1. Explain the following terminology (20%, 5% each)
   (a) Saint-Venant's principle (give an example)
   (b) stress contour
   (c) transformed-section method (give an example)
   (d) complementary energy

2. (a) A tapered bar AB of solid circular cross section is twisted by torque T applied at the ends as shown in figure 2-a. The diameter of the bar varies linearly from d_a at the left-hand end to d_b at the right-hand end, the length of the bar is L. Determine the angle of twisting φ of the bar.
   (b) A circular bar of same material as in (a) which consists two parts of diameters d_a and d_b, and the corresponding lengths are a and b, as shown in figure 2-b. With the same torque T applied, determine the lengths a and b if the angle of twisting φ of the bar is the same as in part (a). (20%)

Note : $d_a = 10$ mm $d_b = 20$ mm, $L = 100$ mm
$T = 60\pi$ N-m shear modulus $G = 80$ GPa

the result of the integral $\int \frac{P\,dx}{(\beta + sx)^4} = -\frac{P}{3s(\beta+sx)^3}$ is given

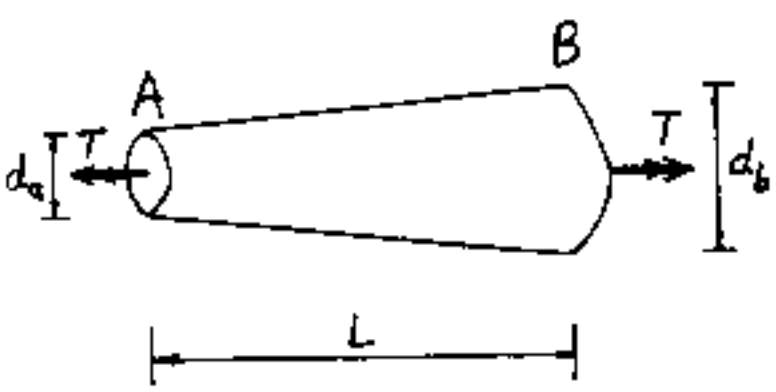

figure 2-a

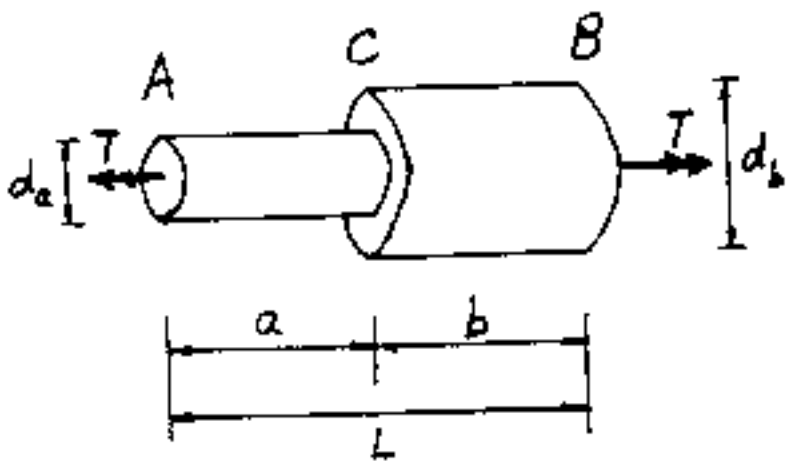

figure 2-b

3. A metal sheet which has length L, bending stiffness EI, and weight W is placed on a $L/3$ wide table as shown in figure 3, please find the gap δ between the metal sheet and the table top. (20%)

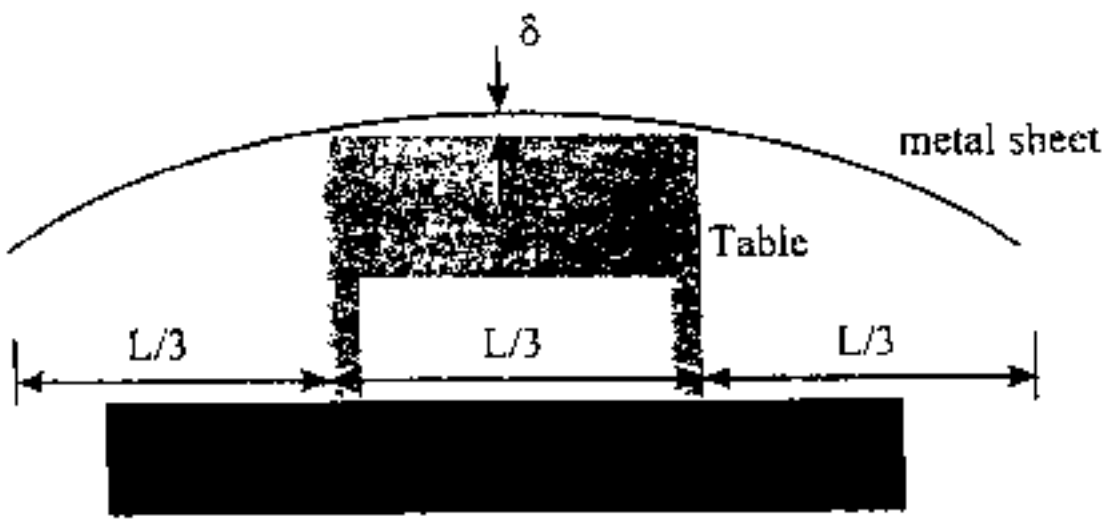

figure 3

4. (a) A cantilever beam of rectangular cross section subjected to a concentrated load P at the end as shown in figure 4. Determine the stress state at points *1*, *2* and *3* on section *m-m* and at points *4*, *5* and *6* on section *n-n*, respectively, also calculate the maximum principal stress at each point.

   (b) Sketch the deformation configuration on sections *m-m* and *n-n*, describe the difference between these two sections and state your reasons. Does the flexure formula $\sigma = My / I$ can be applied on section *m-m*, and why? (20%)

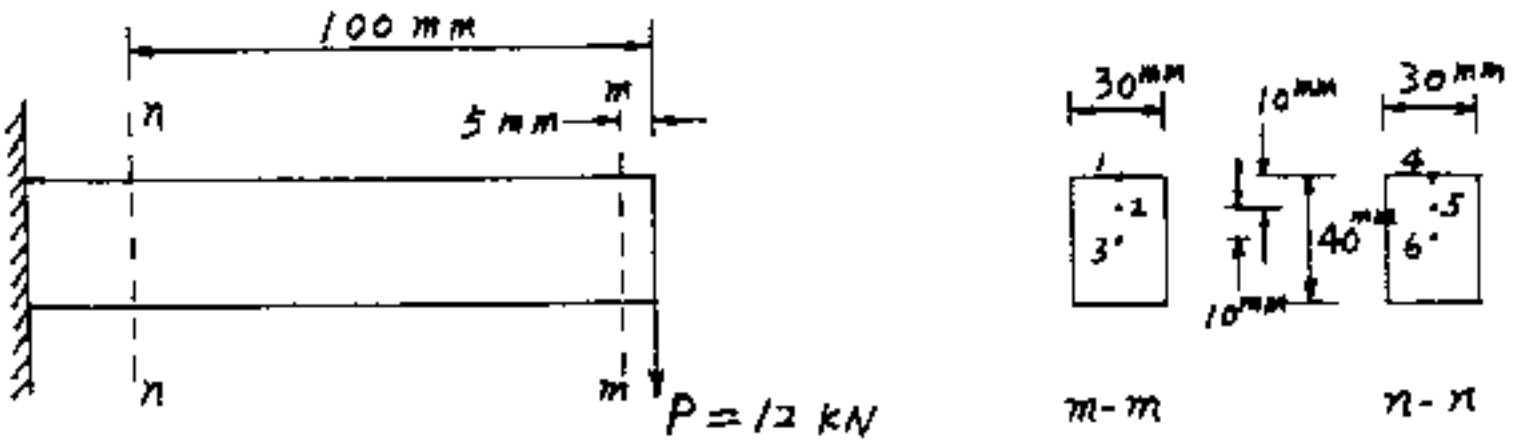

figure 4

5. What's the smallest heating temperature $\triangle T$ to cause beam 2 buckled? Neglecting friction between beam 1 and beam 2. (20%)

$A_1 > A_2$
$L_1 < L_2$
$I_1 > I_2$