MCE4101 Introduction to Robotics
Quiz2 (5%) –SET 1 (ID end with 1,5,8)

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Note:

1. OPEN BOOK.

2. There are 2 questions.

3. 50 Marks equivalent to 5%.

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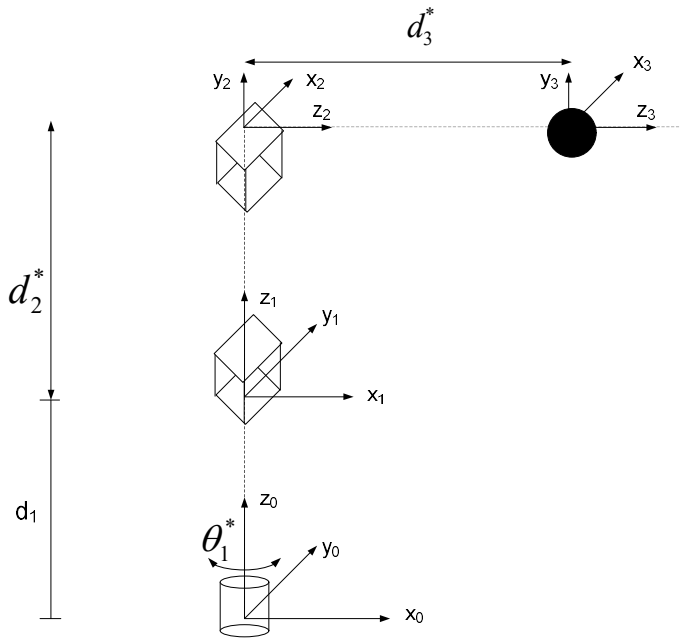
1. (30 Marks). The 3 links RPP robot is shown.
   a) (5 Marks) Obtain DH table and the transformation matrix **equation** T^0_3. Where d_1 is link offset. Given $d_1 = 2.5$.
   b) (15 Marks) Determine with analytic method for possible solution for end point location Pend = [1.77 1.77 2.75]. Show your working steps.
   c) (10 Marks) Check your answer b), show your checked answer and your working steps.



Ans:

(a)

```
%RPP + 1 DOF Wrist Mechanism
syms th1
syms d1 d2 d3
d1 = 2.5;
%%RPP
%%L = link([alpha A theta D])
A1 = link([0 0 th1 d1, 0]); %%0 is revolute (and default), 1 is prismatic
A2 = link([pi/2 0 pi/2 d2, 1]);
A3 = link([0 0 0 d3, 1]);
%%1DOF Wrist Mechanism

RPP1DOF = robot({A1 A2 A3});
T03 = fkine(RPP1DOF,[th1 d2 d3 ])
Pend = T03*[0;0;0;1]
```

$$d_2 = \frac{-X_c}{\sin(th1)} - \frac{3}{2}$$

```
mmand Window
T03 =

[ -sin(th1), 0, cos(th1), d3*cos(th1)]
[  cos(th1), 0, sin(th1), d3*sin(th1)]
[         0, 1,        0,    d2 + 5/2]
[         0, 0,        0,           1]
```

(b)

```
Px = 1.77; Py = 1.77; Pz = 2.75
d1 = 2.5; L2 = 0;
d2 = Pz-d1
th1 = atan2d(Py, Px)
d3 = Px/cosd(th1)-L2
```

```
Pz =

    2.7500

d2 =

    0.2500

th1 =

    45

d3 =

    2.5032
```

(c)

```
Px = 1.77; Py = 1.77; Pz = 2.75;
d1 = 2.5;
d2 = Pz-d1
th1 = atan2d(Py, Px)
d3 = Px/cosd(th1)

%%RPP
%%L = link([alpha A theta D])
A1 = link([0 0 0 d1, 0]); %%0 is revolute (and default), 1 is prismatic
A2 = link([pi/2 0 pi/2 1, 1]);
A3 = link([0 0 0 1, 1]);
%%1DOF Wrist Mechanism

RPP1DOF = robot({A1 A2 A3});
T03 = fkine(RPP1DOF,[deg2rad(45) 0.2500 2.5032])
Pend = T03*[0;0;0;1]
```

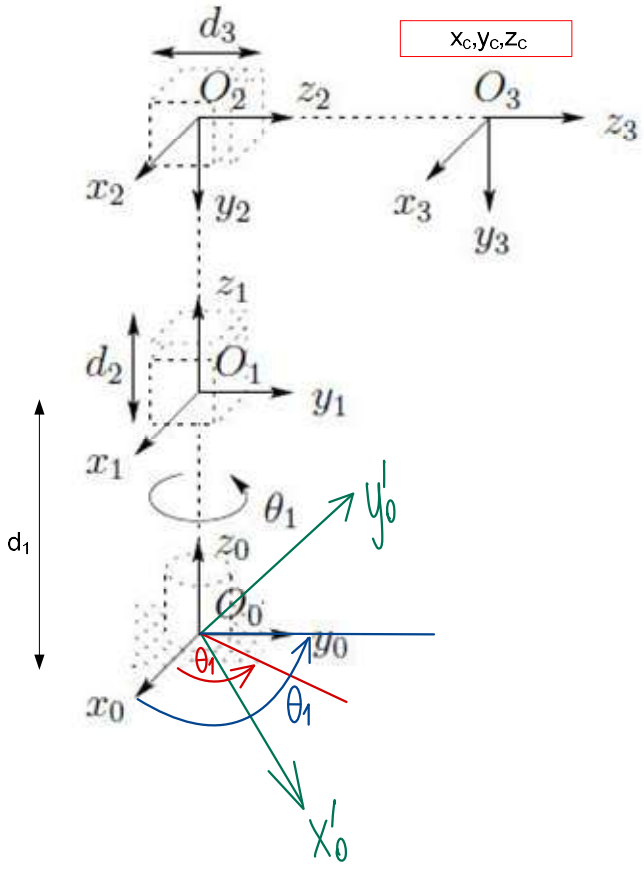
```
mmand Window
Pend =

    1.7700
    1.7700
    2.7500
    1.0000

>>
```

2. (20 Marks)

a) (15 Marks) Given P(x_c, y_c, z_c), determine variable's equation for θ_1^*, d_2^*, d_3^* in term of x_c, y_c, z_c and d_1 for RPP robot by **geometrical** method.

b) (5 Marks) From a), Given $d_1 = 2$ and P(1.25, 1.5, 3.25), obtained 1 set of θ_1^*, d_2^*, d_3^*.

θ_1, d_2, d_3 equation



Ans:

(a)

```
d1

d2 =

Pz - d1

th1 =

(180*atan2(Py, Px))/pi

d3 =

-(Px*abs(Px + Py*1i))/(imag(Py) - real(Px))
```

z.m | Quiz2_2.m* | +

```
%RPP + 1 DOF Wrist Mechanism
sym d1
%d1 = 2;
syms Px Py Pz
%Px = 1.25; Py = 1.5; Pz = 3.25;
d2 = Pz-d1
th1 = atan2d(Py, Px)
d3 = Px/cosd(th1)
```

(b)

```
>> Quiz2_2

d2 =

    1.2500


th1 =

   50.1944


d3 =

    1.9526
```