Ministry of Higher Education
Giza Higher Institute of Engineering & Technology
Civil Engineering Department
Course Name: **Computer Applications in Civil Eng.**
Course Code: **CIV 410** Date: **13 / 7 / 2020**

Academic Year : **2019/2020**
Semester : **Second**
Level : **4th**
Time : 3 **Hours**
Examiner: ***Dr. M. Abdel-Kader***

Final Exam

Total Marks: **60** No. of Questions: **3** (Attempt all questions)

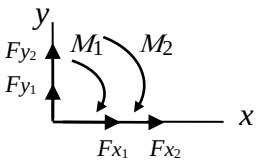
Question (1): (20 Marks) (a2, a5)

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

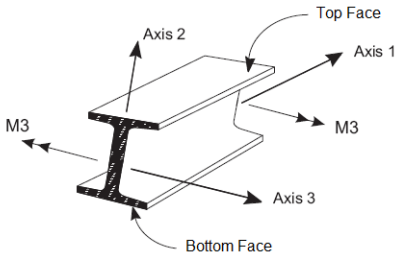
1. In structural analysis programs, properties of material and loads are considered as
   a) Results of the analysis. c) Input data.
   b) Output data. d) Always not required in the analysis.
2. The responsibility of the analytical model results lies on
   a) The structural designer who used the software. c) The input data.
   b) The company developed the software. d) The computer used.
3. Stiffness is the property of an element which is defined as
   a) Displacement per unit area. c) Force per unit mass.
   b) Displacement per unit force. d) Force per unit displacement.
4. 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.
5. For plane frame in X-Z plane, the fixed support has restraints in Joint Local Directions as:

a) b) c) d)

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



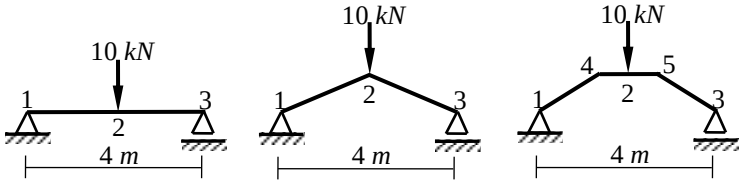
1. For plane frame element 1-2 (connecting joints 1 and 2), the positive sign of forces (forces and moments) is as shown in the figure.
2. The frame element is also called beam-column element.
3. For intermediate hinge, only the compatibility of the displacement is satisfied while the compatibility is not satisfied for the rotation.
4. The abbreviation "CAD" means Computer-Aided Design and the abbreviation "DOF" means Degree of Freedom.
5. In space frames, there are 6 DOF per free node, which are 3 translations and 3 rotations.
6. Bar element used in modeling trusses has two nodes at its ends, every node has 3 DOF in the element axial direction.



7. If the direction of the moment M3 is as shown in the figure, the top face will be subject to a tension.
8. Structures that can be modeled with the frame element include: 3-D and planar frames – 3-D and planar trusses – Flat slabs – Raft foundation.
9. The order of the input data: Editing Supports & Assigning Frame Sections is very important
10. Wind load is usually applied parallel to the surface.
11. In 2-D Analysis, 1D, 2D and 3D elements can be used.
12. For (2D) area elements, the sections must be defined.
13. For (1D) frame elements, the sections must be defined.

Please turn over

14. The bending moments at mid-span (at node 2) of the three beams shown below are the same (= 10 *kN.m*).

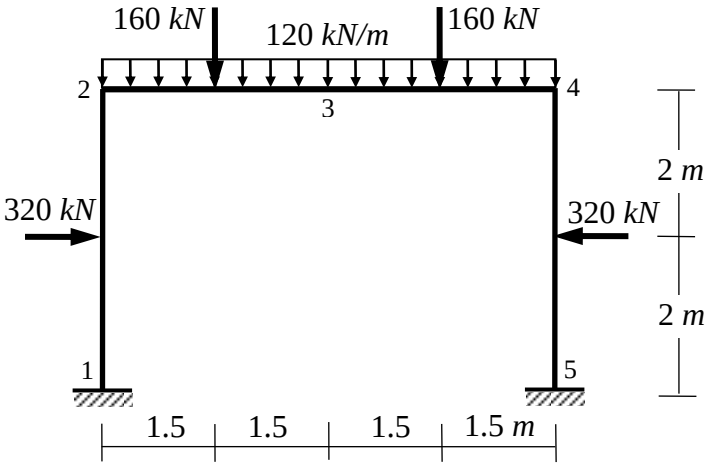


15. In the three beams shown above, when the axial deformation is neglected, $u_3 = 0$ for the first beam only.

Question (2): (20 Marks) (b1, b7, c1, c6)

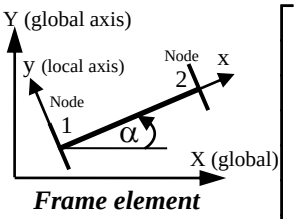
For the shown frame, **using the stiffness method**:
Neglect axial deformation

(a) Determine the displacements at the nodes due to the given load.
(b) Draw the bending moment diagram.



Given Data:

$E = 2.1\times10^{7}\ kN/m^2$ $A = 0.15\ m^2$ $I = 3.125\times10^{-3}\ m^4$



Frame element

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

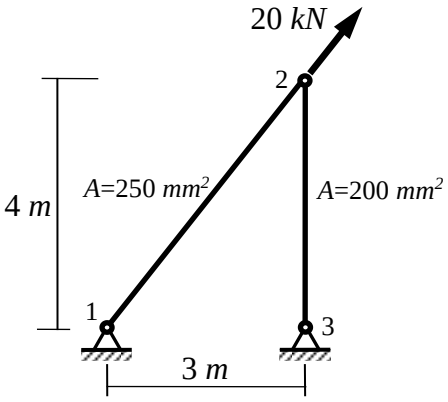
Where, $\lambda = \cos\alpha$ and $\mu = \sin\alpha$

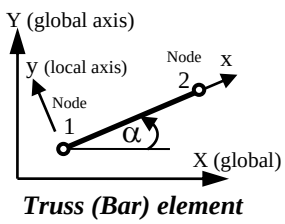
Question (3): (20 Marks) (b1, b7, c1, c6)

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: $E = 2.0\times10^{7}\ kN/m^2$.
A for each member is as shown on the truss.





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