1. (a) In the torsion problem of thin-walled shafts, we often use the following equation to obtain the shear stress distribution:

$$\tau = \frac{M_T}{2A_m t}$$

where τ, M_T, A_m, and t are the shear stress, applied twisting moment, mean area of the cross section, and thickness, respectively. What assumptions have been made in deriving the above equation? (10%)

(b) Briefly describe the maximum distortional energy theory (von-Mises theory). (5%)

2. Consider a beam (Fig. 1) of length L subjected to a uniformly distributed load w (force/length). The cross section of the beam is in rectangular shape with height H and width B (Figure 2). Assume E, G and k are the modulus of elasticity, shear modulus of elasticity and the spring constant, respectively.

(a) Use Castigliano's Theorem to determine the deflection at point B. (10%)

(b) Find the maximum bending stresses σ_{max} and maximum shear stress τ_{max} in the beam. (10%)

(c) If the value of the spring constant k approaches infinity, obtain the ratio σ_{max}/τ_{max} when Poisson's ratio $\nu = 1/3$. (5%)

(d) It is known that the flexure formula for the bending stress is based on the pure bending assumption. In this problem, can we use the bending stress in part (b) in engineering design? Why? (10%)

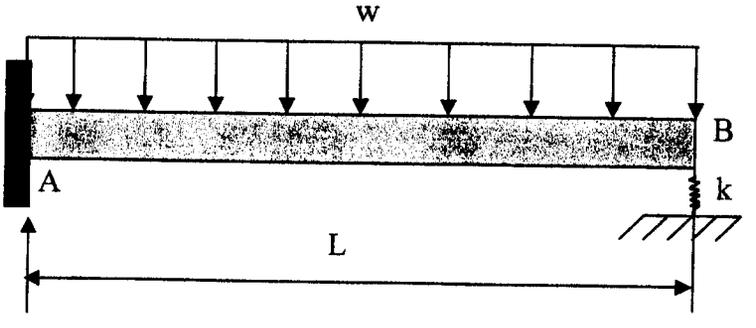

Figure 1

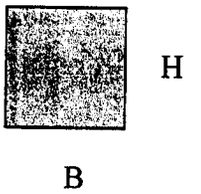

Figure 2

3. As shown in the Figure 3, an L-shape rod has one end fixed on the wall and the other end is subjected to a loading force 100 k_{gf}. The diameter of the rod is 10 *cm*. Please (a) determine the states of stresses at points A and B, and (b) determine the principal normal stresses and maximum shear stresses at points A and B. (25 %)

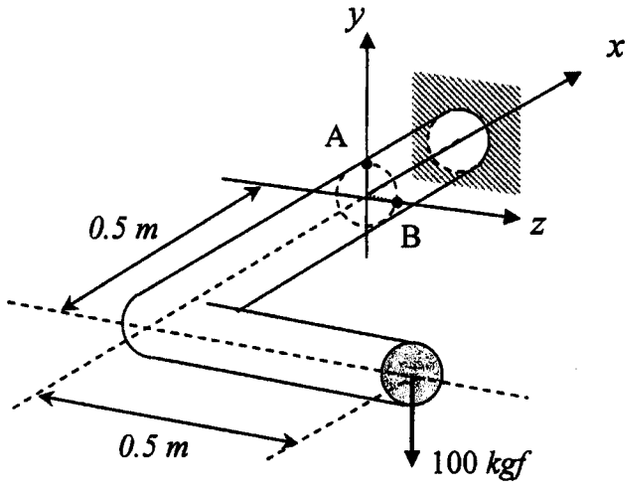

Figure 3

4. As shown in the Figure 4 is a beam with an L-shape cross-section. If a bending moment M_b = 10 *kN-m* is applied to the beam, please determine the orientation of the neutral axis and the maximum normal stress in the beam. (25 %)

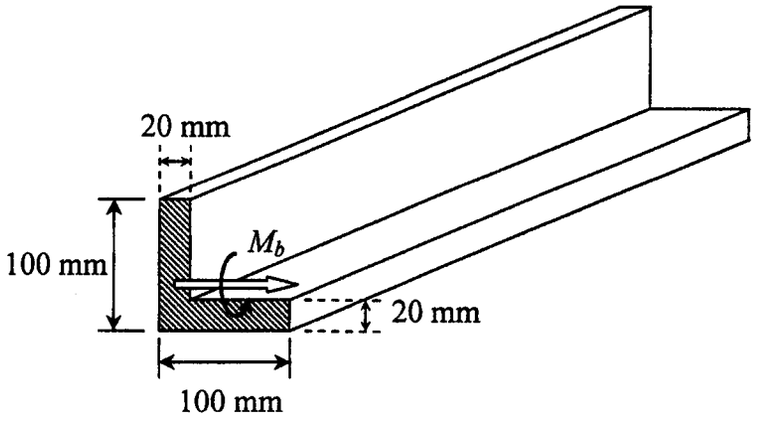

Figure 4