所別：機械工程學系碩士班 乙組(製造與材料) 科目：機械材料及材料力學

A. 機械材料 (50%)

1. 在一鋁合金試片上量測洛式 B 尺(Rockwell B Scale)硬度(RB)，量得下列四個數據：83、88、86、87，試求該試片之平均硬度（RB）$_{ave}$ 及其標準差（S）。(4%)
2. 如何提升鋼鐵材料之硬化能力(Hardenability)。(5%)
3. 簡繪下列二元合金之相圖：(8%)
   (1) Isomorphous system
   (2) Eutectic system
   (3) Peritectic system
   (4) Montectic systm
4. 一塊鐵與一塊銅共同放置於稀氯化鈉溶液中，露在外面的一端以導線相連。
   試寫出其(1)陽極半反應，(2)陰極半反應，(3)何種金屬會被腐蝕? (4)繪此電池並標出：陽極、陰極、導線中電子之流動方向。(8%)
5. Explain why the properties of polycrystalline materials are most often isotropic. (5%).
6. Cite three metallurgical/processing techniques that are employed to enhance the creep resistance of metal alloys. (5%)
7. Briefly describe laminar composites. What is the prime reason for fabricating these materials? (5%)
8. In your own words, explain the mechanism by which charge storing capacity is increased by insertion of a dielectric material within the plates of a capacitor. (5%)
9. Briefly explain why the ferroelectric behavior of $BaTiO_3$ ceases above its ferroelectric Curie temperature? (5%)

B. 材料力學 (50%)

1. (5%) Suppose that the stress state, $\sigma_x = 105MPa$, $\sigma_y = 90MPa$, and $\tau_{xy} = 105MPa$, occurring at point Q (see Figure 1) in a steel beam has caused the beam to yield. As far as yielding is concerned, would another stress state, $\sigma_x = 85MPa$, $\sigma_y = 70MPa$, and $\tau_{xy} = 105MPa$, occurring at the same point cause the beam to yield also? Why or why not?

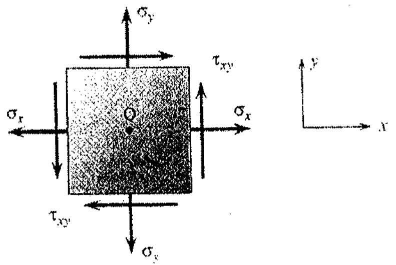

Figure 1

2. (10%) Equations for the transformation of plane stress have been readily developed as follows,

$$\sigma_{x'} = \sigma_x \cos^2\theta + \sigma_y \sin^2\theta + 2\tau_{xy}\sin\theta\cos\theta$$

$$\tau_{x'y'} = -(\sigma_x - \sigma_y)(\sin\theta\cos\theta) + \tau_{xy}(\cos^2\theta - \sin^2\theta)$$

where θ is the angle between the x and x' axes. Using these transformation equations to derive the principal stresses, σ_1 and σ_2, and the angle θ_p defining the principal planes in terms of the stress components.

3. (10%) Consider a slender column of uniform cross-section with pinned ends loaded with an axial compressive load P which acts through the centroid of the cross-section (see Figure 2). The column is assumed to be initially straight and to behave in a linear-elastic manner.

注意：背面有試題

Derive the critical axial load （P_{Cr}），

$$P_{Cr} = \frac{\pi^2 EI}{L^2}$$

under which the column can be in equilibrium both in the straight and slightly deformed position. Note that in the above equation, E is the modulus of elasticity (i.e., Young's modulus) and I is the area moment of inertia of the cross-section about z-axis.

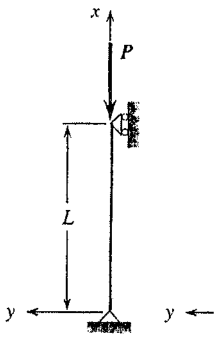

Figure 2

4. (8%) A solid circular bar of diameter d = 2 in. is twisted in a testing machine until the applied torque reaches the value T = 11,000 in.–lb (see Figure 3). At this value of torque, a strain gage oriented at 45° to the axis of the bar gives a reading $\varepsilon = 305 \times 10^{-6}$. Determine the shear modulus G of the material.

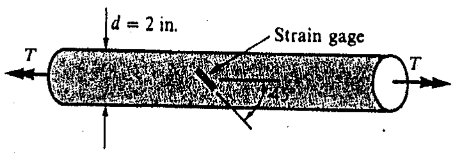

Figure 3

5. (9%) A curved bar ABC is subjected to loads in the form of two equal and opposite forces P, as shown in the Figure 4. The axis of the bar forms a semicircle of radius r. Determine the axial force N, shear force V, and bending moment M acting at a cross section defined by the angle θ (see Figure 4).

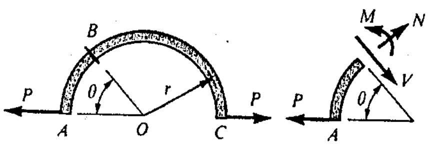

Figure 4

6. (8%) A square pillar is subjected to a compressive force P = 750 kip and a bending moment M = 60 ft–kip (see Figure 5). What is the required side dimension b of the pillar if the allowable stresses are 2600 psi in compression and 900 psi in tension? (Disregard the weight of the pillar itself.)

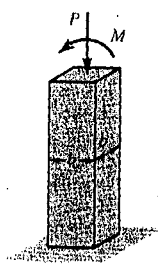

Figure 5