國立成功大學

113學年度碩士班招生考試試題

編　號：116

系　所：工程科學系

科　目：材料力學

日　期：0202

節　次：第 2 節

備　註：可使用計算機

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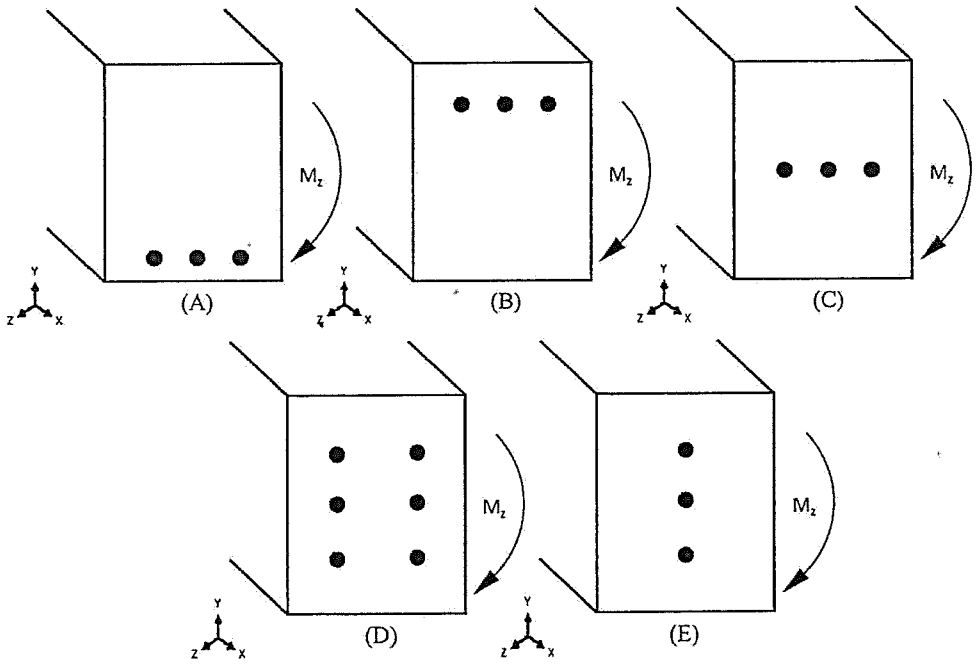
※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Part I Multiple Choice Questions Section (Comprising 30% of the Total Score)

In this part, each question has only **one** correct answer. Correct answers are awarded 6 points, contributing to the overall score. Incorrect answers result in a 3-point deduction (倒扣三分), discouraging guessing. Please note, unanswered questions do not affect the score positively or negatively. If uncertain, it may be strategic to leave a question unanswered to avoid point deduction for incorrect guesses.

1. (6%) In the context of reinforced concrete structures when subjected solely to pure bending — that is, bending characterized by the absence of axial loads or shear forces — which of the specified reinforcement configurations below can withstand the greatest bending moment?



2. (6%) A straight rod with a length of 369*mm* and a cross-section of width 45*mm* and length 150*mm*, made of isotropic linearly elastic-perfectly plastic material with a yield strength of 360MPa. If one end is fixed and the other end is under tension, what is the ultimate load it can withstand?
   (A) 243 N　(B) 2430 kN　(C) 2.43 kN　(D) 2.43 N　(E) None of the above

3. (6%) Referencing the previously described straight rod with a fixed end and a free end, which is made of isotropic linearly elastic-perfectly plastic material and has a yield strength of 360 MPa: if the free end is subjected to a bending moment, what is the maximum bending moment (also known as the ultimate bending moment) that the rod can resist before yielding or failing?
   (A) 91.125 kN·cm　(B) 91.125 kN·mm　(C) 91.125 kN·m　(D) 91.125 N·m　(E) None of the above

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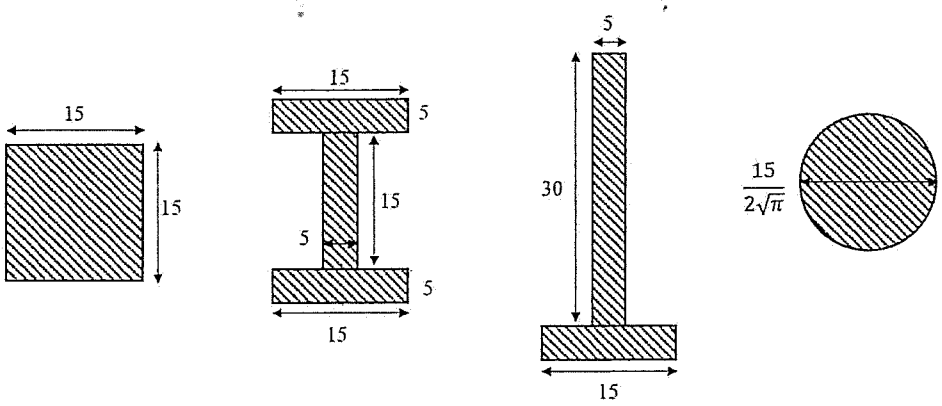
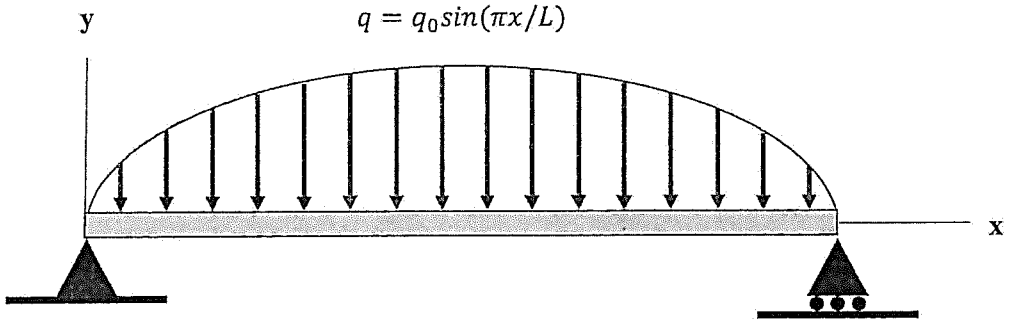
4. (6%) Considering a beam with a uniform cross-sectional area, when comparing different geometric shapes of sections (such as rectangular, circular, I-shaped, etc.), which geometric shape would experience the highest level of bending stress under the same loading conditions?



(A)　(B)　(C)　(D)

5. (6%) Consider a simply supported beam, which is affected by a variable distributed load represented by the equation $q = q_0 sin(x\pi/L)$, where q represents the load per unit length at a point x along the beam, q_0 is the maximum intensity of the distributed load, and L is the length of the beam. Could you determine the vertical deflection at the midpoint of the beam due to this sinusoidally varying distributed force?

(A) $\frac{q_0 L^3}{\pi^4 EI}$　(B) $\frac{q_0 L^4}{\pi^3 EI}$　(C) $\frac{q_0 L^2}{\pi^2 EI}$　(D) $\frac{q_0 L^2}{\pi^4 EI}$　(E) $\frac{q_0 L^4}{\pi^4 EI}$



Part II: Conceptual Questions: In-Depth Definitions and Explanations (20% of the Total Score)

You are expected to provide detailed, accurate, and nuanced explanations of various key terms. Each definition should encompass not only the basic description but also a contextual backdrop, including examples or scenarios where applicable, the significance of the term in its respective field, and any pertinent theoretical or practical implications.

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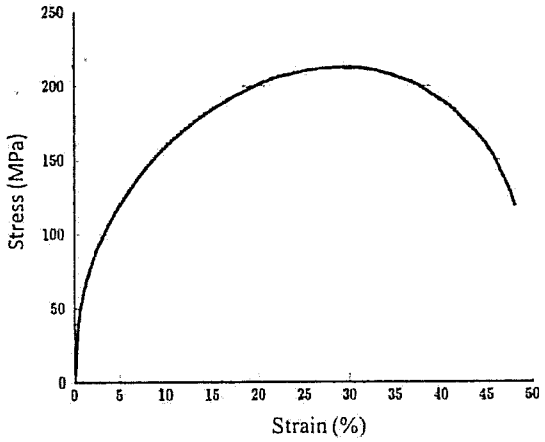
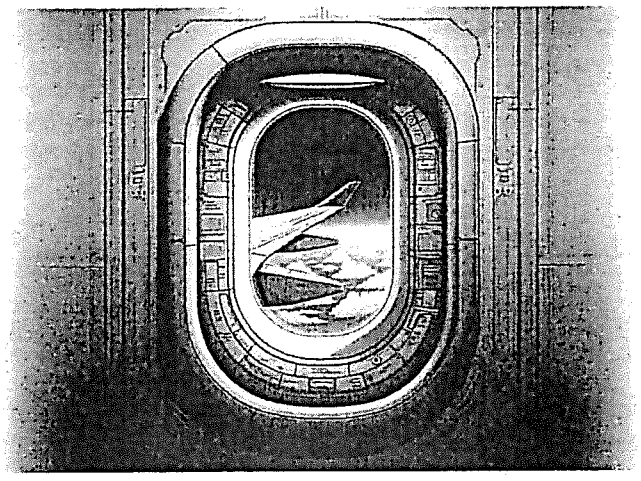
1. (5%) Could you explain what the **stress concentration factor** is, and how one might define or calculate it?
2. (5%) What is the primary cause of **plastic deformation** in low carbon steels at room temperature when they are subjected to mechanical loading?
3. (5%) In the context of the stress-strain diagram provided, how would you identify and define the **yield stress**?



4. (5%)Why are airplane windows designed with an **oval shape**, and what are the benefits of this design choice in terms of structural integrity and safety?



Part III: Derivation Problems (50%)

In this part, you are required to provide comprehensive and detailed derivations for the question presented below. This part will account for 50% of the overall assessment score. Ensure that your derivations are clear, well-structured, and thoroughly explained to demonstrate a deep understanding of the subject matter.

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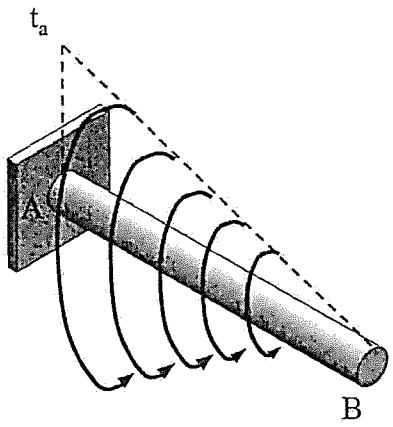
1. (25%) Consider a solid circular shaft, as depicted in the following theoretical diagram. The shaft has point *A* as the fixed end, a length denoted by *L*, and a diameter represented by *d*. It also has a shear modulus *G*. A torque is applied to the shaft, distributed linearly from ta at the left end to 0 at the right end. The goal is to determine the relative twist angle between the two ends. This angle should be expressed in terms of *L*, *d*, *G*, and t_a, considering the direction of the applied torque.



2. (25%) Consider a circular ring that is in contact with the ground, assuming friction is negligible. This ring has a radius, denoted as *r*, thickness *t*, and possesses a bending stiffness represented by *EI*. When a force, labeled *P*, is applied at the ring's top center point (point A), the objective is to determine the vertical displacement at point A. This determination should be made using Castigliano's theorem, which is a principle for calculating displacements in elastic systems subjected to a load.