1. A thermostat consists of two strips of different materials bonded together at their interface. Frequently this configuration takes the form of a cantilever beam, as shown in Fig. 1. If E_1 and E_2 denote the Young's modulus and α_1 and α_2 denote the coefficient of thermal expansion of the two materials, each of thickness h and width b. (25 Points))

   (a) Please take a small segment and draw the free body diagram to show the force and moment equilibrium. (6 Points)
   (b) Without performing any mathematical operations, please tell us how to determine the deflection of the end of the cantilever due to a temperature rise ΔT. (10 Points)
   (c) Please perform detailed mathematical derivation to solve the problem stated in part(b). (9 Points)

2. Please determine the expression of the equivalent stiffness of the system shown in Fig.2(a) The equivalent stiffness is defined as **the total applied force divided by the center deflection**. You may use the information shown in Fig. 2(b) if necessary. (q = distributed load with a unit of force/length; E, I, L are the Young's modulus, inertia, and length of the beam, respectively. v and θ are the deflection and the rotation of the beam) (25 Points)
   (a) Without performing any detail mathematics, please tell us as much as possible how to solve this problem. (12 Points)
   (b) Solve the problem by any methods. (13 Points)

3. As shown in Fig. 3, a long slender, pin-ended bar (Young's modulus E, cross section inertia I, length L) is loaded by an axial compressive force at each end. The line of action of the forces passes through the centroid of the cross-section of the bar. Please show that the critical load $P_{cr} = \dfrac{\pi^2 EI}{L^2}$. (25 Points))
   (a) What is the physical meaning of critical loads ? (5 Points)
   (b) Please formulate the equation and find the boundary conditions (12 Points).
   (c) What is the shape of the deflected beam? (8 Points)

4. A force P is applied to one end of a uniform L-shaped bar of solid circular cross section that is fixed at the other end, as shown in Fig. 4. Force P acts normal to the plane of the bar. The material is isotropic and yields at 280 MPa in a tension test. (25 Points) (背面仍有題目,請繼續作答)

(a) What is the von Mises failure criterion? What is the maximum shear stress criterion? (6 Points)

(b) According to the von Mises criterion, what is the laod P to cause yielding? (10 Points)

(c) If now the material is brittle with a tensile strength σ_T and an a compressive strength σ_C, how to determine the load to cause failure? (9 Points)

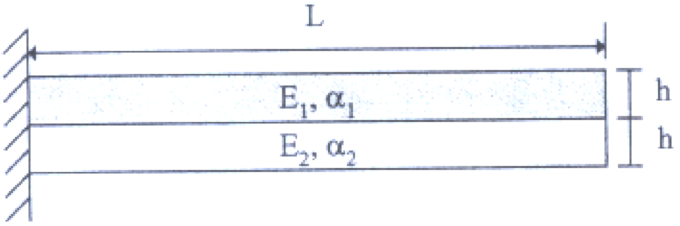
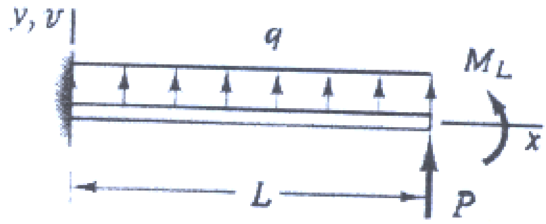


Fig. 1



$$v_L = \frac{M_L L^2}{2EI} + \frac{PL^3}{3EI} + \frac{qL^4}{8EI}$$

$$\theta_{zL} = \frac{M_L L}{EI} + \frac{PL^2}{2EI} + \frac{qL^3}{6EI}$$

Fig. 2(b)

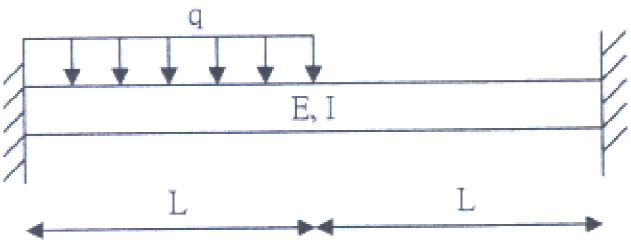


Fig. 2(a)

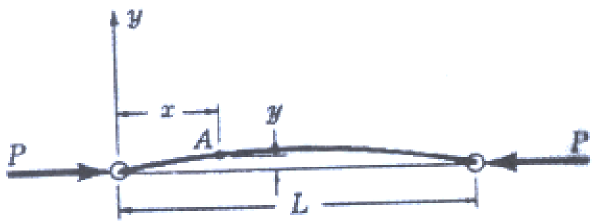


Fig. 3

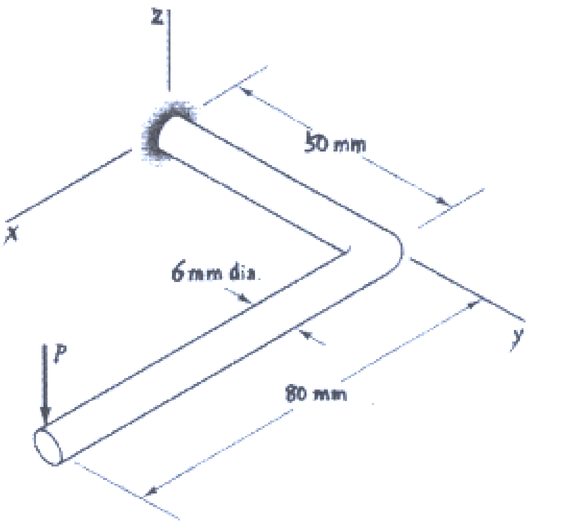


Fig. 4