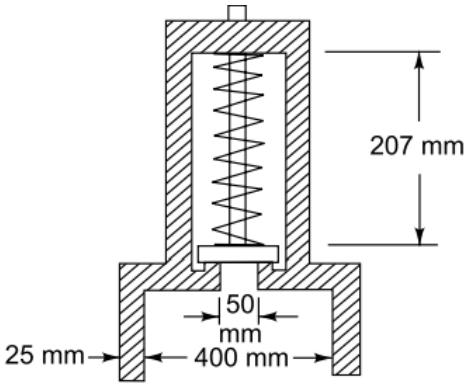
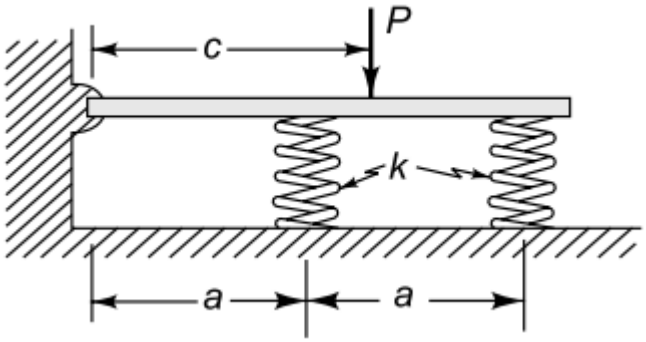
Mechanics of Solids (MEC2112/AEC2112) 2024-25

Tutorial 1 (Unit-1)

1. A safety valve for a pressure system has a discharge hole of 50-mm diameter. The spring has a free length of 250 mm and a spring constant of 120 kN/m. At what pressure will the valve open?



2. A stiff beam is hinged at one end and supported by two springs of spring constant k. Where should a force P be applied so that the spring constant of the system (P divided by the deflection under P) is $20/9k$?



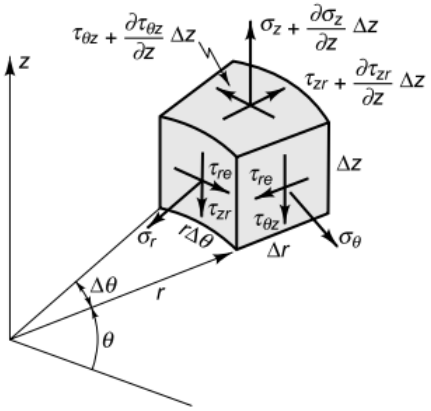
3. Let a body be subjected to external forces such that the state of stress in it at a point P in the body is

$$[\sigma] = \begin{bmatrix} 2 & 10 & 5 \\ 10 & 2 & 1 \\ 5 & 1 & 2 \end{bmatrix} \text{N/m}^2.$$

Find the stress vector at P on a plane with normal $\boldsymbol{n}$ lying in x-y plane and makes an angle 45° with x-axis.

4. Consider a body in a state of plane stress such that $\sigma_x = x^2$ N/m^2 and $\sigma_y = y^2$ N/m^2. Determine σ_{xy} in the absence of body force, provided that the stress vector on positive x-face is $T_x = 1$ N/m^2 and $T_y = 2$ N/m^2 at point $x = 1$ m and $y = 1$ m.

5. Show that if a general state of stress is to be described in cylindrical coordinates, the requirement that $\sum \boldsymbol{F} = \boldsymbol{0}$ leads to the following three equations:

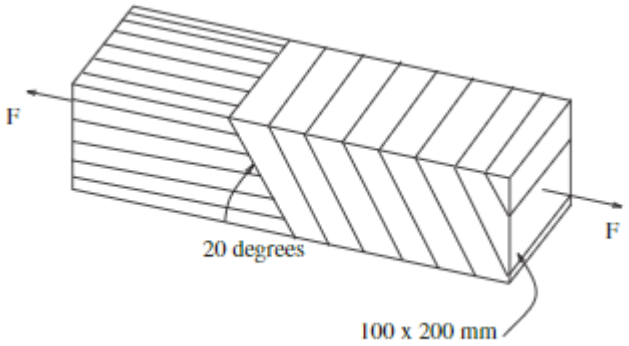


$$\frac{\partial \sigma_r}{\partial r} + \frac{1}{r}\frac{\partial \tau_{r\theta}}{\partial \theta} + \frac{\partial \tau_{zr}}{\partial z} + \frac{\sigma_r - \sigma_\theta}{r} = 0$$

$$\frac{\partial \tau_{r\theta}}{\partial r} + \frac{1}{r}\frac{\partial \sigma_\theta}{\partial \theta} + \frac{\partial \tau_{\theta z}}{\partial z} + 2\frac{\tau_{r\theta}}{r} = 0$$

$$\frac{\partial \tau_{zr}}{\partial r} + \frac{1}{r}\frac{\partial \tau_{\theta z}}{\partial \theta} + \frac{\partial \sigma_z}{\partial z} + \frac{\tau_{zr}}{r} = 0$$

6. Two pieces of wood are to be glued together using a lap joint. The shear strength of the glue is 10N/mm2. Find the maximum permissible load F.



7. In case of plane stress situation, the minimum principal stress is -100 MPa and maximum principal stress is 200 MPa. What would be the radius of Mohr's circle?

8. In case of 3D state of stress, the principal stress values are -10 GPa, 20 GPa and 35 GPa. Draw Mohr's circles. Also, evaluate the shear stress value on the plane of maximum shear.

9. Find principal stresses, principal directions, and deviatoric and hydrostatic parts for following stress states. Also, find the Octahedral shear stress. [Note: Be careful in case of plane strain, i.e., (b) part]

(a) $[\sigma] = \begin{bmatrix} 2 & 10 & 5 \\ 10 & 2 & 1 \\ 5 & 1 & 2 \end{bmatrix}$ N/m^2,

(b) $[\sigma] = \begin{bmatrix} 20 & 10 \\ 10 & 20 \end{bmatrix}$ N/m^2.