CE 525 Fall 2024 HW#2

Due Thursday, September 26, by 5:00pm ET

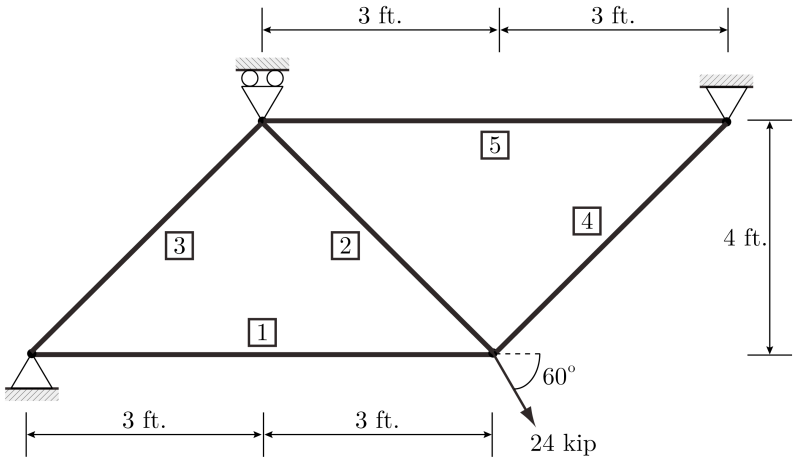
1. For the 2D truss structure shown below determine joint displacements, axial bar forces and stresses, and support reactions using the Matrix Displacement Method:

a. (5 pts) By hand

b. (5 pts) Using SAP2000

c. (5 pts) Computer programming by modifying the uniaxial code for 2D truss analysis

d. (5 pts) Computer programming by modifying the 2D truss code for the finite-element formulation derived from virtual work w/ linear shape functions: e.g. $\bar{u}_x = \sum_{i=0}^{1} a_i x^i$



E = 10,000 ksi ; A = 2.0 in.^{2} for all members

2. Now assume members 1, 2, and 4 have linearly tapered areas A_b = 2.0 in.^{2} (at supports) and A_e = 1.0 in.^{2} (at intersecting joint). Determine joint displacements and support reactions:

a. (5 pts) Computer programming with *exact* stiffness terms for cross-sectional area as function of length prescribed by: $A(x) = A_b(1 - r_a\, x/L)$, $r_a = 1/2$.

b. (5 pts) Computer programming and the *finite-element* (FE) formulation derived from virtual work w/ *linear* shape functions.

c. (5 pts) Computer programming and the *finite-element* (FE) formulation derived from virtual work w/ *quadratic* shape functions where $a_1 \equiv \dfrac{u_j - u_i}{2L}$ (*hint: derive* a_0 & a_2)

3. (10 pts) Compare/comment on the results in Parts 1c with 1d, and Parts 2a with 2b, c.