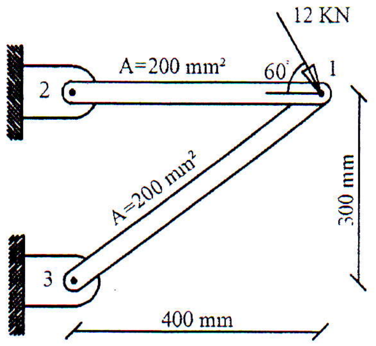
MENOUFIA UNIVERSITY	**Subject: Finite Element Method**
Faculty of Engineering, Shebin El-Kom	**Code: PRE 605**
Prod. Eng. & Mech. Design Dept.	**Graduate Study: Master**
1st Semester Examination 2016/2017	**Time Allowed : 3 hours**
Date : 31/12/2016 M	**Total Mark: 100 Mark**

ANSWER THE FOLLOWING QUESTIONS

QUESTION # 1 (25 degrees)

Determine the displacements of node **one** and the stress in each element. Determine the reaction at nodes 2 and 3.

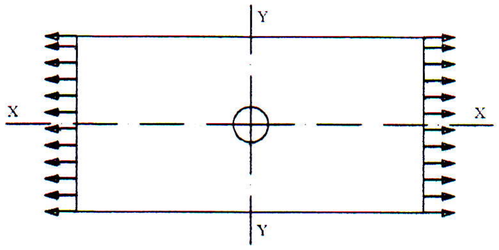


QUESTION # 2 (25 degrees)

A- The stress distribution in the thin plate with a small hole shown in the figure is to be obtained using the finite element method.
  1- Show the finite element mesh.
  2- Illustrate the boundary conditions.
  3- Show the expected deformed configuration.

B- Why the three-node triangular element is called constant-strain triangular element.

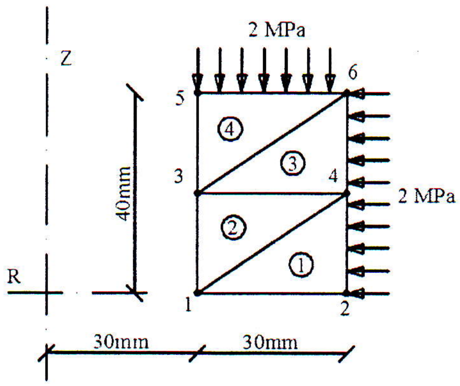
C- Why most of the finite element packages such as ANSYS use numerical integration to calculate the stiffness and mass matrices.



QUESTION # 3 (25 degrees)

A- For the axisymmetric pressure loading shown in the figure, determine the global load vector.

B- Why the three-dimensional axisymmetric solids subjected to symmetric loading reduce to two-dimensional problems in r and z.

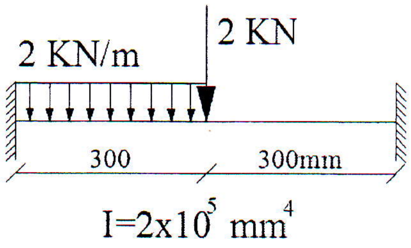


QUESTION # 4 (25 degrees)

For the loaded beam shown in the figure, determine

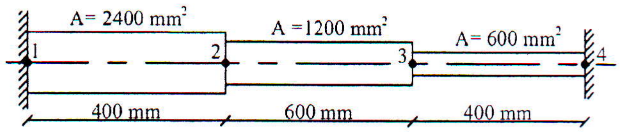
A- The vertical deflection and rotation at the concentrated load point.

B- The vertical deflection at midpoint of the loaded beam length from the left hand side.



QUESTION # 5 (25 degrees)

Determine the eigenvalues and eigenvectors for the stepped bar shown in the figure.



This exam measures the following ILOs															
Question number	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
skills	A1	A1	A3	A1	A4	B2	B2	B5	B5	B2	C1	C3	C1	C3	C3
	Knowledge & Understanding					Intellectual					Professional				

P. T. O.

USEFUL INFORMATIONS

For steel; E =200 GPa, υ = 0.3 and ρ = 7850 kg/m^3.

$$K^e = \frac{EL}{A}\begin{bmatrix} l^2 & lm & -l^2 & -lm \\ lm & m^2 & -lm & -m^2 \\ -l^2 & -lm & l^2 & lm \\ -lm & -m^2 & lm & m^2 \end{bmatrix}, \qquad K^e = \frac{EI}{L^3}\begin{bmatrix} 12 & 6L & -12 & 6L \\ 6L & 4L^2 & -6L & 2L^2 \\ -12 & -6L & 12 & -6L \\ 6L & 2L^2 & -6L & 4L^2 \end{bmatrix},$$

$$F^e = \left[\frac{pL}{2}, \frac{pL^2}{12}, \frac{pL}{2}, \frac{-pL^2}{12}\right]^T, \qquad \sigma = \frac{E_e}{L_e}\begin{bmatrix} -l & -m & l & m \end{bmatrix} q$$

$$\mathrm{v} = \mathbf{Hq}, \quad \mathbf{H} = \left[H_1, \frac{l_e}{2}H_2, H_3, \frac{l_e}{2}H4\right], \quad H_1 = \frac{1}{4}\left[2 - 3\xi + \xi^2\right],$$

$$H_2 = \frac{1}{4}\left[1 - \xi - \xi^2 + \xi^3\right], \quad H_3 = \frac{1}{4}\left[2 + 3\xi - \xi^2\right], \quad H_2 = \frac{1}{4}\left[-1 - \xi + \xi^2 + \xi^3\right]$$

$$B = \frac{1}{\det j}\begin{bmatrix} y_{23} & 0 & y_{31} & 0 & y_{12} & 0 \\ 0 & x_{32} & 0 & x_{13} & 0 & x_{21} \\ x_{32} & y_{23} & x_{13} & y_{31} & x_{21} & y_{12} \end{bmatrix} \qquad K^e = tAB^T DB \qquad J = \begin{bmatrix} x_{13} & y_{13} \\ x_{23} & y_{23} \end{bmatrix}$$

$$D = \frac{E}{1-\nu}\begin{bmatrix} 1 & \nu & 0 \\ \nu & 1 & 0 \\ 0 & 0 & \frac{1-\nu}{2} \end{bmatrix}, \qquad \sigma = D\ B\ q$$

$$k^e = \frac{E_e A_e}{L_e}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}, \qquad m^e = \frac{\rho_e A_e L_e}{6}\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$$

With best regards
Prof. Dr. Mahmoud Abo-Elkhier