

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2013 (Set 2)
Program: B. Sc. Engineering (Civil)

Course Title: Structural Engineering III
 Time: 3 hours

Credit Hours: 3.0

Course Code: CE 411
 Full Marks: 100 (= 10 × 10)

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

1. Determine the degree of kinematic indeterminacy (*doki*) and show the corresponding deflections and rotations 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.

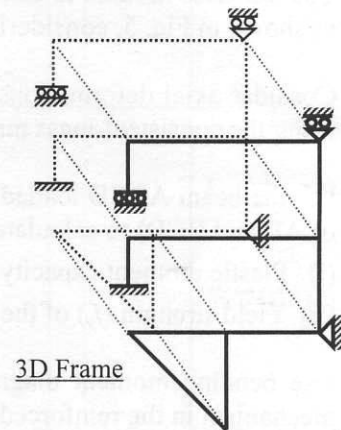
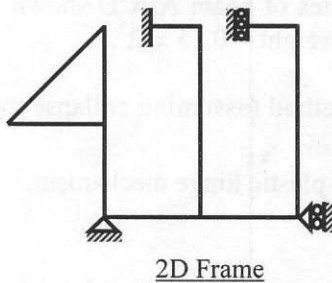
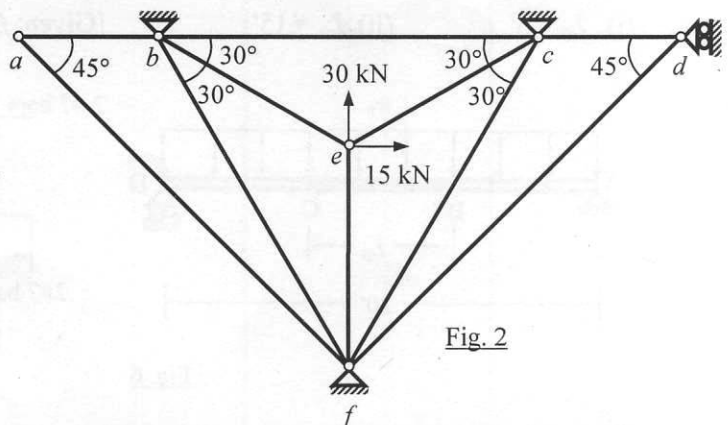


Fig. 1

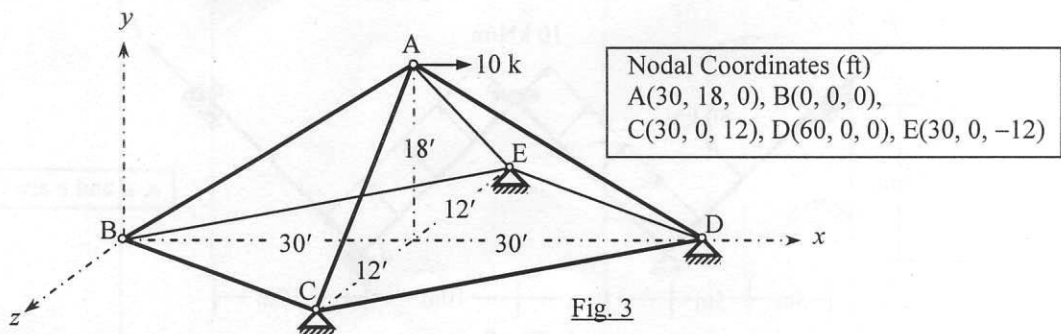
2. In the truss *abcdef* loaded as shown in Fig. 2

- (i) Justify that *ab*, *bc*, *cd*, *af*, *bf*, *cf* and *df* are zero-force members.
 (ii) Use Stiffness Method to calculate the deflections at joint *e*

[Given: $S_x = \text{constant} = 5000 \text{ kN/m}$].



3. Ignore zero-force members to form the stiffness matrix, load vector and write down the boundary conditions of the 3D truss ABCDE shown in Fig. 3 [Given: $S_x = \text{constant} = 500 \text{ k/ft}$].



4. Use Stiffness Method to calculate the deflection and rotation at joint *c* of the grid *abcd* shown in Fig. 4. The spring at *c* represents a circular foundation of radius 3-ft on the surface of sub-soil (half-space) with shear-wave velocity (v_s) equal to 300 ft/sec.

The structure can be simplified by using symmetry about *ac*

[Given: $EI = 60 \times 10^3 \text{ k-ft}^2$, $GJ = 50 \times 10^3 \text{ k-ft}^2$,
 Unit weight of soil = 0.11 k/ft^3 , Poisson's ratio = 0.30].

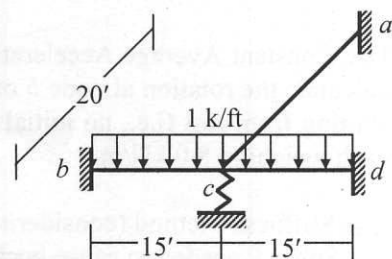


Fig. 4

5. Assemble the stiffness matrix, load vector and specify the boundary conditions of beam ABCD loaded as shown in Fig. 5, considering both axial and flexural deformations [Given: $E = 400 \times 10^3 \text{ k/ft}^2$].

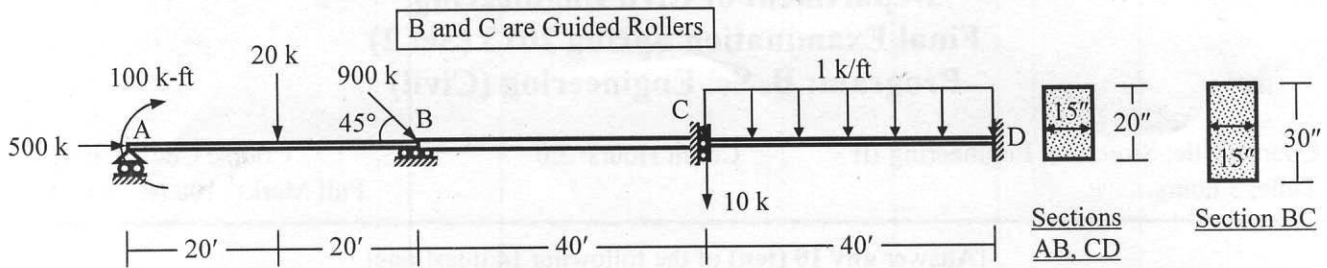


Fig. 5

Beam Sections

6. Use Stiffness Method to calculate the unknown joint deflections and rotations of the beam ABCD loaded as shown in Fig. 5, considering flexural deformations only with geometric nonlinearity.
7. Consider axial deformations only to calculate the natural frequencies of beam ABCD shown in Fig. 5, using the consistent-mass matrix, if it made of a material with unit weight = 0.15 k/ft^3 .
8. For the beam ABCD loaded as shown in Fig. 5, use the Energy Method (assuming collapse mechanism of AB and BCD) to calculate the required
- Plastic moment capacity of the sections to prevent formation of plastic hinge mechanism,
 - Yield strength (f_y) of the material.
9. Use bending moment diagram to calculate the distributed load w_0 required to develop plastic hinge mechanism in the reinforced concrete beam ABCD loaded as shown in Fig. 6 if
- $L_0 = 5'$,
 - $L_0 = 15'$
- [Given: $f_c' = 3 \text{ ksi}$, $f_y = 50 \text{ ksi}$].

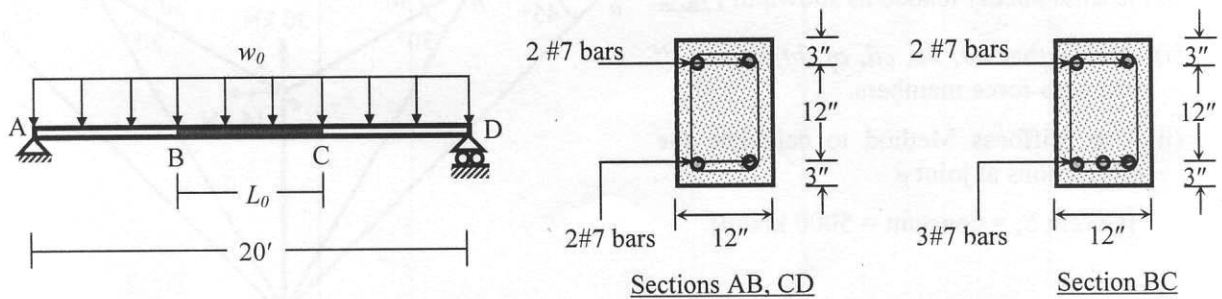


Fig. 6

Beam Sections

10. Use Stiffness Method (considering flexural deformations, if $P = 0$) to calculate the rotation at node b and deflection at d of the frame $abcde$ loaded as shown in Fig. 7 [Given: $EI = \text{constant} = 10 \times 10^3 \text{ kN}\cdot\text{m}^2$].

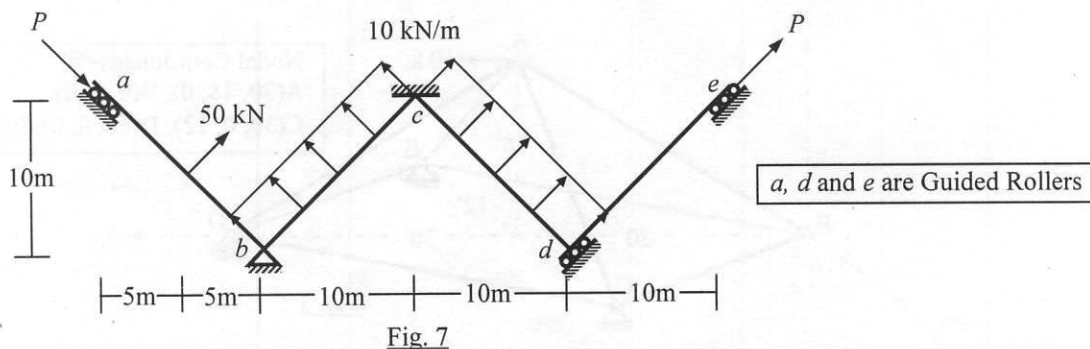


Fig. 7

11. Use Constant Average Acceleration (CAA) Method (considering flexural deformations only, if $P = 0$) to calculate the rotation at node b of the 5% damped frame $abcde$ shown in Fig. 7, at time $t = 0.01 \text{ sec}$ after starting from rest (i.e., no initial displacement and velocity), assuming consistent mass of the members, each weighing 8.0 kN/m .
12. Use Stiffness Method (considering flexural deformations with geometric nonlinearity) to calculate the
- Force P needed to cause buckling of frame $abcde$ shown in Fig. 7 (considering members ab and bc),
 - Deflection at joint d using the force P calculated in (i).

13. The 200-ft long cable acb shown in Fig. 8 (subjected to tension $P = 2000$ lb), carries a concentrated load of $F_0 = 100$ lb, in addition to a distributed self-weight $w_0 = 1$ lb/ft.

Assuming negligible value of $EI (\cong 0)$, consider geometric nonlinearity to calculate the

- (i) Rotation at joint b ,
- (ii) Natural frequency of the cable.

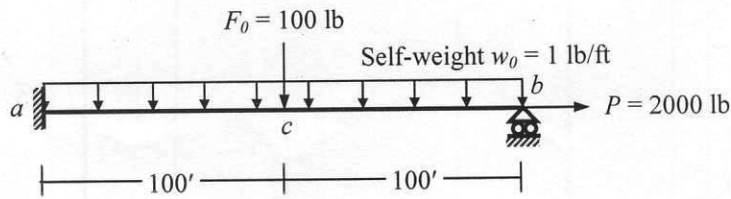


Fig. 8

14. Briefly explain the

- (i) difference between the structural analysis of a 3D frame and grid (considering member properties, joint deflections/rotations and member forces),
- (ii) possible effect of axial force on geometric nonlinearity and structural stiffness,
- (iii) difference between beam mechanism and side-sway mechanism in the plastic analysis of frames,
- (iv) possible effect of material nonlinearity on the natural frequency of a structure,
- (v) effect of soil properties on the stiffness of foundation.