

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

Time: 1.5 hours
Open-book examination
Answer all questions

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Q1. Use *two linear* elements to determine the deformation and stresses due to increase of temperature of $\Delta T = 40^\circ C$ in the bar fixed at both ends as shown.

The bar's area varies according to: $A(x) = \frac{A_0}{\left(1 + \frac{x}{L}\right)^4}$

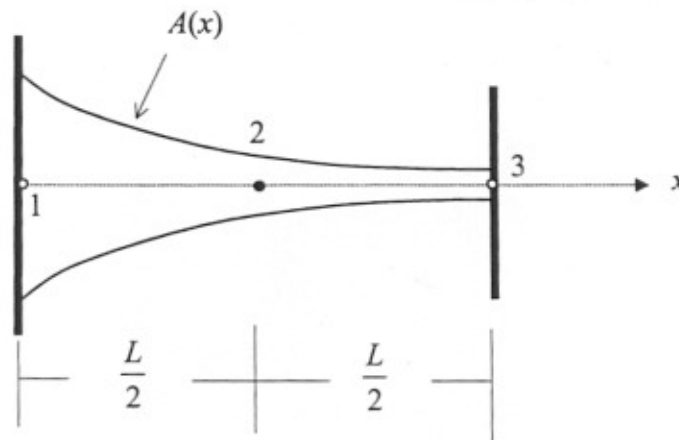
Calculate:

- a) The displacement at node 2.
- b) The reaction forces.
- c) The stresses in the elements.
- d) The nodal stresses.

Plot $u(x)$ and $\sigma(x)$ using the above two-element solution.

Use: $E = 2 \cdot 10^5 MPa$, $A_0 = 400 mm^2$, $\alpha = 1.5 \cdot 10^{-5} \%_C$, $L = 100 mm$

80.47
225.39
222.054
307.654



Briefly comment on accuracy of:
- the displacement calculations,
- the stress calculations.

The following integral may be useful:

$$\int \frac{dx}{\left(1 + \frac{x}{L}\right)^4} = -\frac{L}{3\left(1 + \frac{x}{L}\right)^3}$$

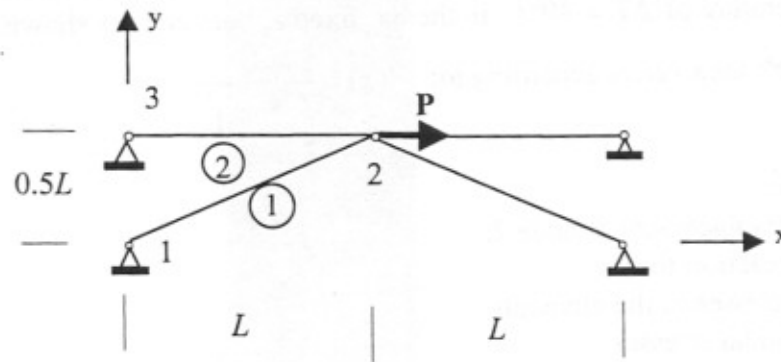
Q2. Apply the truss elements to determine the following:

- The displacement of node 2.
- The reaction forces at nodes 1 and 3.
- The stresses in elements (1) and (2).
- Use the stress results to check equilibrium at node 2.

All results should be obtained in terms of E , A , L , and P .

It is important that you make use of *symmetry* of the truss and *anti-symmetry* of the load.

All elements have the same area A .



Could the quadratic bar elements be used to solve this problem?

How would it affect your results?

Explain briefly your answers.