Physics 430, Winter 2009
Take-Home Problem #2
12 March 2009
due 19 March 2009

Solve the following problems in Matlab. Email a copy of your scripts to Dr. Peterson (bryan_peterson@byu.edu) by 5:00 pm on the due date.

This exam is open notes (code, lab manual, matlab book, etc.) but is closed lab partner and closed lab TA. You are expected to do your own work but you are allowed to reuse appropriate code from previous exercises.

Please also include a note indicating approximately how long you spent on this exam.

Consider the wave equation

$$\frac{\partial^2 y}{\partial t^2} - e^x \frac{\partial^2 y}{\partial x^2} = 0$$

on the interval $x \in [0, 2]$ with boundary conditions $y(x, t) = 0$ at $x = 0$ and $\partial y/\partial x = 0$ at $x = 2$. Use a cell-centered grid for your solutions.

1. Find the first three normal modes for this equation, i.e., let $y(x, t) = f(x)\cos(\omega t)$ and find $\omega_1 < \omega_2 < \omega_3$. Determine these frequencies to 3 significant figures.

2. Animate the wave equation using staggered leapfrog with initial conditions $y(x, 0) = \sin(3\pi x/4)$ and $\partial y/\partial t = 0$. Have your code create a graph of $y(x)$ within 1/2 timestep of the time $t = 4$ and pause so that I can examine the graph.

3. Suppose that the boundary condition at $x = 2$ is changed to $\partial y/\partial x = 3y(x)$, i.e., the slope at the end is three times the value of the function at the end. Change the code you wrote for problem 1 to apply this boundary condition. Then use this modified code to find the new value of the lowest normal mode frequency (again to 3 significant figures).