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```
clc;
clear all;
close all;
```

QUESTION 2

```
syms theta1 theta2 theta3 theta4 theta5 theta6;
theta = [theta1 theta2+90 theta3 theta4 theta5 theta6]
d =  [290,0,0,302,0,72]
a =  [0,-270,-70,0,0,0]
alpha =  [-90,0,90,-90,90,0]
figure;
dh = imread('./screens/DH.png');
imshow(dh);
```

```
theta =

[ theta1, theta2 + 90, theta3, theta4, theta5, theta6]


d =

   290     0     0   302     0    72


a =

     0  -270   -70     0     0     0


alpha =

   -90     0    90   -90    90     0
```

Q. 2

Link	Θ^0	d(mm)	a(mm)	α^0
1	Θ_1	290	0	$-\pi/2$
2	$\Theta_2+\pi/2$	0	-270	0
3	Θ_3	0	-70	$+\pi/2$
4	Θ_4	302	0	$-\pi/2$
5	Θ_5	0	0	$+\pi/2$
6	Θ_6	72	0	0

Here Θ_1... Θ_6 are variables

QUESTION 3

```
figure;
f1 = imread('./screens/func1.png');
imshow(f1);
T = [];
for m = 1:6
    T_temp = dhparam2matrix(theta(m), d(m), a(m), alpha(m));
    T = [T, T_temp];
end

T1 = vpa(T(:, 1:4),4)
T2 = vpa(T(:, 5:8),4)
T3 = vpa(T(:, 9:12),4)
T4 = vpa(T(:, 13:16),4)
```

```
T5 = vpa(T(:, 17:20),4)
T6 = vpa(T(:, 21:24),4)
```

```
T1 =

[ cos(0.01745*theta1), -6.123e-17*sin(0.01745*theta1), -1.0*sin(0.01745*theta1),     0]
[ sin(0.01745*theta1),  6.123e-17*cos(0.01745*theta1),      cos(0.01745*theta1),     0]
[                   0,                           -1.0,                6.123e-17, 290.0]
[                   0,                              0,                        0,   1.0]


T2 =

[ cos(0.01745*theta2 + 1.571), -1.0*sin(0.01745*theta2 + 1.571),   0, -270.0*cos(0.01745*theta2 + 1.571)]
[ sin(0.01745*theta2 + 1.571),      cos(0.01745*theta2 + 1.571),   0, -270.0*sin(0.01745*theta2 + 1.571)]
[                           0,                                0, 1.0,                                  0]
[                           0,                                0,   0,                                1.0]


T3 =

[ cos(0.01745*theta3), -6.123e-17*sin(0.01745*theta3),      sin(0.01745*theta3), -70.0*cos(0.01745*theta3)]
[ sin(0.01745*theta3),  6.123e-17*cos(0.01745*theta3), -1.0*cos(0.01745*theta3), -70.0*sin(0.01745*theta3)]
[                   0,                           1.0,                6.123e-17,                         0]
[                   0,                             0,                        0,                       1.0]


T4 =

[ cos(0.01745*theta4), -6.123e-17*sin(0.01745*theta4), -1.0*sin(0.01745*theta4),     0]
[ sin(0.01745*theta4),  6.123e-17*cos(0.01745*theta4),      cos(0.01745*theta4),     0]
[                   0,                           -1.0,                6.123e-17, 302.0]
[                   0,                              0,                        0,   1.0]


T5 =

[ cos(0.01745*theta5), -6.123e-17*sin(0.01745*theta5),      sin(0.01745*theta5),   0]
[ sin(0.01745*theta5),  6.123e-17*cos(0.01745*theta5), -1.0*cos(0.01745*theta5),   0]
[                   0,                           1.0,                6.123e-17,   0]
[                   0,                             0,                        0, 1.0]


T6 =

[ cos(0.01745*theta6), -1.0*sin(0.01745*theta6),   0,    0]
[ sin(0.01745*theta6),      cos(0.01745*theta6),   0,    0]
[                   0,                        0, 1.0, 72.0]
[                   0,                        0,   0,  1.0]
```

Editor - C:\RBE\RBE 501 Dynamics\Assignments\HW2\solutions\dhparam2matrix.m

q2.m | forwardKin.m | plotarm.m | dhparam2matrix.m

```
function T = dhparam2matrix(theta, d, a, alpha)
    theta = theta * pi /180;
    alpha = alpha * pi /180;
    rot_z = [cos(theta),-sin(theta),0,0; sin(theta),cos(theta),0,0; 0,0,1,0; 0,0,0,1];
    trans_z = [1,0,0,0; 0,1,0,0; 0,0,1,d; 0,0,0,1];
    rot_x = [1,0,0,0; 0, cos(alpha), -sin(alpha), 0; 0, sin(alpha), cos(alpha), 0; 0,0,0,1];
    trans_x = [1,0,0,a; 0,1,0,0; 0,0,1,0; 0,0,0,1];
    T = rot_z * trans_z * rot_x * trans_x;
end
```

QUESTION 4

```
T06 = (T1 * T2 * T3 * T4 * T5 * T6);
T06 = vpa(T06,4);
disp('T06');
disp(T06);
```

```
T06
[ sin(0.01745*theta6)*(6.123e-17*sin(0.01745*theta5)*(sin(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.0174
5*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571
)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + cos(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*th
eta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01
745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)))) - 3.749e-33*sin(0.01745*theta1) - 1.0*cos(0.01745*theta4)*(1.0*sin(0.01745*th
```

eta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e\\\r\n-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 6.123e-17*cos(0.01745*theta5)*(6.123e-17*cos(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) - 6.123e-17*sin(0.01745*theta1) + 1.0*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e\\\r\n-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 1.0*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))))) + cos(0.01745*theta5)*(sin(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + co\\\r\ns(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))))), cos(0.01745*theta6)*(6.123e-17*sin(0.01745*theta5)*(sin(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + cos(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta1) - 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)))) - 3.749e-33*sin(0.01745*theta1) - 1.0*cos(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e\\\r\n-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 6.123e-17*cos(0.01745*theta5)*(6.123e-17*cos(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 6.123e-17*sin(0.01745*theta1) + 1.0*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 1.0*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)))) + cos(0.01745*theta5)*(sin(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + co\\\r\ns(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)))))), 3.749e-33*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 1.0*sin(0.01745*theta5)*(sin(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + cos(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 6.123e-17*cos(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta\\\r\n1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) - 2.296e-49*sin(0.01745*theta1) + 1.0*cos(0.01745*theta5)*(6.123e-17*cos(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) - 6.123e-17*sin(0.01745*theta1) + 1.0*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.\\\r\n571)*sin(0.01745*theta1))) + 1.0*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 6.123e-17*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 3.749e-33*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))), 302.0*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 72.0*sin(0.01745*theta5)*(sin(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + cos(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)))) - 4.409e-15*cos(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))\\\r\n + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) - 270.0*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.849e-14*sin(0.01745*theta1) + 70.0*sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 1.653e-14*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 72.0*cos(0.01745*theta5)*(6.123e-17*cos(0.01745*theta4)*(1.0*sin(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) - 6.123e-17*sin(0.01745*theta1) + 1.0*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 6.123e-17*sin(0.0174\\\r\n5*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 1.0*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) + 4.409e-15*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) - 1.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))) - 70.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + 302.0*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1))]

[- 1.0*cos(0.01745*theta6)*(sin(0.01745*theta5)*(6.123e-17*cos(0.01745*theta1) - 6.123e-17*cos(0.01745*theta4)*(1.0*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) - 6.123e-17

*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) - 1.0*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + 1.0*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))\\\r\n) - 1.0*cos(0.01745*theta5)*(sin(0.01745*theta4)*(1.0*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + cos(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin\\\r\n(0.01745*theta1)) + cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)))) - 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*cos(0.01745*theta5)*(6.123e-17*cos(0.01745*theta1) - 6.123e-17*cos(0.01745*theta4)*(1.0*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.0174\\\r\n5*theta1)) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + 1.0*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))), 1.0*sin(0.01745*theta6)*(sin(0.01745*theta5)*(6.123e-17*cos(0.01745*theta1) - 6.123e-17*cos(0.01745*theta4)*(1.0*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + 1.0*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + 1.0*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) \\\r\n- 1.0*cos(0.01745*theta5)*(sin(0.01745*theta4)*(1.0*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + cos(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)))))) - 1.0*cos(0.01745*theta6)*(6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) - 1.0*cos(0.01745*theta4)*(1.0*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)\\\r\n*sin(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) - 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + 6.123e-17*sin(0.01745*theta5)*(sin(0.01745*theta4)*(1.0*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + cos(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)))) + 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 6.123e-17*cos(0.01745*theta5)*(6.123e-17*cos(0.01745*theta1) - 6.123e-17*cos(0.01745*theta4)*(1.0*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) - 1.0*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + 6.123e-17*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*\\\r\nntheta1)) + cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + 1.0*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)))), 2.296e-49*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta4)*(1.0*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) - 3.749e-33*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + 1.0*sin(0.01745*theta5)*(sin(0.01745*theta4)*(1.0*cos(0.01745*theta1) + 6.123e-17*cos(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01\\\r\n745*theta2 + 1.571)*sin(0.01745*theta1)) - 6.123e-17*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + cos(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)))) - 70.0*cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)) + 302.0*sin(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta4)*(sin(0.01745*theta3)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta1) - 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta1)) + cos(0.01745*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1))) + 1.0*sin(0.0174

5*theta3)*(cos(0.01745*theta2 + 1.571)*sin(0.01745*theta1) + 6.123e-17*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta1)))]
[

sin(0.01745*theta6)*(6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 1.0*sin(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1
.571)*sin(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) + 6.123e-17*sin(0.01745*theta5)*(cos(0.01745*theta4)*(1.0*cos(0.01745*t
heta2 + 1.571)*sin(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) - 1.0*sin(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.57
1)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17)) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*the
ta3) + 1.0*cos(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) +
6.123e-17) + 6.123e-17*cos(0.01745*theta5)*(6.123e-17*sin(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 1.0*sin(0.01745*theta2
+ 1.571)*cos(0.01745*theta3)) - 1.0*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 1.0*sin(0.01745*theta\\\r\n2 + 1.571)*sin(0.01745*theta3) + 6.123e
-17*cos(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-
17) - 3.749e-33) + 2.296e-49) - cos(0.01745*theta6)*(1.0*cos(0.01745*theta5)*(cos(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta3) +
1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) - 1.0*sin(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) - 6.123e-17*c
os(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17)) - sin(0.01745*theta5)*(6.123e-17*sin(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0
.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) - 1.0*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1
.571)*sin(0.01745*theta3) + 6.123e-17*cos(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.
571)*cos(0.01745*theta3) + 6.123e-17) - 3.749e-3\\\r\n3)),

1.0*sin(0.01745*theta6)*(1.0*cos(0.01745*theta5)*(cos(0.01745*theta4)*(1.0*cos(
0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) - 1.0*sin(0.01745*theta4)*(6.123e-17*sin(0.01745*thet
a2 + 1.571)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17)) - sin(0.01745*theta5)*(6.123e-17*sin(0.01745*t
heta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) - 1.0*cos(0.01745*theta2 + 1.571)*cos
(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 6.123e-17*cos(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.0174
5*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17) - 3.749e-33)) + cos(0.01745*theta6)*(6.123e-17*cos(0.01745*theta2 + 1
.571)*cos(0.01745*theta3) + 1.0*sin(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*t
heta3)) \\\r\n+ 6.123e-17*sin(0.01745*theta5)*(cos(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571
)*cos(0.01745*theta3)) - 1.0*sin(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(
0.01745*theta3) + 6.123e-17)) - 6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 1.0*cos(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.57
1)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17) + 6.123e-17*cos(0.01745*theta5)*(6.123e-17*sin(0.01745*t
heta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) - 1.0*cos(0.01745*theta2 + 1.571)*cos
(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 6.123e-17*cos(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.0174
5*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17) - 3.749e-33) + 2.2\\\r\n96e-49),

3.749e-33*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17*sin(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta
3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) - 1.0*sin(0.01745*theta5)*(cos(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*th
eta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) - 1.0*sin(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) - 6.12
3e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17)) - 3.749e-33*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 6.123e-17*cos(0.01745*
theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17) - 1.0*cos(0.
01745*theta5)*(6.123e-17*sin(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3))
- 1.0*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*sin(0.0174\\\r\n5*theta3) + 6.123e-17*cos(0.01745*theta4)*(6.12
3e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17) - 3.749e-33) + 1.406e-65,

270
.0*sin(0.01745*theta2 + 1.571) + 302.0*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 4.409e-15*sin(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.571)*
sin(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) - 72.0*sin(0.01745*theta5)*(cos(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.5
71)*sin(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*cos(0.01745*theta3)) - 1.0*sin(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01
745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17)) + 70.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 70.0*sin(
0.01745*theta2 + 1.571)*cos(0.01745*theta3) - 302.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 4.409e-15*cos(0.01745*theta4)*(6.123e-17*sin(0.017

45*theta2 + 1.571)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17) - 72.0*cos(0.01745*theta5)*(6.123e-17*sin(0.01745*theta4)*(1.0*cos(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 1.0*sin(0.0\\\r\n1745*theta2 + 1.571)*cos(0.01745*theta3)) - 1.0*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 1.0*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) + 6.123e-17*cos(0.01745*theta4)*(6.123e-17*sin(0.01745*theta2 + 1.571)*sin(0.01745*theta3) - 6.123e-17*cos(0.01745*theta2 + 1.571)*cos(0.01745*theta3) + 6.123e-17) - 3.749e-33) + 290.0]
[

0,

0,

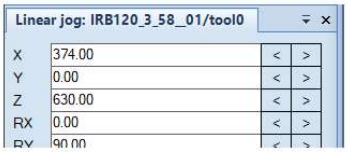
0,

```
1.0]
```

QUESTION 5

```
T_subs_zero = subs(T06, {theta1, theta2, theta3, theta4, theta5, theta6}, {0,0,0,0,0,0});

T_subs_zero = double(vpa(T_subs_zero))
i1 = imread('./screens/compare1.png');
imshow(i1);
```

```
T_subs_zero =

   -0.0000   -0.0000    1.0000  374.0000
    0.0000    1.0000    0.0000    0.0000
   -1.0000    0.0000   -0.0000  630.0000
         0         0         0    1.0000
```

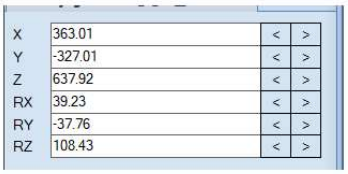



```
Transformatio Matrix for configuration in Q 5
   -0.0000   -0.0000    1.0000  374.0000
    0.0000    1.0000    0.0000    0.0000
   -1.0000    0.0000   -0.0000  630.0000
         0         0         0    1.0000
```

QUESTION 6

```
disp('Solution 6a');
T_subs_1 = subs(T06, {theta1, theta2, theta3, theta4, theta5, theta6}, {-45,30,-30,-30,-45,180});
T_subs_1 = double(T_subs_1)
disp('Solution 6b i');
T_subs_1 = double(vpa(T_subs_1))
disp('The cartesian position of the robot tip in millimeters in X,Y,Z directions is shown below: ');
disp(T_subs_1(1,4));
disp(T_subs_1(2,4));
disp(T_subs_1(3,4));

disp('Solution 6b ii');
fprintf('The unit vector representing the approach vector of the robot in this configuration is: %s %d %e', double(T_subs_1(1,3))...
    , double(T_subs_1(2,3)), double(T_subs_1(3,3)));
i2 = imread('./screens/compare2.png');
imshow(i2);
```

```
Solution 6a

T_subs_1 =

   -0.2500   -0.6124    0.7500  363.0057
    0.7500   -0.6124   -0.2500 -327.0057
    0.6124    0.5000    0.6124  637.9177
         0         0         0    1.0000

Solution 6b i

T_subs_1 =

   -0.2500   -0.6124    0.7500  363.0057
    0.7500   -0.6124   -0.2500 -327.0057
    0.6124    0.5000    0.6124  637.9177
         0         0         0    1.0000

The cartesian position of the robot tip in millimeters in X,Y,Z directions is shown below:
  363.0057

 -327.0057

  637.9177

Solution 6b ii
The unit vector representing the approach vector of the robot in this configuration is: 7.500000e-01 -2.500000e-01 6.123724e-01
```

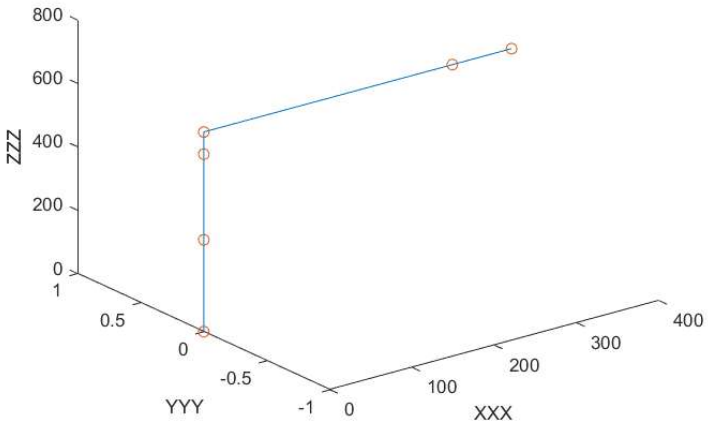


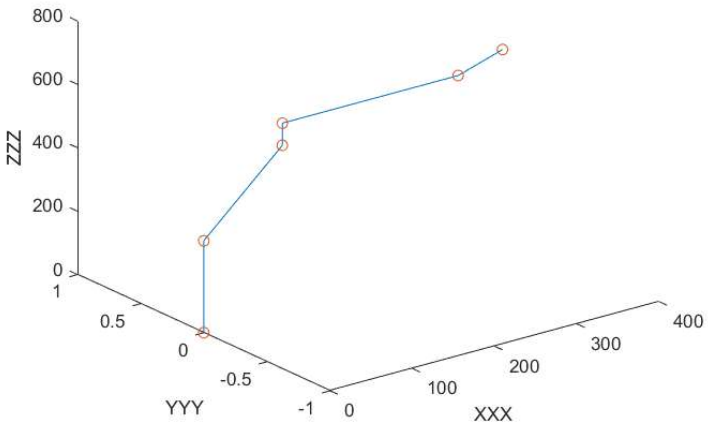

```
Transformatio Matrix for configuration in Q 6
   -0.2500   -0.6124    0.7500  363.0057
    0.7500   -0.6124   -0.2500 -327.0057
    0.6124    0.5000    0.6124  637.9177
         0         0         0    1.0000
```

QUESTION 7

```
config1 = [0,0,0,0,0,0];
config2 = [-45,30,-30,-30,-45,180];

figure;
[T] = forwardKin(config1);
disp('Transformatio Matrix for configuration in Q 5')
disp(T);

figure;
[T] = forwardKin(config2);
disp('Transformatio Matrix for configuration in Q 6')
disp(T);
```

```
Transformatio Matrix for configuration in Q 5
   -0.0000   -0.0000    1.0000  374.0000
    0.0000    1.0000    0.0000    0.0000
   -1.0000    0.0000   -0.0000  630.0000
         0         0         0    1.0000

Transformatio Matrix for configuration in Q 6
   -0.2500   -0.6124    0.7500  363.0057
    0.7500   -0.6124   -0.2500 -327.0057
    0.6124    0.5000    0.6124  637.9177
         0         0         0    1.0000
```



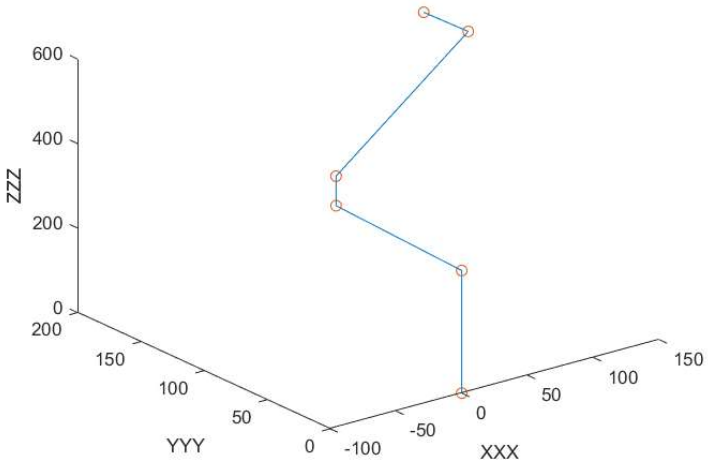


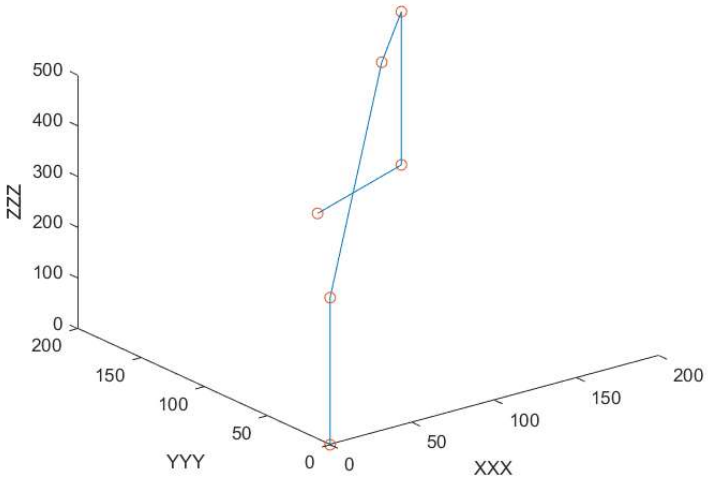
QUESTION 8

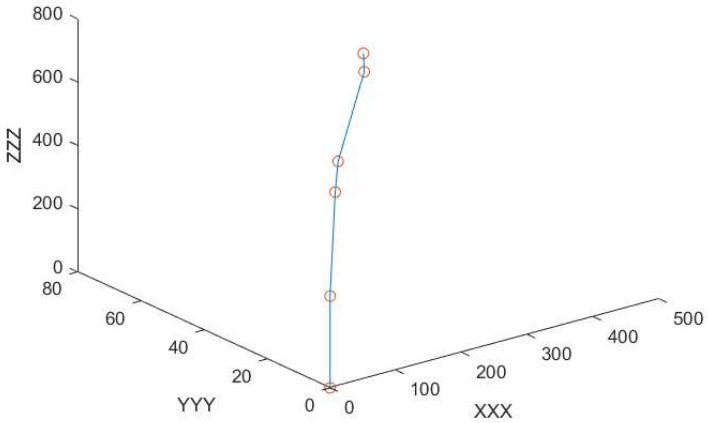
```
config3 = [45,-30,30,30,45, -180];
config4 = [45,45,45,45,45,45];
config5 = [10,10,10,10,10,10];
config6 = [0,45,0,90,0,0];
config7 = [0,-45,0,-90,0,0];
figure;
[T] = forwardKin(config3);
disp('Transformatio Matrix for configuration #1 Q8');

disp(T);

figure;
[T] = forwardKin(config4);
disp('Transformatio Matrix for configuration #2 Q8');
disp(T);
figure;
[T] = forwardKin(config5);
disp('Transformatio Matrix for configuration #3 Q8');
disp(T);
figure;
[T] = forwardKin(config6);
disp('Transformatio Matrix for configuration #4 Q8');
disp(T);
figure;
[T] = forwardKin(config7);
disp('Transformatio Matrix for configuration #5 Q8');
disp(T);
figure;
i3 = imread('./screens/compare3.png');
imshow(i3);

figure;
i4 = imread('./screens/compare4.png');
imshow(i4);

figure;
i5 = imread('./screens/compare5.png');
imshow(i5);

figure;
i6 = imread('./screens/compare6.png');
imshow(i6);

figure;
i7 = imread('./screens/compare7.png');
imshow(i7);

figure;
j1 = imread('./screens/config1.png');
imshow(j1);

figure;
j2 = imread('./screens/config2.png');
imshow(j2);

figure;
j3 = imread('./screens/config3.png');
imshow(j3);

figure;
j4 = imread('./screens/config4.png');
```

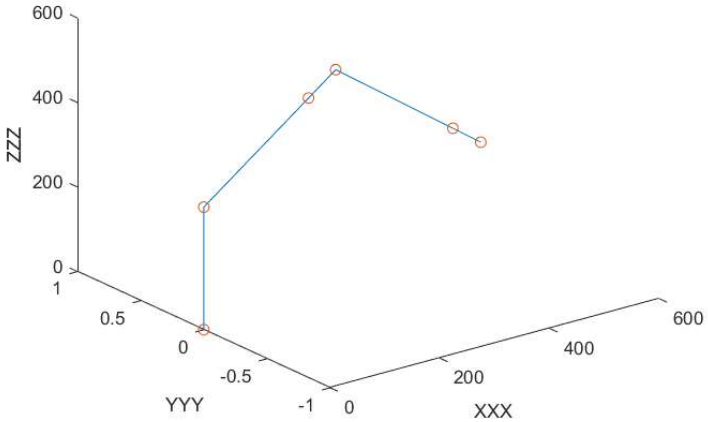
```
imshow(j4);

figure;
j5 = imread('./screens/config5.png');
imshow(j5);

figure;
j6 = imread('./screens/config6.png');
imshow(j6);

figure;
j7 = imread('./screens/config7.png');
imshow(j7);
```

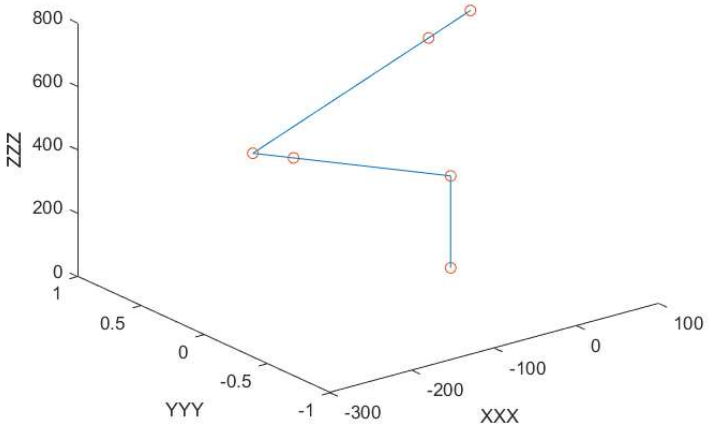
```
Transformatio Matrix for configuration #1 Q8
    0.7500    0.6124    0.2500  136.0868
    0.2500   -0.6124    0.7500  172.0868
    0.6124   -0.5000   -0.6124  549.7360
         0         0         0    1.0000

Transformatio Matrix for configuration #2 Q8
   -0.5000    0.5000   -0.7071  133.5858
    0.7071    0.7071   -0.0000  184.4975
    0.5000   -0.5000   -0.7071  128.0071
         0         0         0    1.0000

Transformatio Matrix for configuration #3 Q8
   -0.5287   -0.0210    0.8485  410.3197
    0.2514    0.9509    0.1802   74.5550
   -0.8107    0.3086   -0.4975  482.5650
         0         0         0    1.0000

Transformatio Matrix for configuration #4 Q8
    0.0000    0.7071    0.7071  504.8742
    1.0000   -0.0000    0.0000    0.0000
    0.0000    0.7071   -0.7071  265.9584
         0         0         0    1.0000

Transformatio Matrix for configuration #5 Q8
   -0.0000    0.7071    0.7071   24.0416
   -1.0000   -0.0000    0.0000   -0.0000
    0.0000   -0.7071    0.7071  794.8742
         0         0         0    1.0000

Warning: Image is too big to fit on screen; displaying at 67%
Warning: Image is too big to fit on screen; displaying at 67%
Warning: Image is too big to fit on screen; displaying at 67%
Warning: Image is too big to fit on screen; displaying at 67%
Warning: Image is too big to fit on screen; displaying at 67%
Warning: Image is too big to fit on screen; displaying at 67%
Warning: Image is too big to fit on screen; displaying at 67%
```

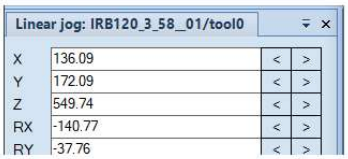



ZZZ
500
400
300
200
100
0
200
150
100
50
0
YYY
0
50
100
150
200
XXX


ZZZ
800
600
400
200
0
80
60
40
20
0
YYY
0
100
200
300
400
500
XXX

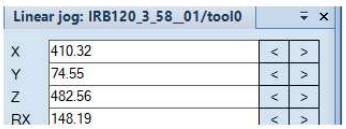

ZZZ
600
400
200
0
1
0.5
0
-0.5
-1
YYY
0
200
400
600
XXX



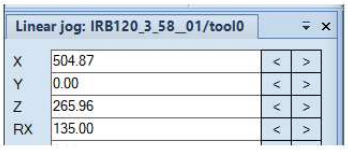



```
Transformatio Matrix for configuration #1 Q8
    0.7500    0.6124    0.2500  136.0868
    0.2500   -0.6124    0.7500  172.0868
    0.6124   -0.5000   -0.6124  549.7360
         0         0         0    1.0000
```

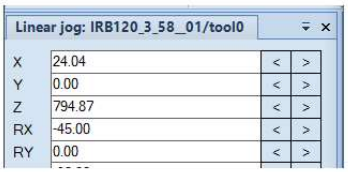

```
Transformatio Matrix for configuration #2 Q8
   -0.5000    0.5000   -0.7071  133.5858
    0.7071    0.7071   -0.0000  184.4975
    0.5000   -0.5000   -0.7071  128.0071
         0         0         0    1.0000
```



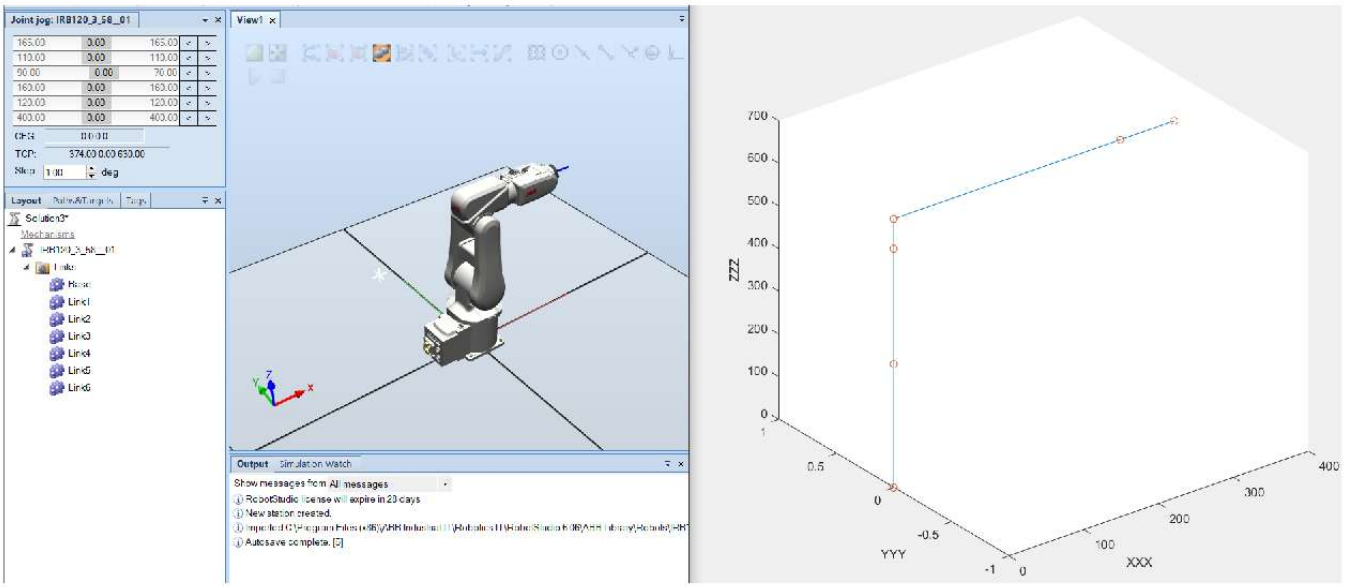

```
Transformatio Matrix for configuration #3 Q8
   -0.5287   -0.0210    0.8485  410.3197
    0.2514    0.9509    0.1802   74.5550
   -0.8107    0.3086   -0.4975  482.5650
         0         0         0    1.0000
```

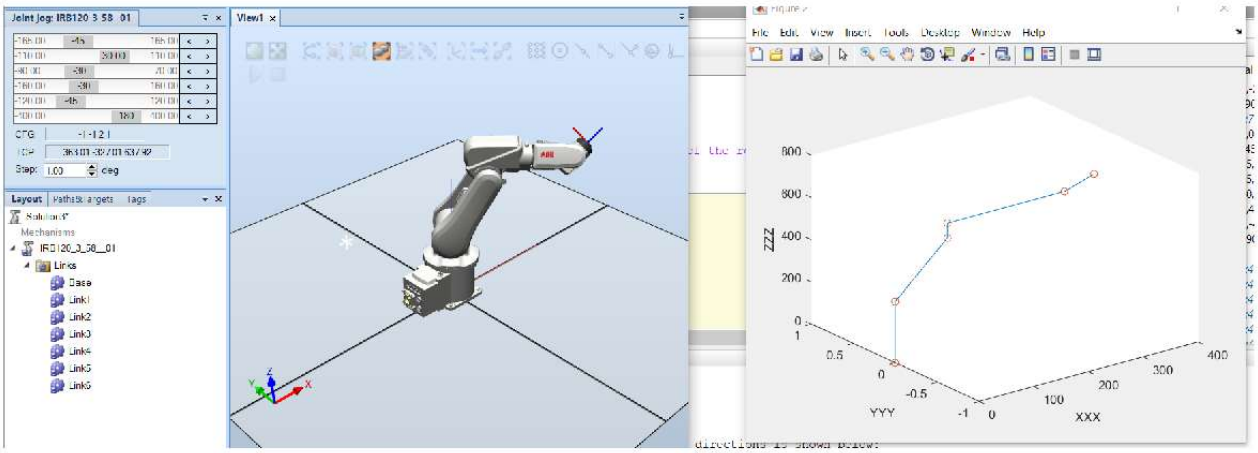


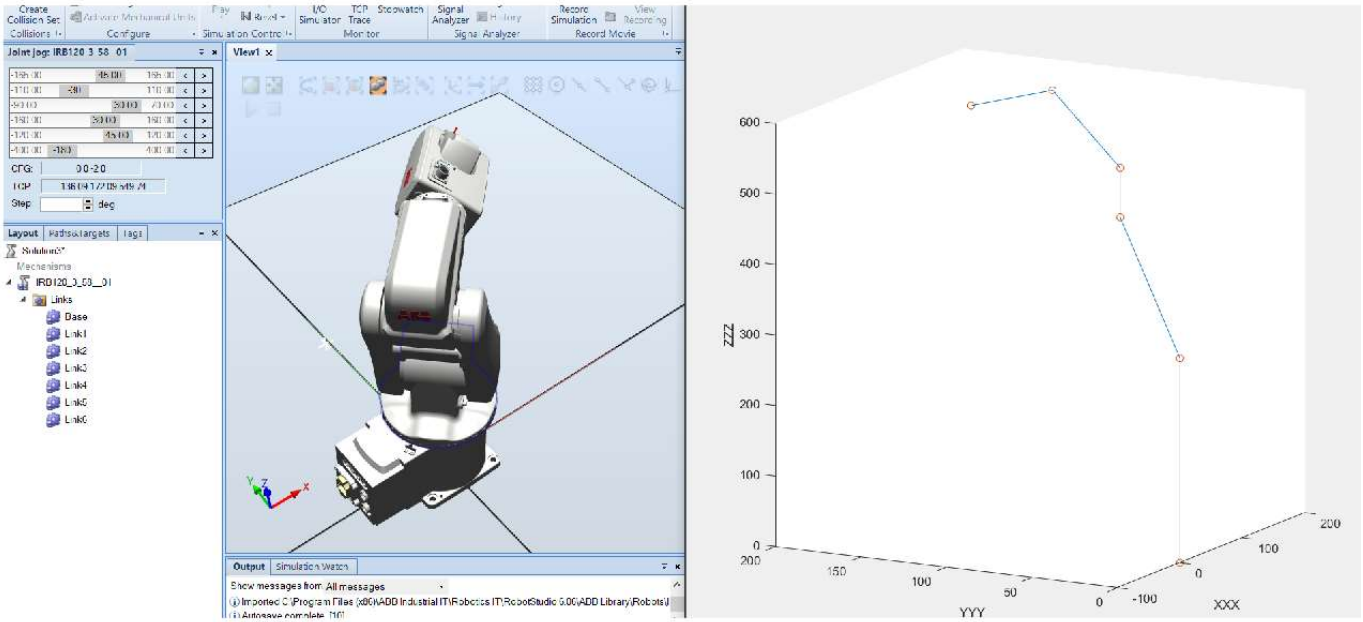

```
         0         0         0    1.0000

Transformatio Matrix for configuration #4 Q8
    0.0000    0.7071    0.7071  504.8742
    1.0000   -0.0000    0.0000    0.0000
    0.0000    0.7071   -0.7071  265.9584
         0         0         0    1.0000
```

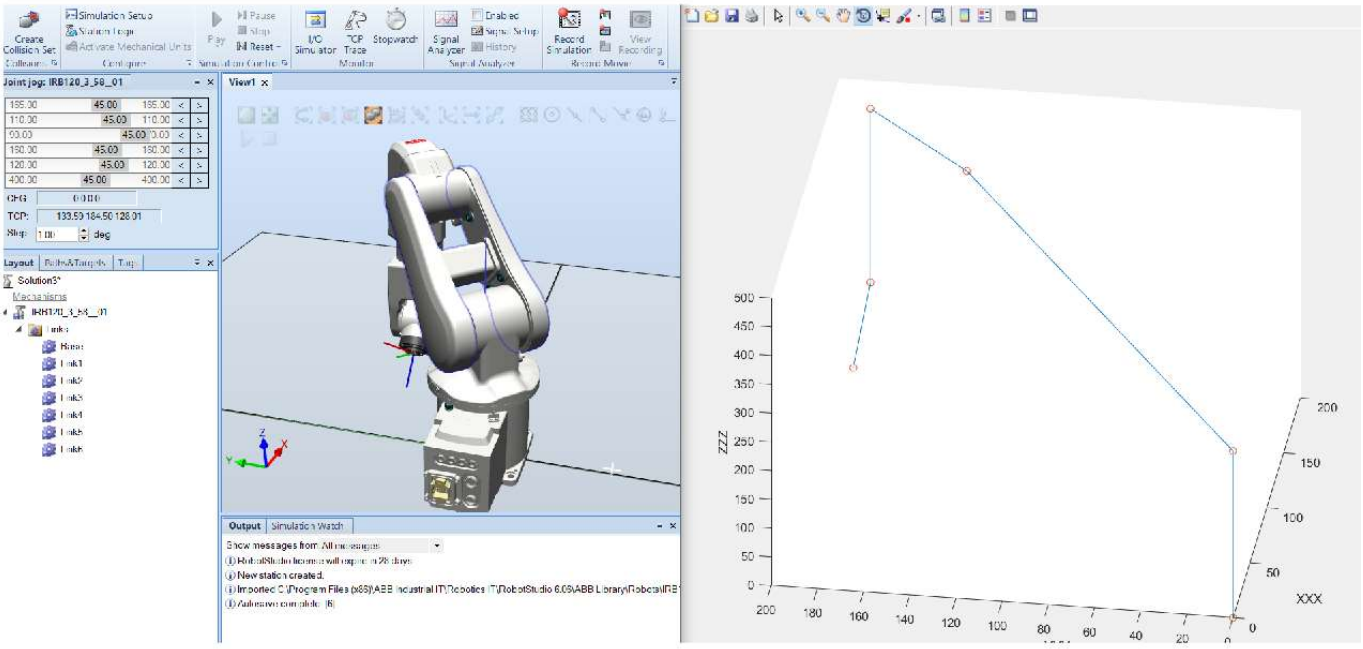


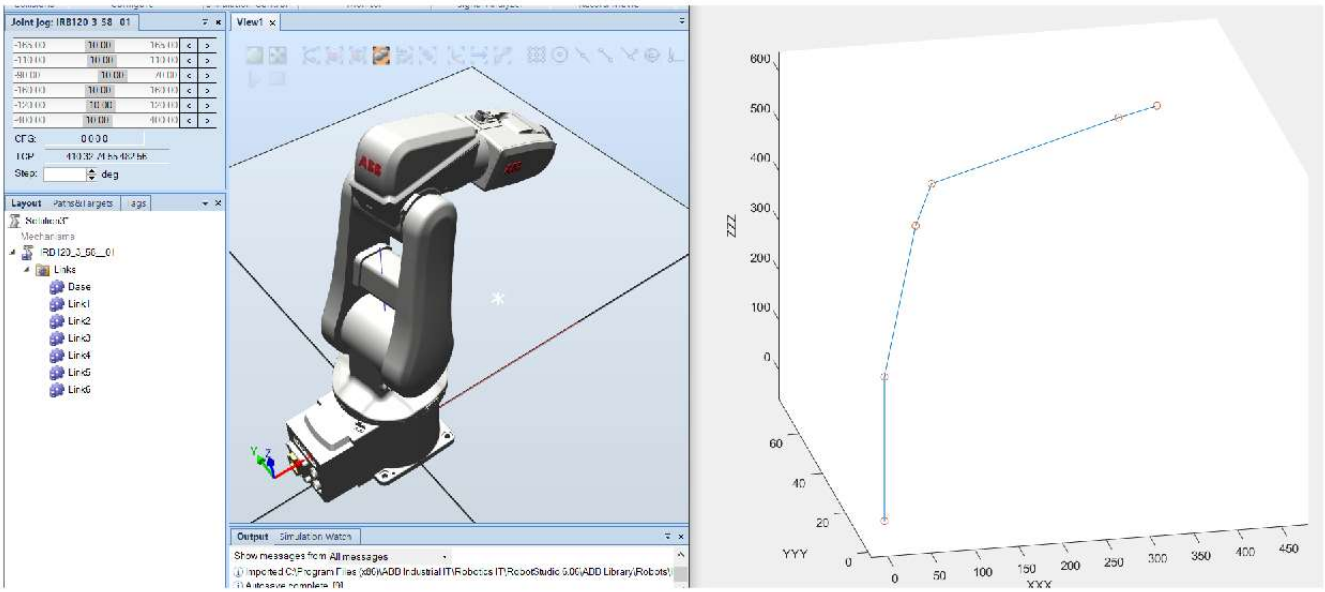

```
Transformatio Matrix for configuration #5 Q8
   -0.0000    0.7071    0.7071   24.0416
   -1.0000   -0.0000    0.0000   -0.0000
    0.0000   -0.7071    0.7071  794.8742
         0         0         0    1.0000
```

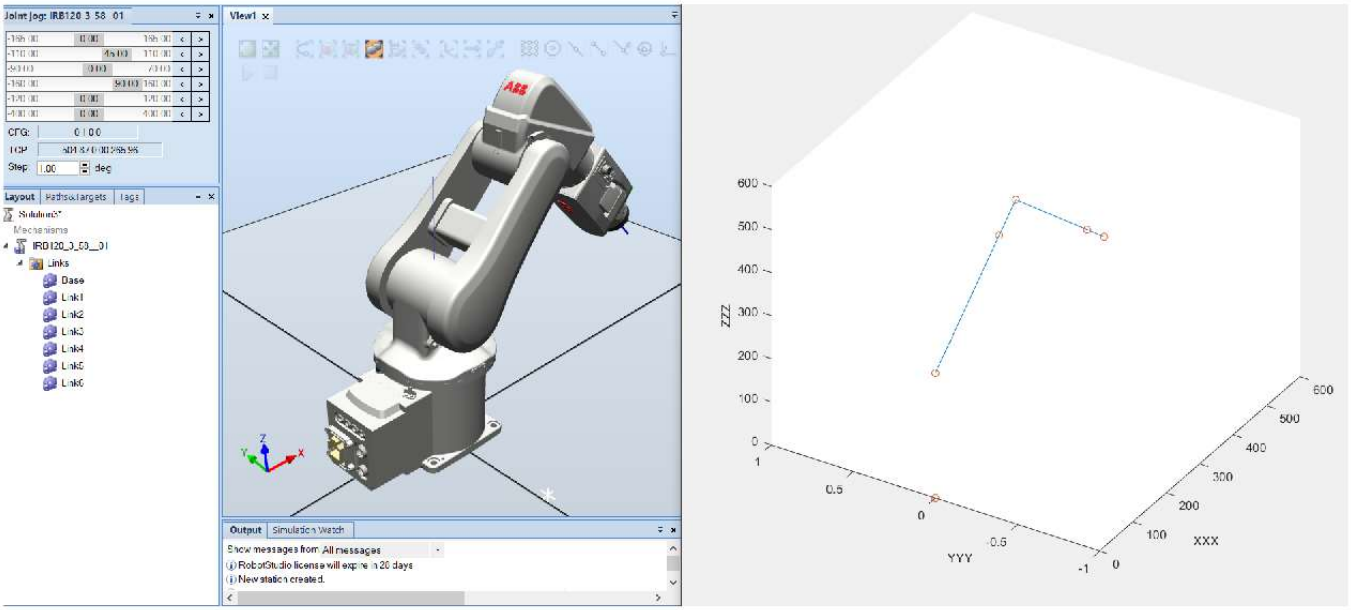


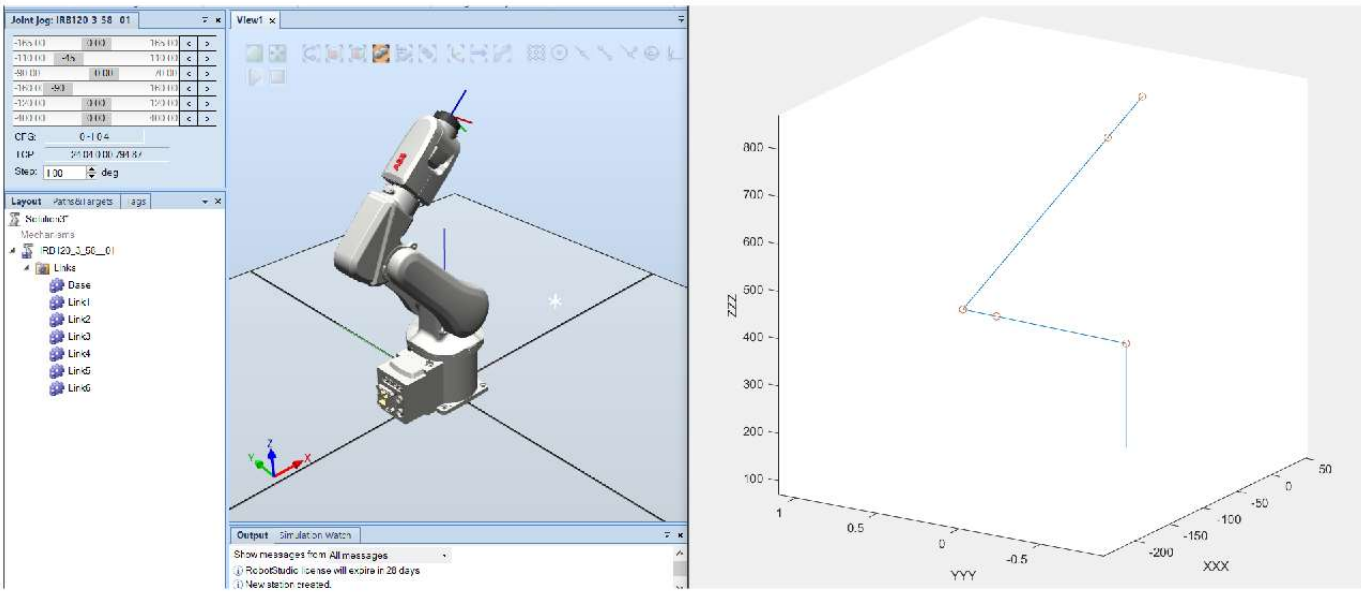



Joint jog: IRB120_3_58_01
View1
Output
Simulation Watch
ZZZ
YYY
XXX


Joint jog: IRB120_3_58_01
View1
Output
Simulation Watch
ZZZ
XXX


Joint Jog: IRB120_3_58__01
View1
Layout
Paths&Targets
Tags
Links
Base
Link1
Link2
Link3
Link4
Link5
Link6
Output
Simulation Watch
ZZZ
YYY
XXX


Joint Jog: IRB120_3_58__01
View1
Layout
Paths&Targets
Tags
Links
Base
Link1
Link2
Link3
Link4
Link5
Link6
Output
Simulation Watch
RobotStudio license will expire in 20 days
New station created.
ZZZ
YYY
XXX



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