Model Answer

SOM
3rd sem
Mechanical Engineering [3X2=6]

1.(a) Stress = $\frac{\text{Internal Resisting Force}}{\text{Area}}$

$\sigma = \frac{P}{A}$, N/m², MPa, GPa.

Strain = $\frac{\text{Change in Dimension}}{\text{Original Dimension}}$

eg. $e_L = \frac{\Delta L}{L}$, unitless.

(b) Hooke's Law: Within elastic limit, the stress is proportional to strain

$\Rightarrow \sigma \propto e \Rightarrow \sigma = Ee \Rightarrow \boxed{E = \frac{\sigma}{e}}$

Always Hooke's Law is applicable within the elastic range.

(c) Modulus of rigidity (G) :-

$G = \frac{\text{shear stress}}{\text{shear strain}} = \frac{\tau}{\phi}$

$\Rightarrow \boxed{G = \frac{\tau}{\phi}}$

(d) FOS :- $FOS = \frac{\text{Ultimate stress}}{\text{Permissible stress}}$

2(a) [2x3.5=7]

Strain produced by σ_1

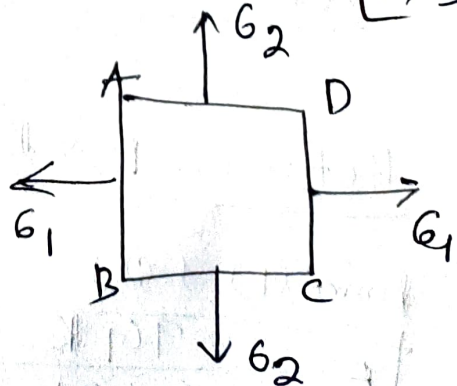
$e_x = \frac{\sigma_1}{E}$, $e_y = -\mu \frac{\sigma_1}{E}$

Strain produced by (σ_2)

$e_y = \frac{\sigma_2}{E}$, $e_x = -\mu \frac{\sigma_2}{E}$

$e_1 = \frac{\sigma_1}{E} - \mu \frac{\sigma_2}{E}$

$e_2 = \frac{\sigma_2}{E} - \mu \frac{\sigma_1}{E}$ } (M)



2(b) Given :- $L = 150\text{cm}$, $D = 2.0\text{cm} = 20\text{mm}$

$A = \frac{\pi}{4} \times (20)^2 = 100\pi\ \text{mm}^2$

$P = 20\text{ kN} = 20{,}000\text{ N}$

$E = 2.0 \times 10^5\ \text{N/mm}^2$

① $\sigma = \frac{P}{A} = \frac{20{,}000}{100\pi} = 63.662\ \text{N/mm}^2$

② $E = \frac{\sigma}{e} \Rightarrow e = \frac{\sigma}{E} = \frac{63.662}{2.0 \times 10^5} = 0.000318$ (u)

③ $e = \frac{dL}{L} \Rightarrow dL = eL = 0.000318 \times 150 = 0.0477\text{cm}$ (u)

2(c) Modulus of Elasticity $(E) = \frac{\text{Tensile stress}}{\text{Tensile strain}}$

$$\boxed{E = \frac{\sigma}{e}}$$

Modulus of rigidity (shear modulus) (or G)

$$G = \frac{\text{shear stress}}{\text{shear strain}} = \frac{\tau}{\phi} \Rightarrow \boxed{G = \tau/\phi}$$

Factor of safety : (FOS)

$$FOS = \frac{\text{Ultimate stress}}{\text{permissible stress.}}$$ (u)

3(a) Relationship between E, K & G ? $\boxed{7 \times 1 = 7}$

Between E & G :- $E = 2G(1+\mu)$

$$\Rightarrow \boxed{G = \frac{E}{2(1+\mu)}} \quad \text{—①}$$

Between E & K

$K = \frac{E}{3(1-2\mu)} \Rightarrow E = 3K(1-2\mu)$ —②

From (1) & (2)

$$\boxed{E = \frac{9GK}{G+3K}}$$

3(b) Data given :-

$E = 1.2 \times 10^5 \text{ N/mm}^2$

$G = 4.8 \times 10^4 \text{ N/mm}^2$

Poisson's ratio (μ) = ?

$E = 2G(1+\mu)$

$1.2 \times 10^5 = 2 \times 4.8 \times 10^4 (1+\mu)$

$\Rightarrow 1+\mu = \frac{1.2 \times 10^5}{2 \times 4.8 \times 10^4} \Rightarrow \boxed{\mu = 0.25}$ (Ans)

$K = \frac{E}{3(1-2\mu)} \Rightarrow K = \frac{1.2 \times 10^5}{3(1-0.25 \times 2)}$

$\Rightarrow \boxed{K = 8 \times 10^4 \text{ N/mm}^2}$ (Ans.)