Inverse Kinematics Calculation

Introduction

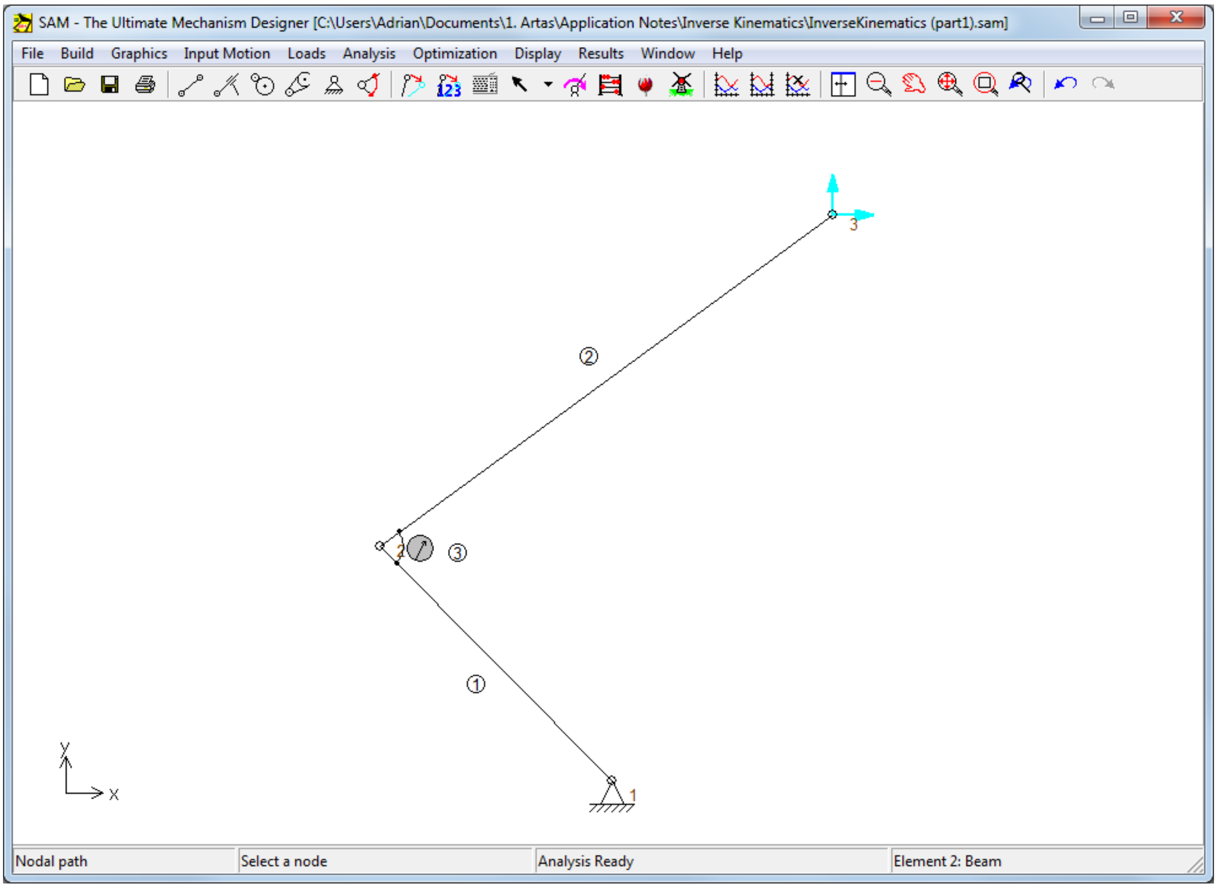
Inverse kinematics refers to the use of the kinematics analysis of a mechanism or (robot) manipulator to determine the motion of all joints that provide a desired position of the end-effector. In this application we will demonstrate how this is done in the software SAM. Three steps will be shown:

1. Inverse kinematics to calculate joint motions that lead to the desired end-effector motion
2. Exporting joint motions and importing these in a new model
3. Regular forward kinematics & kinetostatics to determine driving torques/power and reaction/joint forces.

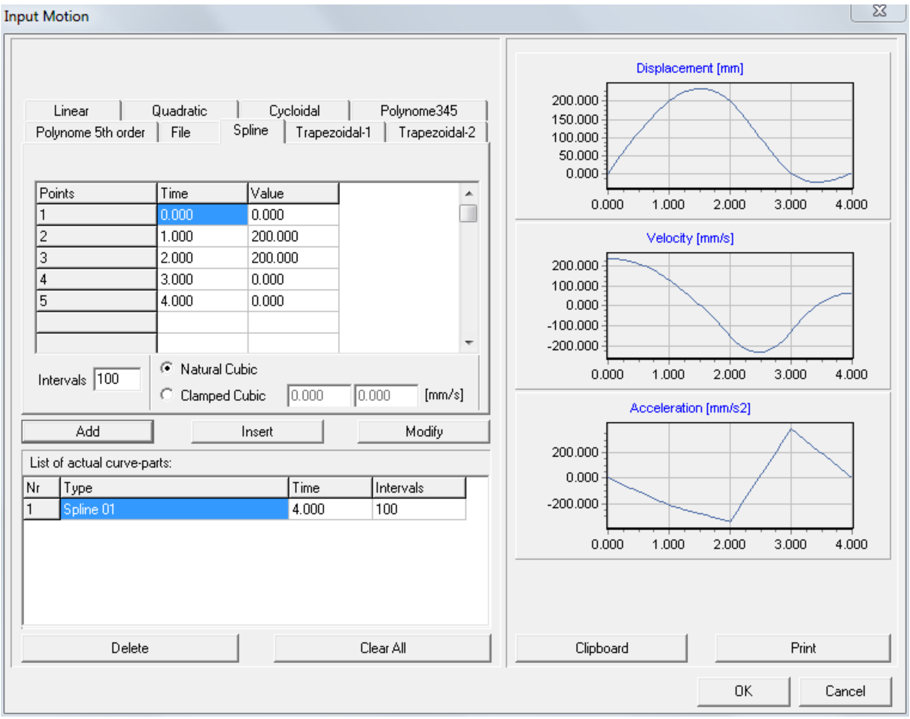
Modelling Steps

Build Model

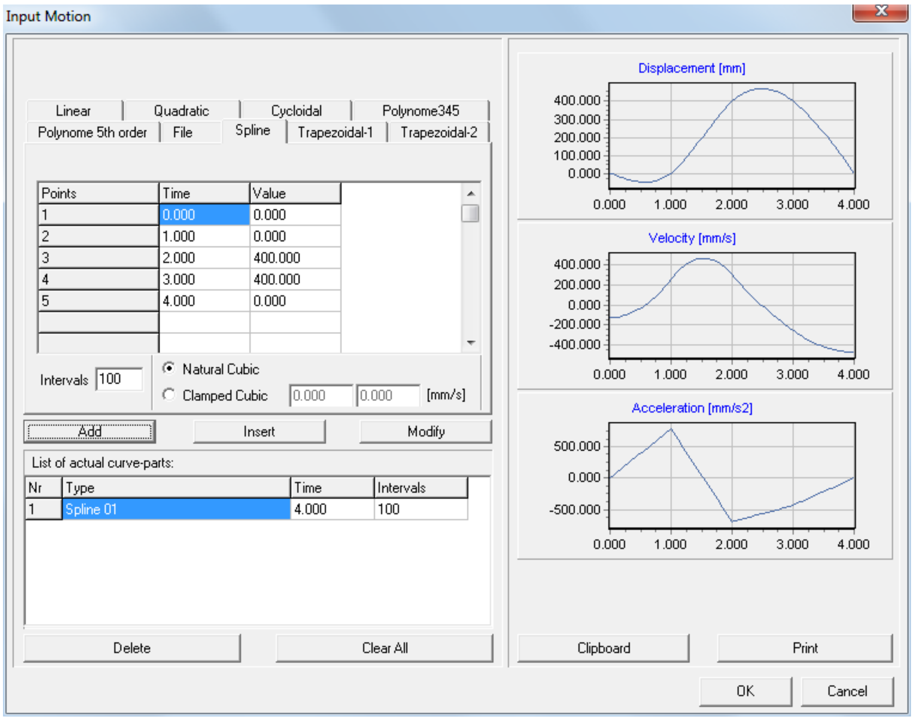
The model in this example consists of two beam plus a rotational sensor (element 3)



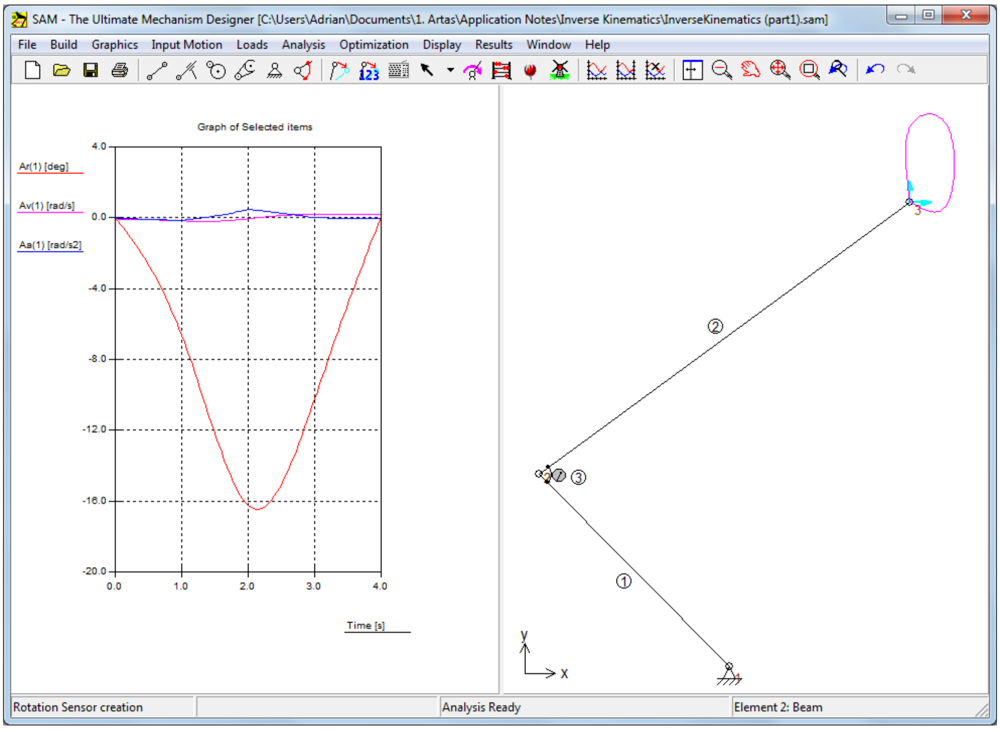
Define motion of node 3: x-motion (spline)



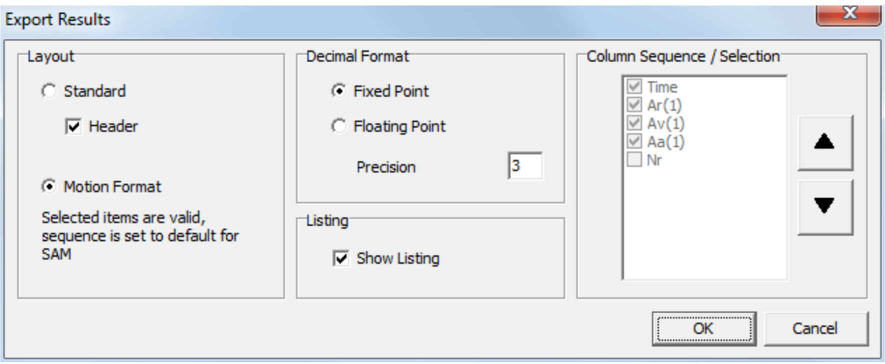
Define motion of node 3: y-motion (spline)



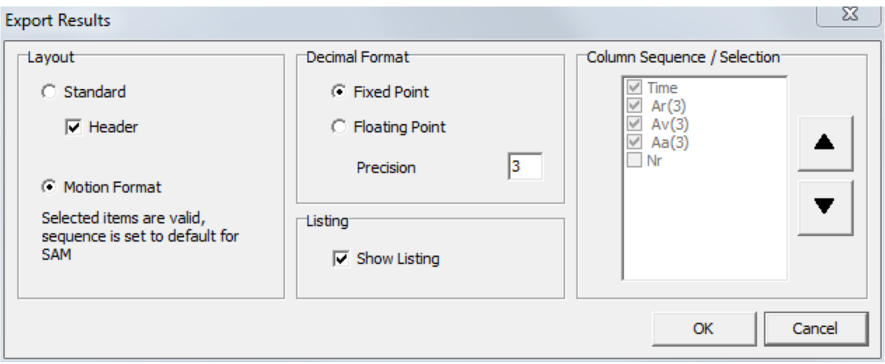
Visualize the path of node 3



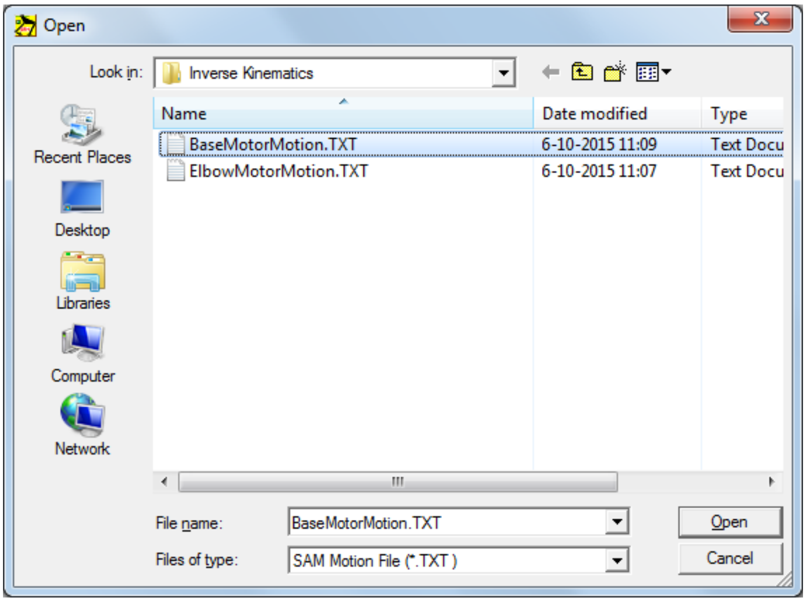
Select results of element 1: AR(1), AV(1) and AA(1) & Export to BaseMotorMotion.txt



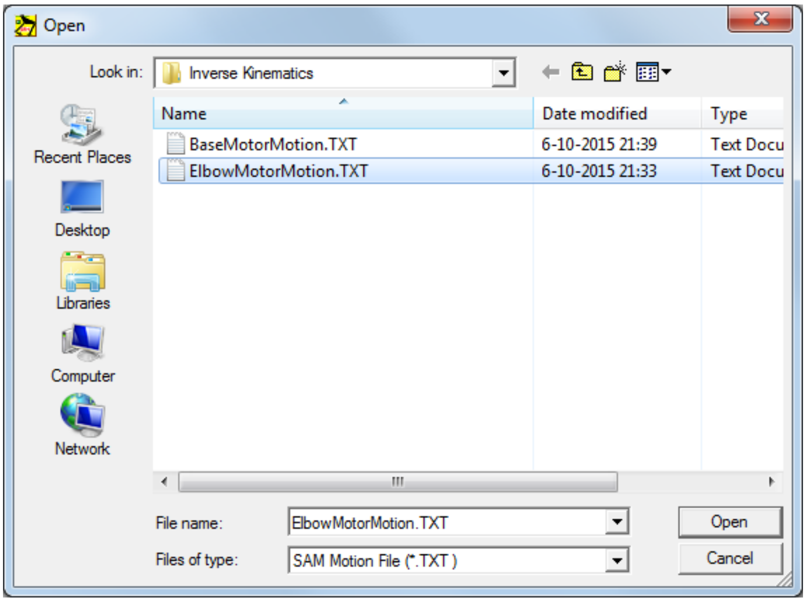
Clear selection
Select results of element 3: AR(3), AV(3) and AA(3) & Export to ElbowMotorMotion.txt



Save SAM file to New Name: InverseKinematics(part2)
Delete x- and y-motion at node 3
Apply input motion ANGLE at base motor using File: BASEMOTORMOTION.TXT

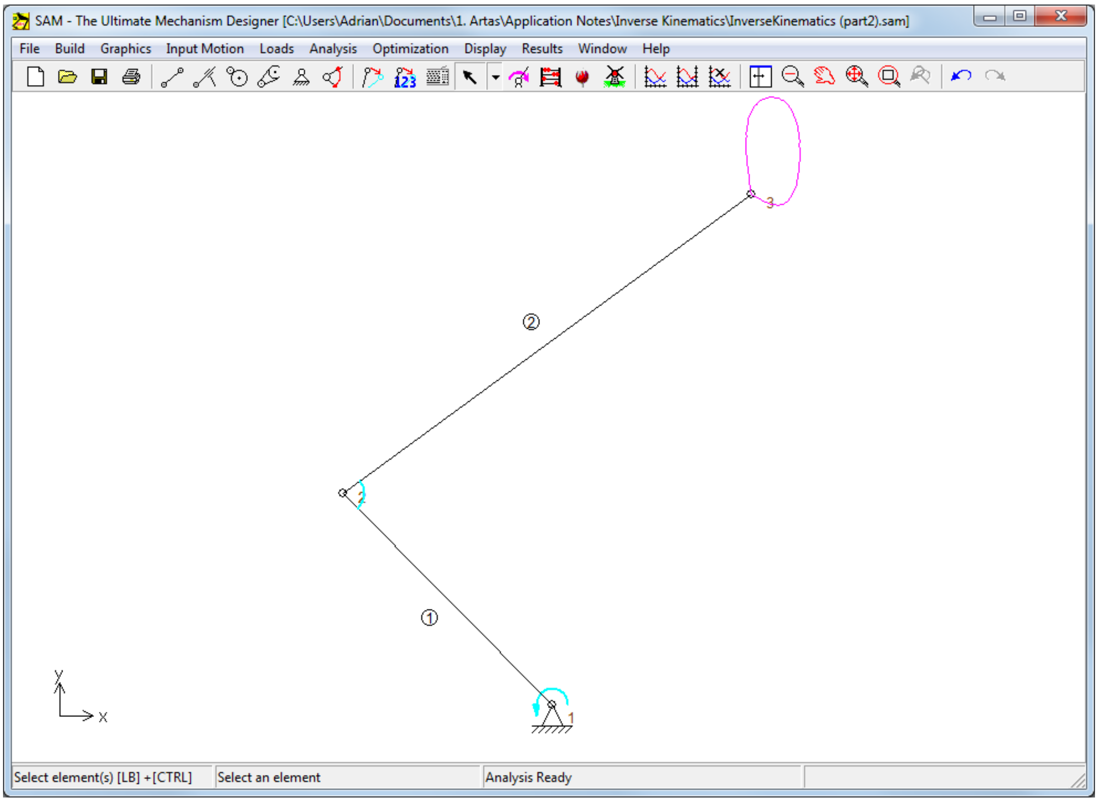


Apply input motion RELATIVE ANGLE to elbow motor using file: ELBOWMOTORMOTION.TXT
Make sure that the sequence in which the elements are selected when defining the relative angle actuator is IDENTICAL to the sequence in which the rotational sensor was defined, because otherwise the elbow motor is turning in the wrong direction and the resulting path of node 3 will be incorrect.

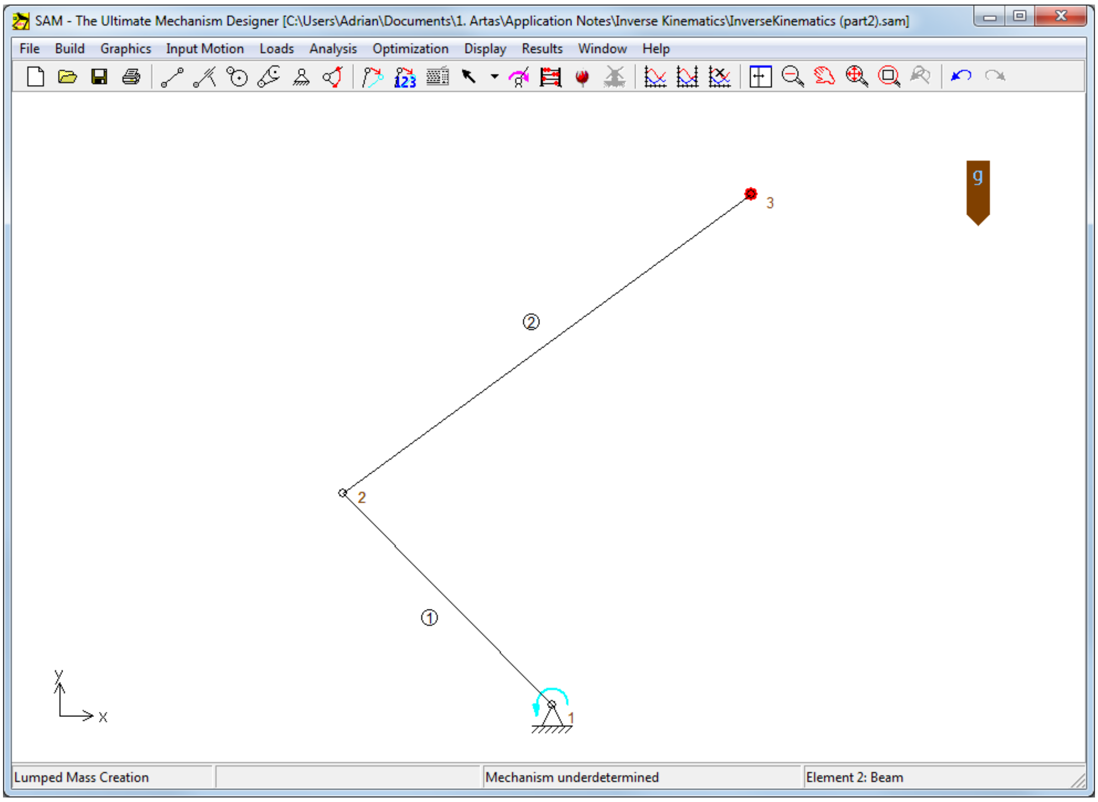


Display the resulting motion of node 3

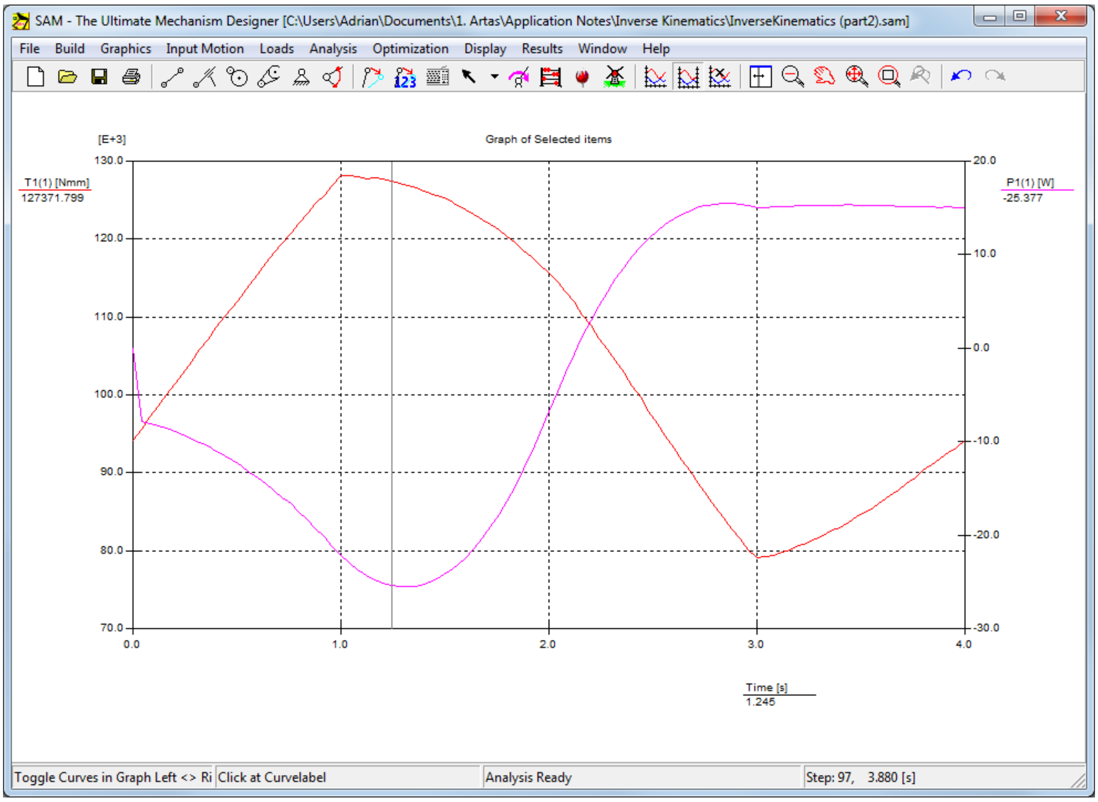
This should now be identical to the starting situation, but driven by base and elbow actuation.



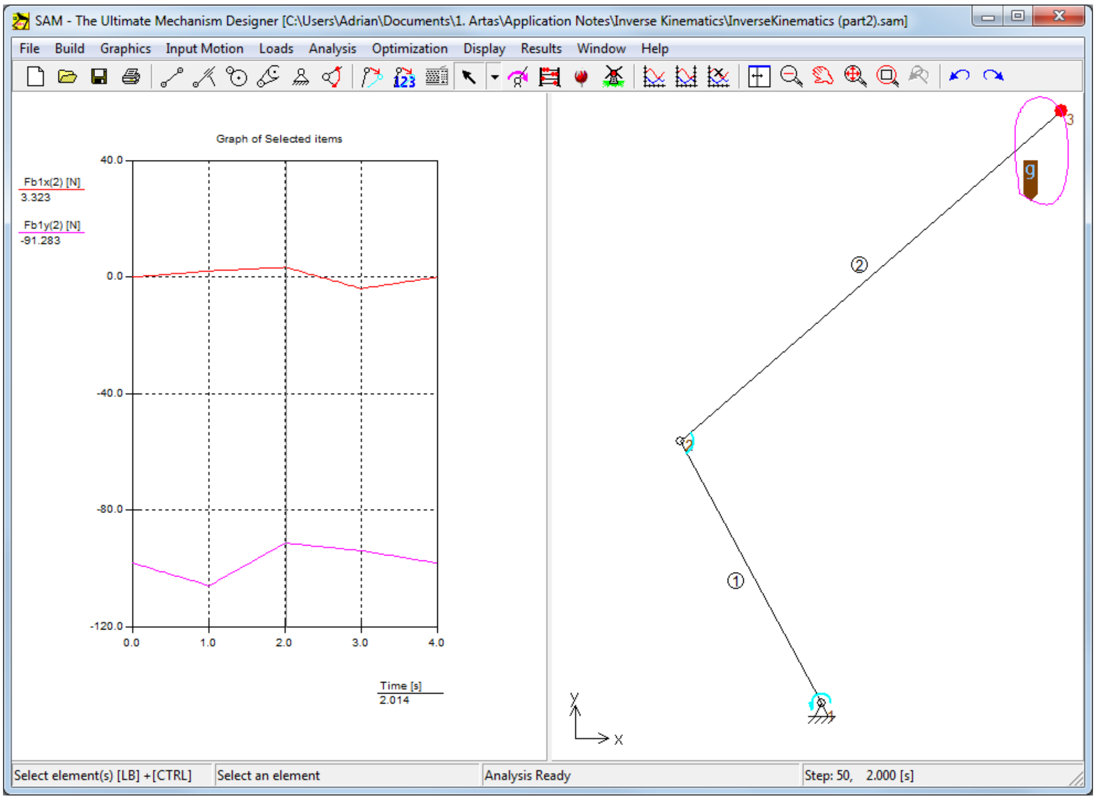
Add a mass of 10kg to node 3 and switch gravity ON



Calculate and plot the required driving torque and power of the base motor.



Calculate and plot joint forces in Fx and Fy of element 2 in node 2d



Conclusion

SAM provides easy support to perform an inverse kinematics calculation, export the results of individual joint movements and import these again for a forward kinematics calculation in which driving torque, driving power and reaction/joint forces can be analyzed.