Assignment 1

Task 1

Base Joint=(0,0)

Elbow Joint

x1=l1cosq1=cosq1

y1=l1sinq1=sinq1

End-Effector Joint

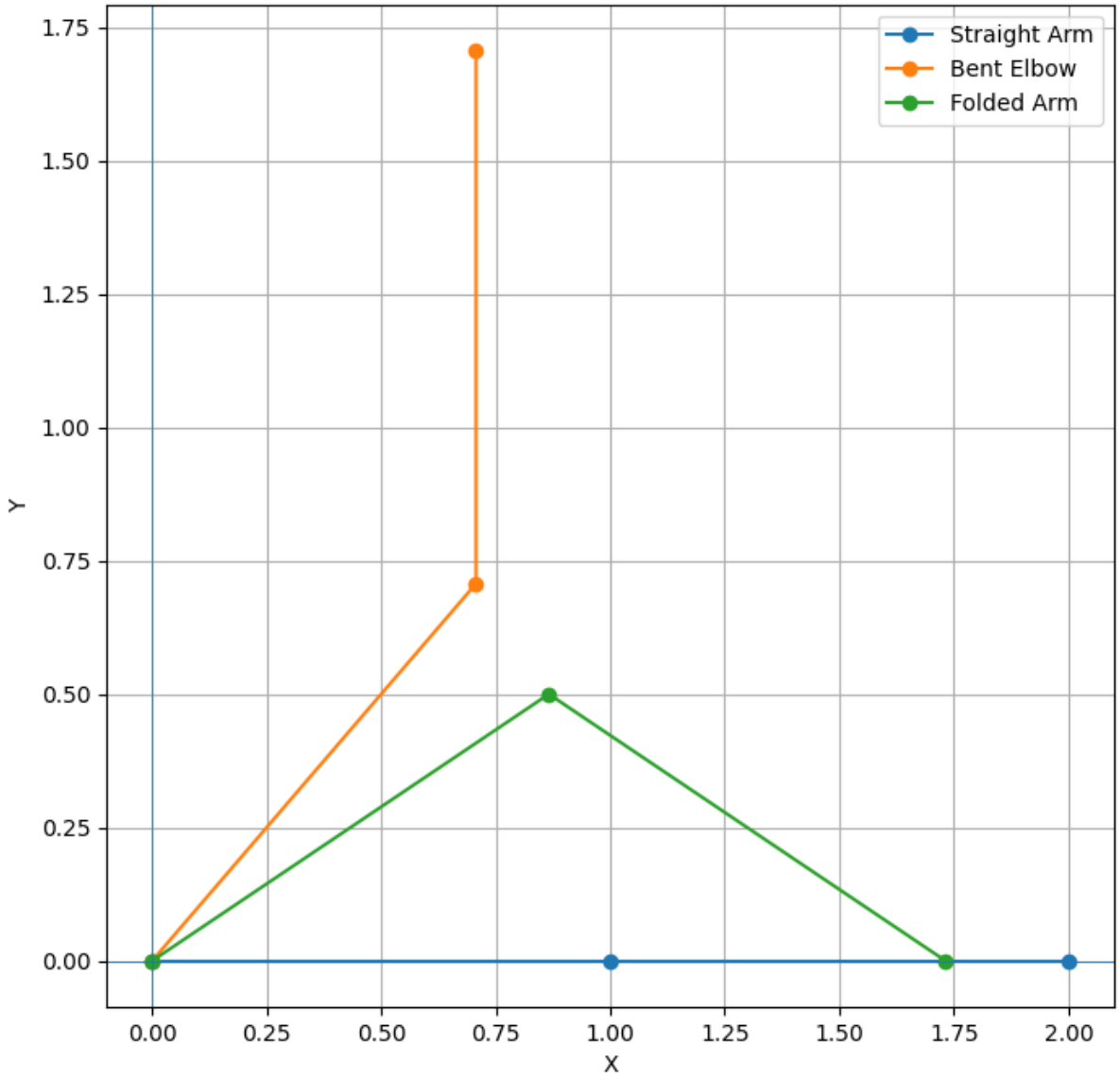
x2=x1+l2cos(q1+q2)=cosq1+cos(q1+q2)

y2=y1+l2sin(q1+q2)=sinq1+sin(q1+q2)

Task2

```
import numpy as np
import matplotlib.pyplot as plt
l1 = l2 = 1

def forward_kinematics(q1, q2):
    x1 = l1 * np.cos(q1)
    y1 = l1 * np.sin(q1)
    x2 = x1 + l2 * np.cos(q1 + q2)
    y2 = y1 + l2 * np.sin(q1 + q2)
    return (0, 0), (x1, y1), (x2, y2)
```

```
configs = {
    "Straight Arm": (0, 0),
    "Bent Elbow": (np.pi/4, np.pi/4),
    "Folded Arm": (np.pi/6, -2*np.pi/6)
}

plt.figure(figsize=(8, 8))

for name, (q1, q2) in configs.items():
    base, elbow, end_eff = forward_kinematics(q1, q2)

    x = [base[0], elbow[0], end_eff[0]]
    y = [base[1], elbow[1], end_eff[1]]

    plt.plot(x, y, '-o', label=name)

plt.axhline(0, linewidth=0.5)
plt.axvline(0, linewidth=0.5)
plt.grid(True)
plt.legend()
plt.xlabel("X")
plt.ylabel("Y")
plt.show()
```



Role of q1

Rotates the entire arm about the base.

Changes the orientation of the workspace

Role of q2

Controls the relative bend at the elbow
Determines whether the arm is fully extended,bent or folded back.

Maximum reach = l1+l2 = 2

Minimum reach = |l1-l2|=0

Workspace is circle of radius 2 with origin as center.