Physically Based Simulation – Exc1 - Michael Rabinovich and Ivo Nussbaumer

2.1) Setting the given initial values: y(0) = -L and y’(0)=0, we get the unique solution with c1 = mg/k = 0.0982 and c2 = (-a\*c1 )/b

2.2) Error displacement with no damping:



It seems that the midpoint method converges the fastest (and actually get to the lowest error), this is as expected since it’s convergence rate is O(n^3) and not O(n^2) like the other methods.

With damping:



Damping doesn’t seem to change the results much.

2.3) Stability with no dumping:



Euler and Midpoint methods are getting unstable with higher step sizes (0.0008 for euler and 0.0256 for midpoint), while the others remain stable. This demonstrates the fact that staggered methods are less stable for this problem.

There’s a high correlation between stability and accuracy. An unstable solution leads to high errors and low accuracy when it “explodes” (as in the case of euler and midpoint here), and an accurate solution can lead to a more stable solution. However, some methods are more stable for certain problem, regardless of their accuracy. For instance, in the general test here, “midpoint” seem to be more accurate than “symplectic euler”, however it is much less stable as noted.



With 1.9 damping all the methods are stable.