**Problem No – 1**

Assume that you have a two link manipulator with 𝑎1 = 15cm and 𝑎2 = 15cm and that the base of the manipulator is at the origin of the coordinate system. Write a Python program to take the list of workspace points and plug them into the inverse kinematics formulas for the two link manipulator. Plot these points on a graph where 𝜃1 is the horizontal axis and 𝜃2 is the vertical axis. You will have to adjust some aspects to get a good looking plot. (Scale factors etc.) Test your code on the workspace line (a) 𝑥 + 𝑦 = 25, 𝑥, 𝑦 > 0 and (b) 𝑥 = 10 cos(𝑡) + 15, 𝑦 = 10 sin(𝑡) for 0 ≤ 𝑡 ≤ 𝜋. The point here is to see what the configuration space curve looks like.

**Problem No – 2**

Assume that you have a two link manipulator with 𝑎1 = 15cm and 𝑎2 = 15cm and that the base of the

manipulator is at the origin of the coordinate system. Write a two link manipulator location program

(Python). This program will take a list of angles and compute the location of the end effector. Show

how this program works with the list of angles you generated in the previous problem. If the angle

inputs are generated by a square, the simulated robot arm’s end effector should trace a square. Plot the

end effector points. You need to plot the input shape and the final shape to see if your code is correct.

You will need to use the previous problem for this problem. Demonstrate your code to trace out the

four segments which form the square with endpoints (5,0), (5, 15), (20, 15), (20,0).

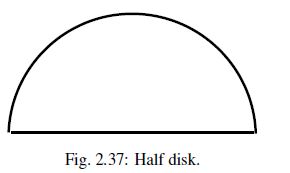
**Problem No – 3**

Using Numpy and the linspace command, build an array of points for Fig. 2.37. The top is given by

(𝑥−10)^2+(𝑦−8)^2 = 25 and the bottom is the line segment along 𝑦 = 8. Traverse the figure starting

at the right corner, going counter clockwise (circle first) and ending on the line segment. Check this

with the Python plot command. Show the result.



**Problem No – 4**

Given a differential drive robot starting from (0,0,0) find the final position when wheel velocities are

given by:

t=0 to t=5: 𝜔1 = 2, 𝜔2 = 2

t=5 to t=6: 𝜔1 = 3, 𝜔2 = 4

t=6 to t=10: 𝜔1 = 1, 𝜔