin(t1) 0;0 1 0 0;-sin(t1) 0 cos(t1) 0;0 0 0 1]

q2=[1 0 0 0;0 cos(t2) -sin(t2) 0;0 sin(t2) cos(t2) 0;0 0 0 1]

q3=[1 0 0 0;0 1 0 0; 0 0 1 -l1;0 0 0 1]

q4=[cos(t3) 0 sin(t3) 0;0 1 0 0;-sin(t3) 0 cos(t3) 0;0 0 0 1]

q5=[1 0 0 0;0 1 0 0; 0 0 1 -l2;0 0 0 1]

q6=[0;0;0;1]

q1 =  
   
[ cos(t1), 0, sin(t1), 0]  
[ 0, 1, 0, 0]  
[-sin(t1), 0, cos(t1), 0]  
[ 0, 0, 0, 1]  
   
   
q2 =  
   
[1, 0, 0, 0]  
[0, cos(t2), -sin(t2), 0]  
[0, sin(t2), cos(t2), 0]  
[0, 0, 0, 1]  
   
   
q3 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, -l1]  
[0, 0, 0, 1]  
   
   
q4 =  
   
[ cos(t3), 0, sin(t3), 0]  
[ 0, 1, 0, 0]  
[-sin(t3), 0, cos(t3), 0]  
[ 0, 0, 0, 1]  
   
   
q5 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, -l2]  
[0, 0, 0, 1]  
   
  
q6 =  
  
 0  
 0  
 0  
 1

k=q1\*q2\*q3\*q4\*q5\*q6

k =  
   
- l2\*(cos(t1)\*sin(t3) + cos(t2)\*cos(t3)\*sin(t1)) - l1\*cos(t2)\*sin(t1)  
 l1\*sin(t2) + l2\*cos(t3)\*sin(t2)  
 l2\*(sin(t1)\*sin(t3) - cos(t1)\*cos(t2)\*cos(t3)) - l1\*cos(t1)\*cos(t2)  
 1

simplify(k)

ans =  
   
- l2\*(cos(t1)\*sin(t3) + cos(t2)\*cos(t3)\*sin(t1)) - l1\*cos(t2)\*sin(t1)  
 sin(t2)\*(l1 + l2\*cos(t3))  
 l2\*(sin(t1)\*sin(t3) - cos(t1)\*cos(t2)\*cos(t3)) - l1\*cos(t1)\*cos(t2)  
 1

Bài 8

syms t1 t2 t3 t4 t5 l1 l2 l3 l4 l5 l6

q1=[cos(t1) -sin(t1) 0 0;sin(t1) cos(t1) 0 0;0 0 1 0;0 0 0 1]

q2=[1 0 0 0;0 1 0 0;0 0 1 l2;0 0 0 1]

q3=[1 0 0 l1;0 1 0 0;0 0 1 0;0 0 0 1]

q4=[cos(t2) 0 sin(t2) 0;0 1 0 0;-sin(t2) 0 cos(t2) 0;0 0 0 1]

q5=[1 0 0 0;0 1 0 0;0 0 1 l3;0 0 0 1]

q6=[cos(t3) 0 sin(t3) 0;0 1 0 0;-sin(t3) 0 cos(t3) 0;0 0 0 1]

q7=[1 0 0 l4;0 1 0 0;0 0 1 0;0 0 0 1]

q8=[cos(t4) 0 sin(t4) 0;0 1 0 0;-sin(t4) 0 cos(t4) 0;0 0 0 1]

q9=[1 0 0 l5;0 1 0 0;0 0 1 0;0 0 0 1]

q10=[cos(t5) -sin(t5) 0 0;sin(t5) cos(t5) 0 0;0 0 1 0;0 0 0 1]

q11=[1 0 0 0;0 1 0 0;0 0 1 -l6;0 0 0 1]

q12=[0;0;0;;1]

q1 =  
   
[cos(t1), -sin(t1), 0, 0]  
[sin(t1), cos(t1), 0, 0]  
[ 0, 0, 1, 0]  
[ 0, 0, 0, 1]  
   
   
q2 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l2]  
[0, 0, 0, 1]  
   
   
q3 =  
   
[1, 0, 0, l1]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q4 =  
   
[ cos(t2), 0, sin(t2), 0]  
[ 0, 1, 0, 0]  
[-sin(t2), 0, cos(t2), 0]  
[ 0, 0, 0, 1]  
   
   
q5 =  
   
[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, l3]  
[0, 0, 0, 1]  
   
   
q6 =  
   
[ cos(t3), 0, sin(t3), 0]  
[ 0, 1, 0, 0]  
[-sin(t3), 0, cos(t3), 0]  
[ 0, 0, 0, 1]  
   
   
q7 =  
   
[1, 0, 0, l4]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q8 =  
   
[ cos(t4), 0, sin(t4), 0]  
[ 0, 1, 0, 0]  
[-sin(t4), 0, cos(t4), 0]  
[ 0, 0, 0, 1]  
   
   
q9 =  
   
[1, 0, 0, l5]  
[0, 1, 0, 0]  
[0, 0, 1, 0]  
[0, 0, 0, 1]  
   
   
q10 =  
   
[cos(t5), -sin(t5), 0, 0]  
[sin(t5), cos(t5), 0, 0]  
[ 0, 0, 1, 0]  
[ 0, 0, 0, 1]  
   
   
q11 =

[1, 0, 0, 0]  
[0, 1, 0, 0]  
[0, 0, 1, -l6]  
[0, 0, 0, 1]  
   
  
q12 =  
  
 0  
 0  
 0  
 1

k=q1\*q2\*q3\*q4\*q5\*q6\*q7\*q8\*q9\*q10\*q11\*q12

k =  
   
l1\*cos(t1) - l5\*(cos(t4)\*(cos(t1)\*sin(t2)\*sin(t3) - cos(t1)\*cos(t2)\*cos(t3)) + sin(t4)\*(cos(t1)\*cos(t2)\*sin(t3) + cos(t1)\*cos(t3)\*sin(t2))) - l6\*(cos(t4)\*(cos(t1)\*cos(t2)\*sin(t3) + cos(t1)\*cos(t3)\*sin(t2)) - sin(t4)\*(cos(t1)\*sin(t2)\*sin(t3) - cos(t1)\*cos(t2)\*cos(t3))) - l4\*(cos(t1)\*sin(t2)\*sin(t3) - cos(t1)\*cos(t2)\*cos(t3)) + l3\*cos(t1)\*sin(t2)  
l1\*sin(t1) - l5\*(cos(t4)\*(sin(t1)\*sin(t2)\*sin(t3) - cos(t2)\*cos(t3)\*sin(t1)) + sin(t4)\*(cos(t2)\*sin(t1)\*sin(t3) + cos(t3)\*sin(t1)\*sin(t2))) - l6\*(cos(t4)\*(cos(t2)\*sin(t1)\*sin(t3) + cos(t3)\*sin(t1)\*sin(t2)) - sin(t4)\*(sin(t1)\*sin(t2)\*sin(t3) - cos(t2)\*cos(t3)\*sin(t1))) - l4\*(sin(t1)\*sin(t2)\*sin(t3) - cos(t2)\*cos(t3)\*sin(t1)) + l3\*sin(t1)\*sin(t2)  
 l2 - l4\*(cos(t2)\*sin(t3) + cos(t3)\*sin(t2)) + l3\*cos(t2) - l5\*(cos(t4)\*(cos(t2)\*sin(t3) + cos(t3)\*sin(t2)) + sin(t4)\*(cos(t2)\*cos(t3) - sin(t2)\*sin(t3))) - l6\*(cos(t4)\*(cos(t2)\*cos(t3) - sin(t2)\*sin(t3)) - sin(t4)\*(cos(t2)\*sin(t3) + cos(t3)\*sin(t2)))  
 1

simplify(k)

ans =  
   
cos(t1)\*(l1 + l4\*cos(t2 + t3) + l3\*sin(t2) + l5\*cos(t2 + t3 + t4) - l6\*sin(t2 + t3 + t4))  
sin(t1)\*(l1 + l4\*cos(t2 + t3) + l3\*sin(t2) + l5\*cos(t2 + t3 + t4) - l6\*sin(t2 + t3 + t4))  
 l2 - l4\*sin(t2 + t3) + l3\*cos(t2) - l6\*cos(t2 + t3 + t4) - l5\*sin(t2 + t3 + t4)  
 1