

**University of Concordia**  
**Department of mechanical Engineering**  
**ENGR 460-FINITE ELEMENT ANALYSIS**  
**Midterm Examination- February 13, 2002**

**TO BE ANSWERED IN BOOKLETS**

**INSTRUCTOR: Dr. R. SEDAGHTI**  
**TIME ALLOWED: 75 minutes**

THIS EXAMINATION PAPER HAS 2 PAGES.  
 ANSWER ALL QUESTIONS.  
 COURSE TEXT AND LECTURE NOTES ARE ALLOWED.

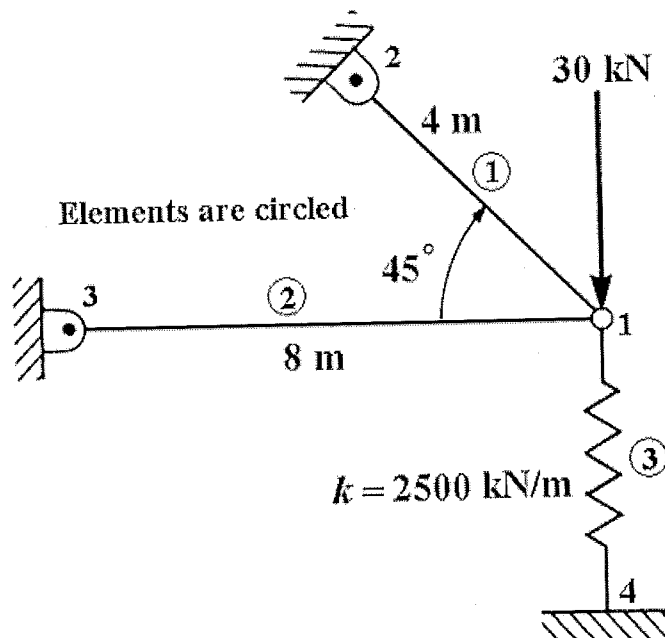
**PROBLEM 1:** (14 marks)

For the plane truss supported by the spring at the node 1 shown in figure below, determine:

- 1: The element stiffness matrix for each element.
- 2: Assemble the system stiffness matrix  $\mathbf{K}$  for the entire system.
- 3: Compute the nodal displacements.
- 4: Calculate the stresses in each truss element and the force in the spring member.
- 5: Find the reaction forces.
- 6: Use one checkpoint to show your results are right.

Module of elasticity  $E=210 \text{ Gpa}$

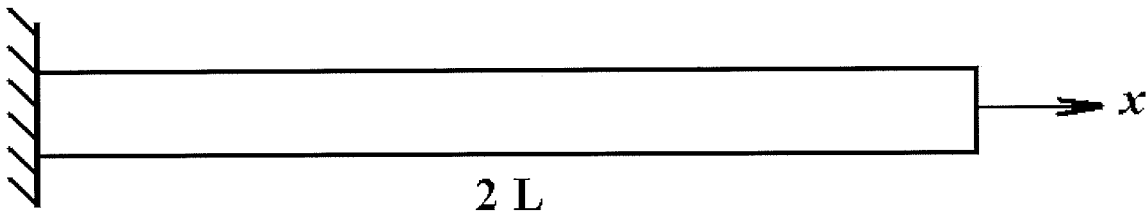
Cross-sectional area  $A=400 \text{ mm}^2$  for both truss elements



**PROBLEM 2:** (6 marks)

For the bar shown in the figure below with length  $2L$ , module of elasticity  $E$ , mass density  $\rho$ , and cross-sectional area  $A$ , use two bar (truss) elements and determine:

- 1: The first two natural frequencies and 2: Their relative mode shapes.



**Note:** Use the consistent mass matrix for truss element written below:

$$\mathbf{M} = \frac{\rho AL}{6} \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$$

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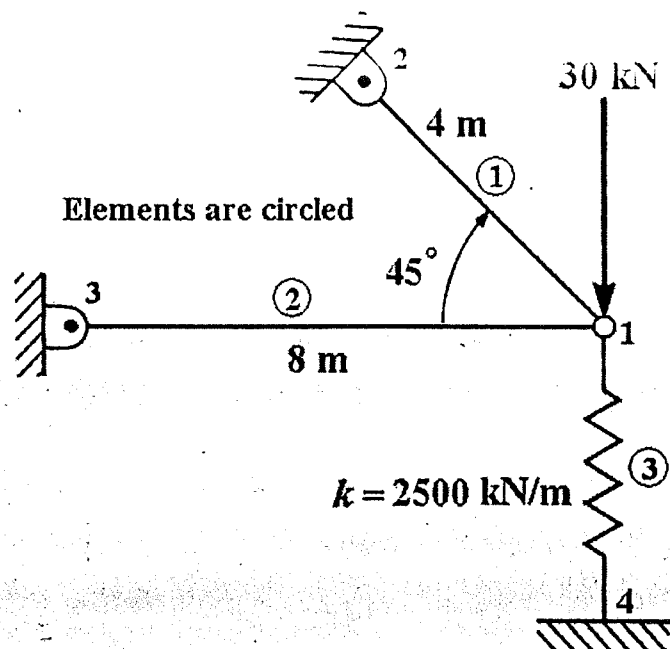
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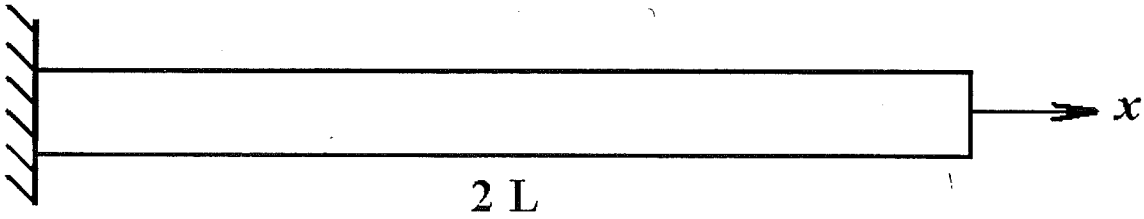
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1 2                  2 3