Experiment:7
Forward Kinematics and validate using Robo Analyzer

MINIMUM SYSTEM REQUIREMENT

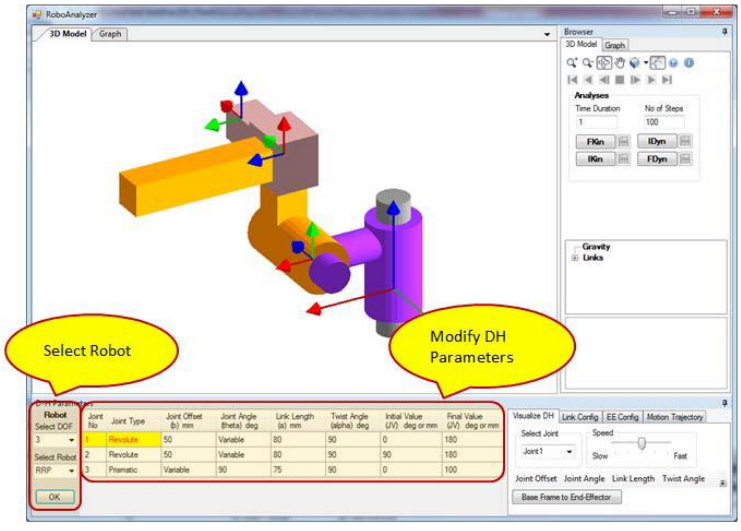
Processor: Atleast 1.5 GHz
RAM: Atleast 512 MB
Operating System: Windows XP, Windows Vista, Windows 7
Dependencies: Microsoft .Net 2.0 framework

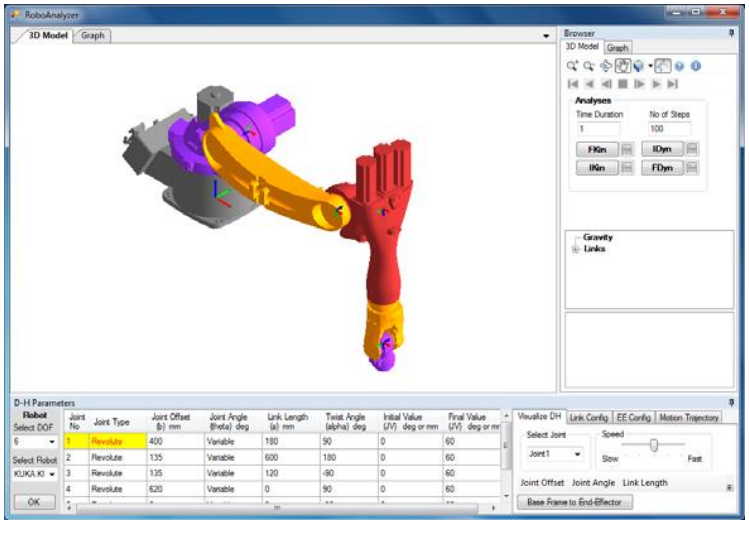
Procedure

Step 1: Visit http://www.roboanalyzer.com
Step 2: Click on **Downloads** tab
Step 3: Click on **RoboAnalyzer V5** (or latest version) to download a .zip file
Step 4: A popup window will appear. Select the folder where the file has to be saved and click on **Save**
Step 5: After downloading is complete, unzip RoboAnalyzer5.zip to any folder on your computer. Open the folder RoboAnalyzer5
Step 6: Double-click on RoboAnalyzer5.exe to start RoboAnalyzer

CODE:

```
import numpy as np

# Define the joint angles in radians

theta1 = np.pi/6

theta2 = np.pi/4

theta3 = np.pi/3

theta4 = np.pi/2

# Define the lengths of the links

L1 = 2

L2 = 1.5

L3 = 1

L4 = 0.5

# Calculate the end effector position

x = L1*np.cos(theta1) + L2*np.cos(theta1+theta2) + L3*np.cos(theta1+theta2+theta3) +
L4*np.cos(theta1+theta2+theta3+theta4)

y = L1*np.sin(theta1) + L2*np.sin(theta1+theta2) + L3*np.sin(theta1+theta2+theta3) +
L4*np.sin(theta1+theta2+theta3+theta4)

print(f"The end effector position is ({x}, {y})")
```

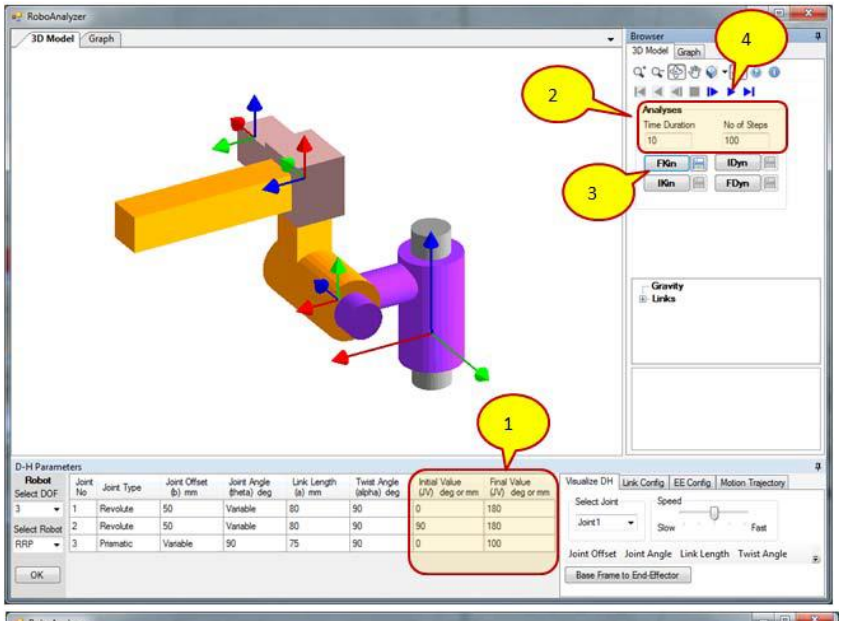


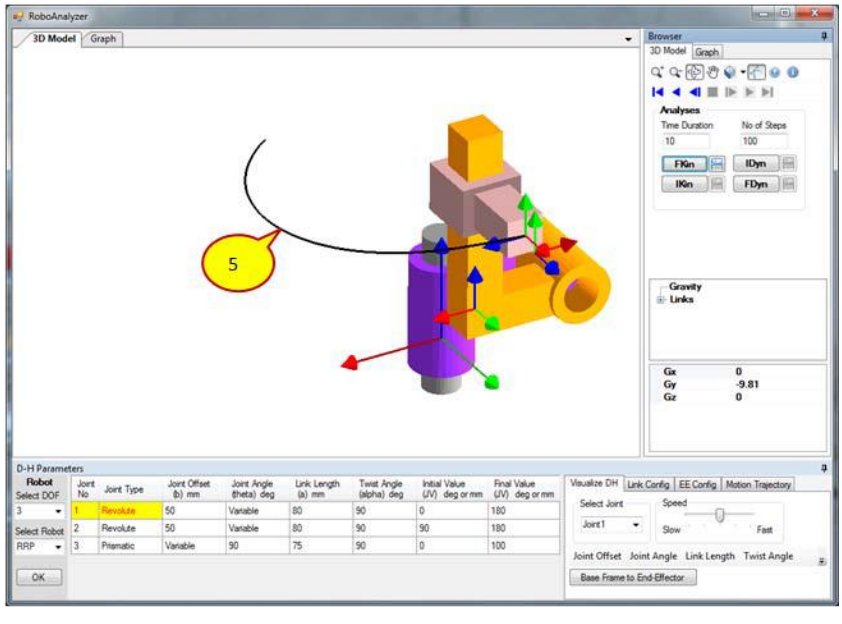


ANIMATION OF FKIN

1. Set the **initial** and **final** values of joint variables
2. Set **Time Duration** and **Number of Steps**
3. Click on **FKin** button
4. Click on **Play** button to see the animation

The end-effector trace can be viewed

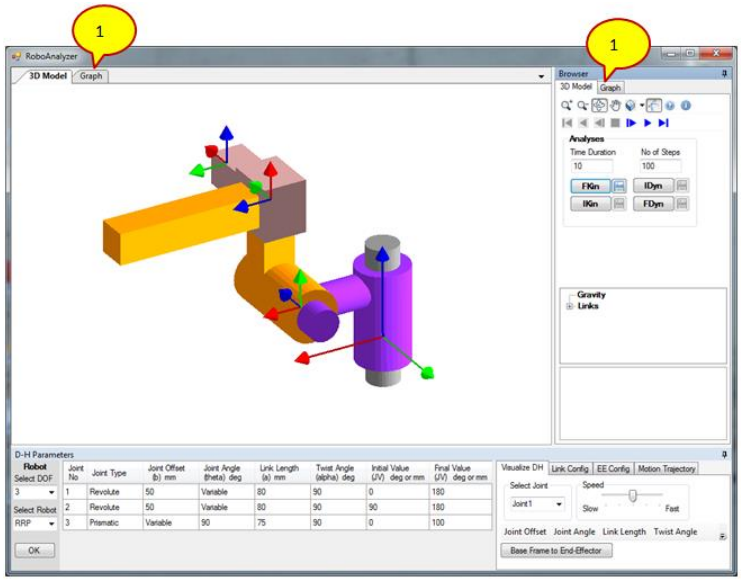


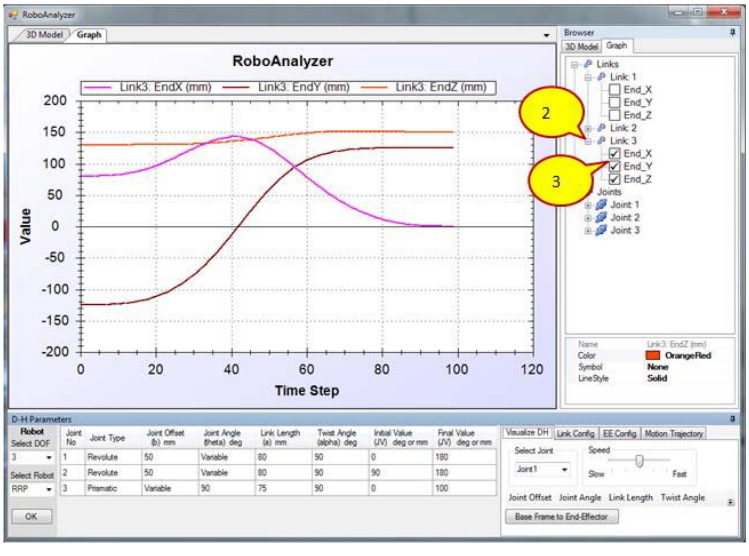


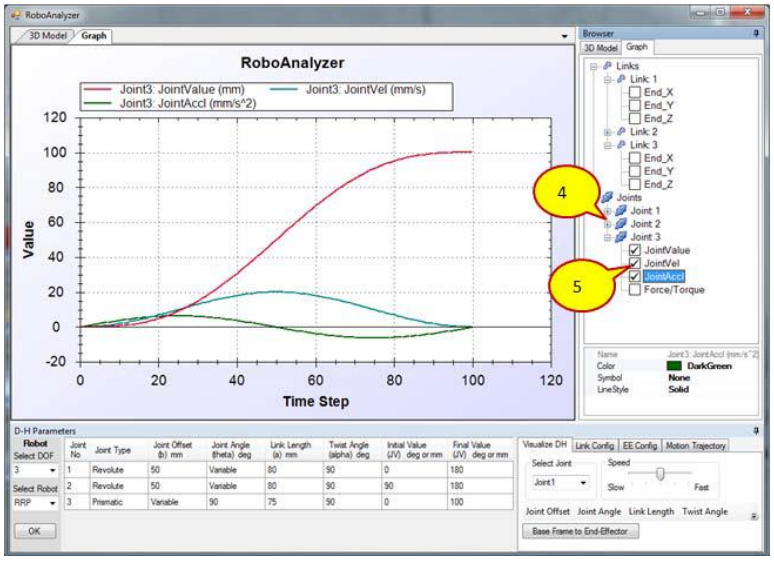
GRAPH PLOTS OF FKIN

To view the graph plots of a forward kinematics (animation) analysis, the following are the steps are

1.Click on **Graph** tab
2.Click on **+** next to the link of which the plots are to be viewed
3. Click on **box** to plot graph of a particular node to see X, Y and Z plots
4. Click on **+** next to the joint of which the plots are to be viewed
5. Click on **box** to plot graph of a particular node to see joint value (joint angle for revolute joint and joint offset for prismatic joints), joint velocity and joint acceleration







Experiment:8

Inverse Kinematics of the real robot and validate using Robo Analyzer

MINIMUM SYSTEM REQUIREMENT

Processor: Atleast 1.5 GHz
RAM: Atleast 512 MB
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Procedure

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Step 6: Double-click on RoboAnalyzer5.exe to start

CODE:

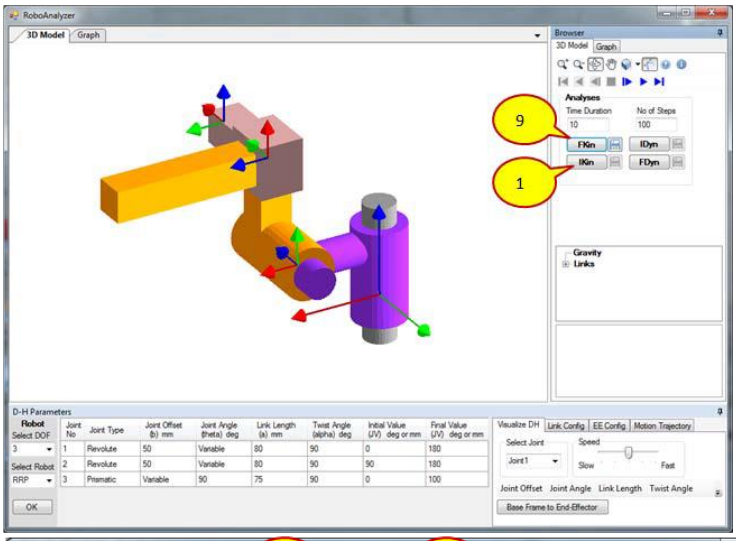
```
import numpy as np

# Define the end effector position

x = 1.5

y = 0.5

# Define the link lengths

L1 = 2

L2 = 1.5

# Calculate the joint angles using inverse kinematics

theta2 = np.arccos((x*2 + y2 - L12 - L2*2) / (2 * L1 * L2))

theta1 = np.arctan2(y, x) - np.arctan2(L2 * np.sin(theta2), L1 + L2 * np.cos(theta2))

print(f"The joint angles are ({theta1}, {theta2}) in radians")
```

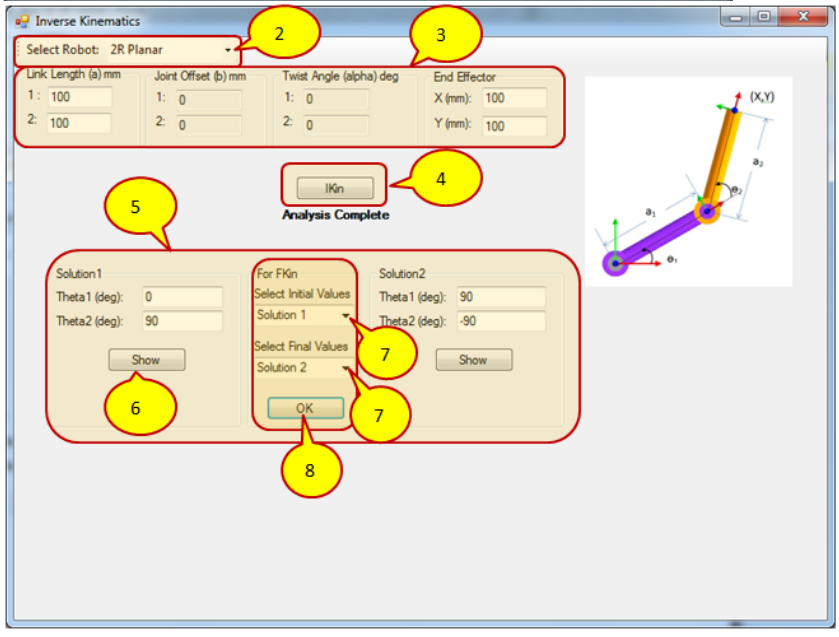
SOLUTIONS OF IKIN

1.Click on **IKin** button. It shows a separate window (Figure 16)
2.Select a Robot
3.Enter Input parameters
4.Click on **IKin** button
5.View the possible solutions
6.Click on **Show** button. It shows the selected solution in 3D Model window. To see this go back to main window by minimizing IKin window
7.Select any of the obtained solution as initial and final solution
Click on **OK.** This step replaces the initial and final joint values in DH Parameter table

(Main window) by values selected in step 7

8.Click on **FKin** button to view animation i.e. how robot moves from one solution to another solution selected in step 7


RoboAnalyzer
3D Model
Graph
Browser
Analyses
Time Duration
No of Steps
FKin
IDyn
IKin
FDyn
Gravity
Links
D-H Parameters
Robot
Select DOF
Select Robot
OK
Visualize DH
Link Config
EE Config
Motion Trajectory
Select Joint
Speed
Slow
Fast
Joint Offset
Joint Angle
Link Length
Twist Angle
Base Frame to End-Effector
9
1


Inverse Kinematics
Select Robot: 2R Planar
Link Length (a) mm
Joint Offset (b) mm
Twist Angle (alpha) deg
End Effector
X (mm): 100
Y (mm): 100
IKin
Analysis Complete
Solution1
Theta1 (deg): 0
Theta2 (deg): 90
Show
For FKin
Select Initial Values
Solution 1
Select Final Values
Solution 2
OK
Solution2
Theta1 (deg): 90
Theta2 (deg): -90
Show
(X,Y)
2
3
4
5
6
7
7
8