1. The slender uniform rod shown in Fig 1 is attached to rigid supports at A and B, and it is stress free when $\Delta T = 0$. It is surrounded by a heating element that can produce linearly varying temperature change $\Delta T(x)$ shown in Fig 2. Determine the stress distribution $\sigma(x)$ and strain distribution $\varepsilon(x)$ that are induced by this nonuniform heating. Let $\alpha = \text{const}$, $E = \text{const}$. (20%)

![Fig 1](image)

![Fig 2](image)

2. The cross section of a thin tube having variable wall thickness $t$ is shown in the figure. The median line of the cross section is a circle of radius $r$, and the thickness is given by the equation $t = t_0 \left(1 + \sin \frac{\theta}{2}\right)$, where $t_0$ is the thickness at the section where $\theta = 0$. If the tube is subjected to a torque $T$, what is the maximum shear stress $\tau_{\text{max}}$? and what is the angle of twist $\phi$ if the length of the tube is $L$? (20%)

Given $\int \frac{dx}{1 + \sin ax} = \frac{1}{a} \tan \left(\frac{\pi + ax}{4} \frac{\pi}{2}\right)$

![Diagram](image)
3. The state of a uniform plane stress as shown can be described by $\sigma_a = 200 \text{ MPa}$, $\tau_a = 400 \text{ MPa}$, and $\tau_b = 100 \text{ MPa}$. Determine the values of $\tau_b$, $\sigma_x$, $\sigma_y$, and $\tau_{xy}$. (20%)

4. Determine the flexural stresses at point A, B, C and D for the composite section shown in Fig. 3 if the moment acting on it is 100 kN-m. The ratio of elastic moduli of the two materials is $E_1 / E_2 = 8$, $\theta = 30^\circ$. (20%)

5. For the beam loaded as shown in Fig. 2, (a) determine the angle of rotations at A and B, and the deflection at A, (b) determine the reactions at B and C, and (c) draw the shear and moment diagrams. (20%)