Q1:

```
Sample values taken for Stanford manipulator:
Link lengths: 2.0,2.0,2.0
Desired coordinates: 1.5,0.9,1.0

Results from Inverse kinematics of Stanford manipulator
Theta1 (in radians): 0.5404195002705842
Theta2 (in radians): -0.5152512025505319
Prismatic Displacement (d3): 1.9855069064904307

Results from Forward kinematics of Stanford manipulator
End-effector x-coordinate: 1.4923274698928548
End-effector y-coordinate: 0.895396481935713
End-effector z-coordinate: 0.9999999999999999
```

Q2

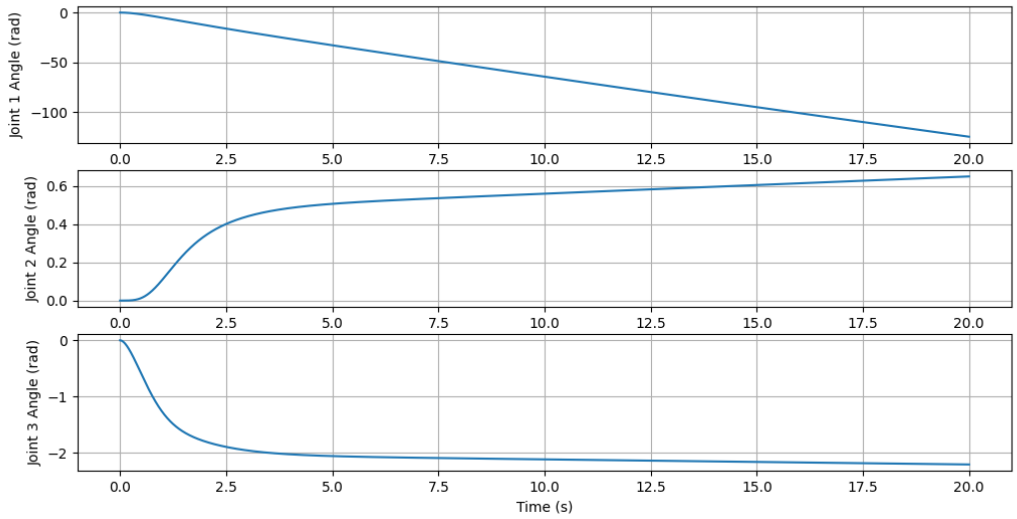
```
Please enter the number of links:
2

Now, kindly provide the elements of the Jacobian matrix row by row:
Jacobian[0][0]: 2.1
Jacobian[0][1]: 1.2
Jacobian[1][0]: 0.98
Jacobian[1][1]: 1.98
Jacobian[2][0]: 1.33
Jacobian[2][1]: 2.51
Jacobian[3][0]: 0
Jacobian[3][1]: 0
Jacobian[4][0]: 0
Jacobian[4][1]: 0
Jacobian[5][0]: 1
Jacobian[5][1]: 1

Enter the end-effector linear velocities (comma-separated) in meters per second: 0.1,0.2,0.3
Enter the end-effector angular velocities (comma-separated) in radians per second: 0,0,0

Here are the calculated joint linear velocities: [-0.03799568  0.12663896]
And the joint angular velocities: []
```

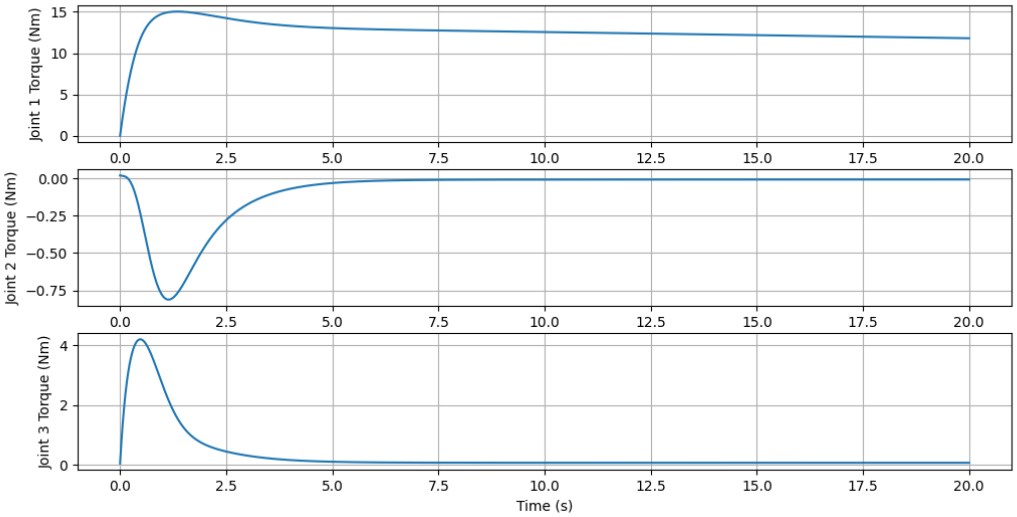
Q3,Q4: Reading task

Q5:

```
Inverse kinematics of Spherical Wrist manipulator:

Enter angle of Joint 1 (degrees): 20
Enter angle of Joint 2 (degrees): 25
Enter angle of Joint 3 (degrees): 30

Enter the elements of the desired end-effector orientation matrix (row by row):
R_desired[0][0]: 0.56
R_desired[0][1]: 0.12
R_desired[0][2]: 0
R_desired[1][0]: 0.45
R_desired[1][1]: 0.63
R_desired[1][2]: 0
R_desired[2][0]: 0
R_desired[2][1]: 0
R_desired[2][2]: 1

Desired Orientation Matrix:
[[0.56 0.12 0.  ]
 [0.45 0.63 0.  ]
 [0.   0.   1.  ]]

Current Orientation Matrix:
[[-0.53898554 -0.76975113  0.34202014]
 [ 0.19617469 -0.2801665  -0.93969262]
 [ 0.81915204  0.57357644  0.        ]]

Calculated Z-Y-Z Euler Angles:
Roll (phi) = 35.0 degrees
Pitch (theta) = 90.0 degrees
Yaw (psi) = -67.22417612655603 degrees
```

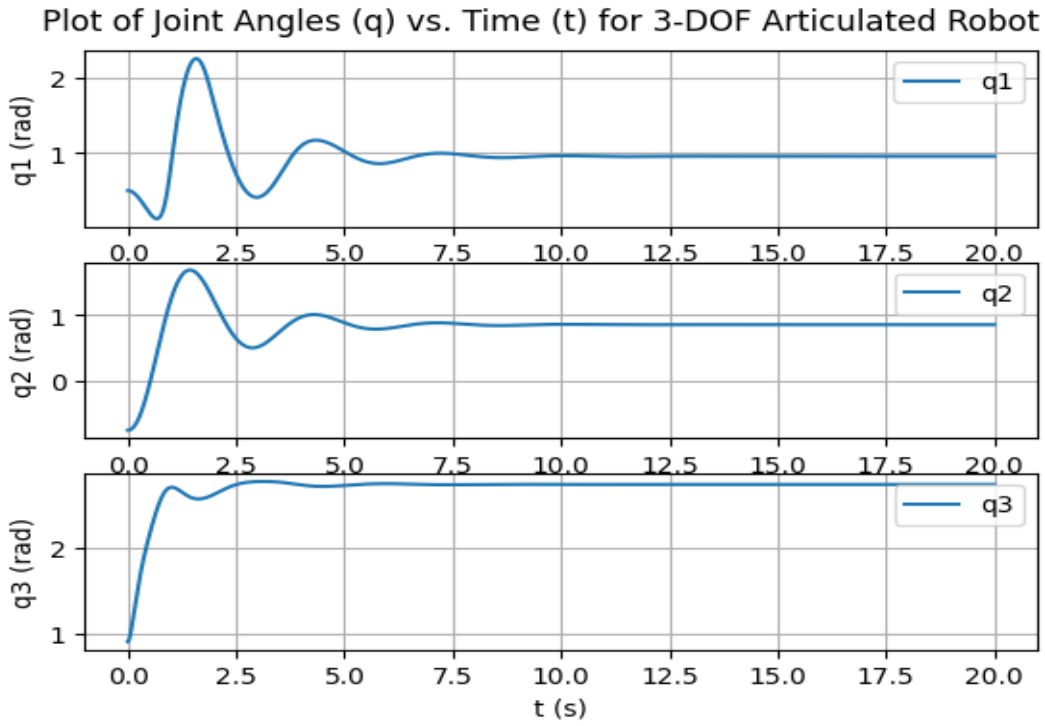
Q6(a):


Joint 1 Angle (rad)
0
−50
−100
Joint 2 Angle (rad)
0.6
0.4
0.2
0.0
Joint 3 Angle (rad)
0
−1
−2
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Time (s)

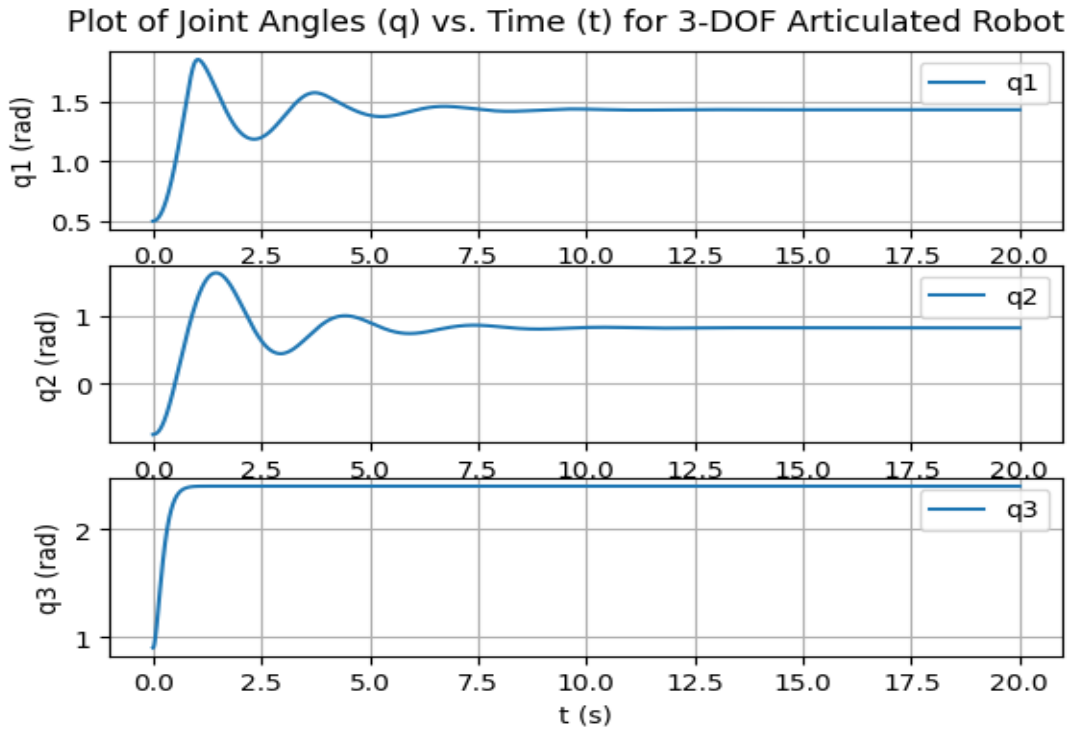

Joint 1 Torque (Nm)
15
10
5
0
Joint 2 Torque (Nm)
0.00
−0.25
−0.50
−0.75
Joint 3 Torque (Nm)
4
2
0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Time (s)

Q6(b):

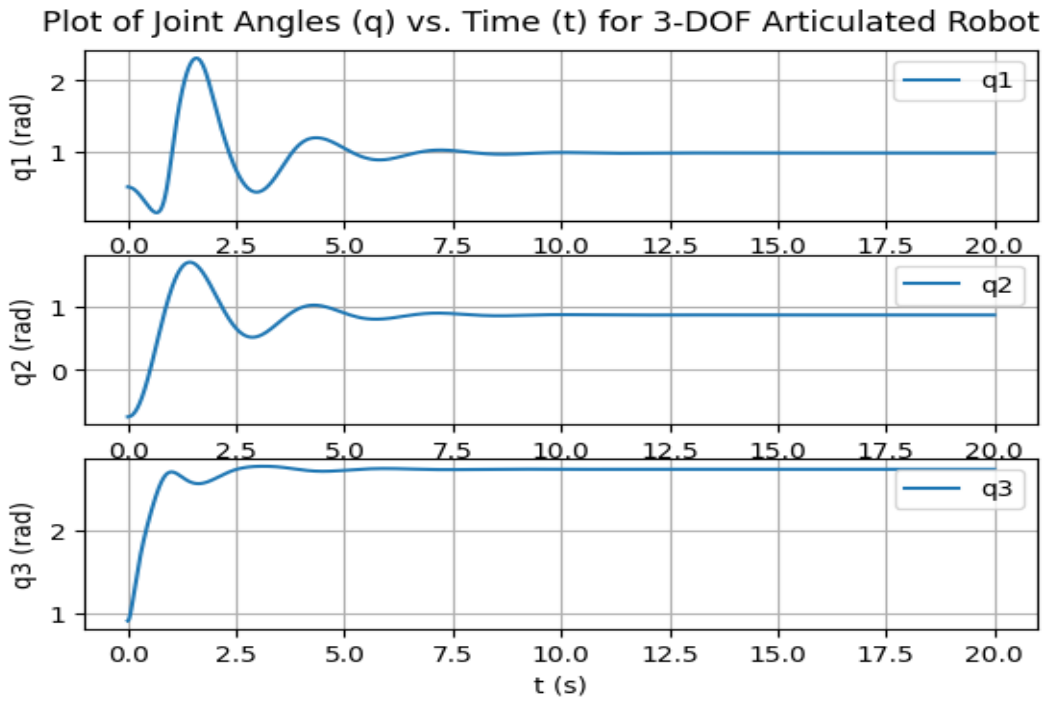
Simple PD Control



PD Control with gravity compensation



PD Control with feed – forward term



PD Control with Computed Torque Control