Ministry of Higher Education
Giza Higher Institute for Eng. & Tech.
Civil Engineering Department
Course Name: Computer Applications in Civil Eng.
Course Code : **CIV 410**

Academic Year : **2014–2015**
Semester : **Second**
Level : **4th**
Time : **3 Hours**
Date : **31 / 5 / 2015**
Examiner: ***Dr. M. Abdel-Kader***

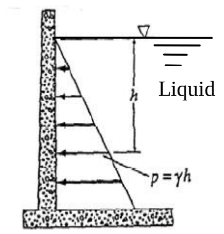
Second Semester Final Examination

- Attempt all questions.
- The Exam consists of **4** questions in **2** pages. - Maximum grade is **60 Marks**.

Question (1): (10 Marks)

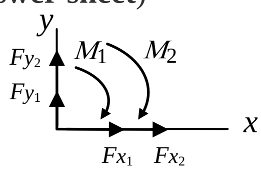
(a) Choose the correct answer (**Put a, b, c or d in front of the statement number in your answer sheet**).

1. In SAP, properties of material and load combinations are considered as
   a) Input data. c) Results of the analysis.
   b) Output data. d) Always not required in the analysis.
2. The responsibility of the analytical model results lies on
   a) The computer used. c) The company developed the software.
   b) The input data. d) The structural designer who used the software.
3. One of the assumptions that the stiffness method is based on to analyze plane frames is
   a) Members (beams and columns) are straight with variable properties between joints.
   b) Members will behave in non-linear and plastic manner.
   c) Axial forces in members are very much less than the respective Euler buckling loads.
   d) Applied loads may act out of the structure plane.
4. The triangle load applied on the shown vertical wall is called:
   a) Earth pressure Load. c) Earthquake Load.
   b) Hydrostatic Load. d) Settlement Load.

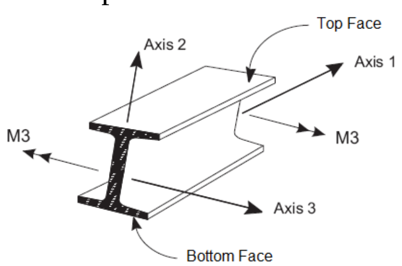


5. Stiffness is the property of an element which is defined as
   a) Force per unit displacement. c) Force per unit mass.
   b) Displacement per unit force. d) Displacement per unit area.
6. The correct choice of modeling and analysis tools/methods depends on
   a) Importance of the structure. c) Purpose of structural analysis.
   b) Required level of response accuracy. d) All the above.

(b) TRUE or FALSE (Put ✓ or ✗ in front of the statement number in your answer sheet)



1. For plane frame element 1-2 (connecting joints 1 and 2), the positive sign of forces (forces and moments) is as shown in the figure.
2. The frame element is also called beam-column element.
3. For intermediate hinge, only the compatibility of the displacement is satisfied while the compatibility is not satisfied for the rotation.
4. The abbreviation "CAD" means Computer-Aided Design and the abbreviation "SAP" means Structural Analysis Programs.
5. Bar element used in modeling trusses has two nodes at its ends, every node has 3 degree of freedom (d.o.f) in the element axial direction.
6. In space frames, there are 6 d.o.f per free node, which are 3 translations and 3 rotations.
7. The default initial output of SAP2000 is the deformed shape of the structure.
8. SAP2000 always assumes that Z is the vertical axis, with +Z being upward.
9. Self-weight loading always acts downward, in the –Z direction.
10. Structures that can be modeled with the frame element include: 3-D and planar frames – 3-D and planar trusses – Flat slabs – Raft foundation.
11. Sections are defined independently of the frame elements, and are assigned to the elements.
12. If the direction of the moment M3 is as shown in the figure, the top face will be subject to a compression.
13. The order of the input data: Editing Supports & Assigning Frame Sections is not important.
14. Wind load is constant over the height of high rise buildings.



Please turn over

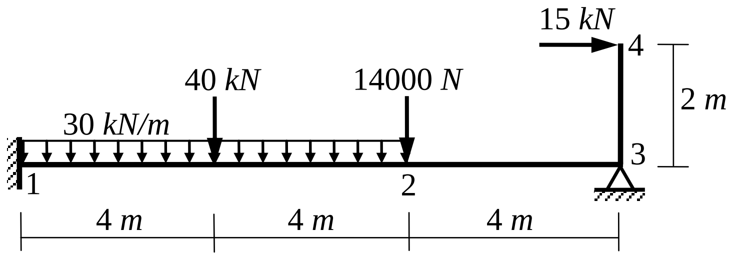
Question (2): (10 Marks)

The matrix equilibrium equation of the shown structure is:

$$\{F\} = [K]\,\{\Delta\} + \{F^f\}$$

Write

- The nodal forces vector $\{F\}$
- The nodal displacements vector $\{\Delta\}$
- The fixed end solution $\{F^f\}$

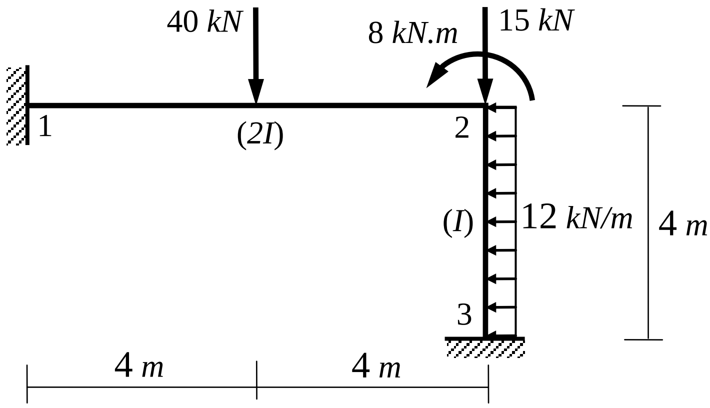


Question (3): (20 Marks)

For the shown loaded frame with variable moment of inertia, using the stiffness method and **neglecting axial deformation,**

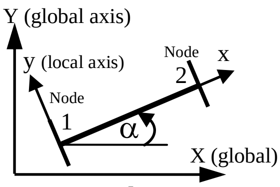
(a) determine the displacements at the nodes due to the given load.

(b) draw the bending moment diagram.



Given Data:

$E = 2.1\times10^{7}\ kN/m^{2}$ $\quad I = 0.8\times10^{-3}\ m^{4}$ $\quad A = 0.02\ m^{2}$



Frame element

$$[K_e]=\begin{bmatrix}
\left(\frac{EA}{L}\lambda^2+\frac{12EI}{L^3}\mu^2\right) & \left(\frac{EA}{L}\mu\lambda-\frac{12EI}{L^3}\mu\lambda\right) & -\frac{6EI}{L^2}\mu & \left(-\frac{EA}{L}\lambda^2-\frac{12EI}{L^3}\mu^2\right) & \left(-\frac{EA}{L}\mu\lambda+\frac{12EI}{L^3}\mu\lambda\right) & -\frac{6EI}{L^2}\mu \\
\left(\frac{EA}{L}\mu\lambda-\frac{12EI}{L^3}\mu\lambda\right) & \left(\frac{EA}{L}\mu^2+\frac{12EI}{L^3}\lambda^2\right) & \frac{6EI}{L^2}\lambda & \left(-\frac{EA}{L}\mu\lambda+\frac{12EI}{L^3}\mu\lambda\right) & \left(-\frac{EA}{L}\mu^2-\frac{12EI}{L^3}\lambda^2\right) & \frac{6EI}{L^2}\lambda \\
-\frac{6EI}{L^2}\mu & \frac{6EI}{L^2}\lambda & \frac{4EI}{L} & \frac{6EI}{L^2}\mu & -\frac{6EI}{L^2}\lambda & \frac{2EI}{L} \\
\left(-\frac{EA}{L}\lambda^2-\frac{12EI}{L^3}\mu^2\right) & \left(-\frac{EA}{L}\mu\lambda+\frac{12EI}{L^3}\mu\lambda\right) & \frac{6EI}{L^2}\mu & \left(\frac{EA}{L}\lambda^2+\frac{12EI}{L^3}\mu^2\right) & \left(\frac{EA}{L}\mu\lambda-\frac{12EI}{L^3}\mu\lambda\right) & \frac{6EI}{L^2}\mu \\
\left(-\frac{EA}{L}\mu\lambda+\frac{12EI}{L^3}\mu\lambda\right) & \left(-\frac{EA}{L}\mu^2-\frac{12EI}{L^3}\lambda^2\right) & -\frac{6EI}{L^2}\lambda & \left(\frac{EA}{L}\mu\lambda-\frac{12EI}{L^3}\mu\lambda\right) & \left(\frac{EA}{L}\mu^2+\frac{12EI}{L^3}\lambda^2\right) & -\frac{6EI}{L^2}\lambda \\
-\frac{6EI}{L^2}\mu & \frac{6EI}{L^2}\lambda & \frac{2EI}{L} & \frac{6EI}{L^2}\mu & -\frac{6EI}{L^2}\lambda & \frac{4EI}{L}
\end{bmatrix}$$

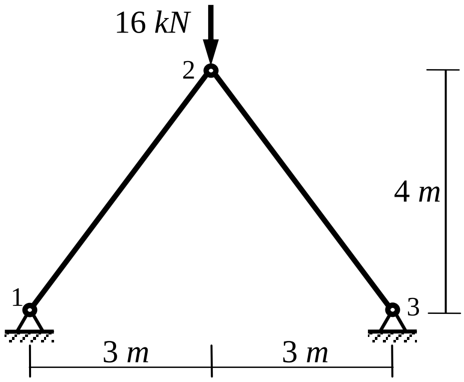
Where, $\lambda = \cos\alpha$ and $\mu = \sin\alpha$

Question (4): (20 Marks)

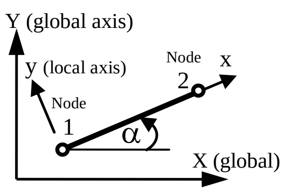
For the shown truss, using the stiffness method:

(a) Determine the displacements at the nodes due to the given load.

(b) Determine the reactions at the supports.



Given Data: $E = 2.0\times10^{7}\ kN/m^{2}$ $\quad A = 2.0\times10^{-4}\ m^{2}$



Truss (Bar) element

$$[K_e]=\begin{bmatrix}
\frac{EA}{L}\lambda^2 & \frac{EA}{L}\mu\lambda & -\frac{EA}{L}\lambda^2 & -\frac{EA}{L}\mu\lambda \\
\frac{EA}{L}\mu\lambda & \frac{EA}{L}\mu^2 & -\frac{EA}{L}\mu\lambda & -\frac{EA}{L}\mu^2 \\
-\frac{EA}{L}\lambda^2 & -\frac{EA}{L}\mu\lambda & \frac{EA}{L}\lambda^2 & \frac{EA}{L}\mu\lambda \\
-\frac{EA}{L}\mu\lambda & -\frac{EA}{L}\mu^2 & \frac{EA}{L}\mu\lambda & \frac{EA}{L}\mu^2
\end{bmatrix}$$

Where, $\lambda = \cos\alpha$ and $\mu = \sin\alpha$

With my best wishes

Dr. M. Abdel-Kader