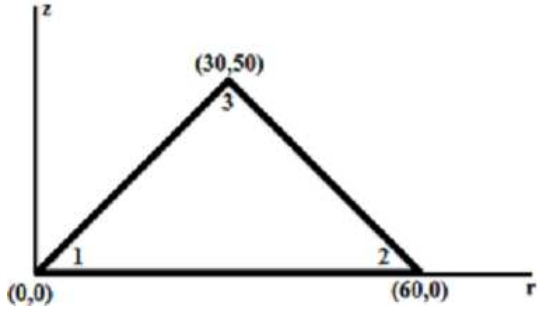
ACADEMIC TASK -3

ROLL NO.: TEST-2 TIME: 45mins

SECTION: M2116 FINITE ELEMENT METHODS (MEC912) FULL MARKS-20

(1) For the axisymmetric triangular element shown in figure below, determine the element strain $[\varepsilon_r\ \varepsilon_z\ \gamma_{rz}\ \varepsilon_\theta]^T$ and element stress $[\sigma_r\ \sigma_z\ \tau_{rz}\ \sigma_\theta]^T$. Take E=2.1x10^5 N/mm^2 and υ= 0.25. The co – ordinates are in mm. The nodal displacements are u_1=0.05mm, w_1=0.03mm, u_2=0.02mm, w_2=0.02mm, u_3=0.0mm, w_3=0.0mm.



The strain-displacement matrix is given by:

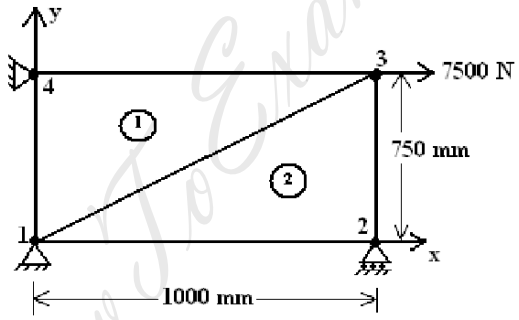
$$\mathbf{B} = \begin{bmatrix} \frac{z_{23}}{\det \mathbf{J}} & 0 & \frac{z_{31}}{\det \mathbf{J}} & 0 & \frac{z_{12}}{\det \mathbf{J}} & 0 \\ 0 & \frac{r_{32}}{\det \mathbf{J}} & 0 & \frac{r_{13}}{\det \mathbf{J}} & 0 & \frac{r_{21}}{\det \mathbf{J}} \\ \frac{r_{32}}{\det \mathbf{J}} & \frac{z_{23}}{\det \mathbf{J}} & \frac{r_{13}}{\det \mathbf{J}} & \frac{z_{31}}{\det \mathbf{J}} & \frac{r_{21}}{\det \mathbf{J}} & \frac{z_{12}}{\det \mathbf{J}} \\ \frac{N_1}{r} & 0 & \frac{N_2}{r} & 0 & \frac{N_3}{r} & 0 \end{bmatrix}$$

and the stress-strain matrix is given by:

$$\mathbf{D} = \frac{E(1-\nu)}{(1+\nu)(1-2\nu)} \begin{bmatrix} 1 & \frac{\nu}{1-\nu} & 0 & \frac{\nu}{1-\nu} \\ \frac{\nu}{1-\nu} & 1 & 0 & \frac{\nu}{1-\nu} \\ 0 & 0 & \frac{1-2\nu}{2(1-\nu)} & 0 \\ \frac{\nu}{1-\nu} & \frac{\nu}{1-\nu} & 0 & 1 \end{bmatrix}$$

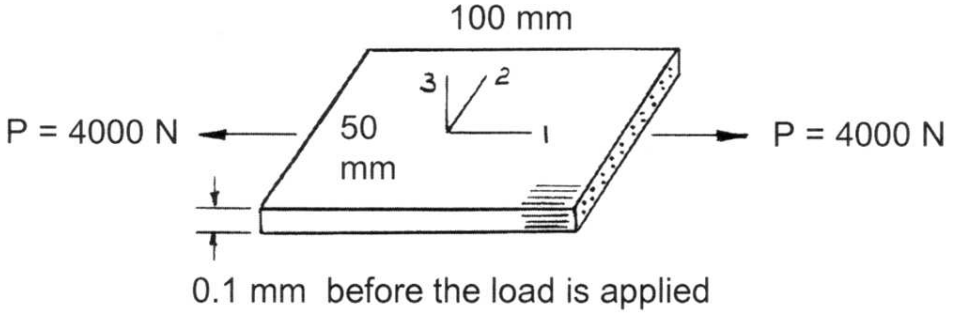
[8]

(2) A two dimensional propped beam is shown in figure below:



It is divided into two CST elements. Determine the nodal displacement and element stresses using plane stress conditions. Body force is neglected in comparison with the external forces.
Take, Thickness (t) = 10mm,
Young's modulus (E) = 2x10^5 N/mm^2,
Poisson's ratio (ν) = 0.25. [6]

(3) A unidirectionally-reinforced glass-epoxy lamina shown below has the following properties:
E_1 = 53 GPa, E_2 = 18 GPa, ν_{12} = 0.25, G_{12} = 9 GPa. The load *P* is applied in the 1-direction.
Note: This lamina is orthotropic.



Determine strains ε_1 and ε_2 under the force *P*. [4]

(4) Wood is an orthotropic material. Comment [2]