1. A uniform bar $AB$ of weight $W = 250$ N is supported by two axial bars, as shown in the figure 1. The left bar has the cross-sectional area $A_1 = 25$ mm$^2$, the modulus of elasticity $E_1 = 3$ MPa and the length $L_1 = 250$mm. The right bar has the cross-sectional area $A_2 = 20$ mm$^2$, the modulus of elasticity $E_2 = 4$ MPa and the length $L_2 = 200$mm. The distance between the bars is $L = 350$mm, and the bar on the right is supported at a distance $h = 80$mm below the point of support for the bar on the left. At what distance $x$ from the left-hand bar should a load $P = 180$ N be placed in order to bring the bar(AB) to a horizontal position? (20%)
2. A thin-walled semicircular cross section of radius $r$ and thickness $t$ is shown in the figure 2. Determine the distance $e$ from the center $O$ of the circular arcs to the shear center $S$. (20%)
3. A cantilever beam of rectangular cross section (width $b = 25$ mm, height $h = 100$ mm) is loaded by a force $P$ that acts at the midheight of the beam and is inclined at an angle $\alpha$ to the vertical (see figure 3). Two strain gages are placed at point $C$, which also is at the midheight of the beam. Gage $A$ measures the strain in the horizontal direction and gage $B$ measures the strain at an angle $\beta = 60^\circ$ to the horizontal. The measured strains are $\varepsilon_a = 250 \times 10^{-6}$ and $\varepsilon_b = -750 \times 10^{-6}$. Determine the force $P$ and the angle $\alpha$, assuming the material is steel with $E = 100$ GPa and $\nu = 1/3$. ($\sin 60^\circ = 0.866$, $\cos 60^\circ = 0.5$) (20%)
4. A cantilever beam of T-section is loaded by an inclined force of magnitude 10 kN (see figure 4). The line of action of the force is inclined at an angle of 30° to the horizontal and intersects the top of the beam at the end cross section. The beam is 2.0 m long and the cross section has the dimensions shown. Determine the principle stress $\sigma_1$ and $\sigma_2$ and the maximum shear stress $\tau_{max}$ at point $A$ and $B$ in the web of the beam. (20%)
5. The overhang beam $ABCD$ supports two concentrated loads $P$ and $2Q$ (see figure 5). (a) For what ratio $P/Q$ will the deflection at point $B$ be zero? (b) For what ratio will the deflection at point $D$ be zero? (20%)

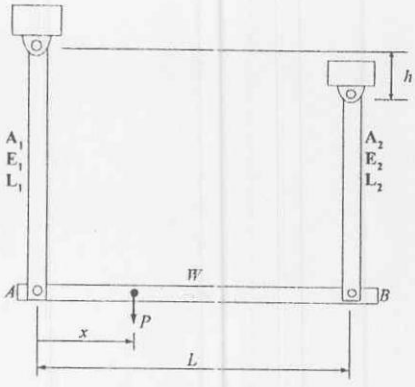

Fig. 1

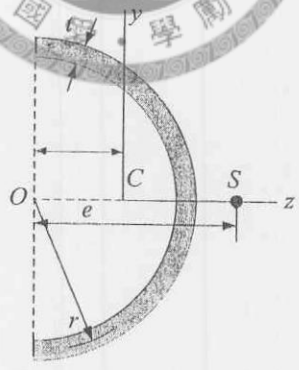

Fig. 2

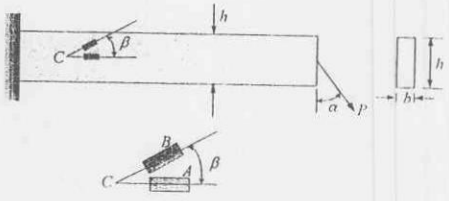

Fig. 3

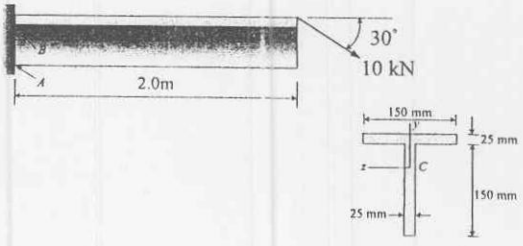

Fig. 4

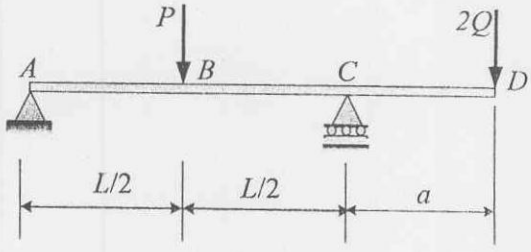

Fig. 5