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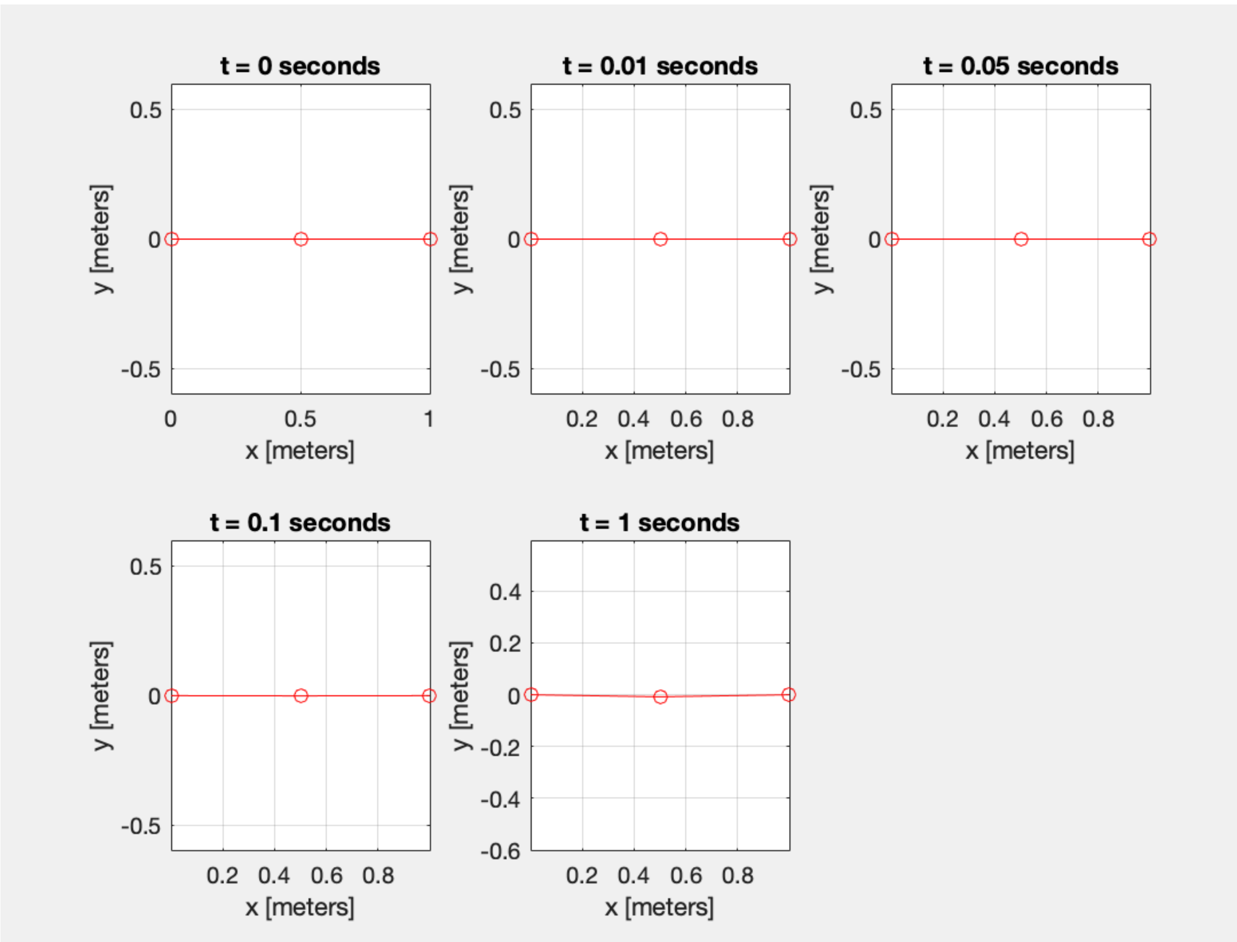
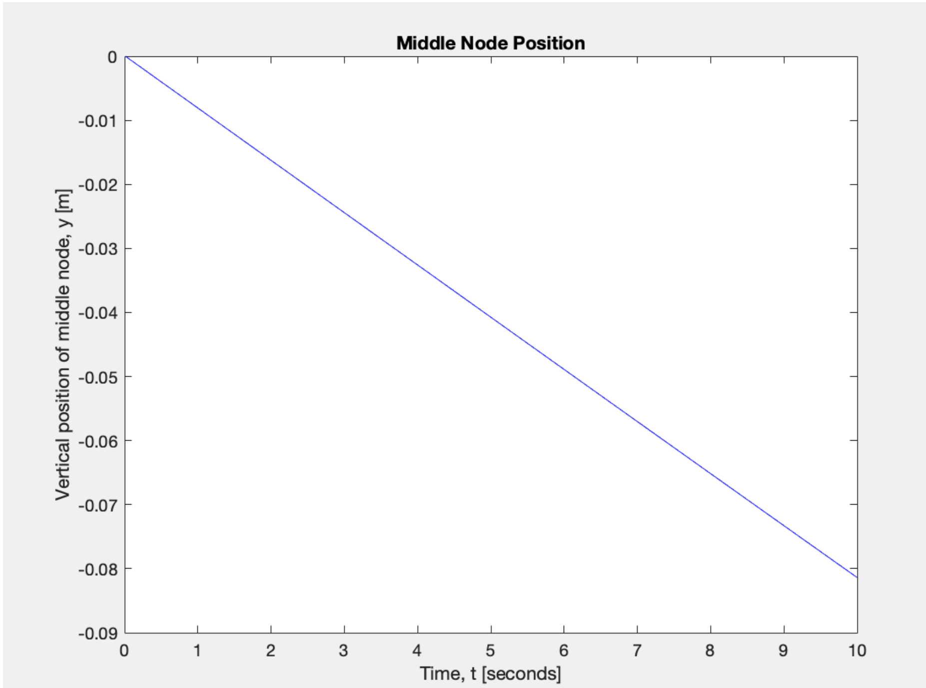
Fall 2024

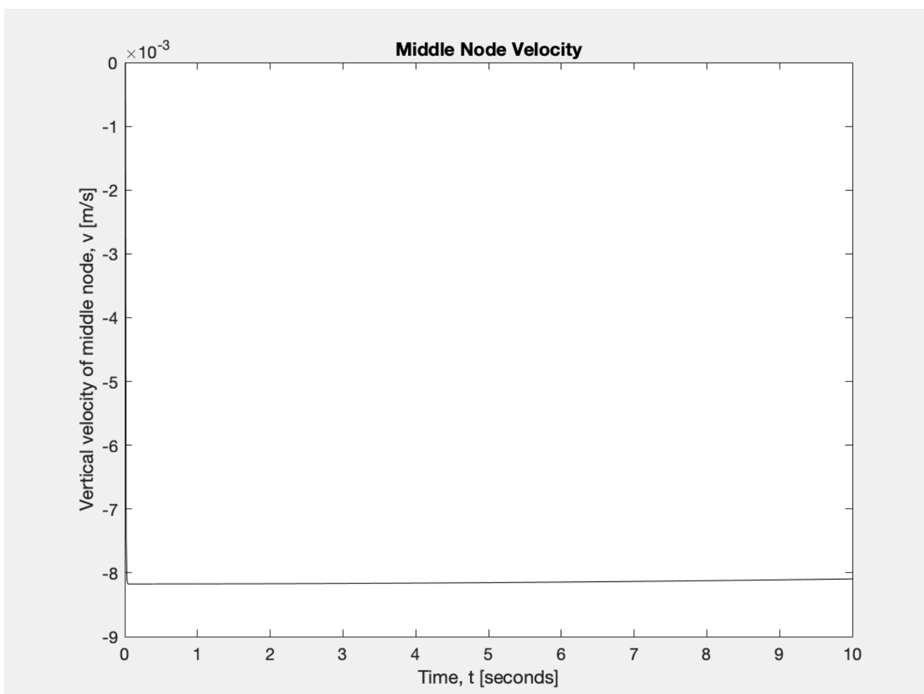
MAE C263F Homework 1

Problem 1 - Three Connected Spheres Falling Inside Viscous Fluid

1) Structure shape at t = {0, 0.01, 0.05, 0.10, 1.0, 10} and position and velocity vs. time plots of R_2.







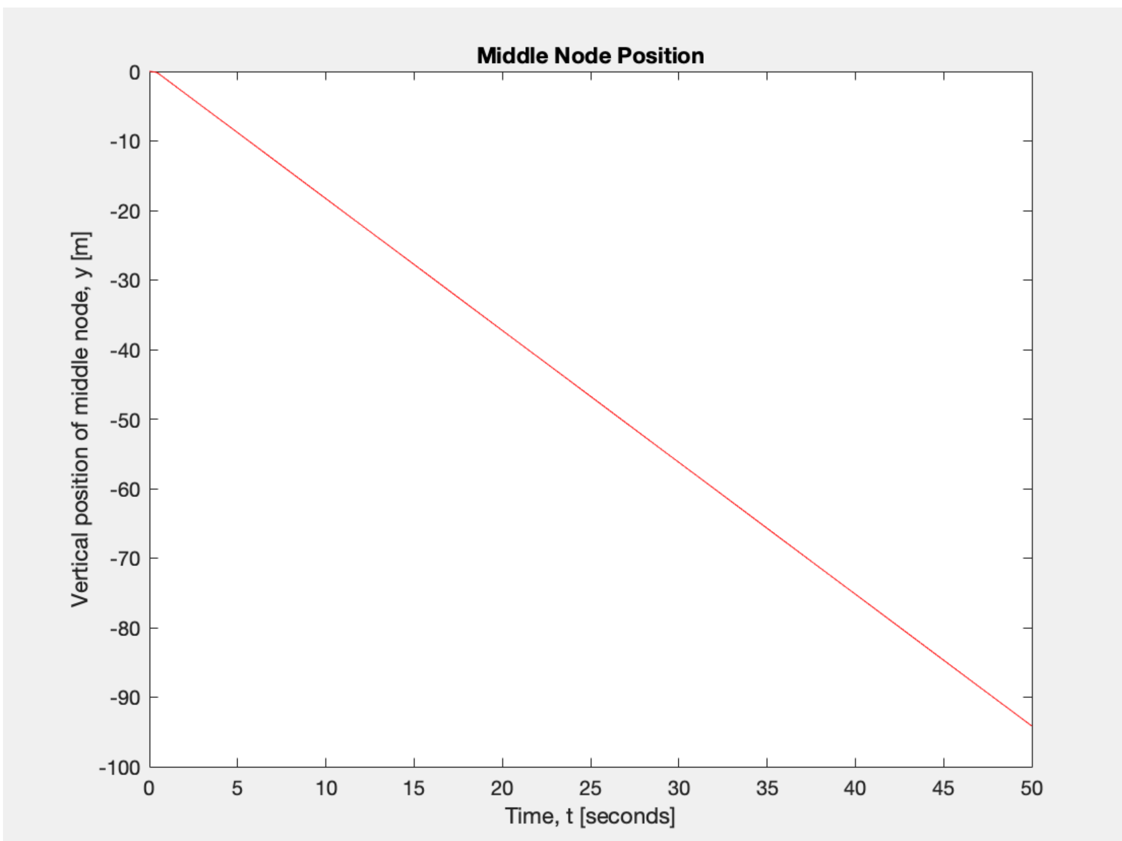
2) The terminal velocity along the y-axis of this system is -0.008175 m/s.
3) The turning angle remains 180° (flat) when the radii of all the spheres are the same. My simulation supports this claim.
4)

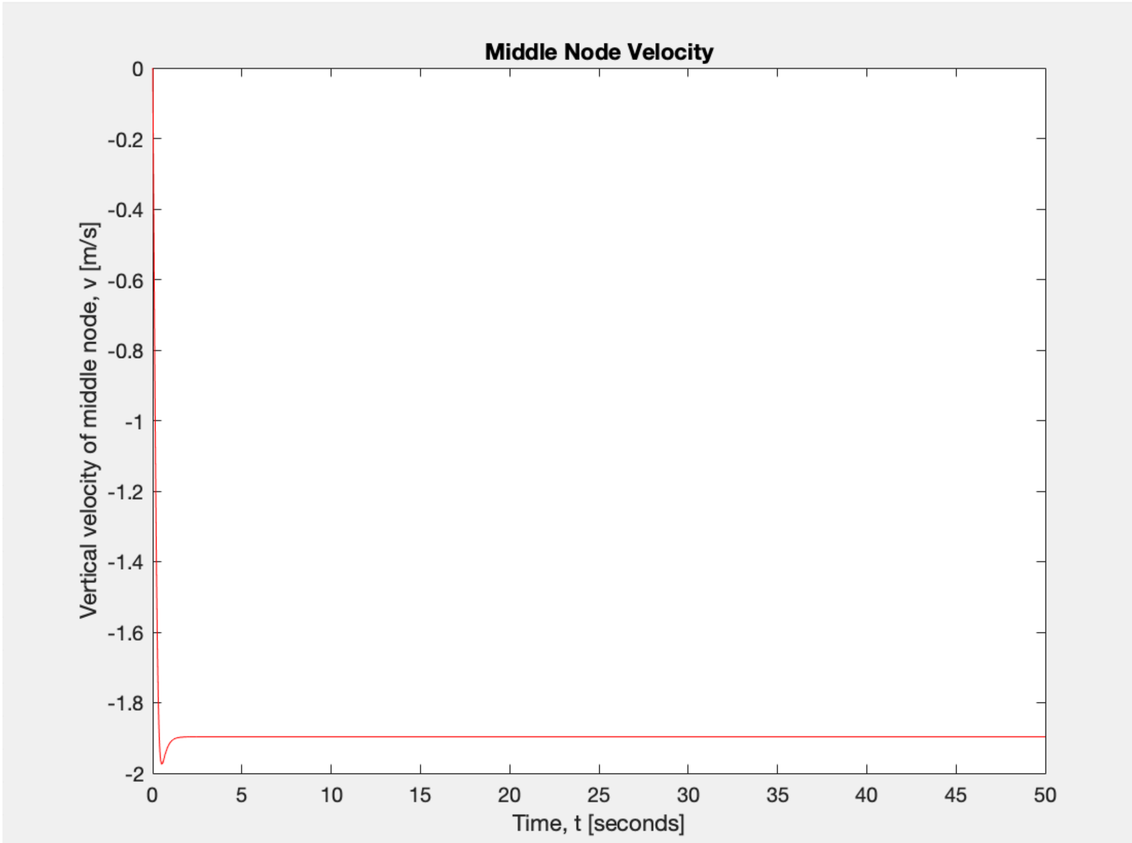
Approach	Benefits	Drawbacks

Explicit	Simple to implement and efficient for problems with many DOFs	Requires a very small time step which can be computationally costly
Implicit	Unconditionally stable, even for large time steps	Requires complex algorithms which can be computationally costly

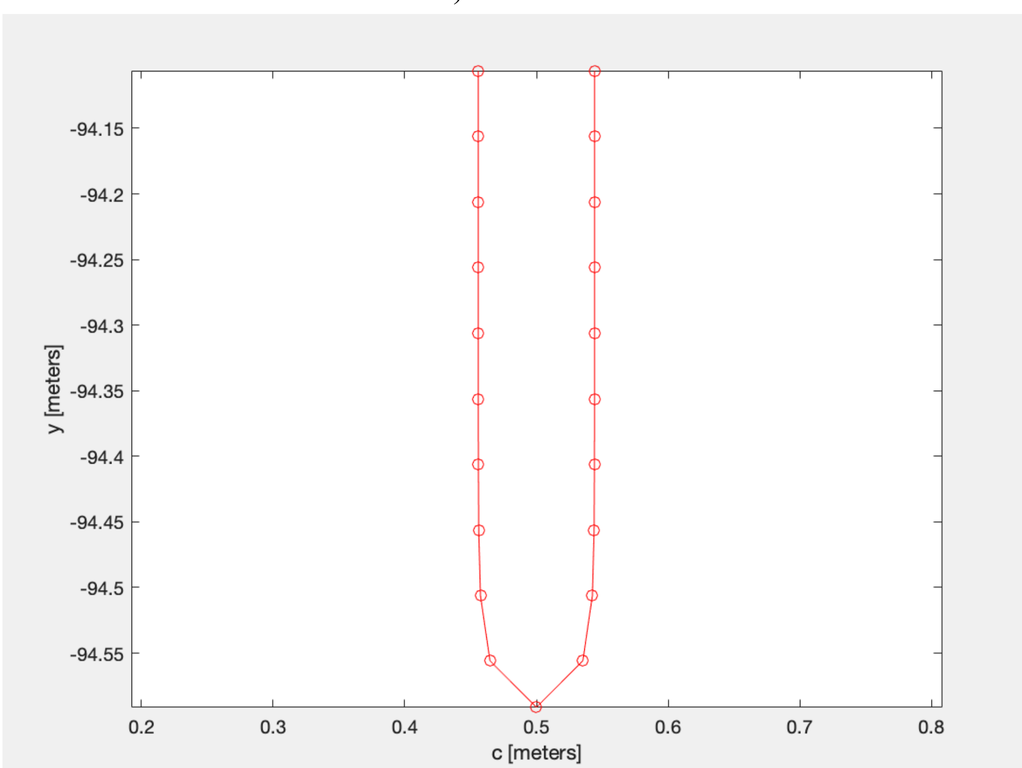
Problem 2 - General Connected Spheres Falling Inside Viscous Fluid

1) The terminal velocity is -1.974 m/s at 0.51 seconds.

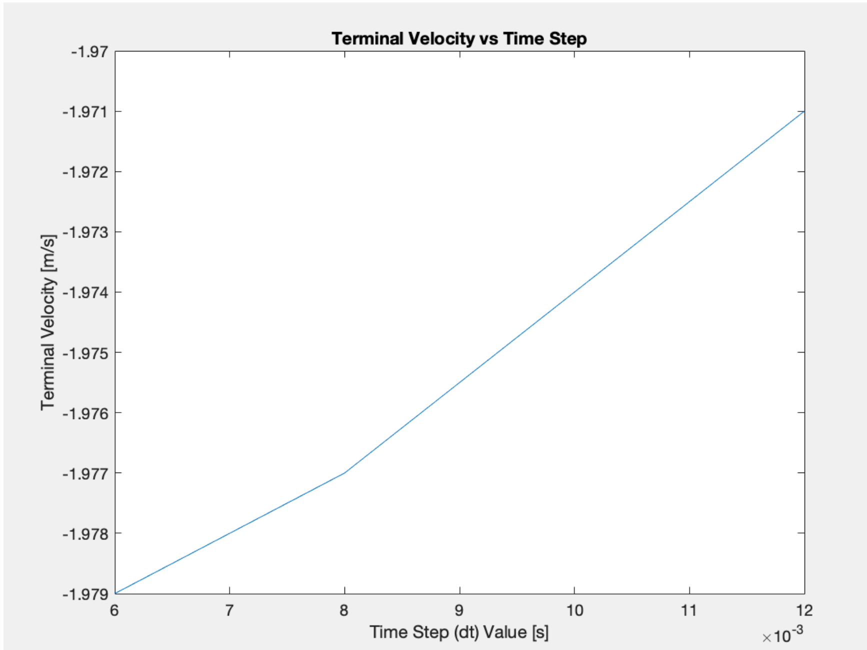




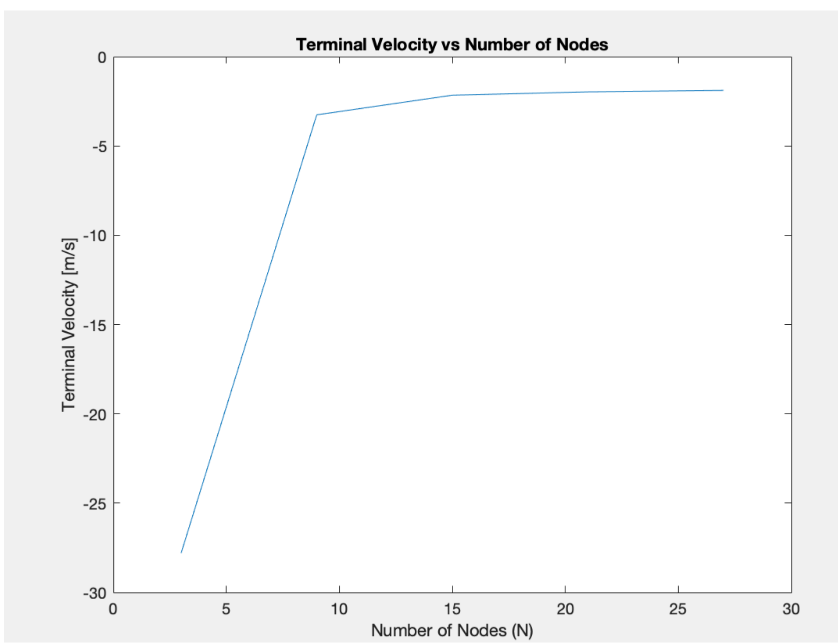
2) Final Position



3) Varying number of nodes and time step



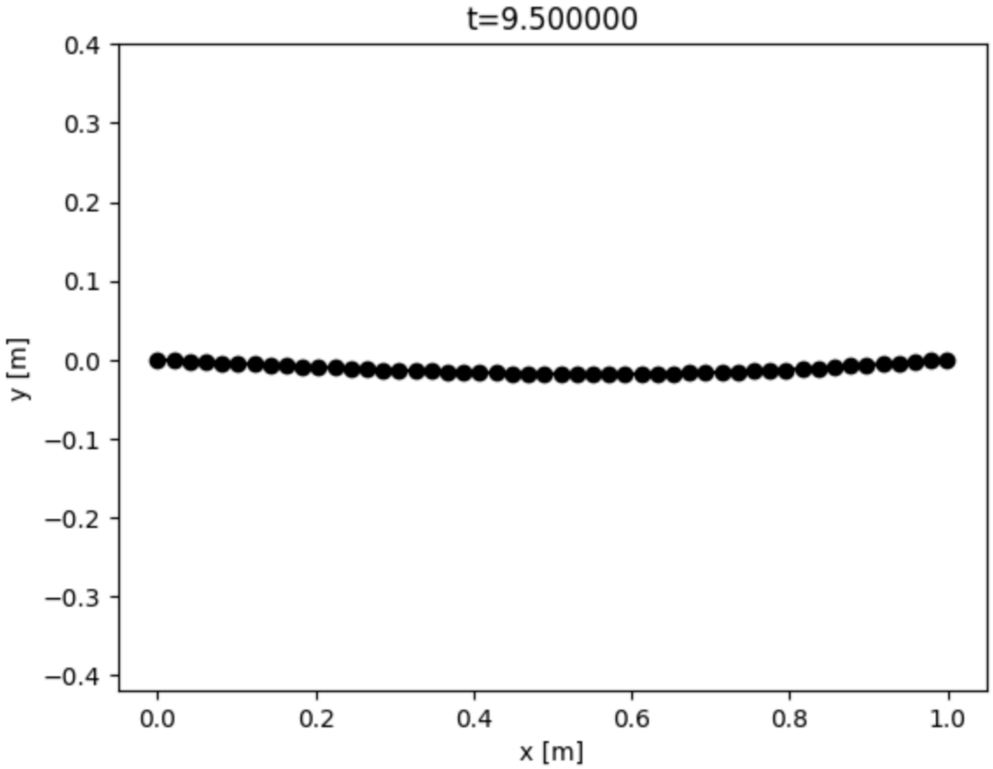
As we can see in this plot, varying the time step does not greatly affect the terminal velocity, as the y-axis is on an order of magnitude of -3.

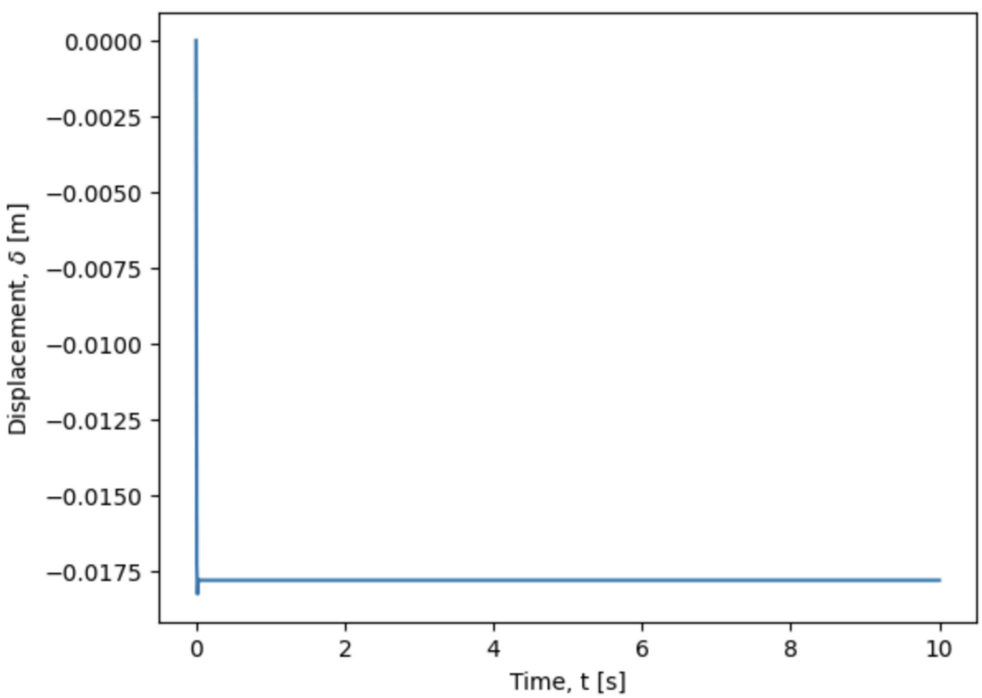


Increasing the number of nodes does not greatly affect the terminal velocity, but decreasing the number does. Once ~17 or so nodes are being used, the results seem to plateau and are generally unaffected.

Problem 3 - Elastic Beam Bending

Load of P = 2000 N





1) The beam does reach a steady state maximum displacement of around -0.0177 m. The predicted value with the Euler model is -0.0380 m. This is a decent way off.
2) When applying a load of 20000 N, my model predicts a maximum displacement of -0.154 m whereas the Euler model predicts a maximum displacement of -0.3804 m.

Load of P = 20000 N