University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2012 (Set 2)
Program: B. Sc. Engineering (Civil)

Course Title: Structural Engineering III | Credit Hours: 3.0 | Course Code: CE 411
Time: 3 hours | Full Marks: 100 (= 10 × 10)

[Answer **any 10 (ten)** of the following 14 questions]

1. Determine the size of stiffness matrices (**K**) of the 2D frame and 3D frame shown in Fig. 1
   (i) with and without considering the boundary conditions,
   (ii) if axial deformations are neglected.

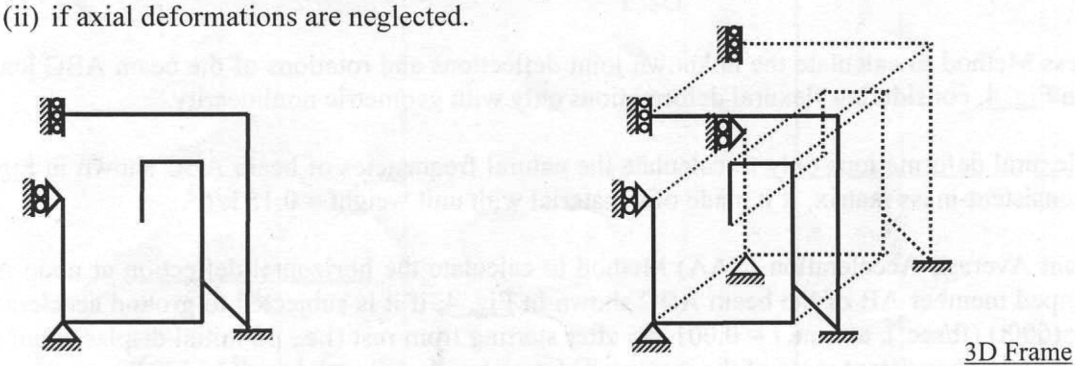


Fig. 1

2. Ignore the zero-force members and formulate the stiffness matrix, load vector and write down the boundary conditions of the truss *abcdef* shown in Fig. 2.

S_x = constant = 5000 kN/m

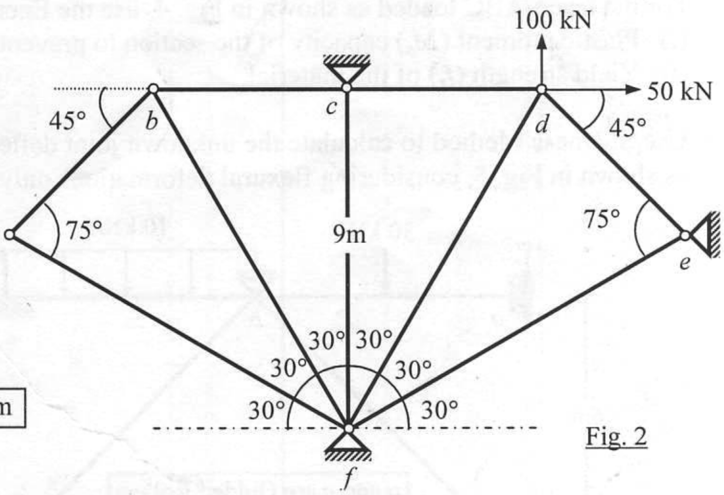
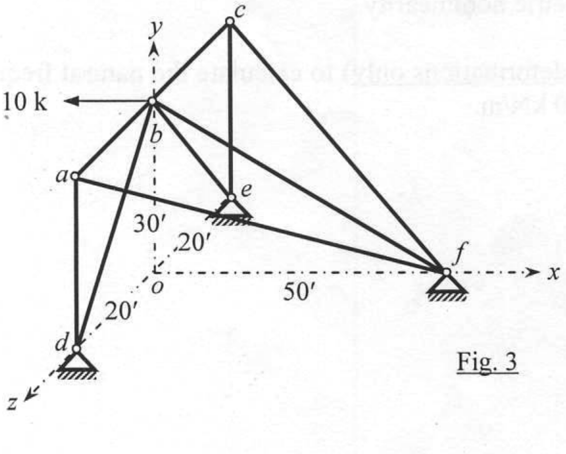


Fig. 2

3. If truss *abcdef* shown in Fig. 2 is supported at joint *e* on a horizontal spring of stiffness k_h = 2500 kN/m and vertical spring of stiffness k_v = 5000 kN/m (instead of the hinge support shown at joint *e*), formulate its stiffness matrix and load vector, ignoring the zero-force members.

4. Ignore zero-force members to form the stiffness matrix, load vector and write down the boundary conditions of the 3D truss *abcdef* shown in Fig. 3 [Given: S_x = constant = 1000 k/ft].



Nodal Coordinates (m)
a (0, 30, 20), *b* (0, 30, 0), *c* (0, 30, –20)
d (0, 0, 20) , *e* (0, 0, –20), *f* (50, 0, 0)

Fig. 3

5. Assemble the stiffness matrix, load vector and calculate the unknown joint deflections and rotations of the beam ABC loaded as shown in Fig. 4, considering both axial and flexural deformations.

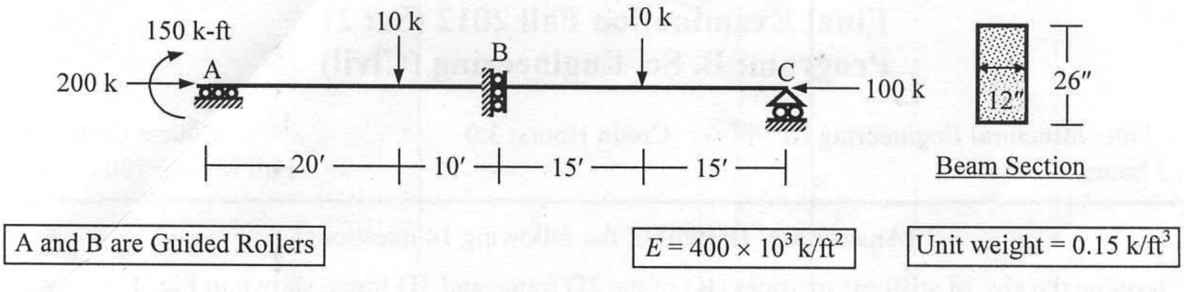


Fig. 4

6. Use Stiffness Method to calculate the unknown joint deflections and rotations of the beam ABC loaded as shown in Fig. 4, considering flexural deformations only with geometric nonlinearity.

7. Consider flexural deformations only to calculate the natural frequencies of beam ABC shown in Fig. 4, using the consistent-mass matrix, if it made of a material with unit weight = 0.15 k/ft^3.

8. Use Constant Average Acceleration (CAA) Method to calculate the horizontal deflection at node A of the 5% damped member AB of the beam ABC shown in Fig. 4, if it is subjected to ground acceleration $a_g = 15\ Cos(600t)$ (ft/sec^2), at time $t = 0.001$ sec after starting from rest (i.e., no initial displacement and velocity), assuming consistent mass of the member [Material with unit weight = 0.15 k/ft^3].

9. For the beam ABC loaded as shown in Fig. 4, use the Energy Method to calculate the required
   (i) Plastic moment (M_p) capacity of the section to prevent development of plastic hinge mechanism,
   (ii) Yield strength (f_y) of the material.

10. Use Stiffness Method to calculate the unknown joint deflections and rotations of the frame *abcde* loaded as shown in Fig. 5, considering flexural deformations only (if the force $P = 0$).

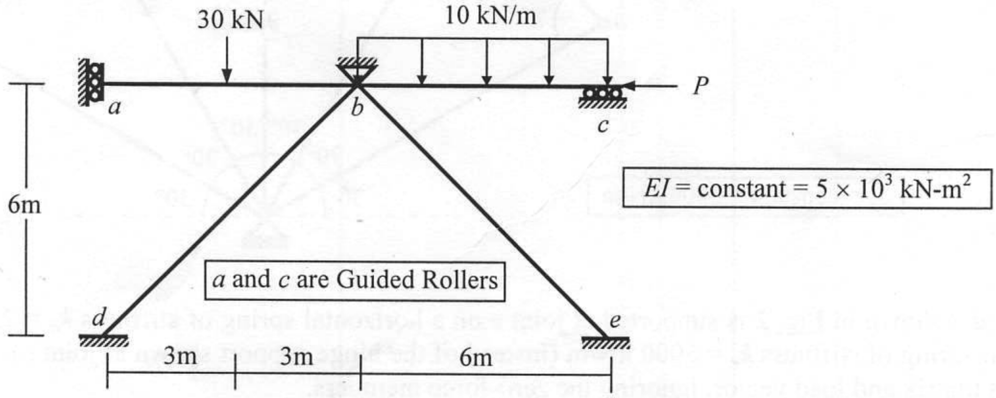


Fig. 5

11. Use Stiffness Method to calculate the force P needed to cause buckling of frame *abcde* shown in Fig. 5, considering flexural deformations only with geometric nonlinearity.

12. Use consistent-mass matrix (considering flexural deformations only) to calculate the natural frequencies of the frame *abcde* shown in Fig. 5, if it weighs 3.0 kN/m.

13. Use the bending moment diagram to calculate the force P needed to develop plastic hinge mechanism in the reinforced concrete beam ABCD loaded as shown in Fig. 6 [Given: $f_c' = 3$ ksi, $f_y = 50$ ksi].

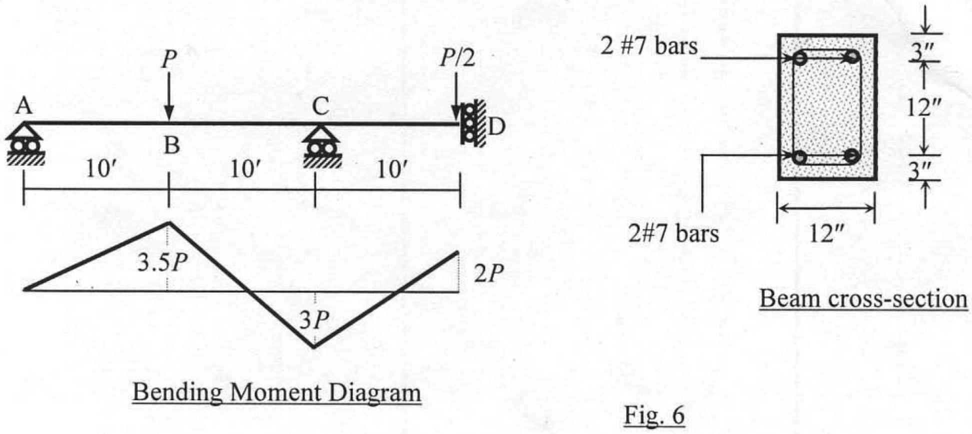


Fig. 6

14. Briefly explain
   (i) how the effect of support settlement can be incorporated in the structural analysis of beams,
   (ii) why the stiffness matrix and mass matrix of a structure are both symmetric (use equations with shape function ψ),
   (iii) the main advantage and disadvantage of using the energy method to obtain the collapse load of a structure,
   (iv) the main advantage and disadvantage of using lumped-mass matrix in structural dynamics,
   (v) the effect of foundation flexibility on the structural response to wind vibration.