*This coding assignment was discussed with Haoyuan Zheng, Yuquan Hu and Yuan Zhou.

P1a:

i	a(i)	alpha(i)	theta(i)	d(i)
0	0	0	None	None
1	0.033	pi/2	theta(1)+pi/2	0.1
2	0.155	0	theta(2)+pi/2	0
3	0.135	0	theta(3)	0
4	0	pi/2	theta(4)+pi/2	0
5	0	0	theta(5)	0

P2a:

(1) Homogeneous matrices first:

$$H_1^0 = \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 & 0 \\ 0 & 0 & 1 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_2^1 = \begin{bmatrix} \cos\theta_2 & -\sin\theta_2 & 0 & a_1 \\ 0 & 0 & -1 & 0 \\ \sin\theta_2 & \cos\theta_2 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_3^2 = \begin{bmatrix} \cos\theta_3 & -\sin\theta_3 & 0 & a_2 \\ \sin\theta_3 & \cos\theta_3 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_4^3 = \begin{bmatrix} \cos\theta_4 & -\sin\theta_4 & 0 & a_3 \\ \sin\theta_4 & \cos\theta_4 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(2) By multiplying them together (Forward Kinematics), we get the homogeneous transform matrix:

```
[[ (−sin(θ2)*sin(θ3)*cos(θ1) + cos(θ1)*cos(θ2)*cos(θ3))*cos(θ4) + (−sin(θ2)*cos(θ1)*cos(θ3) − sin(θ3)*cos(θ1)*cos(θ2))*sin(θ4)
  −(−sin(θ2)*sin(θ3)*cos(θ1) + cos(θ1)*cos(θ2)*cos(θ3))*sin(θ4) + (−sin(θ2)*cos(θ1)*cos(θ3) − sin(θ3)*cos(θ1)*cos(θ2))*cos(θ4)
  sin(θ1)
  −0.135*sin(θ2)*sin(θ3)*cos(θ1) + 0.135*cos(θ1)*cos(θ2)*cos(θ3) + 0.155*cos(θ1)*cos(θ2) + 0.33*cos(θ1)]
 [ (−sin(θ1)*sin(θ2)*sin(θ3) + sin(θ1)*cos(θ2)*cos(θ3))*cos(θ4) + (−sin(θ1)*sin(θ2)*cos(θ3) − sin(θ1)*sin(θ3)*cos(θ2))*sin(θ4)
  −(−sin(θ1)*sin(θ2)*sin(θ3) + sin(θ1)*cos(θ2)*cos(θ3))*sin(θ4) + (−sin(θ1)*sin(θ2)*cos(θ3) − sin(θ1)*sin(θ3)*cos(θ2))*cos(θ4)
  −cos(θ1)
  −0.135*sin(θ1)*sin(θ2)*sin(θ3) + 0.135*sin(θ1)*cos(θ2)*cos(θ3) + 0.155*sin(θ1)*cos(θ2) + 0.33*sin(θ1)]
 [ (−sin(θ2)*sin(θ3) + cos(θ2)*cos(θ3))*sin(θ4) + (sin(θ2)*cos(θ3) + sin(θ3)*cos(θ2))*cos(θ4)
  (−sin(θ2)*sin(θ3) + cos(θ2)*cos(θ3))*cos(θ4) − (sin(θ2)*cos(θ3) + sin(θ3)*cos(θ2))*sin(θ4)
  0
  0.135*sin(θ2)*cos(θ3) + 0.155*sin(θ2) + 0.135*sin(θ3)*cos(θ2) + 0.1]
 [0 0 0 1]]
```

(3) By differentiating theta1, theta2, theta3, theta4, theta5 correspondly in the homogeneous matrix and concatenate the result matrices together, we get the jacobian matrix:

```
[[ −0.2175*(sin(θ1)*sin(θ2)*sin(θ3) − sin(θ1)*cos(θ2)*cos(θ3))*sin(θ4) + 0.2175*(sin(θ1)*sin(θ2)*cos(θ3) + sin(θ1)*sin(θ3)*cos(θ2))*cos(θ4)
  0.2175*(sin(θ2)*sin(θ3)*cos(θ1) − cos(θ1)*cos(θ2)*cos(θ3))*cos(θ4) − 0.2175*(−sin(θ2)*cos(θ1)*cos(θ3) − sin(θ3)*cos(θ1)*cos(θ2))*sin(θ4)
  0.2175*(sin(θ2)*sin(θ3)*cos(θ1) − cos(θ1)*cos(θ2)*cos(θ3))*cos(θ4) − 0.2175*(−sin(θ2)*cos(θ1)*cos(θ3) − sin(θ3)*cos(θ1)*cos(θ2))*sin(θ4)
  −0.2175*(−sin(θ2)*sin(θ3)*cos(θ1) + cos(θ1)*cos(θ2)*cos(θ3))*cos(θ4) − 0.2175*(−sin(θ2)*cos(θ1)*cos(θ3) − sin(θ3)*cos(θ1)*cos(θ2))*sin(θ4)
  0]
 [ −0.2175*(−sin(θ2)*sin(θ3)*cos(θ1) + cos(θ1)*cos(θ2)*cos(θ3))*sin(θ4) + 0.2175*(−sin(θ2)*cos(θ1)*cos(θ3) − sin(θ3)*cos(θ1)*cos(θ2))*cos(θ4)
  0.2175*(sin(θ1)*sin(θ2)*sin(θ3) − sin(θ1)*cos(θ2)*cos(θ3))*cos(θ4) − 0.2175*(−sin(θ1)*sin(θ2)*cos(θ3) − sin(θ1)*sin(θ3)*cos(θ2))*sin(θ4)
  0.2175*(sin(θ1)*sin(θ2)*sin(θ3) − sin(θ1)*cos(θ2)*cos(θ3))*cos(θ4) − 0.2175*(−sin(θ1)*sin(θ2)*cos(θ3) − sin(θ1)*sin(θ3)*cos(θ2))*sin(θ4)
  −0.2175*(−sin(θ1)*sin(θ2)*sin(θ3) + sin(θ1)*cos(θ2)*cos(θ3))*cos(θ4) − 0.2175*(−sin(θ1)*sin(θ2)*cos(θ3) − sin(θ1)*sin(θ3)*cos(θ2))*sin(θ4)
  0]
 [0
  −0.2175*(−sin(θ2)*sin(θ3) + cos(θ2)*cos(θ3))*sin(θ4) + 0.2175*(−sin(θ2)*cos(θ3) − sin(θ3)*cos(θ2))*cos(θ4)
  −0.2175*(−sin(θ2)*sin(θ3) + cos(θ2)*cos(θ3))*sin(θ4) + 0.2175*(−sin(θ2)*cos(θ3) − sin(θ3)*cos(θ2))*cos(θ4)
  −0.2175*(−sin(θ2)*sin(θ3) + cos(θ2)*cos(θ3))*sin(θ4) − 0.2175*(sin(θ2)*cos(θ3) + sin(θ3)*cos(θ2))*cos(θ4)
  0]]
```