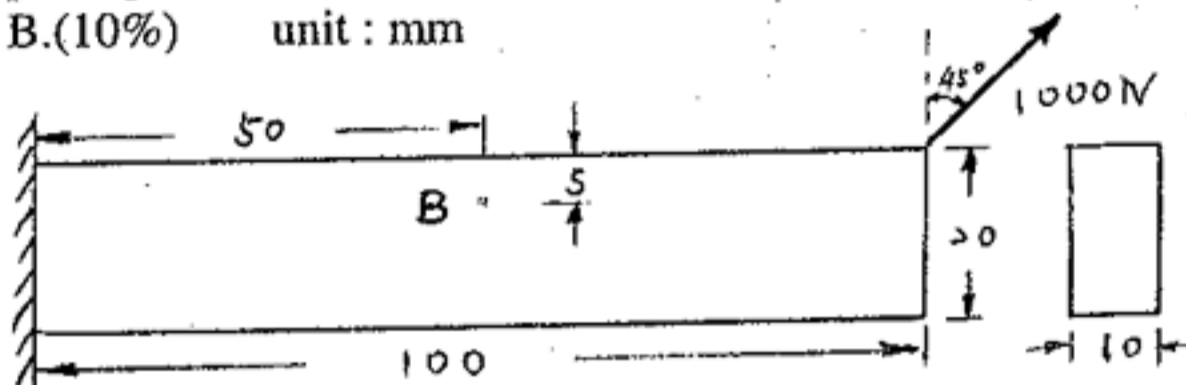1. Please derive the flexure formula(the stress and moment relationship) of a beam.(20%)

2. Please derive the torsion formula(the stress and torque relationship) of a circular shaft.(20%)

3. What is the stress state at point B(20%). What are the principal stresses and the principal directions at point B.(10%)　　unit : mm

4. For a plane stress problem, show that
$\varepsilon_x = \partial u / \partial x$, $\varepsilon_y = \partial v / \partial y$ 及 $\gamma_{xy} = \partial u / \partial y + \partial v / \partial x$, where u(x, y), v(x, y) are displacement functions in x and y direction. What are the assumptions in these formulas.(10%)

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5. (20%) A refrigeration cycle operating between two reservoirs receives energy Q_C from a cold reservoir at Tc = 250 K and rejects energy Q_H to a hot reservoir at T_H= 300 K. For each of the following cases , determine whether the cycle operates reversibly, irreversibly, or is impossible:

(a) Q_C = 1000 KJ, W_{cycle} = 250 KJ　　　(6%)

(b) Q_C = 1000 KJ, Q_H = 1150 KJ　　　(7%)

(c) Q_H = 1500 KJ, W_{cycle} = 250 KJ　　　(7%)