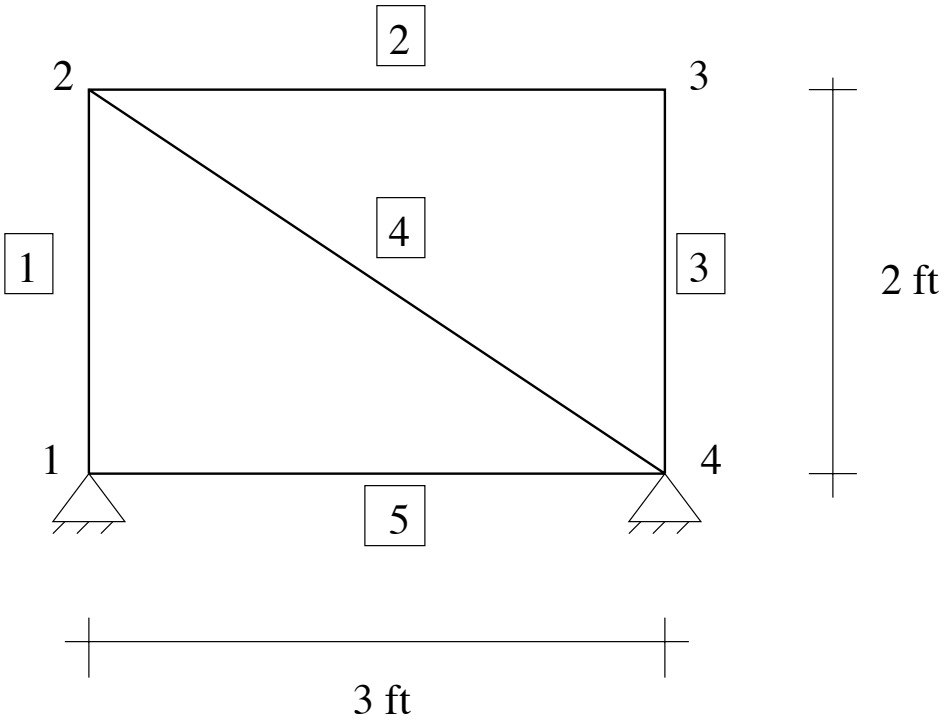
HW 4: Due Wednesday March 3

1. Consider the truss shown below. Assume the bars are steel $E = 30 \times 10^6$ psi. The vertical bars have a diameter of 0.5 in, the horizontal 0.75 in, and the diagonal 1.0 in. Use the number scheme shown and your program from Lab 3 to help solve this problem.



   (a) Find the compatibility matrix for the truss.

   (b) Find the diagonal matrix $\lceil AE/L \rfloor$.

   (c) Assume $u_{2x} = 0.1$ in, $u_{2y} = 0.0$ in, $u_{3x} = -0.1$ in, $u_{3y} = 0.1$ in,

      i. Find the strains in the 5 bars.

      ii. What are the stresses in the 5 bars?

      iii. What are the internal forces in the 5 bars?

      iv. What forces must have been applied to nodes 2 and 3?

      v. What are the support reactions at nodes 1 and 4?

2. Consider the force field $\boldsymbol{F}(x, y) = fxy\boldsymbol{e}_x + f\boldsymbol{e}_y$, where f is a given constant. Demonstrate that this force field is not conservative.

3. Accounting only for bending energy (ignoring shear strain energy), find an expression for the tip deflection of a cantilever beam loaded with a single point force at its end. Assume a beam of length L and a constant bending modulus EI.

4. A solid circular bar is bent 90^o at two locations and is built-in at one end. Assume A, I, J, E, and G are constants.

   (a) Using conservation of energy, determine a formula for the vertical deflection at the point of load application.

   (b) Let $L = 200$ mm and the diameter of the bar be $d = 30$ mm. What is the percent contribution to the total deflection from axial loading, bending, torsion, and direct shear? Assume $E/G = 2$.

   (c) Repeat with $L = 500$ mm and $d = 10$ mm.