# Bengal Engineering and Science University, Shibpur

## 1st Semester PG Final Examination, December 2011

**Full Marks: 70** **Time 3 hours**

**Subject: Advance Structural Analysis (CE-901)**

***i. Answer any Five Questions ii. All questions carry equal marks***

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1. Determine the displacements at nodes of the truss shown in Figure Q1. Use the following data: Modulus of Elasticity $E=2\times10^{11}$ N/m$^2$, Cross-section area of Member 1-2: $4\times10^{-4}$m$^2$, Member 2-3: $4\times10^{-4}$m$^2$, Member 2-4: $6\times10^{-4}$m$^2$

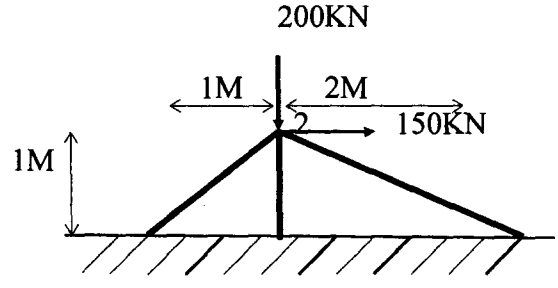


Figure Q1

2. Using two beam elements to model the structure as shown in Figure Q2, find the deflection and internal force quantities for left side member only.

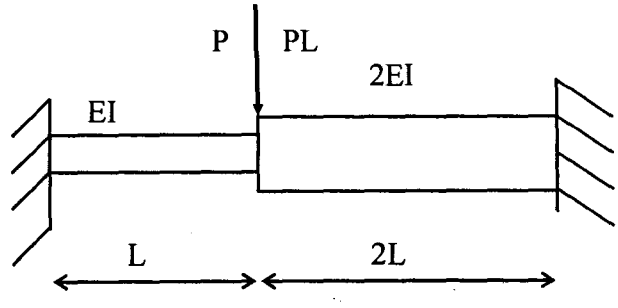


Figure Q2

3 a) Derive the stiffness matrix of a 3D truss element.

b) The element stiffness matrices for a two nodded bar and beam elements are given as follows:

Axial Element

$$[k]=\frac{AE}{L}\begin{bmatrix}1 & -1\\ -1 & 1\end{bmatrix}$$

Beam Element

$$[k]=\frac{EI}{L}\begin{bmatrix}12/L^2 & 6/L & -12/L^2 & 6/L\\ 6/L & 4 & -6/L & 2\\ -12/L^2 & -6/L & 12/L^2 & -6/L\\ 6/L & 2 & -6/L & 4\end{bmatrix}$$

How you will obtain the element stiffness matrix for a two-nodded frame element from above.

4. (a) How you will apply the skew support conditions in a 2D truss

(b) How you will apply spring support condition in a beam structure?

5. Explain plastic hinge, shape factor, load factor and different types of mechanisms of plastic collapse. Determine the shape factor for a steel I-section made of 200 mm x 25 mm thick top flange plate, 500 mm x 10 mm thick web plate and 150 mm x 25 mm thick bottom flange plate.

6. A continuous beam ABC is simply supported at the three supports A, B and C. AB = 5.0 m and BC = 8.0 m with a central concentrated load of 2W on span AB and an uniformly distributed load of W/4 on the entire span of BC. The beam has a uniform section with fully plastic moment $M_p$ = 300 kNm. Determine the loads at the formation of the first and second plastic hinges in the continuous beam ABC.

7. In a rectangular portal frame ABCD the support A is pinned and the support D is fixed. The columns AB and CD are vertical with heights 3.0m and 4.0m respectively. The beam BC is horizontal with a span of 6.0m.The fully plastic moment capacities of AB, BC and CD are $M_p$, $3M_p$ and $2M_p$ respectively. A vertical load of 3P acts at mid span of BC and a horizontal load P acts at B towards C. Find the collapse load P and draw the Bending Moment Diagram at collapse.

8. A two span continuous beam ABC is of uniform flexural rigidity EI and is simply supported at A, B and C. AB = 4.0m and BC = 6.0m. Find the influence line diagram for bending moment at a point P which is 2.0 m away from B on BC.