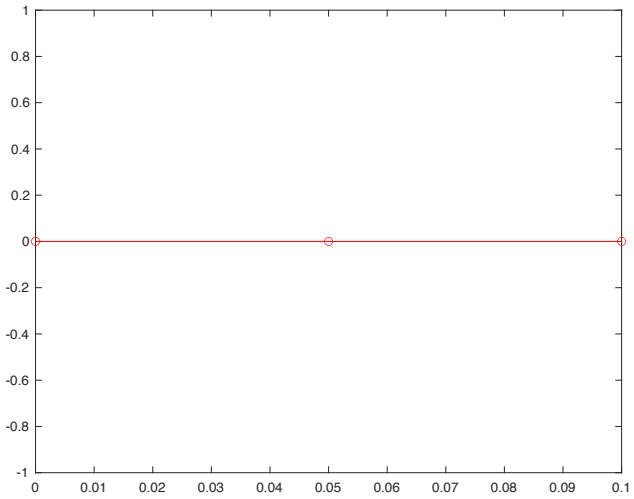
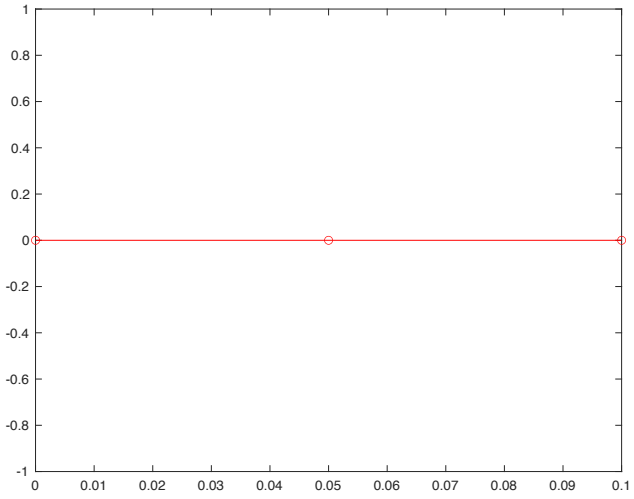
MAE 263F--Homework 1

Question 1

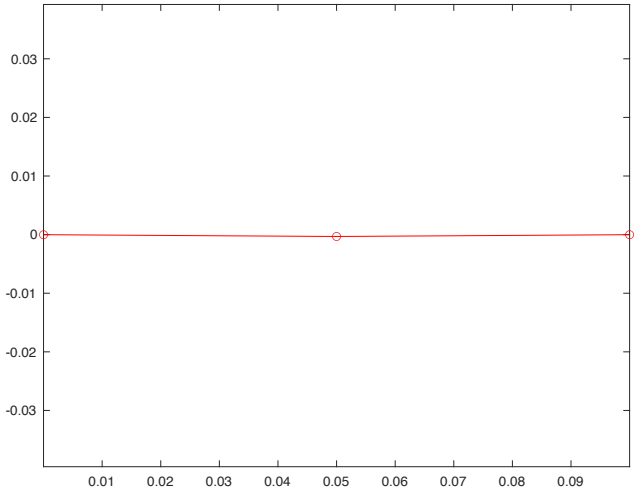
1. The shapes of the structure at t = {0, 0.01, 0.05, 0.1, 1, 10} are the following:



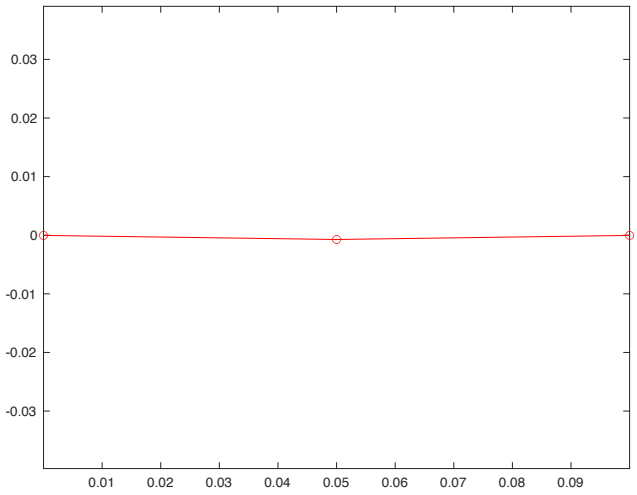
t = 0



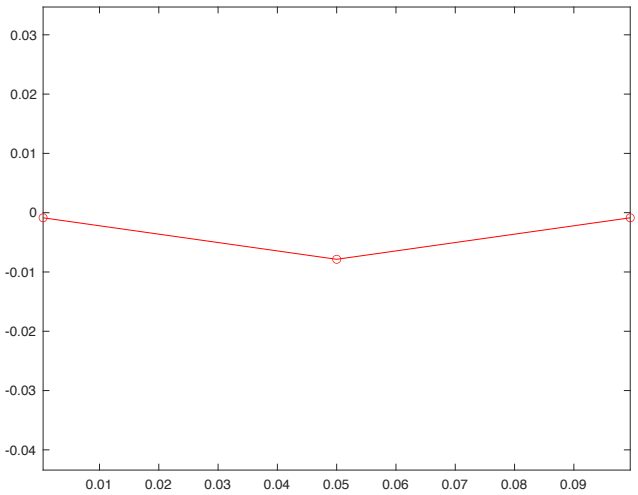
t = 0.01


0.03
0.02
0.01
0
-0.01
-0.02
-0.03
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09

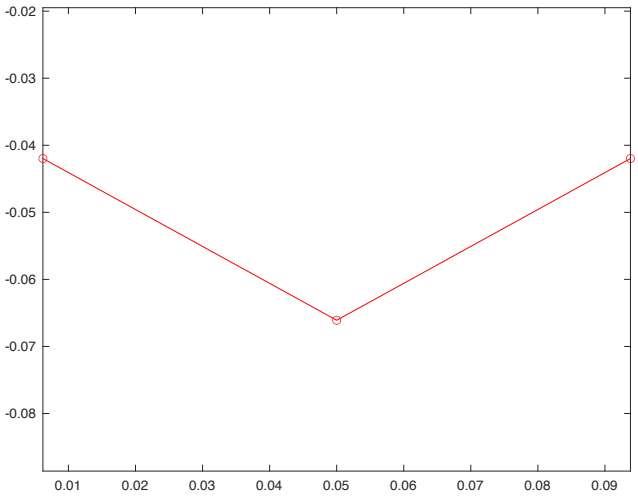
t = 0.05


0.03
0.02
0.01
0
-0.01
-0.02
-0.03
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09

t = 0.1

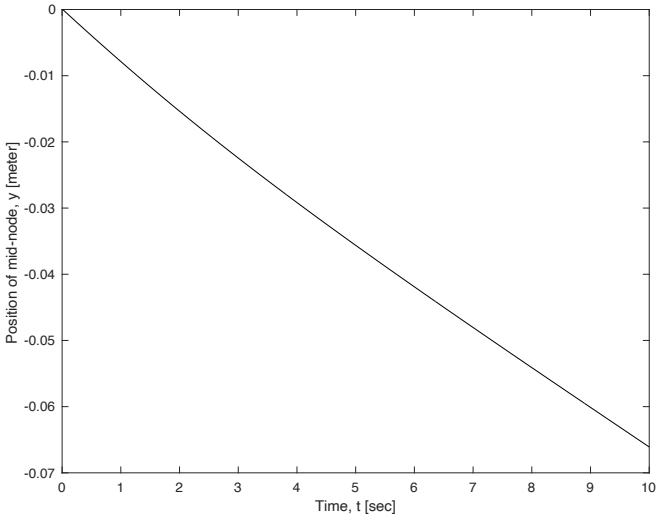

0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09

t = 1

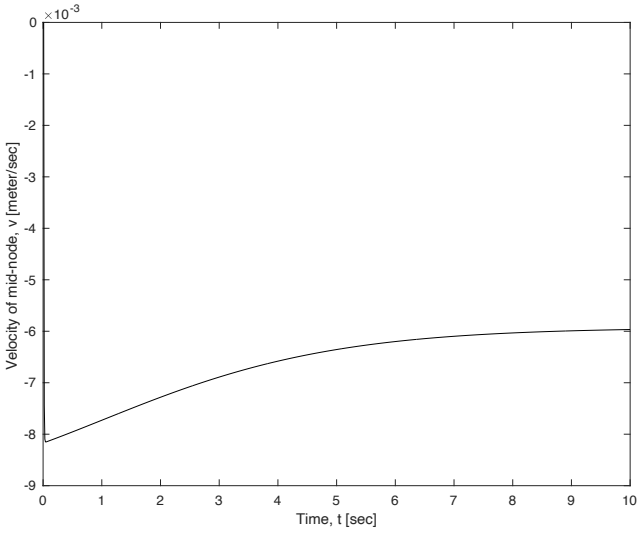

-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09

t = 10

The position of R2 as a function of time:



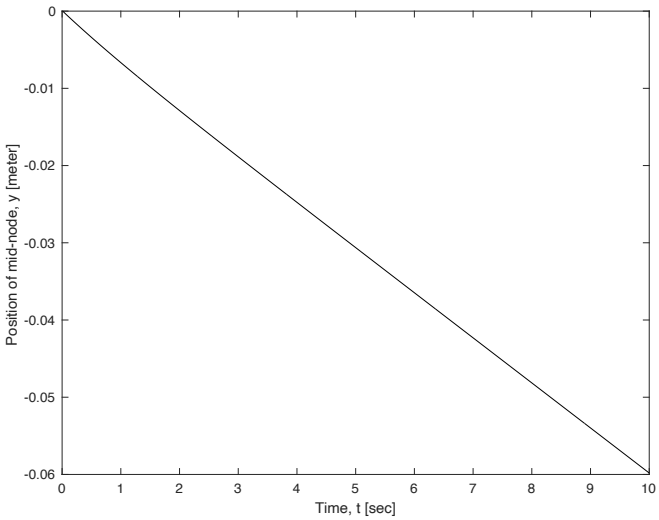
The velocity of R2 as a function of time:



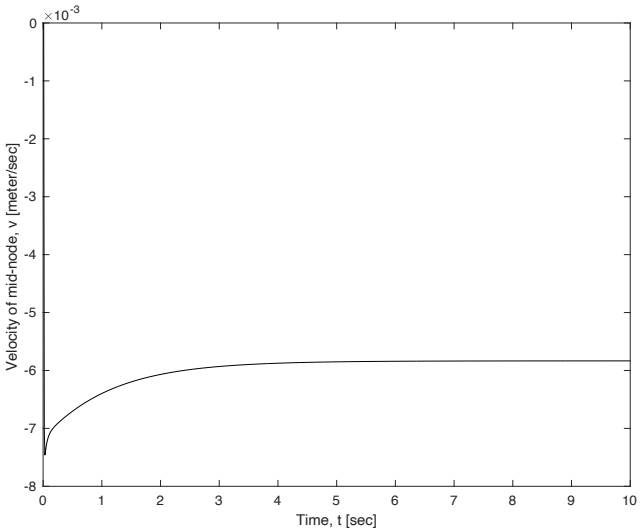
2. As shown in the figure, the terminal velocity of the system is -0.0060 m/s
3. If the radii are the same, the turning angle will be 180 degree, and three balls will be on the same line. The simulation also proves the intuition.

Q2

1. Position of the middle node with time:

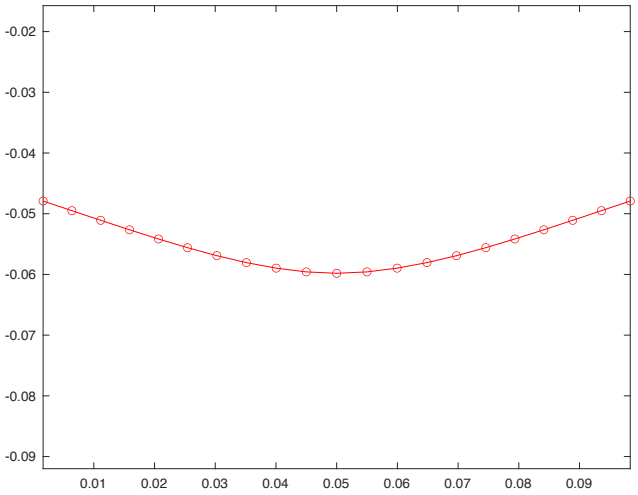


Velocity of the middle node with time:

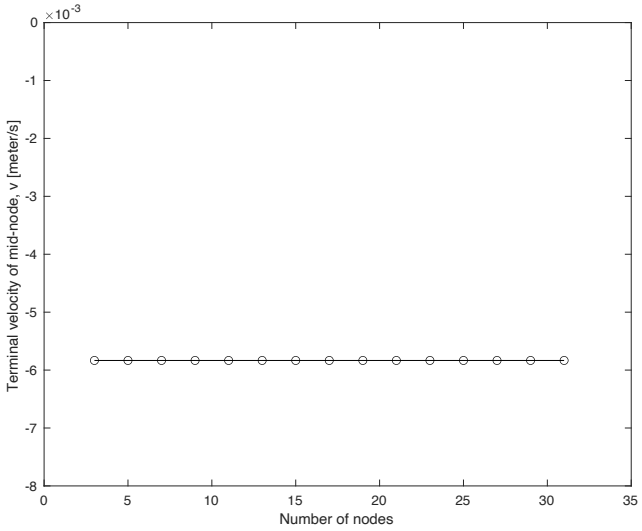


As shown in the plot, the terminal velocity of the middle node is -0.0058 m/s.

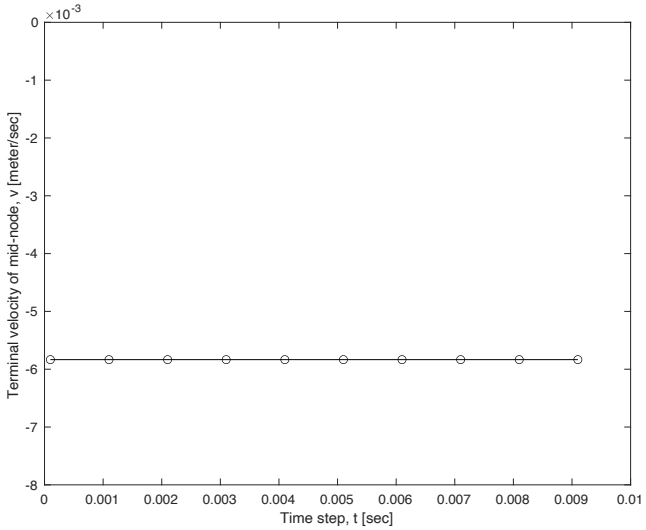
2. The final shape of the beam:



3. Firstly, to show the signature of spatial discretization, we need to apply different node numbers N. Let's assign N with all the odd numbers from 3 to 31. After calculating the terminal velocity of the middle node, we can get the following plot:



We can see that no matter what the node number is, the terminal velocity basically remains unchanged around -0.0059 m/s.
Next, we keep the node number fixed at 21 and try variable time steps from 0.0001s to 0.01s with an interval of 0.001s. After calculating the terminal velocity, we get the following plot:



Once again, we can observe that the terminal velocity remains at -0.0059 m/s as the time step varies.