This homework assignment introduces the concept of strain, stress-strain relationships, and strain gauge problems. ♣ Textbook problem : 4-29, 10-53 (stress-strain relationship), 3-7, 3-10, 3-12 (s-s curve)

1. A square reinforced-concrete pier $0.3 \times 0.3m$ in cross section and $1.2m$ high is loaded as shown in the figure. The concrete is strengthened by the addition of eight vertical $25 \times 25mm$ square steel reinforcing bars placed symmetrically about the vertical axis of the pier. Find the stress in the steel and concrete and the deflection. For concrete, take $E = 17GN/m^2$.

![Figure 1: A square reinforced-concrete pier](image)

2. In a particular machine it is necessary to have a very stiff spring with a “kink” in the load-deflection curve. The suggested design consists of a $150mm$-diameter brass cylinder with a $6.25mm$ wall thickness and a $250mm$ diameter aluminum cylinder with $6.25mm$ wall thickness, the aluminum cylinder being made $0.08mm$ shorter than the brass cylinder. Sketch ACCURATELY the graph of the load-deflection relation for this spring.
3. In a state of plane strain in the $xy$ plane the strain components associated with the $xy$ axes are

$$
\varepsilon_x = 800 \times 10^{-6} \\
\varepsilon_y = 100 \times 10^{-6} \\
\gamma_{xy} = -800 \times 10^{-6}
$$

Find the magnitude of the principal strains and the orientation of the principal strain directions.

4. At a point in a body the principal strains are

$$
\varepsilon_I = 700 \times 10^{-6} \\
\varepsilon_{II} = 300 \times 10^{-6} \\
\varepsilon_{III} = -300 \times 10^{-6}
$$

What is the maximum shear strain components at the point? What is the orientation of the axes which experiences the maximum shear strain?

5. The readings of a $45^\circ$ strain rosette are

$$
(a) \ \varepsilon_0 = 100 \times 10^{-6} \quad (b) \ \varepsilon_0 = 1200 \times 10^{-6} \\
\varepsilon_{45} = 200 \times 10^{-6} \quad \varepsilon_{45} = 400 \times 10^{-6} \\
\varepsilon_{90} = 900 \times 10^{-6} \quad \varepsilon_{90} = 60 \times 10^{-6}
$$

Find the magnitude of the principal strains in the plane of the rosette.