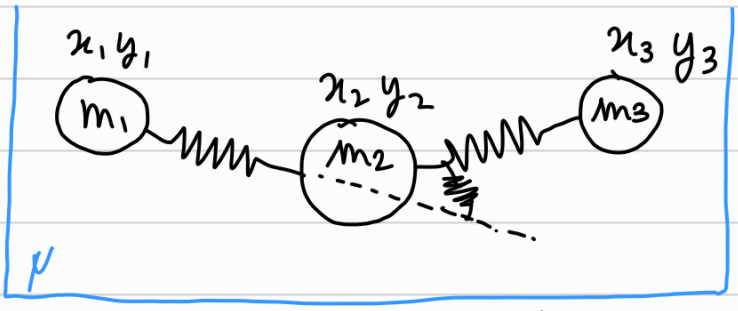
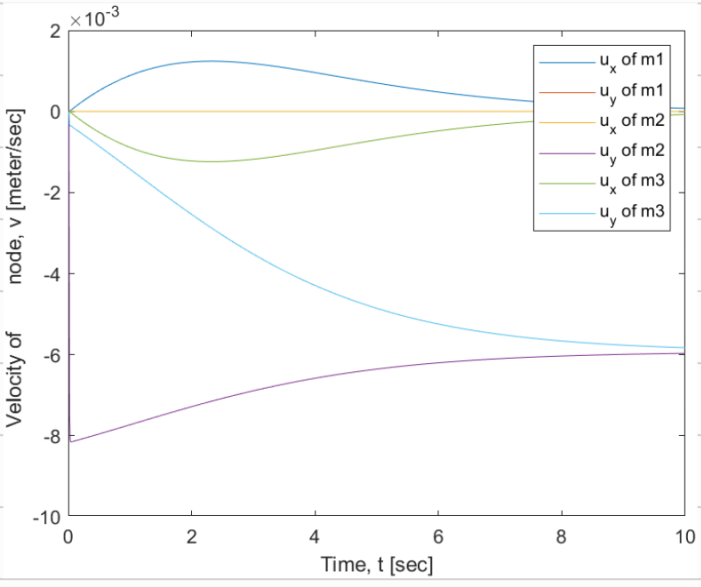
Assignment 1.



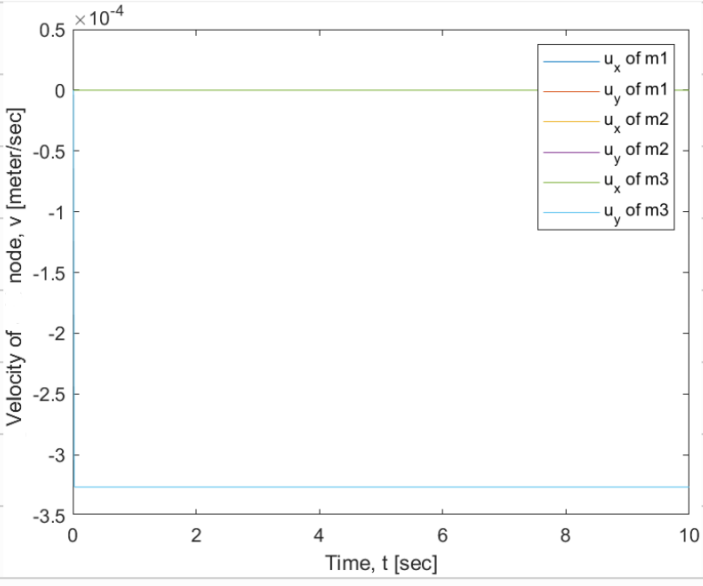
1) Intuition dictates that when radius of all balls are same, they will fall at the same rate. The springs will NOT apply a traverse load and hence $V_x = 0$ for $m_{1,2,3}$. The springs will have no energy as they will not be stretched. So,

- $E_s = E_b = 0$.
- $V_x = 0$ for m_1, m_2, m_3.

The above is illustrated with graphs below:



Different Radii



Same Radii, Constant V in x.

The graphs confirm that the velocity of all 3 masses are equal and constant in the y direction.

2. The time step is changed for both Implicit & Explicit. The table is as below:-

Implicit Simulation for 10s			DEFAULT			
Time	0.0001	0.001	0.01	0.1	1	2
q(1)	0.00620	0.00620	0.00620	0.00617	0.00588	0.00537
q(2)	-0.04203	-0.04203	-0.04198	-0.04147	-0.03653	-0.03131
q(3)	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000
q(4)	-0.06615	-0.06615	-0.06609	-0.06555	-0.06006	-0.05385
q(5)	0.09380	0.09380	0.09380	0.09383	0.09412	0.09463
q(6)	-0.04203	-0.04203	-0.04198	-0.04147	-0.03653	-0.03131
AVG	0%	0%	-1%	-7%	-14%	

The above table shows that increasing the dt by 10 i.e. 0.1 sec causes an error of 6.1. A further increase to dt = 1 sec causes a 14% error. So, dt must be as small as possible.

Explicit Simulation for 10s					
Time	0.000001	0.00001	0.00002	0.00004	0.00006
q(1)	0.00620	0.00620	0.00620	0.00620	0.00000
q(2)	0.04203	0.04203	0.04203	0.04203	0.00000
q(3)	0.05000	0.05000	0.05000	0.05000	0.05000
q(4)	0.06615	0.06615	0.06615	0.06615	0.00000
q(5)	0.09380	0.09380	0.09380	0.09380	0.10000
q(6)	0.04203	0.04203	0.04203	0.04203	0.00000
AVG	0.00%	0.00%	0.00%	-66%	-100%
Convergen	550	55	100		

We also observe that implicit solutions are not that susceptible to step size vs explicit ones, and have more accuracy.

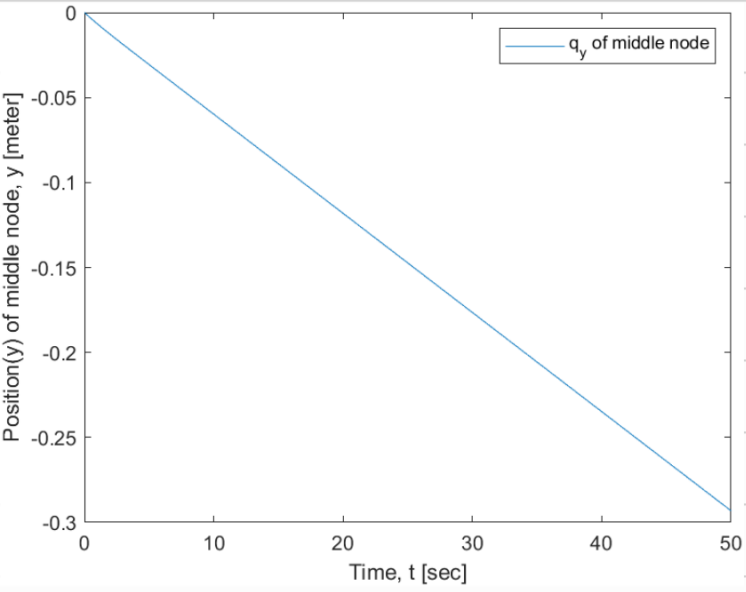
Conclusion:

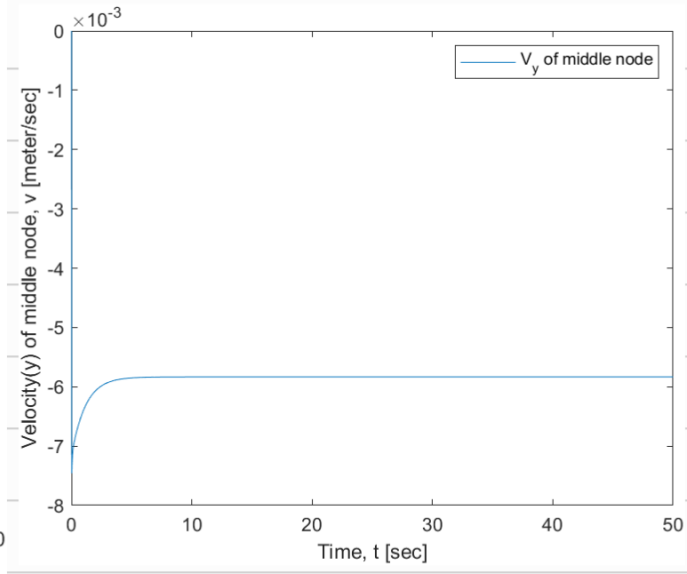
Implicit is better than explicit because:

- lesser error
- more convergence.

Assignment 2

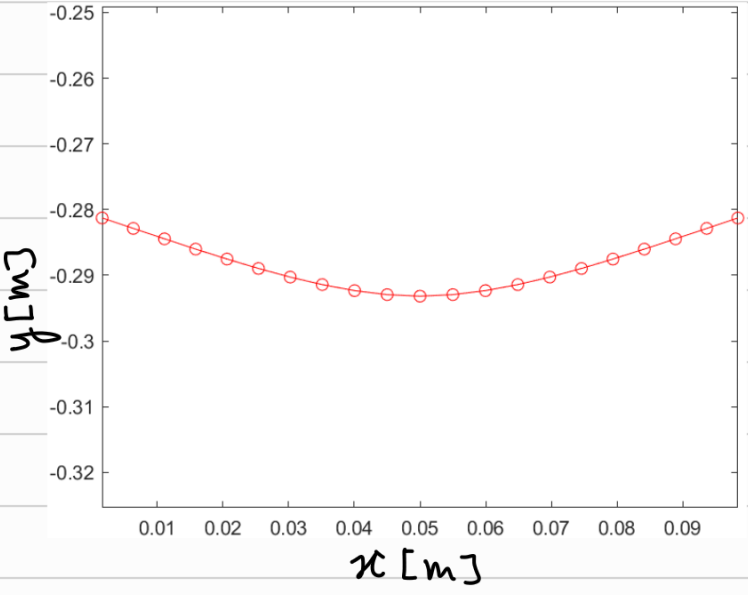
1) The 2 plots are:



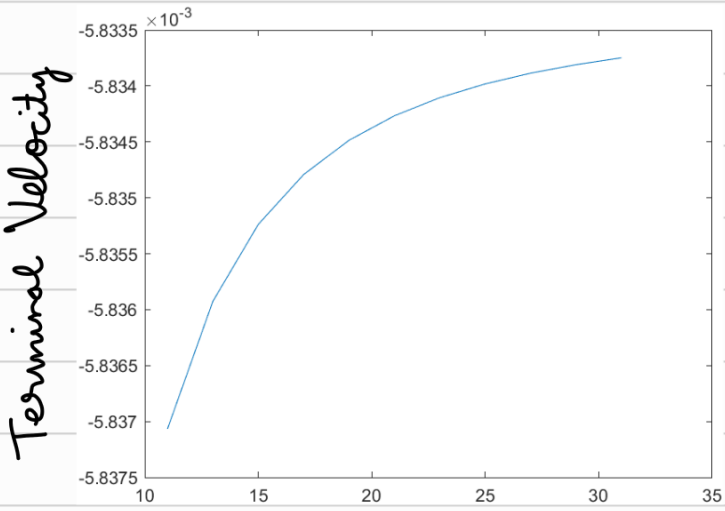


From MATLAB, we see that the terminal velocity is 5.8×10^{-3} m/s.

2) The final deformed shape of the beam is:



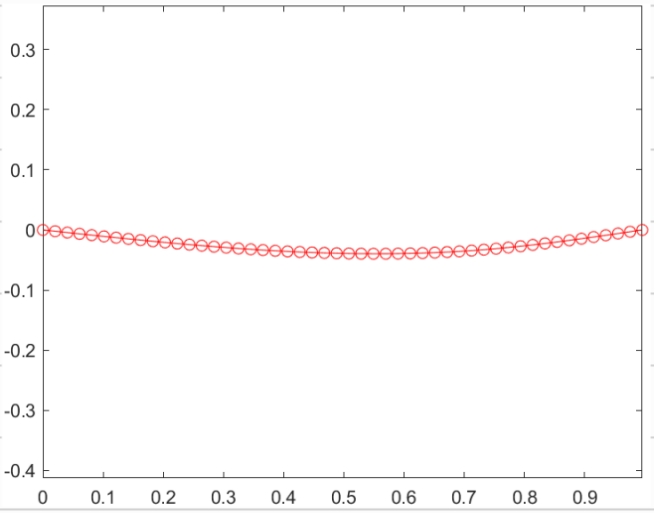
3) Plots:

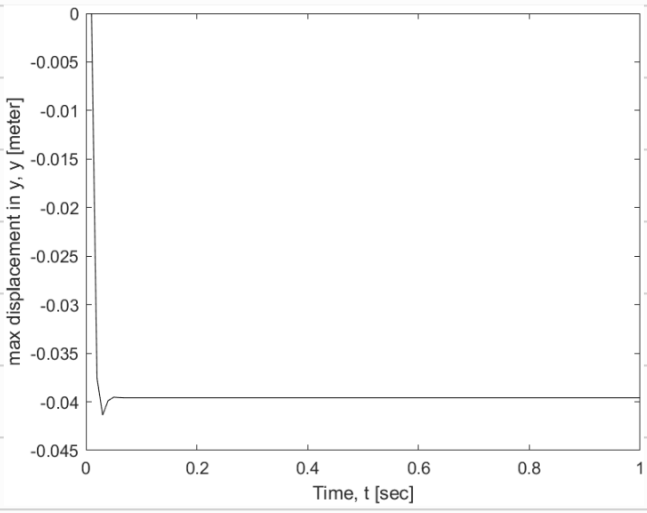


We can say that the no. of nodes has almost no effect in terminal velocity as the change in accuracy is minimal.

Assignment 3

$P = 2000\,N$. $\Delta t = 0.01\,sec$.



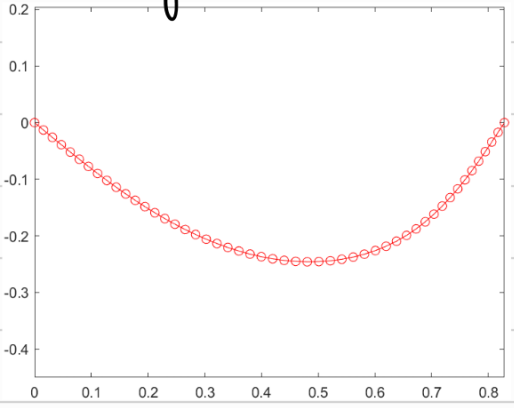


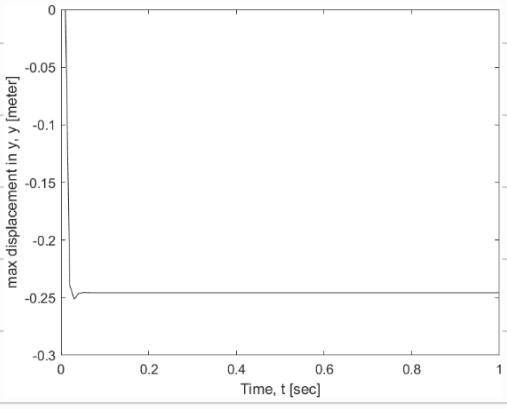
Shape.

The steady state value from DER is $-0.03956\,m$.

From Euler theory, we get $-0.03804\,m$.

2) Setting the $P = 20000\,N$.

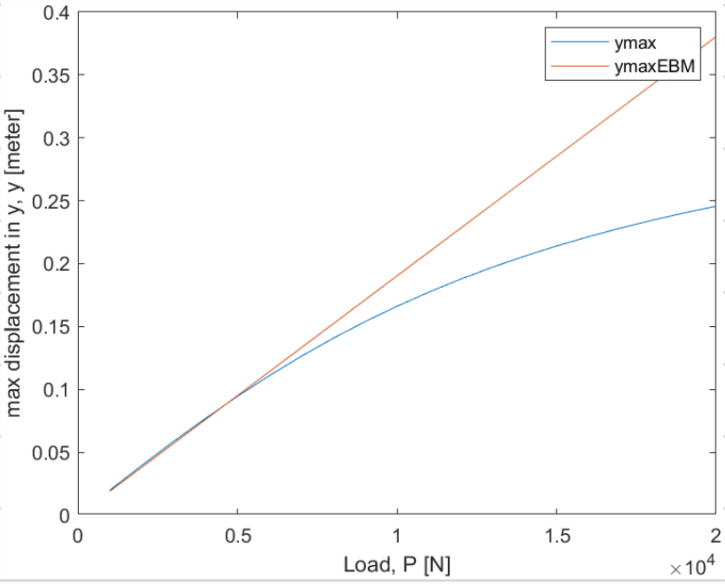




Shape. Y_{max} vs time

From DER simulation, we get $0.2457\,m$.
From EBM simulation, we get $0.3804\,m$.
They are not same as EBM assumes linearity.

Plot – P vs Ymax



As we see, it starts diverging at 5000N for this beam.