1. (20%) A circular bar AB with ends fixed against rotation has a hole extending for half of its length. The outer diameter of the bar is 100mm and the diameter of the hole is 80mm. The length of the bar is 1200mm. At what distance x from the left-hand end of the bar should a torque \( T_0 \) be applied so that the reactive torques at the supports will be equal?

![Diagram of a circular bar with a hole and a torque applied at x distance from the left-hand end.]

2. (20%) A thin plate is subjected to tensile stress \( \sigma_x = 30\text{MPa} \) and \( \sigma_y = 15\text{MPa} \). The corresponding strains in the plate are \( \varepsilon_x = 550 \times 10^{-6} \) and \( \varepsilon_y = 100 \times 10^{-6} \).

Please determine the Poisson's ratio and modulus of elasticity of the material.

3. (20%) A channel section is used as a cantilever beam to support a uniformly distributed load of intensity \( q \) and a concentrated load of \( P = qL \), as shown in the figure (a) below. The relevant dimensions of the cross section are shown in the figure (b). (a) Sketch the shear and moment diagrams for the beam and (b) determine the maximum tensile and compressive flexural stresses (please specify both the values and locations).

![Diagram of a cantilever beam with a uniform load and a concentrated load, along with a channel section cross section.](image)
4. (20%) A prismatic steel beam $ABC$ (constant bending rigidity $EI$) is supported and subjected to a uniformly distributed load of intensity $q$ as shown in the figure. Assume the spring constant is $k = \frac{3EI}{L^3}$. Determine all of the reactions.

![Beam Diagram](image)

5. (20%) An axial member $BCD$ comprising two parts, ie, $BC$ and $CD$, of same properties is fixed at the two ends. A rod $CH$ with a roller and a hinge at, respectively, the top and bottom ends of the rod is used to support member $BCD$ at point $C$ as shown in the figure. Assume that part $BC$ is suddenly subjected to a temperature rise, $\Delta T$, and the temperatures of part $CD$ and rod $CH$ remain the same all the time. The weights of the members are negligible.

1. Find the reactions at $B$ and $C$ induced by $\Delta T$. (10 points)
2. Find the displacement of point $C$. (10 points)

Use the following information to solve the problem:

Member $BCD$: $A =$ area, $E =$ Young's modulus, $L =$ length of parts $BC$ and $CD$, $\alpha =$ thermal expansion coefficient.

Rod $CH$: $A_1 =$ area, $E_1 =$ Young's modulus, $I_1 =$ moment of inertia, $\alpha_1 =$ thermal expansion coefficient.

![Rod Diagram](image)