

Astronomy 802, Numerical Techniques
Homework # 2, Due Thursday, Feb. 12, 2004
Show All Your Work

1. Write a program or IDL procedure to solve the second order wave equation

$$\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0 \quad (1)$$

I suggest writing this as two coupled first order equations and using one of the methods we have discussed in class. Your method should be stable and reasonably accurate. Be sure to include appropriate boundary conditions. Apply your solution to a sinusoidal wave. Try it also for a step function wave, e.g.

$$u(x, 0) = 1 \text{ for } 0 \leq x < 1 \quad (2)$$

$$= .1 \text{ for } 1 \leq x \leq 2 \quad (3)$$

Check your answer with the analytic solution. Plot your results and their comparison with the analytic solution.

2. Solve the coupled first order differential equations

$$\frac{du}{dx} = 998u + 1998v \quad (4)$$

$$\frac{dv}{dx} = -999u - 1999v \quad (5)$$

Use the initial conditions $u(0) = v(0) = 1$.

(a) Find the analytic solution

(b) Write a program or IDL procedure to solve the equations numerically. Include a copy of your procedure or program and a graphical presentation of the solution for u and v as a function of x . Compare your numerical solution with the analytic solution. You may need to try out several methods to find one that is satisfactory.