Midterm-Part2

EEC-647: Robot Dynamics and Control

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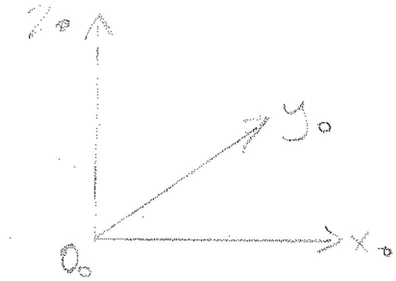
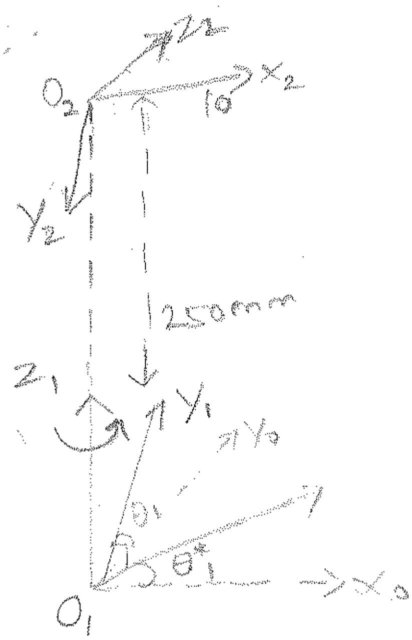
Midterm – Part II

	Link	θ	d	a	α
A_1^0	1	θ_1^*	0	0	0
A_2^1	1'	0	250	0	-90
A_3^2	1''	$-90°$	0	0	0
A_4^3	2	θ_2^*	0	220	0
A_5^4	2'	+90	0	0	0
A_6^5	3	$-\theta_3^*$	0	160	0
A_7^6	3'	+90	0	0	0
A_8^7	4	$-\theta_4^*$	0	0	0
A_9^8	4'	90	0	0	90
A_{10}^9	5	θ_5^*	177.6	0	0

World frame:



Frame 0 to 2:

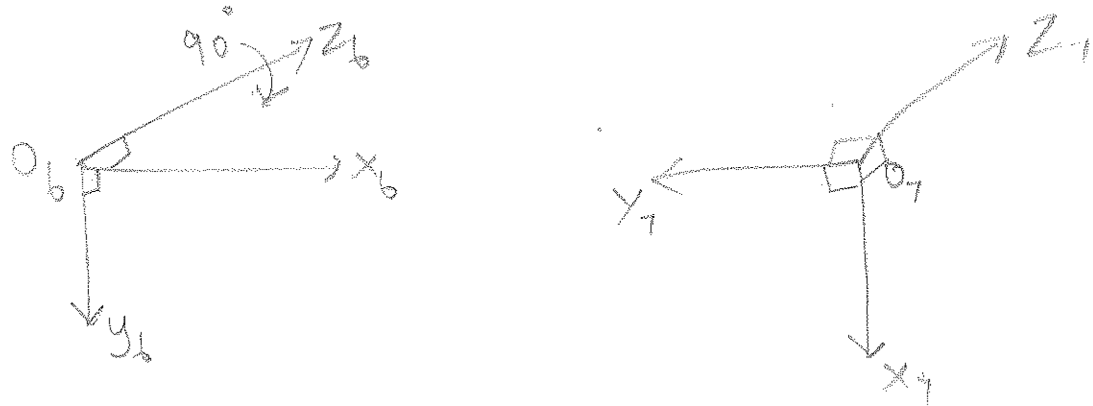


$\theta = 0$
$d = 250$
$a = 0$
$\alpha = -90°$

$\theta = \theta_1$

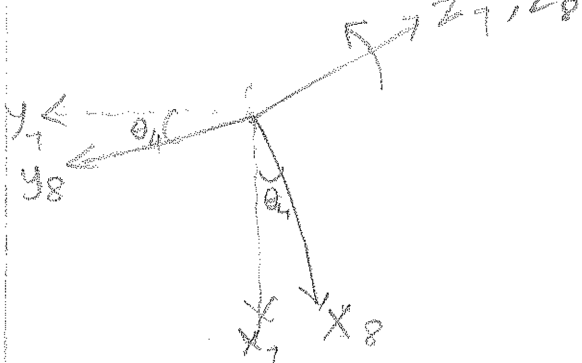
Frame 6 to 7:

$\theta = 90^\circ$



Frame 7 to 8:

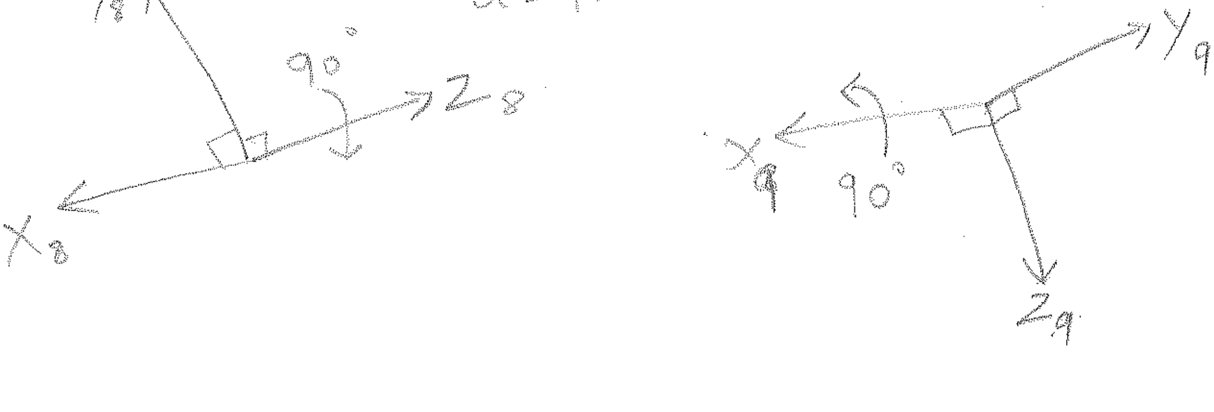
$\theta = -\theta_4$

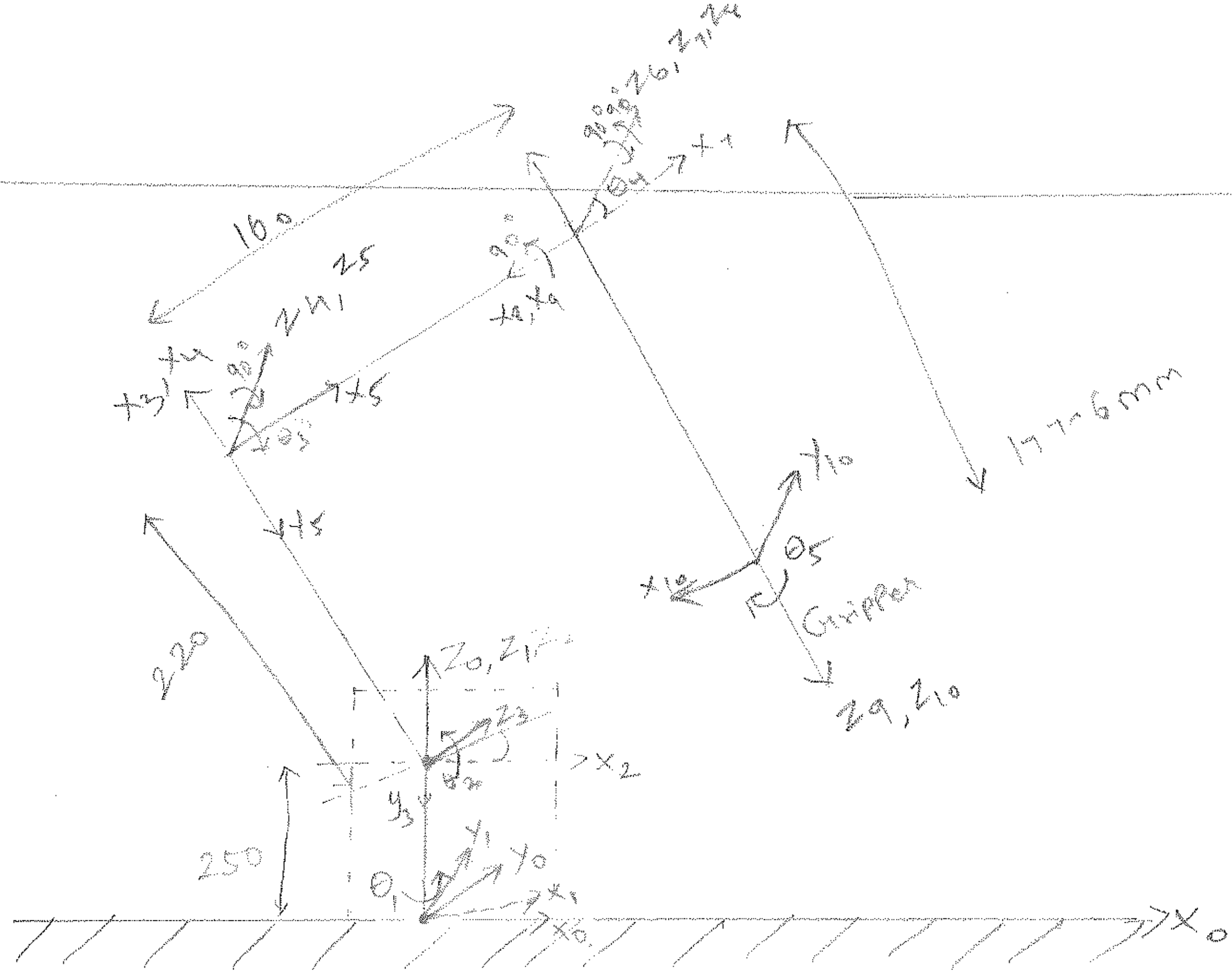


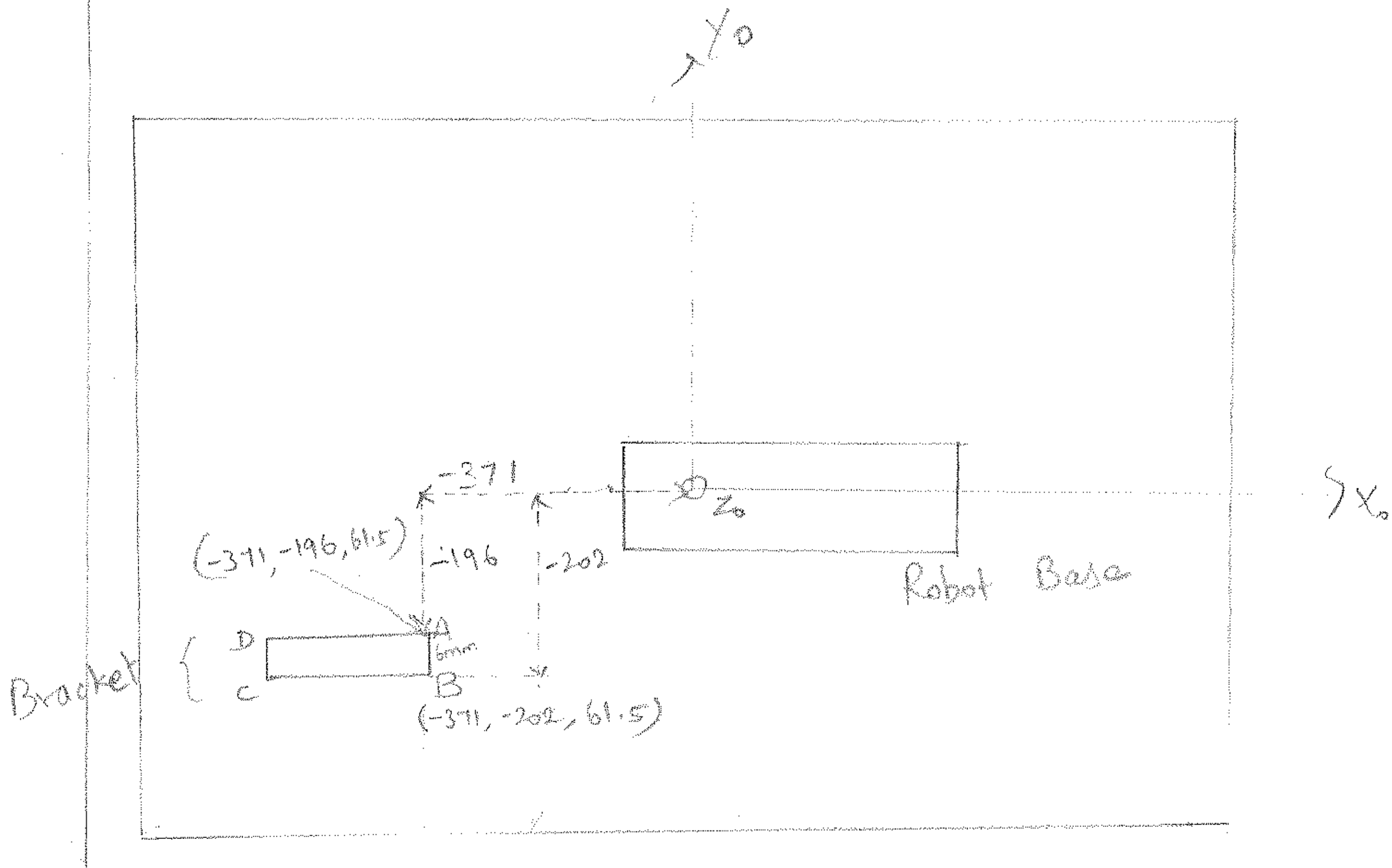
Frame 8 to 9:

$\theta = 90^\circ$

$\alpha = 90^\circ$




160
177.6mm
220
250
Gripper


(-371, -196, 61.5)
-371
-196
-202
Robot Base
Bracket
(-371, -202, 61.5)

Input:

CASE	Counter Clock (R+21)°	P°	(X+30) °	(Y-14) °	Z°
1.	19.8	14.1	179.43	94.18	73.75
2.	27.71	18.83	181.05	93.08	71.05
3.	29.1	20.06	181.0	92.18	68.38
4.	78	32.96	177.9	85.88	52.38
5.	97.24	64.76	177.0	76.35	23.48

The points of Bracket from world Frame are:

A:[-371;-196;61.5]

B:[-371;-202;61.5]

The points of the end gripper are:

A:[-9.5;-4;38;1]

B:[-9.5;4;38;1]

C:[9.5;4;38;1]

D:[9.5;-4;38;1]

Result:

After computing the transformation matrices and multiplying with the respective point of the end frame, we get the results from the MATLAB as:

CASE	Gripper pt - Bracket pt	Calculated from MATLAB	Measured manually from World Fr
1.	B-A	[-362.36;-200.78;57.24]	[-371.00;-196.00;61.50]
2.	A-B	[-363.19;-207.25;58.15]	[-371.00;-202.00;61.50]
3.	A-B	[-360.26;-204.97;56.21]	[-371.00;-202.00;61.50]
4.	C-A	[-363.00;-202.11;56.60]	[-371.00;-196.00;61.50]
5.	D-A	[-371.99;-196.81;61.22]	[-371.00;-196.00;61.50]

```
function [M]=matrix(value,axis,th)

if(value=='r')                    %'r'for rotational matrix of any axis
    if(axis=='z')
    M=[cos(th) -sin(th) 0 0;sin(th) cos(th) 0 0;0 0 1 0;0 0 0 1];
elseif(axis=='y')
    M=[cos(th) 0 sin(th) 0;0 1 0 0;-sin(th) 0 cos(th) 0;0 0 0 1];
else
    M=[1 0 0 0;0 cos(th) -sin(th) 0;0 sin(th) cos(th) 0;0 0 0 1];
    end
elseif(value=='t')                %'t'for translational matrix of any axis
    if(axis=='z')
    M=[1 0 0 0;0 1 0 0;0 0 1 th;0 0 0 1];
elseif(axis=='y')
    M=[1 0 0 0;0 1 0 th;0 0 1 0;0 0 0 1];
else
    M=[1 0 0 th;0 1 0 0;0 0 1 0;0 0 0 1];
    end
end
```

```
syms X Y Z R P
R=deg2rad(input('R:')+21);                          % Angle R with offset of 21 degree
P=deg2rad(input('P:'));
th1=deg2rad(input('X:')+30);                        % Angle from X with offset of 30 degree
th2=deg2rad(input('Y:')-14);                        % Angle from Y with offset of -14 degree
th3=deg2rad(input('Z:'));
A10=matrix('r','z',th1);
A21=matrix('t','z',250)*matrix('r','x',-pi/2);
A32=matrix('r','z',-pi/2);
A43=matrix('r','z',th2)*matrix('t','x',220);
A54=matrix('r','z',pi/2);
A65=matrix('r','z',-th3)*matrix('t','x',160);
A76=matrix('r','z',pi/2);
A87=matrix('r','z',-P);
A98=matrix('r','z',pi/2)*matrix('r','x',pi/2);
A10_9=matrix('r','z',R)*matrix('t','z',177.6);
H0_10=A10*A21*A32*A43*A54*A65*A76*A87*A98*A10_9;
T05= H0_10((1:3),(1:4));                             % Considering 3 rows and 4 columns
Agrip=[-9.5;-4;38;1];                                % Point 'A' on the gripper
Bgrip=[-9.5;4;38;1];                                 % Point 'B' on the gripper
Cgrip=[9.5;4;38;1];                                  % Point 'C' on the gripper
Dgrip=[9.5;-4;38;1];                                 % Point 'D' on the gripper
```

```
R:19.8      % CASE 1
P:14.1
X:179.43
Y:94.18
Z:73.75
>> c5=Bgrip;
>> c0=T05*c5

c0 =

 -362.3675
 -200.7830
   57.2411

R:27.71   %CASE 2
P:18.83
X:181.05
Y:93.08
Z:71.05
>> c5=Agrip;
>> c0=T05*c5

c0 =

 -363.1960
 -207.2489
   58.1561

R:29.1   %CASE 3
P:20.06
X:181
Y:92.18
Z:68.38
>> c5=Agrip;
>> c0=T05*c5

c0 =

 -360.2670
 -204.9744
   56.2171

>>
```

```
R:78  %CASE 4
P:32.96
X:177.9
Y:85.88
Z:52.38
>> c5=Cgrip;
>> c0=T05*c5

c0 =

 -363.0045
 -202.1101
   56.6002

R:97.24   %CASE 5
P:64.76
X:177
Y:76.35
Z:23.48
>> c5=Dgrip;
>> c0=T05*c5

c0 =

 -371.9970
 -196.8108
   61.2267

>>
```