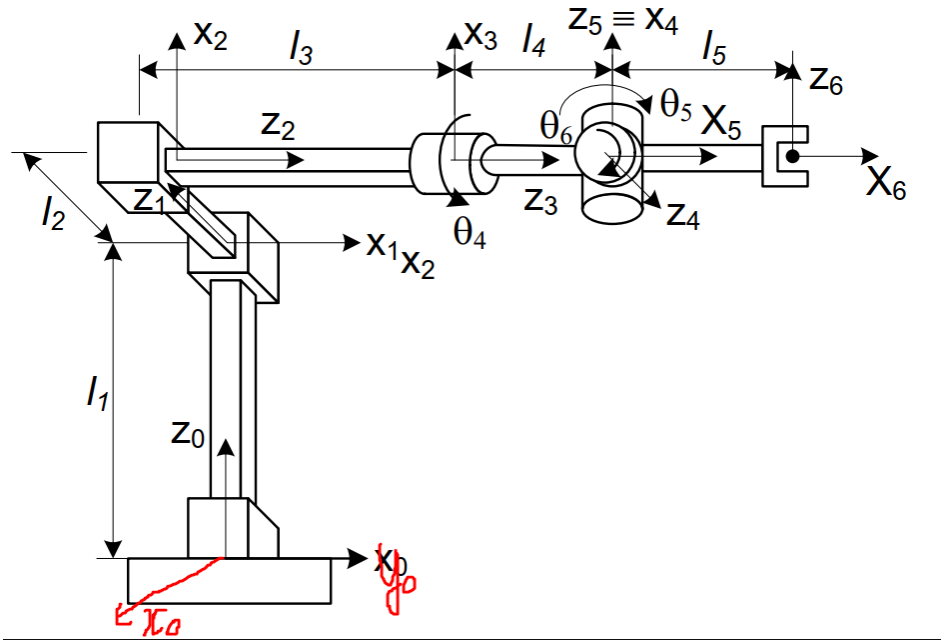
Họ tên: Lê Thanh Phước Đạt

MSSV: 20146192

BÀI TẬP VỀ NHÀ 2

Bài 1:



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

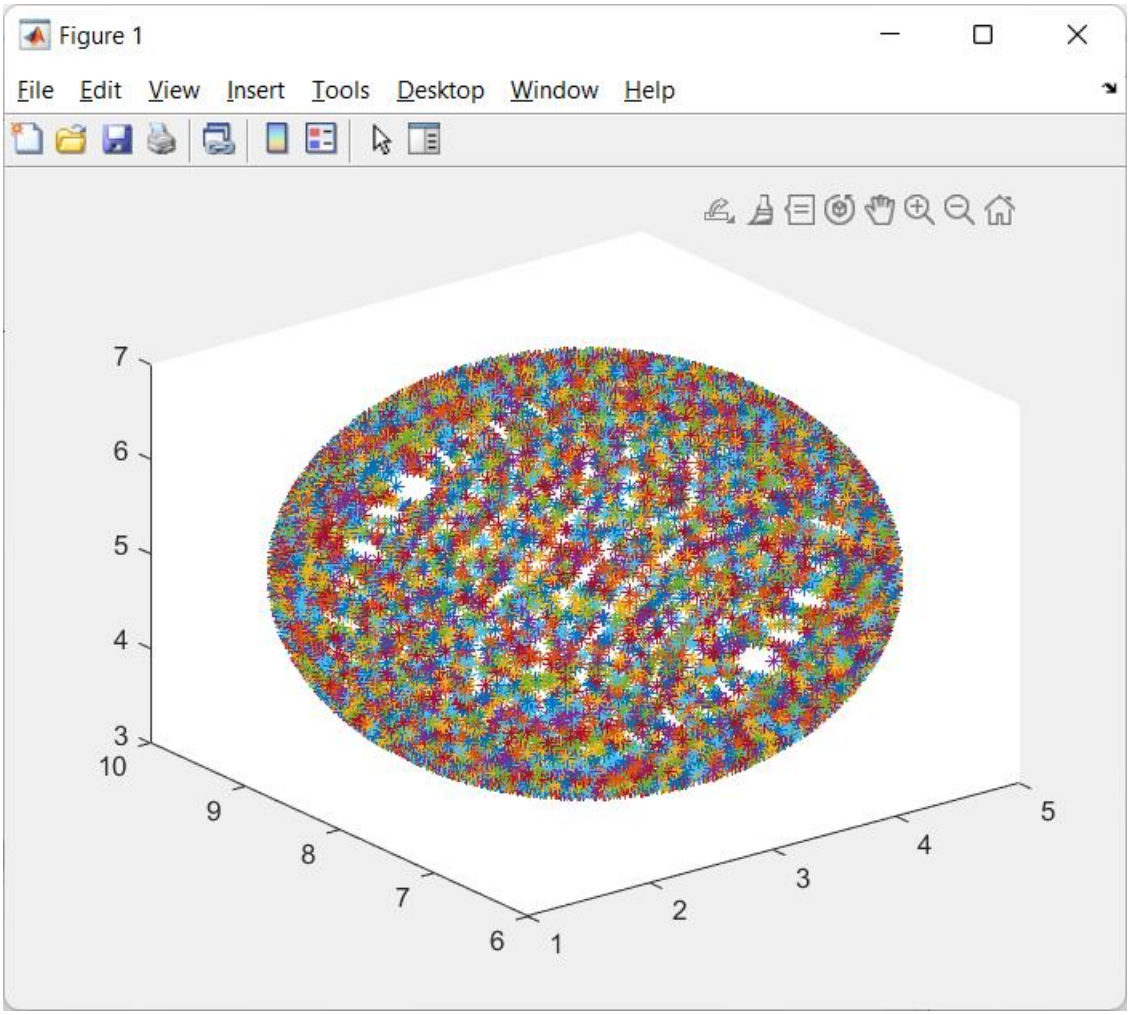
$$\Rightarrow {}^{o}P = \begin{bmatrix} l_2 + l_5(s_4s_6 - c_4c_6s_5) \\ l_3 + l_4 + l_5c_5c_6 \\ l_1 + l_5(c_4s_6 + c_6s_4s_5) \\ 1 \end{bmatrix}$$

Code Matlab:

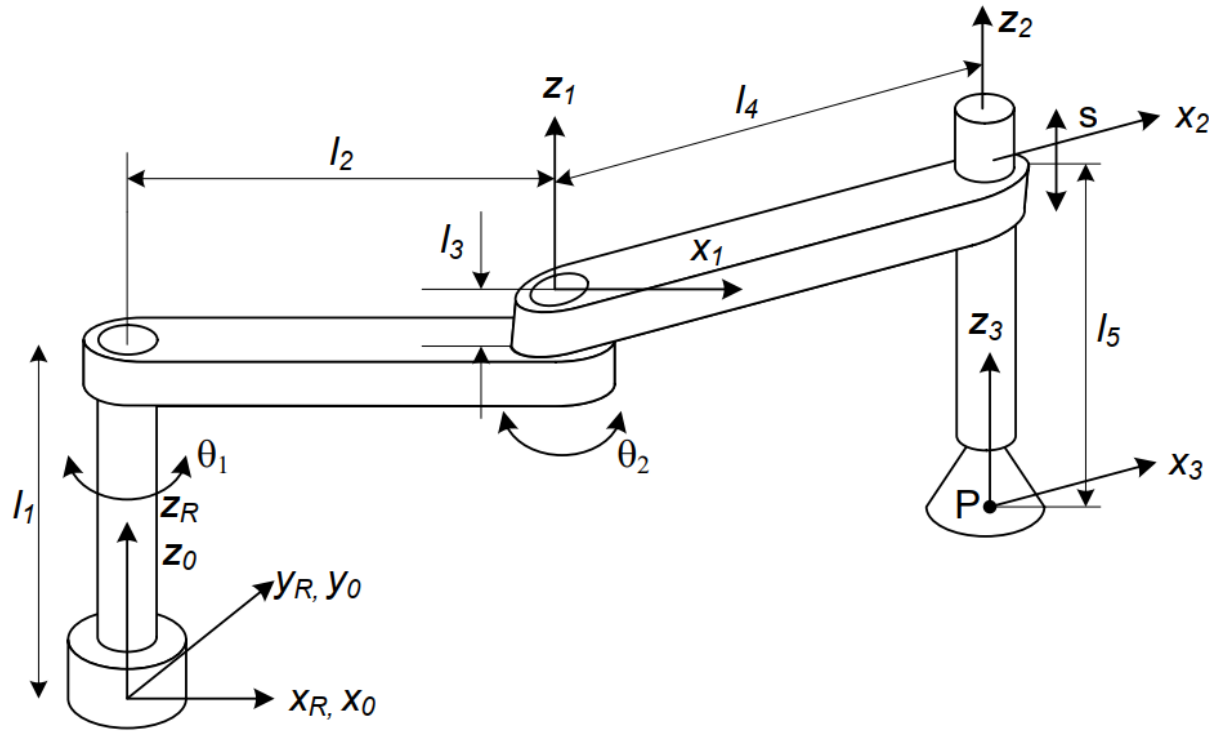
```
hold off
clear
l1 = 5; l2 = 3; l3 = 6; l4 = 2; l5 = 2;
for t4=0:pi/18:2*pi
   for t5=0:pi/18:2*pi
      for t6=0:pi/18:2*pi
         P = Trans(0,0,l1)*Trans(l2,0,0)*Trans(0,l3,0)*Rot_y(t4)*Trans(0,l4,0)
                        *Rot_z(t5)*Rot_x(t6)*Trans(0,l5,0)*[0;0;0;1];
         Px = P(1,1);
         Py = P(2,1);
         Pz = P(3,1);
         plot3(Px,Py,Pz,"*");
```

```
            hold on;
        end
    end
end
```

Không gian hoạt động:



Bài 2:



$$^{o}P = R(z,\theta_1)T(0,0,l_1)T(l_2,0,0)R(z,\theta_2)T(0,0,l_3)T(l_4,0,0)T(0,0,-l_5)P$$

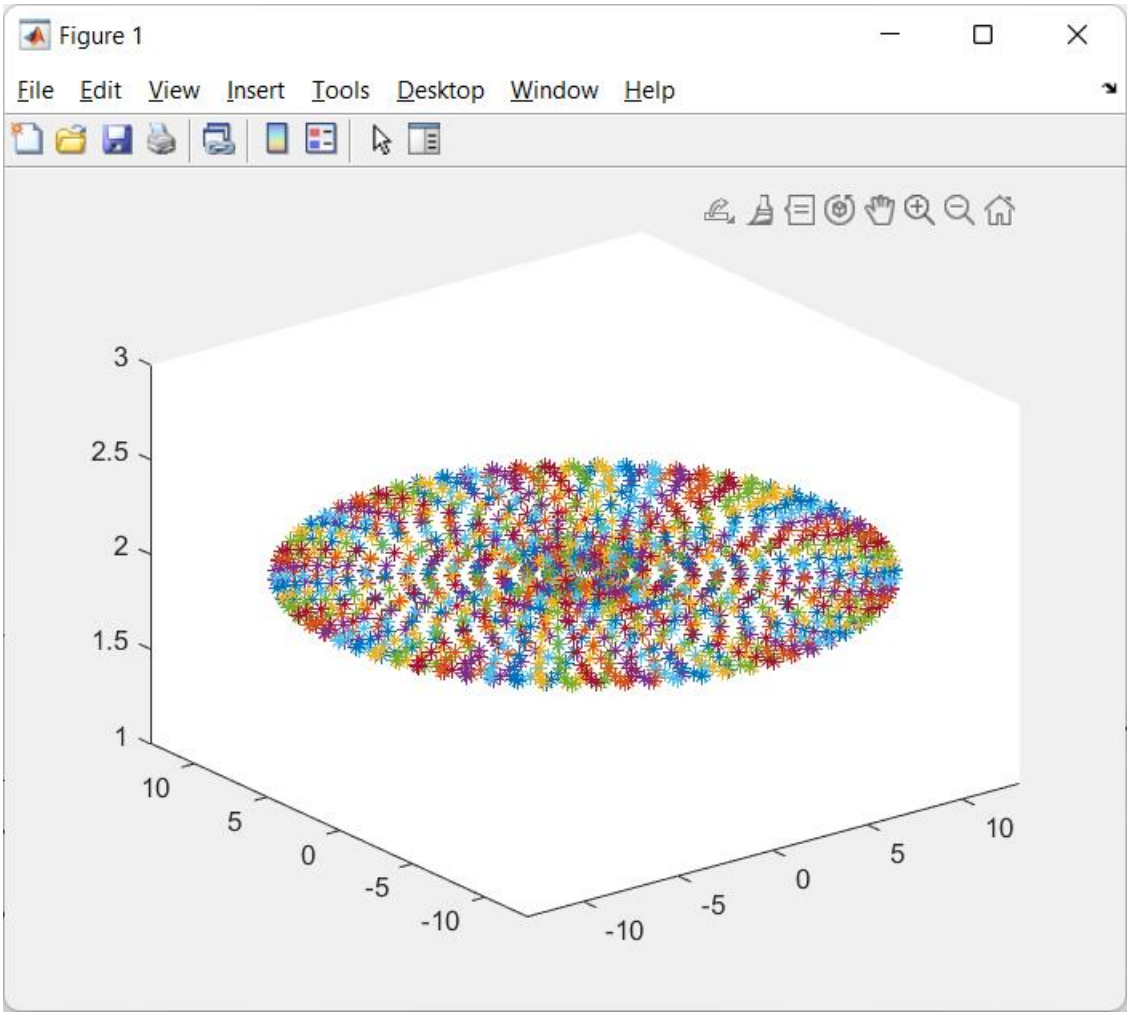
$$\Rightarrow {}^{o}P = \begin{bmatrix} l4c_{12} + l2c_1 \\ l4s_{12} + l2s_1 \\ l_1 + l_3 - l_5 \\ 1 \end{bmatrix}$$

Code Matlab:

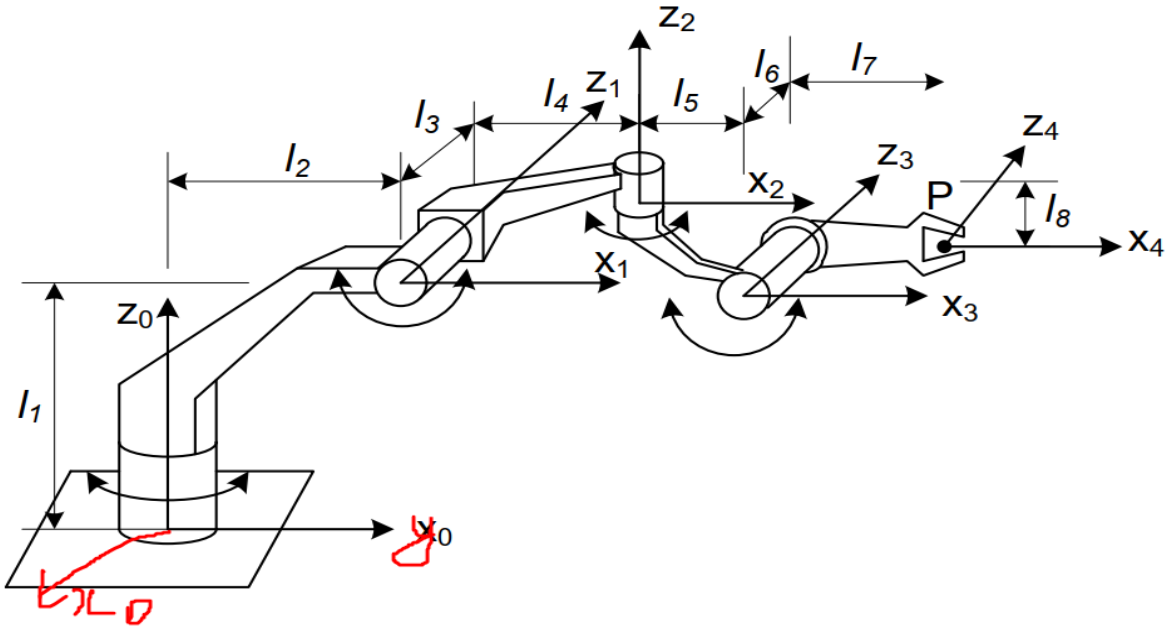
```
hold off
clear
l1 = 5; l2 = 6; l3 = 2; l4 = 7; l5 = 5;
for t1=0:pi/18:2*pi
   for t2=0:pi/18:2*pi
      for t3=0:pi/18:2*pi
         P = Rot_z(t1)*Trans(0,0,l1)*Trans(l2,0,0)*Rot_z(t2)*Trans(0,0,l3)
                        *Trans(l4,0,0)*Trans(0,0,-l5)*[0;0;0;1];
         Px = P(1,1);
         Py = P(2,1);
         Pz = P(3,1);
         plot3(Px,Py,Pz,"*");
         hold on;
      end
```

```
    end
end
```

Không gian hoạt động:



Bài 3:



$$^{O}P = R(z,\theta_1)T(0,0,l_1)T(0,l_2,0)R(x,\theta_2)T(-l_3,0,0)T(0,l_4,0)R(z,\theta_3)T(0,l_5,0)R(x,\theta_4)T(-l_6,0,0)T(0,l_7,0$$

$$T(0,0,-l_8)P$$

$$\Rightarrow {}^{O}P =$$

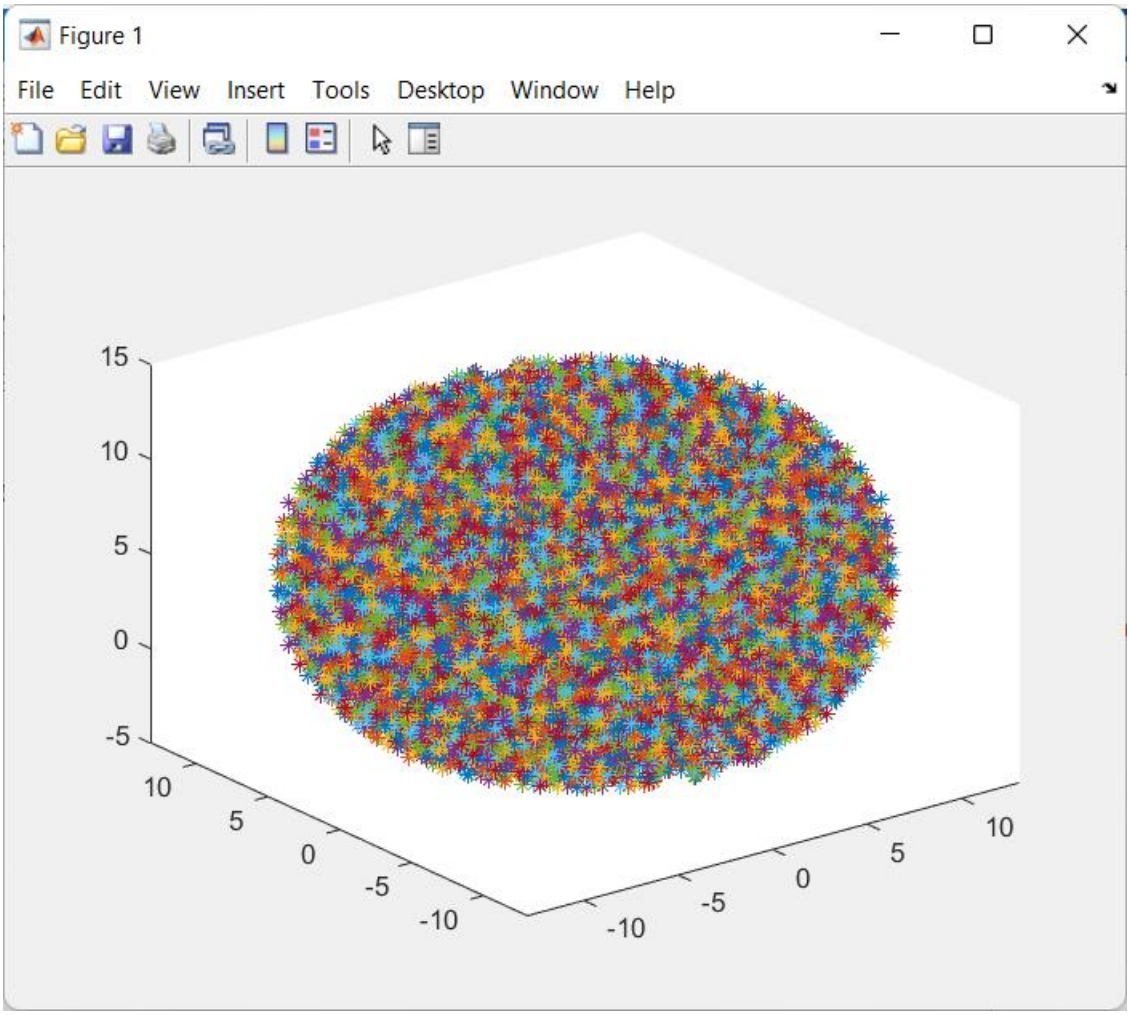
$$= \begin{bmatrix} \{-l5*(\cos(t1)*\sin(t3)+\cos(t2)*\cos(t3)*\sin(t1)) \\ -l6*(\cos(t1)*\cos(t3)-\cos(t2)*\sin(t1)*\sin(t3)) \\ -l3*\cos(t1)-\ l2*\sin(t1)-\sin(t4)*(\cos(t1)*\sin(t3)+\cos(t2)*\cos(t3)*\sin(t1)) \\ -l7*(\cos(t4)*(\cos(t1)*\sin(t3)+\cos(t2)*\cos(t3)*\sin(t1))-\sin(t1)*\sin(t2)*\sin(t4)) \\ -\cos(t4)*\sin(t1)*\sin(t2)-\ l4*\cos(t2)*\sin(t1)\} \\ \{l2*\cos(t1)-\ l6*(\cos(t3)*\sin(t1)+\cos(t1)*\cos(t2)*\sin(t3)) \\ -l5*(\sin(t1)*\sin(t3)-\cos(t1)*\cos(t2)*\cos(t3)) \\ -l3*\sin(t1)-\sin(t4)*(\sin(t1)*\sin(t3)-\cos(t1)*\cos(t2)*\cos(t3)) \\ -l7*(\cos(t4)*(\sin(t1)*\sin(t3)-\cos(t1)*\cos(t2)*\cos(t3))+\cos(t1)*\sin(t2)*\sin(t4)) \\ +l4*\cos(t1)*\cos(t2)+\cos(t1)*\cos(t4)*\sin(t2)\} \\ \{l1\ -\cos(t2)*\cos(t4)+\ l7*(\cos(t2)*\sin(t4)+\cos(t3)*\cos(t4)*\sin(t2)) \\ +l4*\sin(t2)+\cos(t3)*\sin(t2)*\sin(t4)+\ l5*\cos(t3)*\sin(t2)-\ l6*\sin(t2)*\sin(t3)\} \\ 1 \end{bmatrix}$$

Code Matlab:

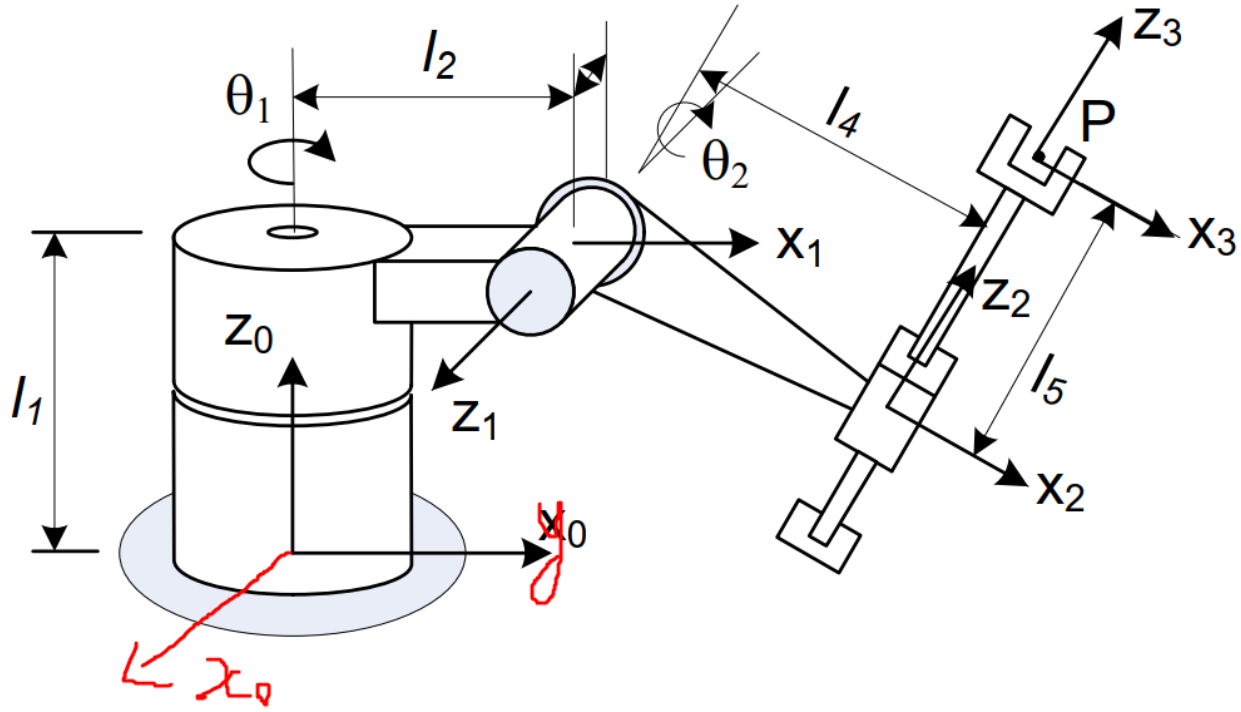
```
hold off
clear
l1 = 5; l2 = 4; l3 = 3; l4 = 3; l5 = 2; l6 = 2; l7 = 3; l8 = 1;
for t1=0:pi/9:2*pi
```

```
    for t2=0:pi/9:2*pi
        for t3=0:pi/9:2*pi
            for t4=0:pi/9:2*pi
                P = Rot_z(t1)*Trans(0,0,l1)*Trans(0,l2,0)*Rot_x(t2)
                    *Trans(-l3,0,0)*Trans(0,l4,0)*Rot_z(t3)*Trans(0,l5,0)*Rot_x(t4)
                    *Trans(-l6,0,0)*Trans(0,l7,0)*Trans(0,0,-l8)*[0;0;0;1];
                Px = P(1,1);
                Py = P(2,1);
                Pz = P(3,1);
                plot3(Px,Py,Pz,"*");
                hold on;
            end
        end
    end
end
```

Không gian làm việc:



Bài 4:



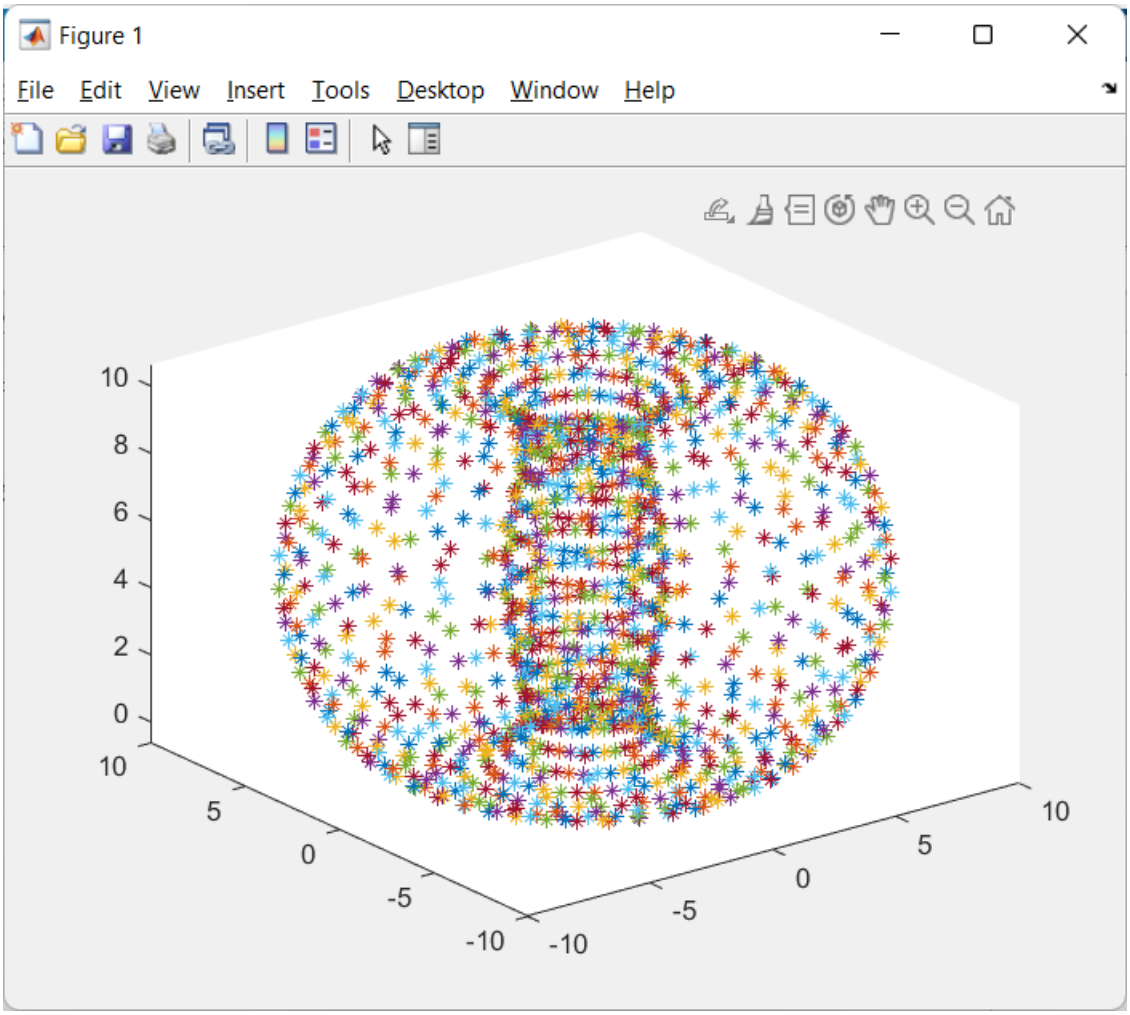
$$^{o}P = R(z,\theta_1)T(0,0,l_1)T(0,l_2,0)R(x,\theta_2)T(-l_3,0,0)T(0,l_4,0)T(0,0,l_5)P$$

$$\Rightarrow {}^{o}P = \begin{bmatrix} l_5 s_1 s_2 - l_2 s_1 - l_4 c_2 s_1 - l_3 c_1 \\ l_2 c_1 - l_3 s_1 + l_4 c_1 c_2 - l_5 c_1 s_2 \\ l_1 + l_5 c_2 + l_4 s_2 \\ 1 \end{bmatrix}$$

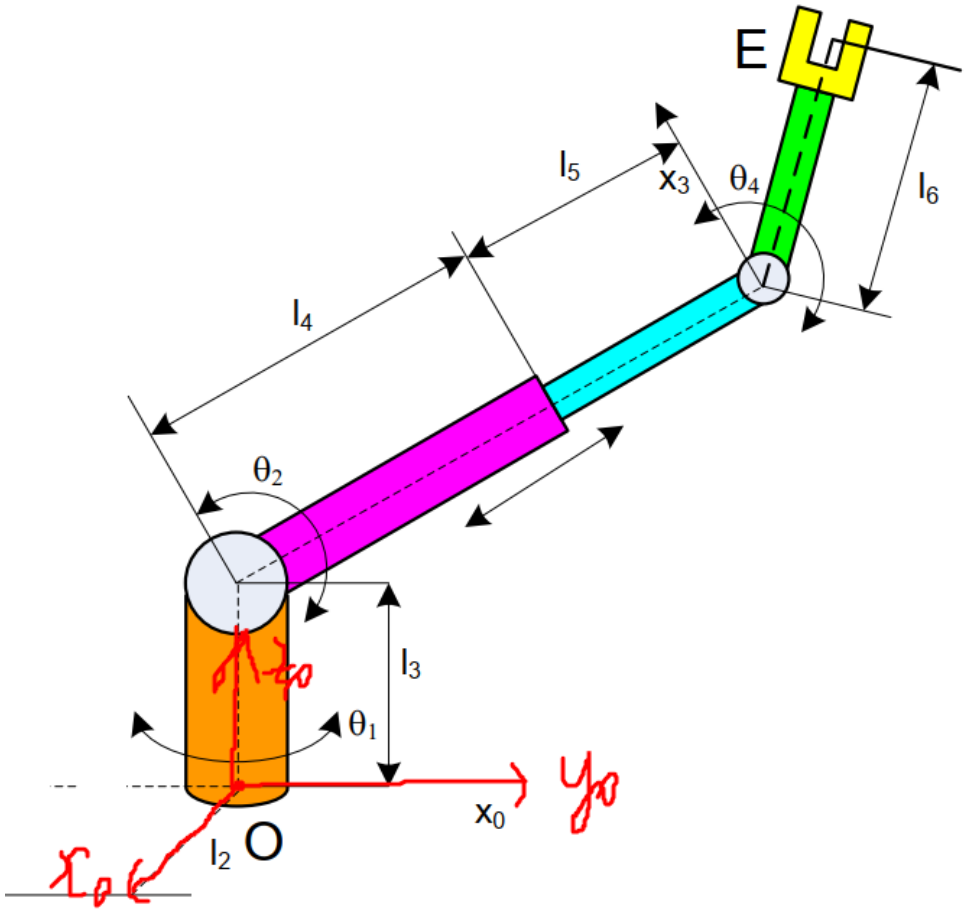
Code Matlab:

```
hold off
clear
l1 = 5; l2 = 4; l3 = 2; l4 = 4; l5 = 4;
for t1=0:pi/18:2*pi
   for t2=0:pi/18:2*pi
      %for t3=0:pi/18:2*pi
         P = Rot_z(t1)*Trans(0,0,l1)*Trans(0,l2,0)*Rot_x(t2)
                  *Trans(-l3,0,0)*Trans(0,l4,0)*Trans(0,0,l5)*[0;0;0;1];
         Px = P(1,1);
         Py = P(2,1);
         Pz = P(3,1);
         plot3(Px,Py,Pz,"*");
         hold on;
      %end
   end
end
```

Không gian làm việc:



Bài 4b:



$$^{o}P = R(z,\theta_1)T(0,0,l_3)R(x,\theta_2)T(0,l_4,0)T(0,l_5,0)R(x,\theta_3)T(0,l_6,0)P$$

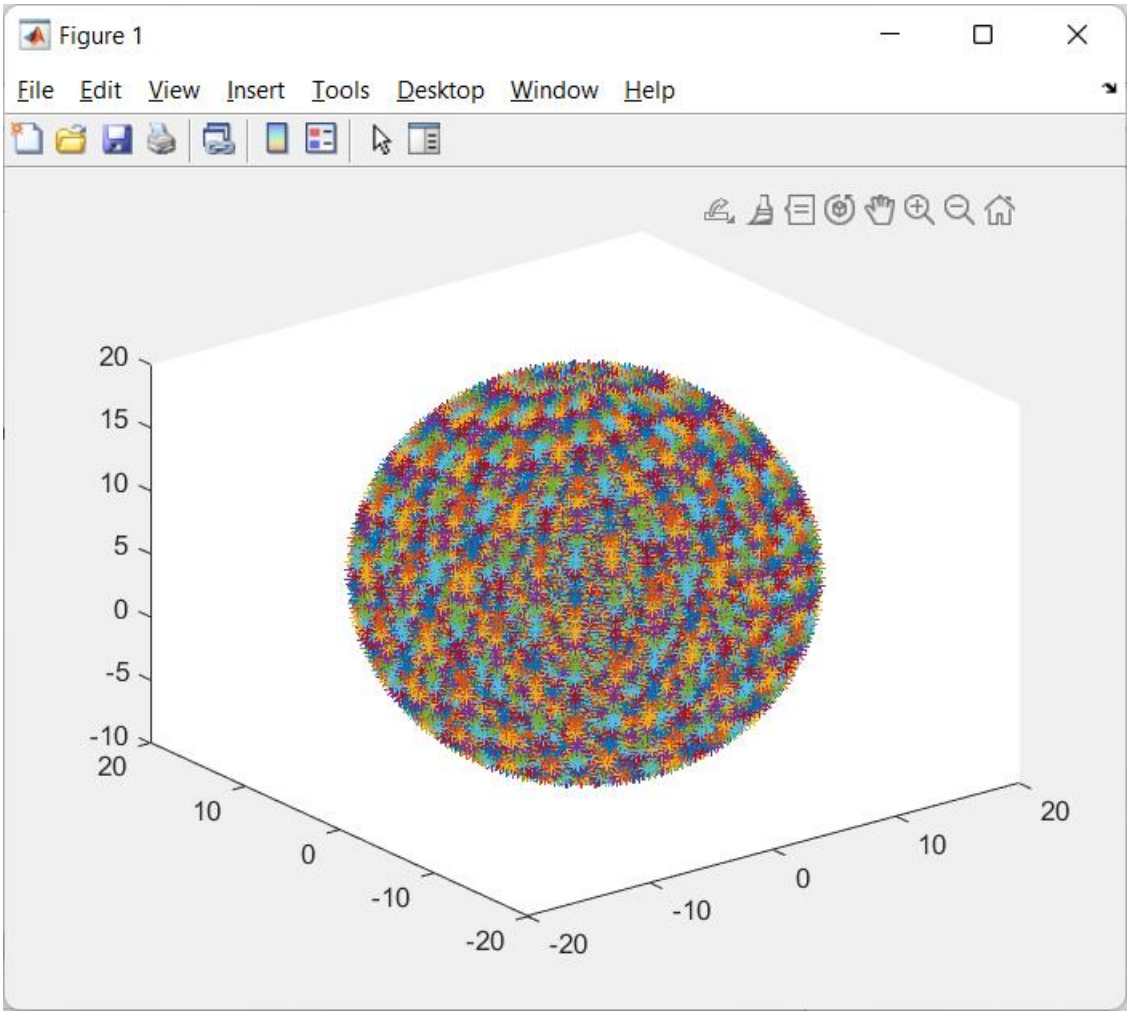
$$\Rightarrow {}^{o}P = \begin{bmatrix} -s_1 * (l_6c_{23} + l_4c_2 + l_5c_2) \\ c_1(l_6c_{23} + l_4c_2 + l_5c_2) \\ l_3 + l_6s_{23} + l_4s_2 + l_5s_2 \\ 1 \end{bmatrix}$$

Code Matlab:

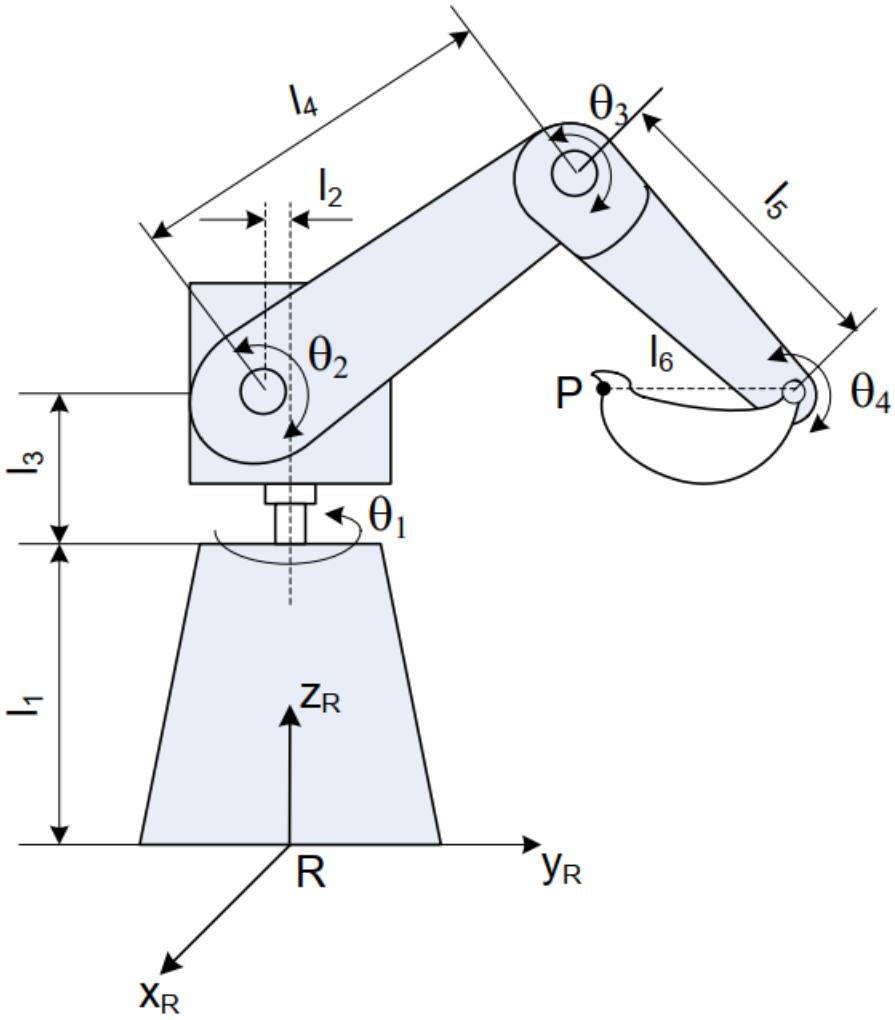
```
hold off
clear
l3 = 5; l4 = 7; l5 = 4; l6 = 4;
for t1=0:pi/18:2*pi
   for t2=0:pi/18:2*pi
      for t3=0:pi/18:2*pi
         P = Rot_z(t1)*Trans(0,0,l3)*Rot_x(t2)*Trans(0,l4,0)
                *Trans(0,l5,0)*Rot_x(t3)*Trans(0,l6,0)*[0;0;0;1];
         Px = P(1,1);
         Py = P(2,1);
```

```
            Pz = P(3,1);
            plot3(Px,Py,Pz,"*");
            hold on;
        end
    end
end
```

Không gian làm việc:



Bài 6:



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

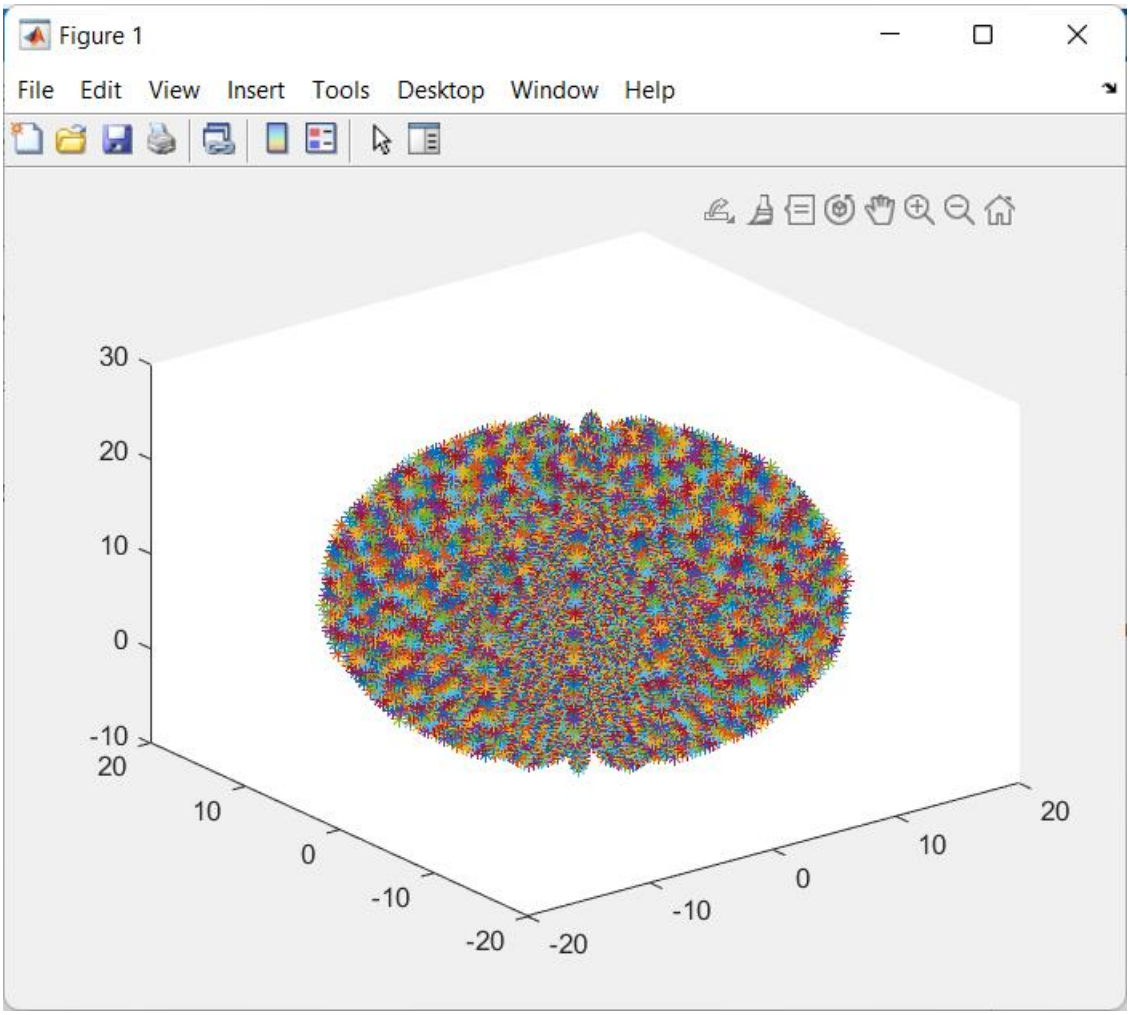
$$\Rightarrow {}^{o}P = \begin{bmatrix} s_1(l_2 - l_5c_{23} - l_4c_2 + l_6c_{234}) \\ -c_1(l_2 - l_5c_{23} - l_4c_2 + l_6c_{234}) \\ l_1 + l_3 + l_5s_{23} + l_4s_2 - l_6s_{234} \\ 1 \end{bmatrix}$$

Code Matlab:

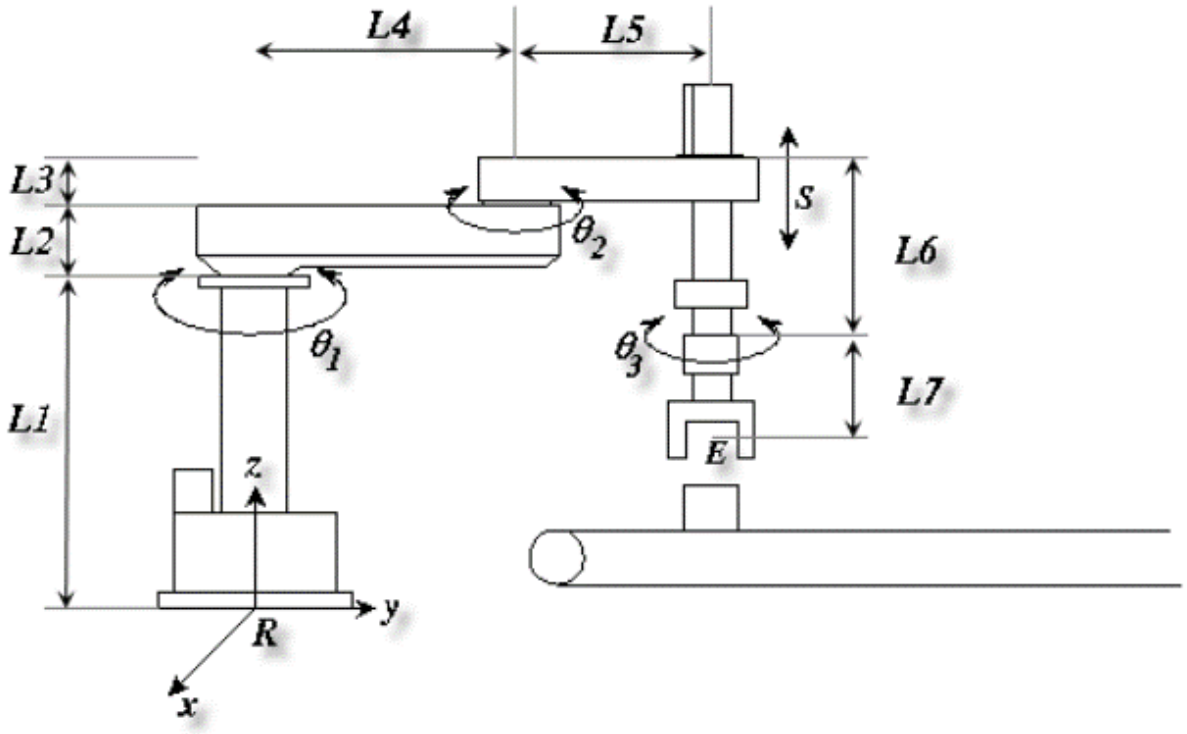
```
hold off
clear
l1 = 5; l2 = 2; l3 = 3; l4 = 7; l5 = 5; l6 = 3;
for t1=0:pi/9:2*pi
    for t2=0:pi/9:2*pi
        for t3=0:pi/9:2*pi
            for t4=0:pi/9:2*pi
```

```
            P = Rot_z(t1)*Trans(0,0,l1)*Trans(0,-l2,0)
                *Trans(0,0,l3)*Rot_x(t2)*Trans(0,l4,0)*Rot_x(t3)*Trans(0,l5,0)
                *Rot_x(t4)*Trans(0,-l6,0)*[0;0;0;1];
            Px = P(1,1);
            Py = P(2,1);
            Pz = P(3,1);
            plot3(Px,Py,Pz,"*");
            hold on;
        end
    end
  end
end
```

Không gian làm việc:



Bài 7:



$$^{o}P = T(0,0,l_1)R(z,\theta_1)T(0,0,l_2)T(0,0,l_3)T(0,l_4,0)R(z,\theta_2)T(0,l_5,0)T(0,0,-l_6)R(z,\theta_3)T(0,0,-l_7)P$$

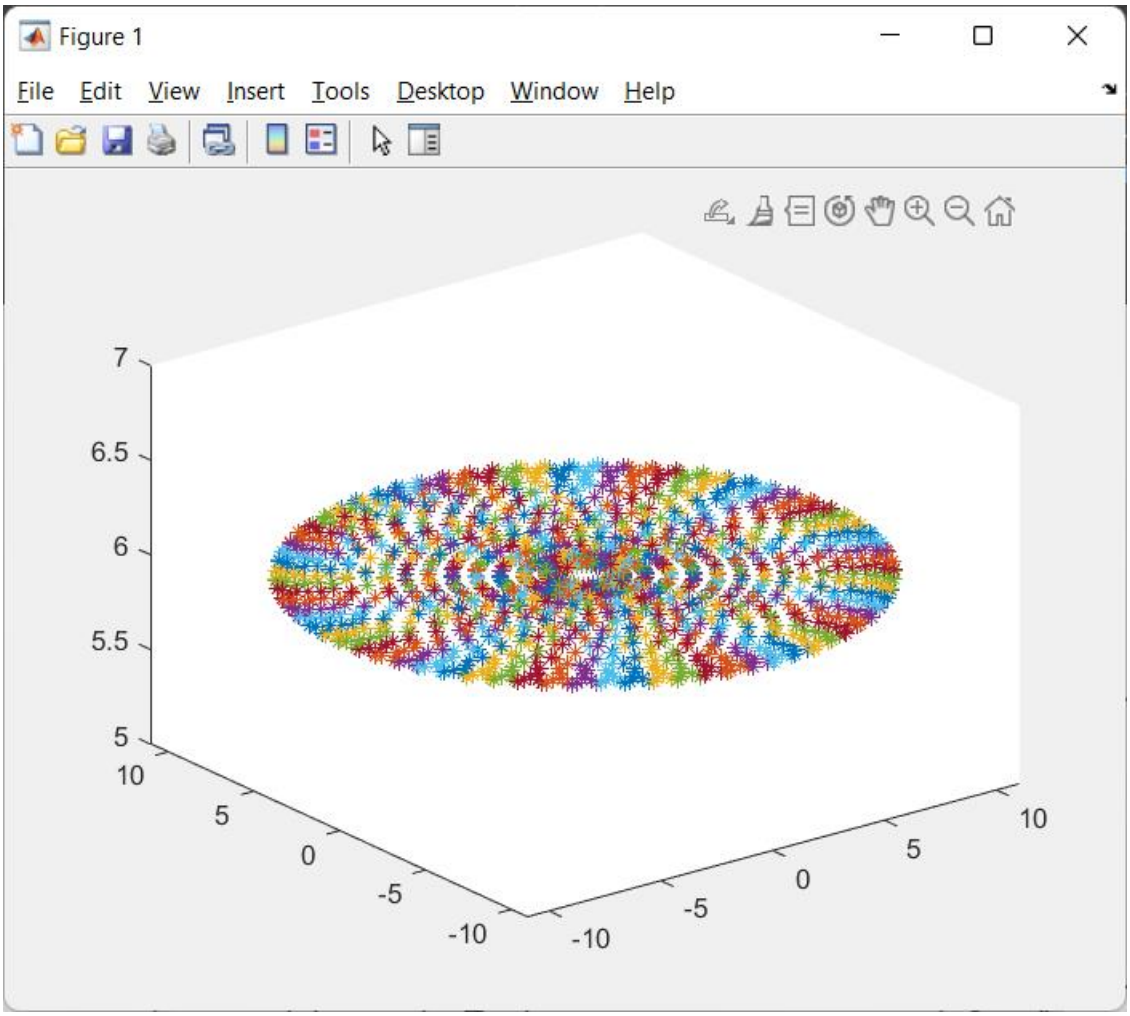
$$\Rightarrow {}^{o}P = \begin{bmatrix} -l_5 s_{12} - l_4 s_1 \\ l_5 c_{12} + l_4 c_1 \\ l_1 + l_2 + l_3 - l_6 - l_7 \\ 1 \end{bmatrix}$$

Code Matlab:

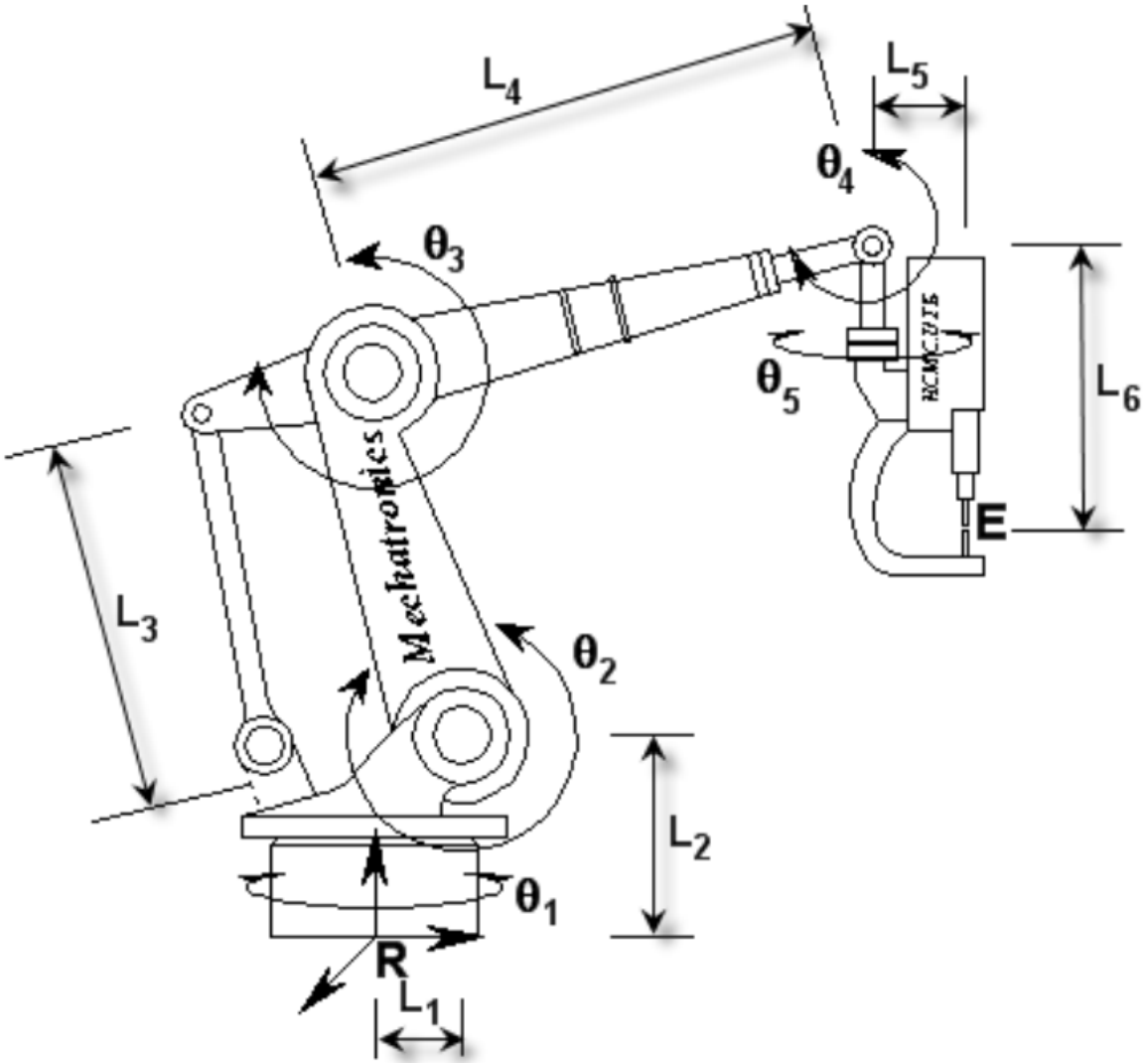
```
hold off
clear
l1 = 10; l2 = 3; l3 = 2; l4 = 6; l5 = 5; l6 = 5; l7 = 4;
for t1=0:pi/18:2*pi
   for t2=0:pi/18:2*pi
      for t3=0:pi/18:2*pi
         P = Trans(0,0,l1)*Rot_z(t1)*Trans(0,0,l2)*Trans(0,0,l3)*Trans(0,l4,0)
                  *Rot_z(t2)*Trans(0,l5,0)*Trans(0,0,-l6)*Rot_z(t3)*Trans(0,0,-l7)*[0;0;0;1];
         Px = P(1,1);
         Py = P(2,1);
         Pz = P(3,1);
         plot3(Px,Py,Pz,"*");
         hold on;
      end
```

```
    end
end
```

Không gian làm việc:



Bài 8:



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

$$\Rightarrow {}^{o}P = \begin{bmatrix} -s_1(l_1 + l_4c_{23} - l_3s_2 + l_5c_{234} + l_6s_{234}) \\ c_1(l_1 + l_4c_{23} - l_3s_2 + l_5c_{234} + l_6s_{234}) \\ l_2 + l_4s_{23} + l_3c_2 - l_6c_{234} + l_5s_{234} \\ 1 \end{bmatrix}$$

Code Matlab:

```
hold off
clear
l1 = 2; l2 = 5; l3 = 10; l4 = 15; l5 = 3; l6 = 7;
for t1=0:pi/9:2*pi
    for t2=0:pi/9:2*pi
        for t3=0:pi/9:2*pi
```

```
        for t4=0:pi/9:2*pi
            P = Rot_z(t1)*Trans(0,l1,0)*Trans(0,0,l2)*Rot_x(t2)*Trans(0,0,l3)
                *Rot_x(t3)*Trans(0,l4,0)*Rot_x(t4)*Trans(0,l5,0)*Trans(0,0,-l6)*[0;0;0;1];
            Px = P(1,1);
            Py = P(2,1);
            Pz = P(3,1);
            plot3(Px,Py,Pz,"*");
            hold on;
        end
    end
  end
end
```

Không gian làm việc: