

MCG 4102 / 5108 - Assignment 1

Note: Numerical values may change slightly due to round-off errors.

Using the truss example given in class (4 nodes, and 5 elements involving 2 materials):

1) Show that $[K^{(1)}] = 10^3 \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 982 & 0 & -982 \\ 0 & 0 & 0 & 0 \\ 0 & -982 & 0 & 982 \end{bmatrix}$ lbf/in.

2) Given $[K^{(2)}] = 10^3 \begin{bmatrix} 115 & 0 & -115 & 0 \\ 0 & 0 & 0 & 0 \\ -115 & 0 & 115 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ lbf/in, $[K^{(3)}] = 10^3 \begin{bmatrix} 351 & 176 & -351 & -176 \\ 176 & 88 & -176 & -88 \\ -351 & -176 & 351 & 176 \\ -176 & -88 & 176 & 88 \end{bmatrix}$ lbf/in,

$[K^{(4)}] = 10^3 \begin{bmatrix} 98 & -33 & -98 & 33 \\ -33 & 11 & 33 & -11 \\ -98 & 33 & 98 & -33 \\ 33 & -11 & -33 & 11 \end{bmatrix}$ lbf/in and $[K^{(5)}] = 10^3 \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 589 & 0 & -589 \\ 0 & 0 & 0 & 0 \\ 0 & -589 & 0 & 589 \end{bmatrix}$ lbf/in, show that

$[K^a] = 10^3 \begin{bmatrix} 115 & 0 & 0 & 0 & -115 & 0 & 0 & 0 \\ & 982 & 0 & -982 & 0 & 0 & 0 & 0 \\ & & 450 & 143 & -351 & -176 & -98 & 33 \\ & & & 1080 & -176 & -88 & 33 & -11 \\ & & & & 466 & 176 & 0 & 0 \\ & & & & & 677 & 0 & -589 \\ & & & & & & 98 & -33 \\ \text{Sym} & & & & & & & 600 \end{bmatrix}$ lbf/in.

3) What are the boundary conditions? Given $\{F^a\}^T = \{-1000 \quad -1732 \quad 0 \quad 0 \quad R_{x3} \quad 0 \quad R_{x4} \quad R_{y4}\}^T$ lbf, apply the boundary conditions and solve the remaining system of equations for displacements using MatLab (do not do it by hand!).

4) Verify that $u_1 = -0.00879$ in $u_2 = 0.01012$ in
 $v_1 = -0.03581$ in $v_2 = -0.03405$ in
 $u_3 = 0$ $u_4 = 0$
 $v_3 = -0.00180$ in $v_4 = 0$

5) In Element 3, compute elongation δ , strain $\epsilon = \frac{\delta}{L}$, stress $\sigma = E\epsilon$ and force $F = \sigma A$. Verify that $F^{(3)} = -2352$ lbf (compressive force).