

```
In[101]:= ClearAll[θ, d, a, α, A, P];
```

```
In[3]:= θ = {θ1, θ2, θ3, θ4, θ5, θ6};
d = {d1, d2, d3, d4, d5, d6};
a = {a1, a2, a3, a4, a5, a6};
α = {α1, α2, α3, α4, α5, α6};
```

```
In[102]:= θ = {θ1, θ2, θ3, θ4, θ5, θ6};
d = {L1, 0, 0, L3 + L4, 0, L5 + L6};
a = {0, L2, 0, 0, 0, 0};
α = {-π/2, 0, -π/2, π/2, -π/2, 0};
```

```
P = IdentityMatrix[4];
```

```
For [i = 1, i ≤ 6, i++,
```

```
  A =
```

$$\begin{pmatrix} \cos[\theta[[i]]] & -\cos[\alpha[[i]]] \sin[\theta[[i]]] & \sin[\alpha[[i]]] \sin[\theta[[i]]] & a[[i]] \cos[\theta[[i]]] \\ \sin[\theta[[i]]] & \cos[\alpha[[i]]] \cos[\theta[[i]]] & -\sin[\alpha[[i]]] \cos[\theta[[i]]] & a[[i]] \sin[\theta[[i]]] \\ 0 & \sin[\alpha[[i]]] & \cos[\alpha[[i]]] & d[[i]] \\ 0 & 0 & 0 & 1 \end{pmatrix};$$

```
  P = P.A; Print[i - 1, "A", i, "=", A // MatrixForm];
```

```
]
```

" After Substitution from DH table: "

$$0A1 = \begin{pmatrix} \cos[\theta 1] & 0 & -\sin[\theta 1] & 0 \\ \sin[\theta 1] & 0 & \cos[\theta 1] & 0 \\ 0 & -1 & 0 & L1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$1A2 = \begin{pmatrix} \cos[\theta_2] & -\sin[\theta_2] & 0 & L_2 \cos[\theta_2] \\ \sin[\theta_2] & \cos[\theta_2] & 0 & L_2 \sin[\theta_2] \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$2A3 = \begin{pmatrix} \cos[\theta 3] & 0 & -\sin[\theta 3] & 0 \\ \sin[\theta 3] & 0 & \cos[\theta 3] & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$3A4 = \begin{pmatrix} \cos[\theta 4] & 0 & \sin[\theta 4] & 0 \\ \sin[\theta 4] & 0 & -\cos[\theta 4] & 0 \\ 0 & 1 & 0 & L3 + L4 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$4A5 = \begin{pmatrix} \cos[\theta 5] & 0 & -\sin[\theta 5] & 0 \\ \sin[\theta 5] & 0 & \cos[\theta 5] & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$5A6 = \begin{pmatrix} \cos[\theta 6] & -\sin[\theta 6] & 0 & 0 \\ \sin[\theta 6] & \cos[\theta 6] & 0 & 0 \\ 0 & 0 & 1 & L5 + L6 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

In[108]:=

```
Print ["0A6 " , "=", Grid[P] ];
```

0A6 =			
Cos[06]	Cos[06]	Cos[05]	L2 Cos[01] Cos[02] +
(Cos[05] (Cos[04]	(Cos[04] Sin[01] -	(-Cos[01] Cos[03]	(L3 + L4)
(Cos[01]	(Cos[01] Cos[02]	Sin[02] -	(-Cos[01] Cos[03]
Cos[02]	Cos[03] -	Cos[01] Cos[02]	Sin[02] -
Cos[03] -	Cos[01]	Sin[03]) -	Cos[01] Cos[02]
Cos[01]	Sin[02]	(Cos[04] (Cos[01]	Sin[03]) +
Sin[02]	Sin[03])	Cos[02]	(L5 + L6)
Sin[03]) +	Sin[04]) -	Cos[03] -	(Cos[05] (-Cos[01]
Sin[01]	(Cos[05] (Cos[04]	Cos[01]	Cos[03]
Sin[04]) +	(Cos[01]	Sin[02]	Sin[02] -
(-Cos[01]	Cos[02]	Sin[03]) +	Cos[01]
Cos[03]	Cos[03] -	Sin[01] Sin[04])	Cos[02]
Sin[02] -	Cos[01]	Sin[05]	Sin[03]) -
Cos[01]	Sin[02]		(Cos[04]
Cos[02]	Sin[03]) +		(Cos[01]

$\text{Cos}[\theta 2]$	$\text{Sin}[\theta 1]$	$\text{Cos}[\theta 2]$	$\text{Cos}[\theta 1]$
$\text{Sin}[\theta 3]) +$	$\text{Sin}[\theta 4]) +$	$\text{Cos}[\theta 3] -$	$\text{Cos}[\theta 1]$
$(\text{Cos}[\theta 4] \text{Sin}[\theta 1] -$	$(-\text{Cos}[\theta 1] \text{Cos}[\theta 3]$	$\text{Sin}[\theta 2]$	$\text{Sin}[\theta 3]) +$
$(\text{Cos}[\theta 1] \text{Cos}[\theta 2]$	$\text{Sin}[\theta 2] -$	$\text{Sin}[\theta 1]$	$\text{Sin}[\theta 4])$
$\text{Cos}[\theta 3] -$	$\text{Cos}[\theta 1]$	$\text{Sin}[\theta 5])$	$\text{Sin}[\theta 5])$
$\text{Cos}[\theta 1]$	$\text{Cos}[\theta 2]$		
$\text{Sin}[\theta 2]$	$\text{Sin}[\theta 3])$		
$\text{Sin}[\theta 3])$	$\text{Sin}[\theta 5])$		
$\text{Sin}[\theta 4])$	$\text{Sin}[\theta 6]$		
$\text{Sin}[\theta 6]$			
$\text{Cos}[\theta 6]$	$\text{Cos}[\theta 6]$	$\text{Cos}[\theta 5]$	$\text{L2 Cos}[\theta 2] \text{Sin}[\theta 1] +$
$(\text{Cos}[\theta 5] (\text{Cos}[\theta 4]$	$(-\text{Cos}[\theta 1] \text{Cos}[\theta 4] -$	$(-\text{Cos}[\theta 3] \text{Sin}[\theta 1]$	$(\text{L3} + \text{L4})$
$(\text{Cos}[\theta 2]$	$(\text{Cos}[\theta 2] \text{Cos}[\theta 3]$	$\text{Sin}[\theta 2] -$	$(-\text{Cos}[\theta 3] \text{Sin}[\theta 1]$
$\text{Cos}[\theta 3]$	$\text{Sin}[\theta 1] -$	$\text{Cos}[\theta 2] \text{Sin}[\theta 1]$	$\text{Sin}[\theta 2] -$
$\text{Sin}[\theta 1] -$	$\text{Sin}[\theta 1]$	$\text{Sin}[\theta 3]) -$	$\text{Cos}[\theta 2] \text{Sin}[\theta 1]$
$\text{Sin}[\theta 1]$	$\text{Sin}[\theta 2]$	$(\text{Cos}[\theta 4] (\text{Cos}[\theta 2]$	$\text{Sin}[\theta 3]) +$
$\text{Sin}[\theta 2]$	$\text{Sin}[\theta 3])$	$\text{Cos}[\theta 3]$	$(\text{L5} + \text{L6})$
$\text{Sin}[\theta 3]) -$	$\text{Sin}[\theta 4]) -$	$\text{Sin}[\theta 1] -$	$(\text{Cos}[\theta 5] (-\text{Cos}[\theta 3]$
$\text{Cos}[\theta 1]$	$(\text{Cos}[\theta 5] (\text{Cos}[\theta 4]$	$\text{Sin}[\theta 1]$	$\text{Sin}[\theta 1]$
$\text{Sin}[\theta 4]) +$	$(\text{Cos}[\theta 2]$	$\text{Sin}[\theta 2]$	$\text{Sin}[\theta 2] -$
$(-\text{Cos}[\theta 3]$	$\text{Cos}[\theta 3]$	$\text{Sin}[\theta 3]) -$	$\text{Cos}[\theta 2]$
$\text{Sin}[\theta 1]$	$\text{Sin}[\theta 1] -$	$\text{Cos}[\theta 1] \text{Sin}[\theta 4])$	$\text{Sin}[\theta 1]$
$\text{Sin}[\theta 2] -$	$\text{Sin}[\theta 1]$	$\text{Sin}[\theta 5]$	$\text{Sin}[\theta 3]) -$
$\text{Cos}[\theta 2]$	$\text{Sin}[\theta 2]$		$(\text{Cos}[\theta 4]$
$\text{Sin}[\theta 1]$	$\text{Sin}[\theta 3]) -$		$(\text{Cos}[\theta 2]$
$\text{Sin}[\theta 3])$	$\text{Cos}[\theta 1]$		$\text{Cos}[\theta 3]$
$\text{Sin}[\theta 5]) +$	$\text{Sin}[\theta 4]) +$		$\text{Sin}[\theta 1] -$
$(-\text{Cos}[\theta 1]$	$(-\text{Cos}[\theta 3]$		$\text{Sin}[\theta 1]$
$\text{Cos}[\theta 4] -$	$\text{Sin}[\theta 1]$		$\text{Sin}[\theta 2]$
$(\text{Cos}[\theta 2] \text{Cos}[\theta 3]$	$\text{Sin}[\theta 2] -$		$\text{Sin}[\theta 3]) -$
$\text{Sin}[\theta 1] -$	$\text{Cos}[\theta 2]$		$\text{Cos}[\theta 1]$
$\text{Sin}[\theta 1]$	$\text{Sin}[\theta 1]$		$\text{Sin}[\theta 4])$
$\text{Sin}[\theta 2]$	$\text{Sin}[\theta 3])$		$\text{Sin}[\theta 5])$
$\text{Sin}[\theta 3])$	$\text{Sin}[\theta 5])$		
$\text{Sin}[\theta 4])$	$\text{Sin}[\theta 6]$		
$\text{Sin}[\theta 6]$			
$\text{Cos}[\theta 6]$	$-\text{Cos}[\theta 6]$	$\text{Cos}[\theta 5]$	$\text{L1} - \text{L2 Sin}[\theta 2] +$
$(\text{Cos}[\theta 4] \text{Cos}[\theta 5]$	$(-\text{Cos}[\theta 3] \text{Sin}[\theta 2] -$	$(-\text{Cos}[\theta 2] \text{Cos}[\theta 3] +$	$(\text{L3} + \text{L4})$
$(-\text{Cos}[\theta 3]$	$\text{Cos}[\theta 2] \text{Sin}[\theta 3])$	$\text{Sin}[\theta 2]$	$(-\text{Cos}[\theta 2] \text{Cos}[\theta 3] +$
$\text{Sin}[\theta 2] -$	$\text{Sin}[\theta 4] -$	$\text{Sin}[\theta 3]) -$	$\text{Sin}[\theta 2]$
$\text{Cos}[\theta 2]$	$(\text{Cos}[\theta 4] \text{Cos}[\theta 5]$	$\text{Cos}[\theta 4]$	$\text{Sin}[\theta 3]) +$
$\text{Sin}[\theta 3]) +$	$(-\text{Cos}[\theta 3]$	$(-\text{Cos}[\theta 3] \text{Sin}[\theta 2] -$	$(\text{L5} + \text{L6})$
$(-\text{Cos}[\theta 2]$	$\text{Sin}[\theta 2] -$	$\text{Cos}[\theta 2] \text{Sin}[\theta 3])$	$(\text{Cos}[\theta 5] (-\text{Cos}[\theta 2]$
$\text{Cos}[\theta 3] +$	$\text{Cos}[\theta 2]$	$\text{Sin}[\theta 5]$	$\text{Cos}[\theta 3] +$
$\text{Sin}[\theta 2]$	$\text{Sin}[\theta 3]) +$		$\text{Sin}[\theta 2]$
$\text{Sin}[\theta 3])$	$(-\text{Cos}[\theta 2]$		$\text{Sin}[\theta 3]) -$
$\text{Sin}[\theta 5]) -$	$\text{Cos}[\theta 3] +$		$\text{Cos}[\theta 4]$
$(-\text{Cos}[\theta 3] \text{Sin}[\theta 2] -$	$\text{Sin}[\theta 2]$		$(-\text{Cos}[\theta 3]$
$\text{Cos}[\theta 2] \text{Sin}[\theta 3])$	$\text{Sin}[\theta 3])$		$\text{Sin}[\theta 2] -$
$\text{Sin}[\theta 4]$	$\text{Sin}[\theta 5])$		$\text{Cos}[\theta 2]$
$\text{Sin}[\theta 6]$	$\text{Sin}[\theta 6]$		$\text{Sin}[\theta 3])$
$\theta 6]$			$\text{Sin}[\theta 5])$
0	0	0	1

In[109]:=

```

X = P[[1]][[4]];
Y = P[[2]][[4]];
Z = P[[3]][[4]];
Print["X", "= ", X];
Print["Y", "= ", Y];
Print["Z", "= ", Z];

```

```

X= L2 Cos[θ1] Cos[θ2] + (L3 + L4) (-Cos[θ1] Cos[θ3] Sin[θ2] - Cos[θ1] Cos[θ2] Sin[θ3]) +
    (L5 + L6) (Cos[θ5] (-Cos[θ1] Cos[θ3] Sin[θ2] - Cos[θ1] Cos[θ2] Sin[θ3]) -
    (Cos[θ4] (Cos[θ1] Cos[θ2] Cos[θ3] - Cos[θ1] Sin[θ2] Sin[θ3]) + Sin[θ1] Sin[θ4])
    Sin[θ5])

```

```

Y= L2 Cos[θ2] Sin[θ1] + (L3 + L4) (-Cos[θ3] Sin[θ1] Sin[θ2] - Cos[θ2] Sin[θ1] Sin[θ3]) +
    (L5 + L6) (Cos[θ5] (-Cos[θ3] Sin[θ1] Sin[θ2] - Cos[θ2] Sin[θ1] Sin[θ3]) -
    (Cos[θ4] (Cos[θ2] Cos[θ3] Sin[θ1] - Sin[θ1] Sin[θ2] Sin[θ3]) - Cos[θ1] Sin[θ4])
    Sin[θ5])

```

```

Z= L1 - L2 Sin[θ2] + (L3 + L4) (-Cos[θ2] Cos[θ3] + Sin[θ2] Sin[θ3]) +
    (L5 + L6) (Cos[θ5] (-Cos[θ2] Cos[θ3] + Sin[θ2] Sin[θ3]) -
    Cos[θ4] (-Cos[θ3] Sin[θ2] - Cos[θ2] Sin[θ3]) Sin[θ5])

```