Homework assignment 3

3.1.0. Derive

$$E_{i+1} = E_i + (1/2)mgl\ [\omega_i^2 + (g/l)\theta_i^2](\Delta t)^2$$

from

$$E=(1/2)m\,l^2\,[\omega^2 + (g/l)\theta^2]$$

by applying Euler descritisation method [basically, prove Eq. (3.8) using Eq. (3.7), page 51, Giordana and Nakasishi (2^{nd} edition).]

3.1

Investigate the stability of the Euler-Cromer method. Modify our program so that it also calculates the total energy, kinetic plus potential, of the pendulum as a function of time. Show that the energy is conserved over each complete cycle of the motion.

3.2

Repeat the previous problem using the Runge-Kutta method described in Appendix 1. Compare the accuracy of the Runge-Kutta method with that of the Euler-Cromer algorithm using the same time step.

3.7. Numerically investigate the forced (externally driven) pendulum with friction of Eq. (3.14) in page 55, Giodano 2^{nd} edition. Show numerically the existence of the resonance, and confirm the dependence of the resonant amplitude on the driving angular frequency Ω_D. You may either use Euler-Cromer method, or use the command NDSolve in Mathematica. Basically, you will need to plot the amplitude as a function of Ω_D/Ω with fixed value of q, and see whether you get a resonance peak when $\Omega_D/\Omega = 1$.

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