Mechanics of Solids (MEC2112/AEC2112) 2024-25

Tutorial 2 (Unit-2)

1. In a state of plane strain, the strain components associated with the x-y axes are

$$\begin{aligned}
\epsilon_{xx} &= 800 \times 10^{-6} \\
\epsilon_{yy} &= 100 \times 10^{-6} \\
\gamma_{xy} &= -800 \times 10^{-6}
\end{aligned}$$

   Find the principal strains and the principal strain directions.

2. The displacements for a rigid-body rotation through an angle β about an axis may be described by

$$\begin{aligned}
u(x,y) &= (\cos\beta - 1)x - (\sin\beta)y \\
v(x,y) &= (\sin\beta)x + (\cos\beta - 1)y.
\end{aligned}$$

   Find the strain tensor and rotation ω_z. What will happen to strain tensor and rotation in case of small β?

3. Consider a thin (1m x 1m x 1cm) steel plate which is loaded on one edge with a uniformly distributed 10 kN load and supported on the other end with a center pin and edge rollers, as shown. Assume we make a measurement of the displacement field and find that $u(x,y) = (5 \times 10^{-6})x$ m, and $v(x,y) = (0.15 \times 10^{-6})y$ m. Determine the strain field in the plate.
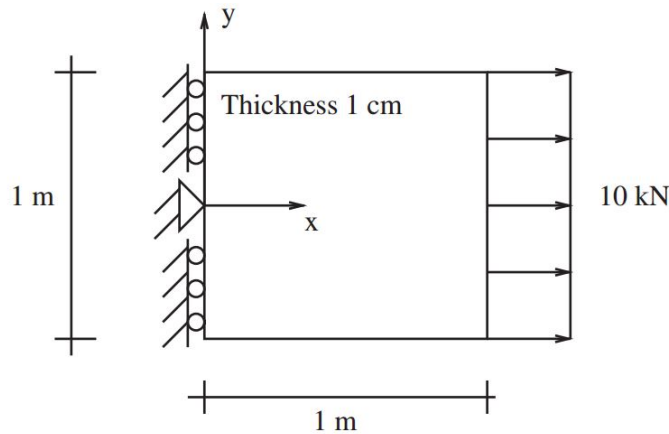
4. Consider a two-dimensional body shown. The undeformed state of the body is shown on the left. After the application of load, the body takes on the configuration shown on the right. What is the average shear strain, γ_{xy}, in the body?
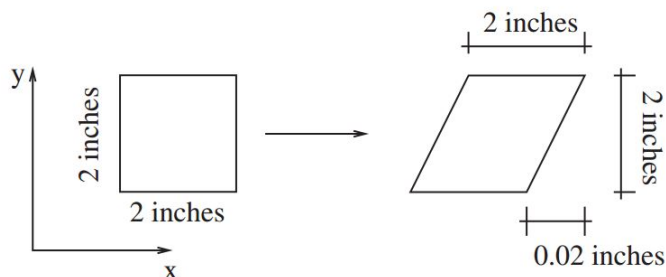
5. Consider a two dimensional body occupying the region [0,1] Œ [0,1] whose displacement field is given by $u = (4x^2 + 2) \times 10^{-4}$ and $v = (2x^4 + 3y^4) \times 10^{-4}$. What is the strain field for the body? Assume the numerical constants have consistent units.

6. Shown below is a solid circular rod of material. The bottom is clamped, and torque is applied to the top. The motion of the material has been measured in cylindrical coordinates as $u_r = 0$, $u_\theta = \alpha rz$, $u_z = 0$, where α is a given constant with appropriate dimensions. What is the strain field in the rod? [Note: You need to use strain-displacement relation in cylindrical coordinate system]