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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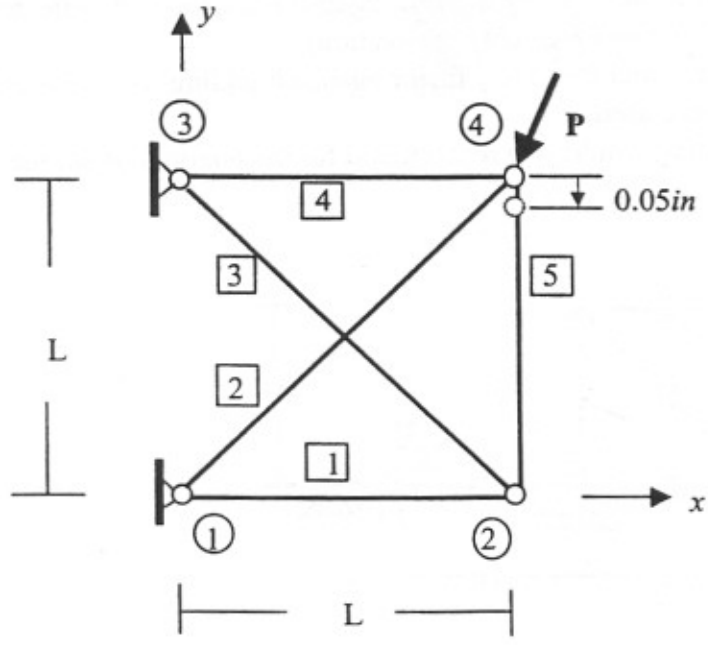
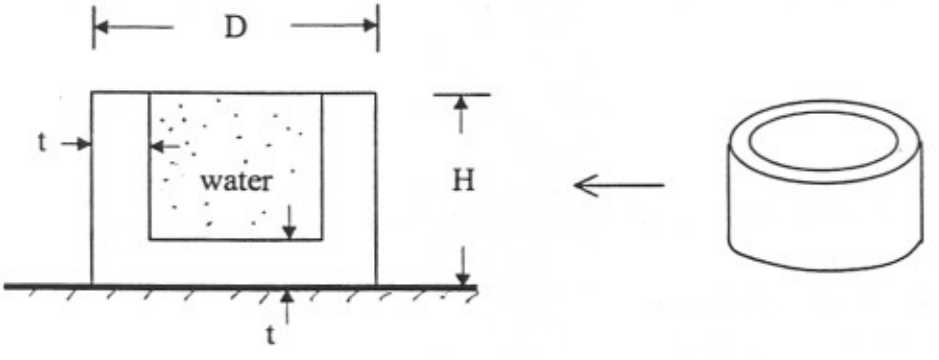
Q1. Node *4* of the truss shown is to be moved 0.05*in* down (u_4=0, v_4=-0.05in) by applying force **P**.
Using the bar elements determine:
a) The displacement at node *2*.
b) The components of **P**.
c) The axial forces in elements *1*, *3*, *5* and verify equilibrium of node *2*.

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



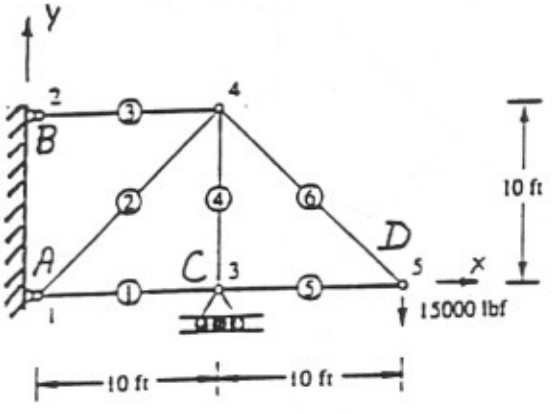
Q2. This question is related to your lab work.

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=4in, H=3in, t=0.5in.



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.

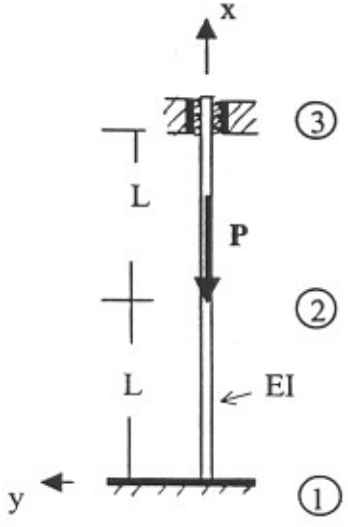
DE: $\frac{d}{dx}\left[(1+x)\frac{du}{dx}\right]-6u+4=0$ where $0\le x\le 1$

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

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.

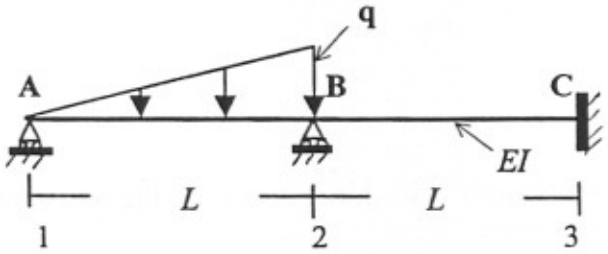
Calculate (in terms of *EI*, *L* and **q**):

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 !!!