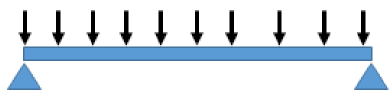
CMPS 443 Final Project
Due: Thursday, May 10 by 10:15 a.m.

- NOTE: Graduating seniors must submit theirs by Tuesday, May 8 at 10:15 a.m.
- Choose ONE of the following problems to complete.

1. **Simulate the deflection of a beam with supported ends.**



The deflection of a beam with simply supported ends is subject to uniform loading. The boundary-value problem governing this physical situation is given by

$$\frac{d^2y}{dx^2} = \frac{S}{EI}y + \frac{qx}{2EI}(x - L),\ 0 < x < L,$$

with boundary conditions $y(0) = 0$ and $y(L) = 0$. Suppose the beam is a W10-type steel I-beam with the following characteristics: length $L = 120$ in., intensity of the uniform load $q = 100$ lb/ft, modulus of elasticity $E = 3.0 \times 10^7$ lb/in^2, stress at ends $S = 1000$ lb, and central moment of inertia $I = 625$ in^4. Use the finite difference method to approximate the deflection $y(x)$ of the beam every 6 in. Plot and label your results. Turn in all work (hand written and coded).

2. **Simulate the motion of a vibrating string with fixed ends.**

The displacement $u(x, t)$ of the string is modeled with the one-dimensional wave equation:

$$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2},\ 0 < x < L,\ t > 0.$$

The boundary conditions are:
$u(0, t) = 0$ and $u(L, t) = 0$ for all $t > 0$.
The initial conditions are:
$u(x, 0) = f(x)$ and $\frac{\partial u}{\partial t}(x, 0) = g(x)$ for $0 < x < L$.

The ends of a stretched string of length $L = 6$ are fixed at $x = 0$ and $x = 1$. The string is set to vibrate from rest by plucking it from an initial triangular shape modeled by the function.

$$f(x) = \begin{cases} 2 - 2|x - 2|, & 1 < x < 3, \\ 0, & \text{otherwise} \end{cases}$$

The initial velocity of the string is $g(x) = 0$. Use finite differences to simulate the motion of the string with a step size in the x direction of $h = 0.1$ and a time step of $k = 0.1$. Create a movie of your results from $t = 0$ to $t = 13$. Plot your solution at $t = 13$.