

Mid-Term Exam

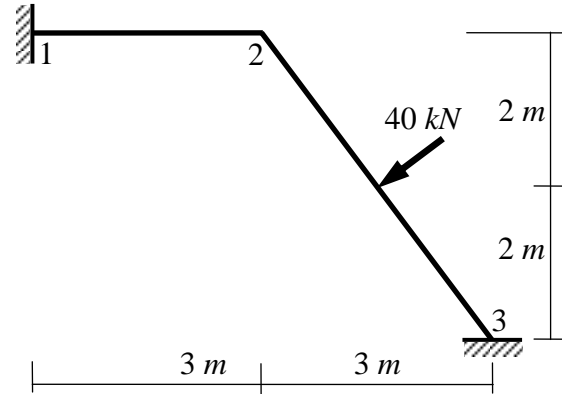
Total Marks: 15

No. of Questions:1

Question (1): (15 Marks)

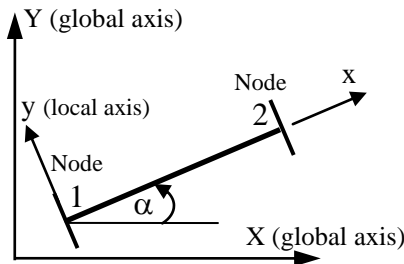
For the shown frame, using the stiffness method (**neglect axial deformation**):

- Determine the displacements at the nodes due to the given load.
- Draw the bending moment diagram.



Given Data:

E , I and A are constants.



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 $\mu = \sin \alpha$

With my best wishes

Dr. M. Abdel-Kader