國立清華大學 102 學年度碩士班考試入學試題

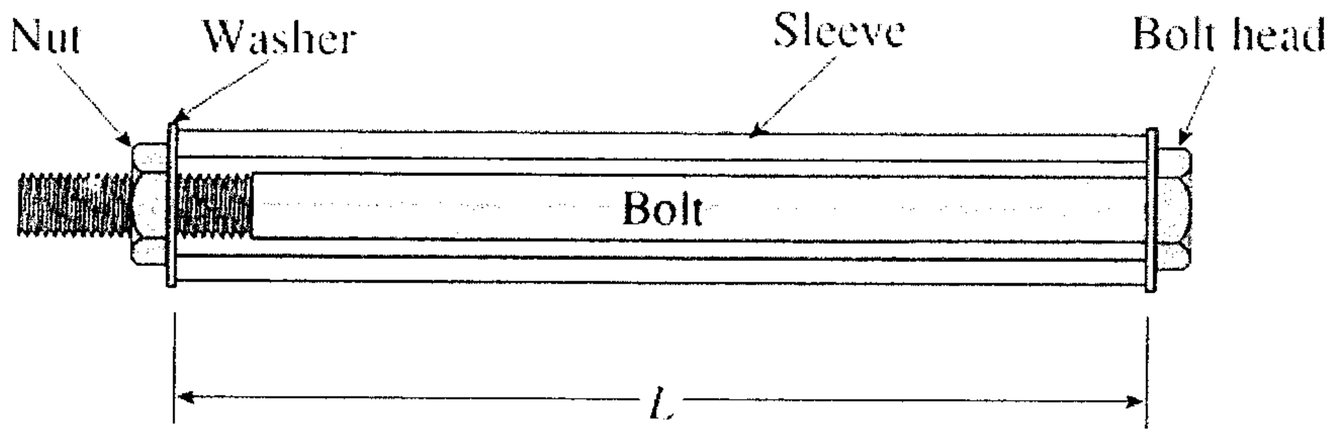
系所班組別：動機系碩士班丙組

考試科目（代碼）：材料力學(1301)

1. A sleeve in the form of a circular tube of length L is placed around a bolt and fitted between washers at each end. The nut is then turned until it is just snug. The sleeve and bolt are made of different materials and have different cross-sectional areas. (Assume that the coefficient of thermal expansion α_S of the sleeve is greater than the coefficient α_B of the bolt.)

(a) If the temperature of the entire assembly is raised by an amount ΔT, what stresses σ_S and σ_B are developed in the sleeve and bolt, respectively? [7%]

(b) What is the increase δ in the length L of the sleeve and bolt? [8%]

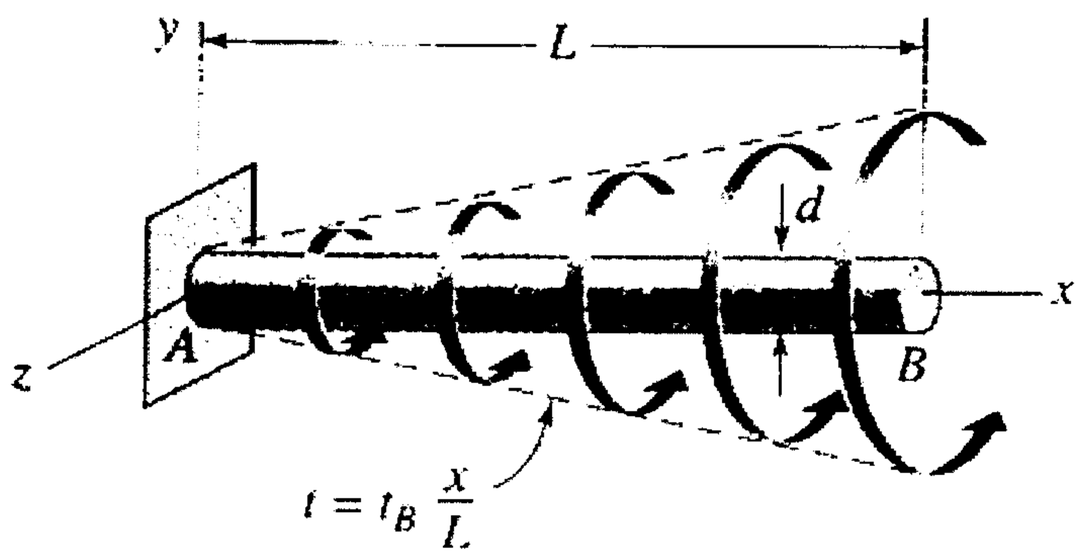


2. The figure shows a steel shaft of length L=1.5 m and diameter d=25 mm that carries a distributed torque of intensity (torque per unit length) $t=t_B\,(x/L)$, where t_B = 200 N·m/m. (Use G=80 GPa for steel.)

Determine:

(a) the maximum shear stress in the shaft. [7%]

(b) the angle of twist. [8%]



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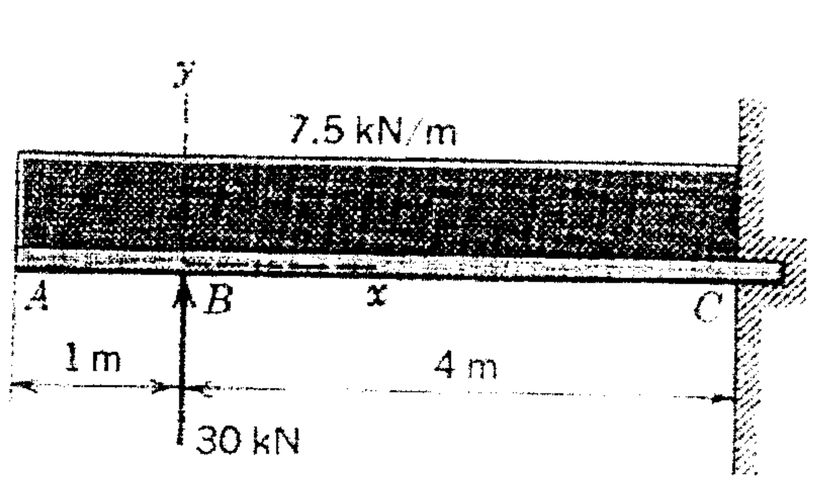
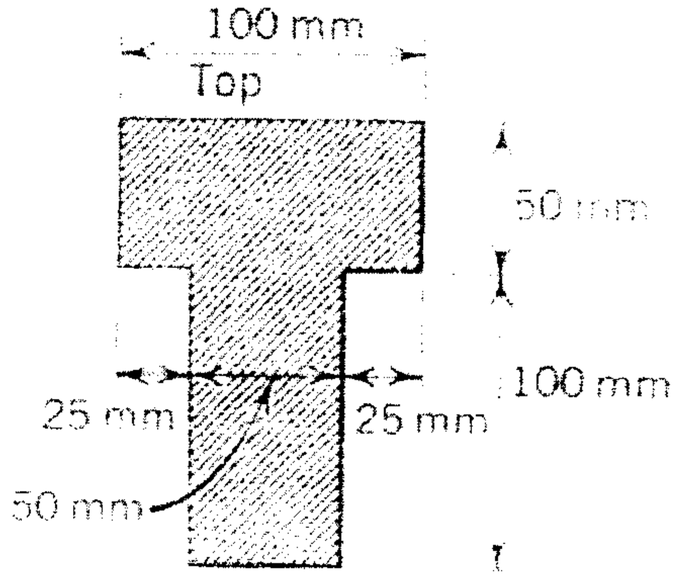
3. Measured strains at a point on the free surface of a machine element yield the following strain data: $\varepsilon_x = 100\mu$, $\varepsilon_y = 180\mu$, and $\gamma_{xy} = 60\mu$. The material is magnesium alloy with a modulus of elasticity of 45 GN/m^2 and Poisson's ratio of 0.35. Determine the principal strains, maximum shearing strain, principal stresses and maximum shearing stress at the point. [20%]

4. The beam shown in Fig. (a) has the cross section shown in Fig. (b). Determine:
   (a) The maximum tensile fiber stress in the beam and state where it occurs.
   (b) The maximum compressive fiber stress in the beam and state where it occurs. [15%]

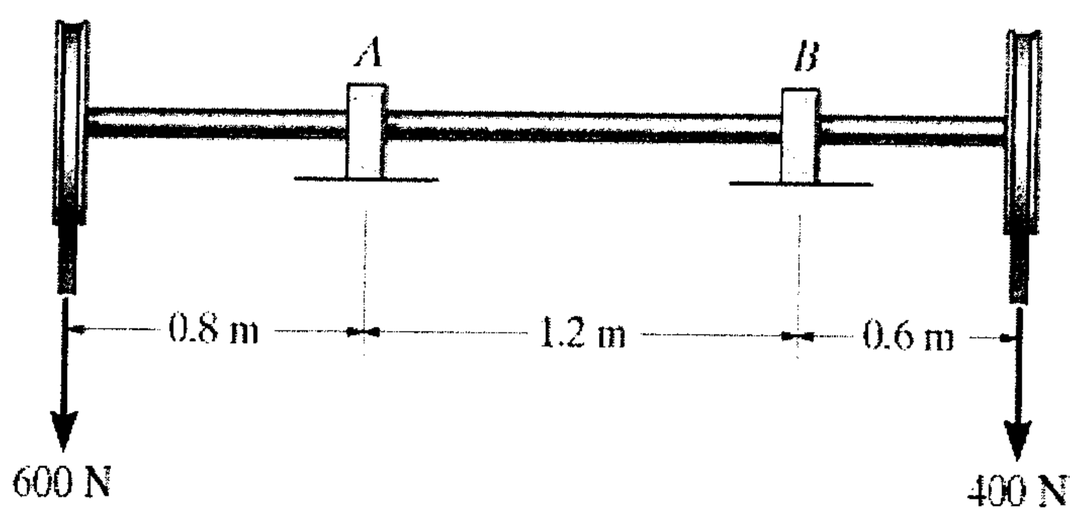


(a)



(b)

5. You're given a task to design diameter of the solid circular shaft in automobile transmission system as shown below. Due to space constraints, research and development team have decided to fix bearing A and B locations and length of the shaft to transmit forces 600N and 400N through pulleys at the shaft's two ends. The sleeve bearings at A and B support only vertical forces.



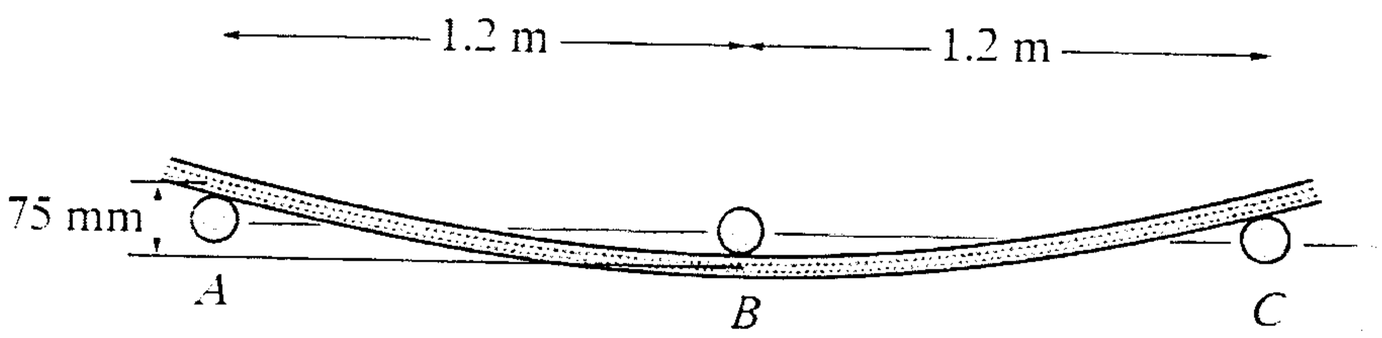
To figure out the proper diameter of the shaft, please draw shear force and moment diagrams in for the shaft as function of shaft's longitudinal axis then complete the following questions.

(a) What is the absolute maximum shear force inside the shaft? [5%]

(b) What is the absolute maximum moment inside the shaft? [5%]

(c) You're advised that allowable bending stress is $\sigma_{allow} = 160$ MPa. What is the smallest closest allowable diameter of the shaft as shown which is subjected to the concentrated forces? [5%]

6. The fence board weaves between the 3 smooth fixed posts. The posts remain along the same line as shown. The board has a width of 150 mm and a thickness of 12 mm. Use E= 12 GPa for the board and assume the displacement of each end of the board relative to its centre is 75 mm.



Suppose the centre post B provides force P acting toward the board, to complete the following two questions, you may want to draw free body diagram of the entire system to figure reaction loads on the board by posts A and B, followed by sectioning the beam and using free body diagram and equilibrium equations to figure internal bending moment, shear force, and equation describing elastic curve of the board. From your calculation,

(a) What is the required forced P provided by post B in Newtown? [10%]

(b) What is the maximum normal stress in the board due to bending? [5%]

(c) What is the maximum shear stress in the board due to bending? [5%]