

امتحان منتصف الترم

- The Exam consists of **2** questions in **1** page.

Question (1): (14 Marks)

For the shown frame, using the stiffness method:

Neglect axial deformation

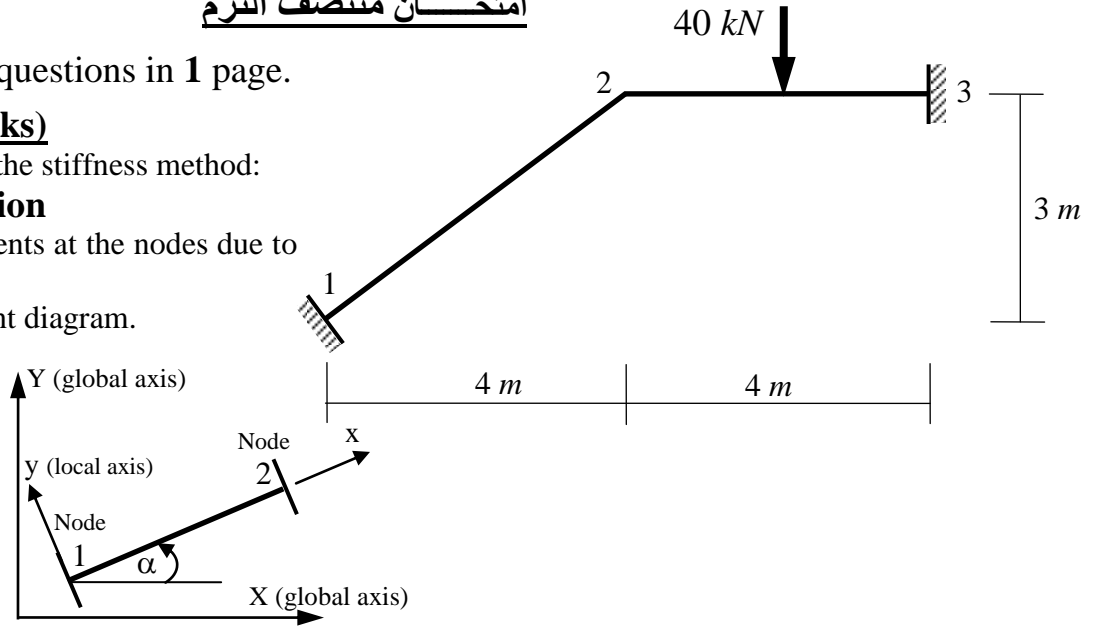
- (a) determine the displacements at the nodes due to the given load.
- (b) draw the bending moment diagram.

Given Data:

$$E = 2.1 \times 10^7 \text{ kN/m}^2$$

$$A = 0.15 \text{ m}^2$$

$$I = 3.125 \times 10^{-3} \text{ m}^4$$



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 $\mu = \sin \alpha$

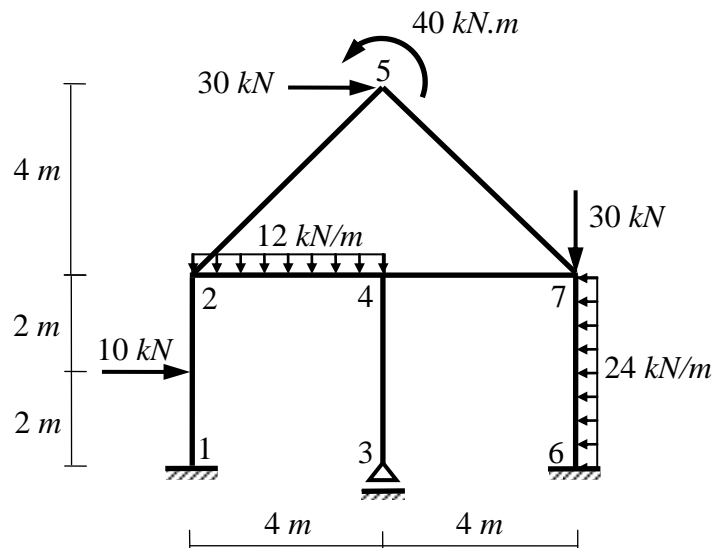
Question (2): (6 Marks)

The matrix equilibrium equation of the shown frame is:

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

Write

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



With my best wishes

Dr. M. Abdel-Kader