國立成功大學

115學年度碩士班招生考試試題

編　號：86

系　所：工程科學系

科　目：材料力學

日　期：0204

節　次：第 2 節

注　意：1.可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

考生請注意：本試題可使用計算機。請於答案卷（卡）作答，於本試題紙上作答者，不予計分。
材料力學共有 5 題，請詳細條列計算或推導過程。請考生將每題的答案（若有單位請包含單位）以方匡標註出來，以利批改考卷。

1. Briefly explain the following terms and their physical significance (15 pts)
(a) Shear Modulus (5 pts)
(b) Young's Modulus (5 pts)
(c) Saint-Venant's Principle (5 pts)

2. An aluminum alloy rod (E_{al}=70 GPa, α_{al}=23*10^{-6}/°C) is securely fixed between two rigid walls. The rod has a total length L= 500 mm and a cross-sectional area A= 200 mm^2. (15 pts)
(a) If the ambient temperature increases by $\Delta T = 50$ °C, determine the thermal stress σ_{th} induced within the rod. (7 pts)
(b) Following part (a), if an axial force P= 10 kN is applied to the right at the midpoint of the rod, calculate the reaction force at the left fixed support. Please solve this by using the Compatibility Equation. (8 pts)

3. (Total: 20 pts)
(a) Structural Efficiency in Bending (8 pts)
Consider two beams with the same cross-sectional area A.

1. Define the **Section Modulus (S)** and explain its physical significance in bending resistance. (3 pts)
2. By considering a rectangular cross-section (A = b * h), prove that the beam with a larger depth h possesses a larger section modulus and is therefore more effective in resisting the maximum bending stress. (5 pts)

(b) Mechanics of Composite Beams (12 pts)
Consider a composite bar consisting of two different materials bonded together (as shown in Fig. 1).

1. Describe the fundamental assumption of the **Transformed-Section Method** regarding the strain distribution across the interface. (4 pts)
2. Let n = E_2 / E_1 be the modular ratio. Show that the actual normal stress σ_2 at a point in the original material (Material 2) must be n times larger than the stress calculated at the corresponding point in the transformed section (Material 1). (8 pts)

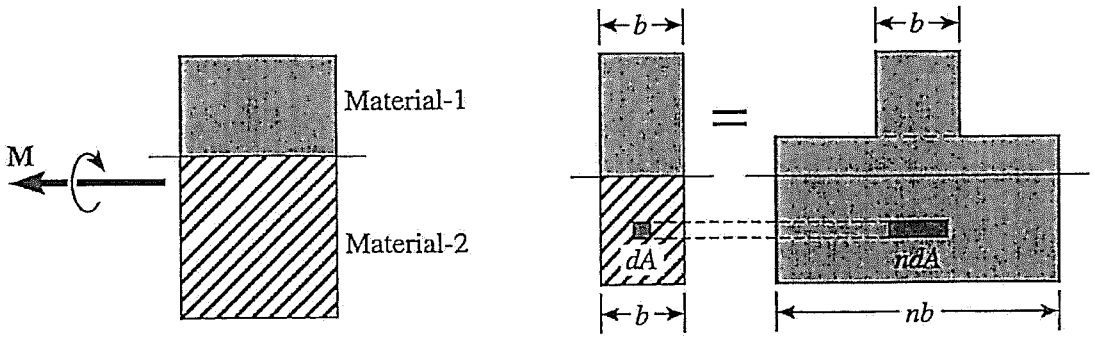
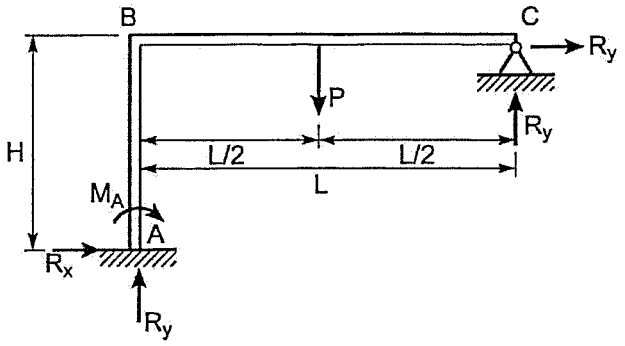


Fig. 1

4. A L-shaped frame *ABC* is fixed at point *A* and pinned at point *C*. The horizontal member *BC* has length *L* and the vertical member *AB* has height *H*. A downward vertical load **P** is applied at the midpoint of *BC*. Assume constant flexural rigidity *EI* and neglect axial/shear deformation.



(a) Determine the degree of static indeterminacy for this frame.(5 pts)

(b) If the pin at *C* is chosen as the redundant, identify the redundant force R_c. (10 pts)

(c) Determine the reaction at the pin support C using **Castigliano's Second Theorem**. (15 pts)

5. A point in a continuum is defined by the following stress tensor σ in MPa:

$$[\sigma] = \begin{bmatrix} 40 & 20 & 0 \\ 20 & 10 & 0 \\ 0 & 0 & 30 \end{bmatrix}$$

(a) Determine the principal stresses σ_1, σ_2, and σ_3 by solving the characteristic equation. (10 pts)

(b) Draw the 3D Mohr's Circle. Label the centers and radii of the three circles connecting the principal stresses. (10 pts)