UNIVERSITY OF SASKATCHEWAN
DEPARTMENT OF MECHANICAL ENGINEERING
ME 450.3 FINITE ELEMENT ANALYSIS
MIDTERM EXAMINATION

Time: 1.5 hours
Solve 3 questions only
Closed-book examination
One-page formula sheet allowed

October 2014
W. Szyszkowski

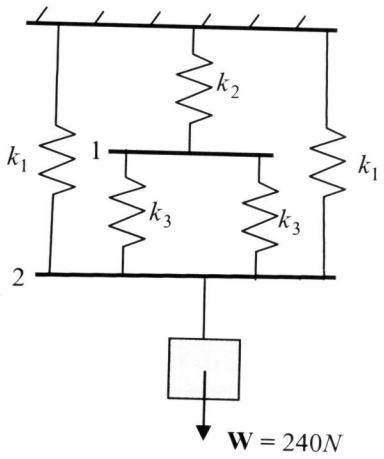
Q1. Apply the Principle of Minimum Energy Potential to analyze the spring system shown.

a) If $k_1 = k_2 = k_3 = 30\frac{N}{mm}$ determine:

- The displacements at nodes 1 and 2.
- The forces in the springs.

Check the equilibrium of nodes 1 and 2.

b) If $k_2 = 90\frac{N}{mm}$ ($3\times$ stiffer) and $k_1 = k_3 = 30\frac{N}{mm}$ (unchanged) determine the displacement at node 2 and the force in spring k_1.



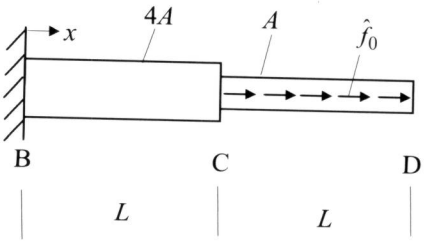
Q2. Apply the RR method to solve the problem below.

a) Use the linear approximation $\tilde{u}(x) = \alpha_0 + \alpha_1 x$

- Identity DOFs and the corresponding trial functions.
- Determine and plot the displacements for the rod
- Determine and plot the stresses for the rod.
- Comment on the expected accuracy of your results

b) Identify DOFs and the corresponding trial functions if the cubic approximation is used $\tilde{u}(x) = \alpha_0 + \alpha_1 x + \alpha_2 x^2 + \alpha_3 x^3$

Note that only the segment CD (of area A) is under the constant line load $\hat{f}_0$. and also that the cross-sectional area of segment BC is $4A$.

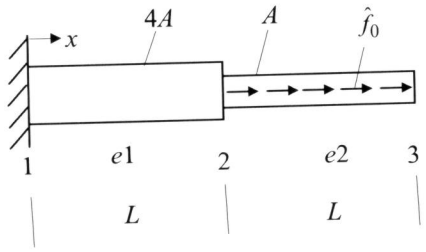


Given $L=60in$, $\hat{f}_0 = 900\frac{lb}{in}$

$A = 2in^2$, $E = 30\cdot 10^6 psi$

Q3. Use <u>two linear bar elements</u> to analyze the rod in **Q1**.

a) Determine the nodal displacement and the reaction forces, check the equilibrium.
b) Plot the displacements for the rod.
c) Calculate and plot the element stresses.
d) Calculate and plot the nodal stresses.
Comment on the expected accuracy of your results.

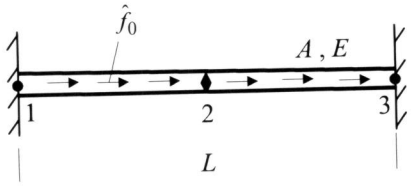


Given $L=60in$, $\hat{f}_0 = 900\frac{lb}{in}$

$A = 2in^2$, $E = 30\cdot10^6\ psi$

Q4. Use <u>one quadratic bar element</u> to analyze the rod under a constant line load $\hat{f} = \hat{f}_0$ as shown.

a) Determine the nodal displacement and the reaction forces, check the equilibrium.
b) Plot the displacements of the rod.
c) Calculate and plot the element stresses.
d) Calculate and plot the nodal stresses.
Comment on the expected accuracy of your results.



Given $L=120in$, $\hat{f}_0 = 1000\frac{lb}{in}$

$A = 5in^2$, $E = 30\cdot10^6\ psi$