

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

Time: 3 hours

Open-book examination

Answer **four** questions: Q1, Q2, Q3, and Q4 or Q5

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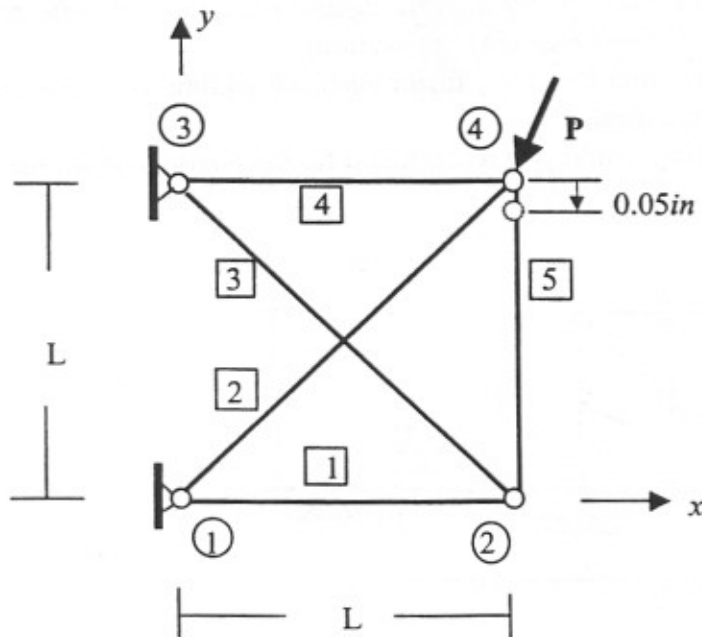
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**Q1.** Node 4 of the truss shown is to be moved  $0.05\text{in}$  down ( $u_4=0$ ,  $v_4=-0.05\text{in}$ ) by applying force **P**.

Using the bar elements determine:

- a) The displacement at node 2.
- b) The components of **P**.
- c) The axial forces in elements 1, 3, 5 and verify equilibrium of node 2.

Assume:  $A=0.1\text{ in}^2$ ,  $E=30 \cdot 10^6\text{ psi}$ ,  $L=30\text{in}$ .



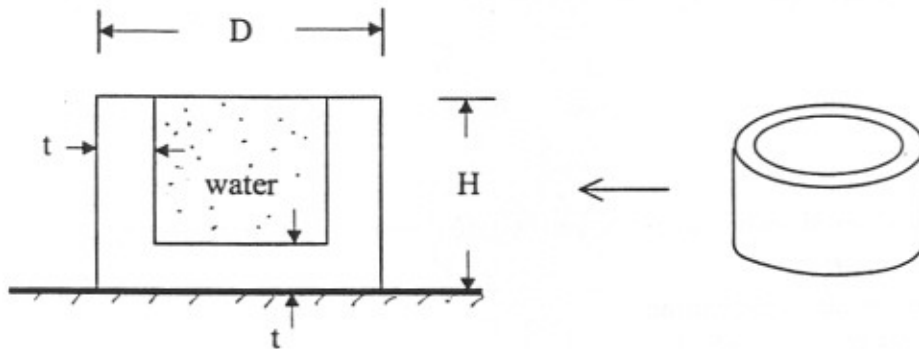
Q2. This question is related to your lab work.

a) An axisymmetric cup made of glass is to be filled with hot water (212°F).

The cup is to be analyzed for the thermal stresses.

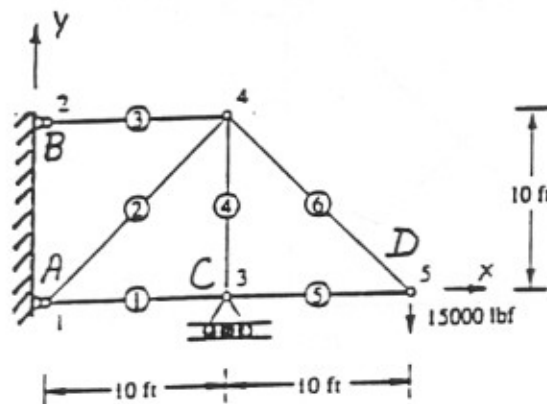
Write the **PREP7** file to model this problem in ANSYS (note that the loads and BC may be specified in the solution phase, use the material data as in Q3, Lab #3.).

Assume:  $D=4\text{in}$ ,  $H=3\text{in}$ ,  $t=0.5\text{in}$ .



- b) The structure shown was analyzed in *Lab #1* and *#4* using different types of elements and meshing patterns. Explain (qualitatively, exact numbers not required):
- how the displacement at **D** was effected by the element type (*link1* or *beam4*),
  - how the displacement at **D** and the safety factor against buckling were effected by the meshing (one or five *beam4* elements per section),
  - how the displacement at **D** and the safety factor against buckling would be effected if the element *beam3* were used.

What element type and meshing would you recommend for the analysis of similar structures?



c) The elements *plane42* used in *Lab #2* and *shell63* used in *Lab #4* are visually similar.

- Could *shell63* be used to solve Q1 in *Lab #2*?
- Could *plane42* be used to solve Q3 in *Lab #4*?

Justify your answers.

Q3. The following problem was solved in your midterm exam using the *linear* shape functions.

$$\text{DE: } \frac{d}{dx} \left[ (1+x) \frac{du}{dx} \right] - 6u + 4 = 0 \quad \text{where} \quad 0 \leq x \leq 1$$

$$\text{BC: } \frac{du}{dx}(0) = 1 \quad \text{and} \quad u(1) = 0$$

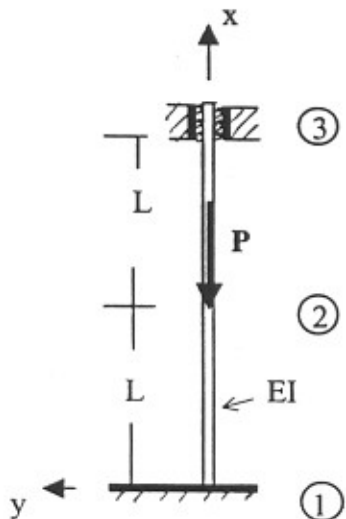
Use the *quadratic* shape functions to obtain a *one-element* solution.

Sketch your new approximate solution for the function  $u(x)$  and the derivative  $\frac{du}{dx}(x)$ .

Q4. Use two beam elements to determine the buckling load  $P$  for the post shown.

Sketch the buckling modes obtained.

How accurate are your results?



Q5. Use two elements to solve the beam shown.

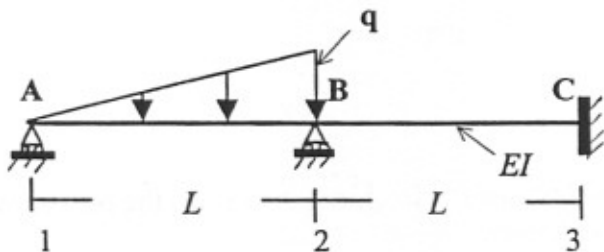
Calculate (in terms of  $EI$ ,  $L$  and  $q$ ):

a) The slopes at **A** and **B**.

b) The vertical reactions at **A**, **B**, and **C** (check the vertical equilibrium).

c) The maximum deflection in the section **BC**.

How accurate are your results?



THE END

Merry Christmas and Happy New Year !!!