國立臺灣科技大學 108 學年度碩士班招生試題

系所組別：機械工程系碩士班戊組

科　　目：材料原理

(總分為 100 分)

1. Between methane (CH_4) and water, which one would be expected to have a higher boiling temperature? Why? (10%)

2.

(a) Do you expect iron and aluminum to have the same atomic packing factor, volume of unit cell, number of atoms per unit cell, and coordination number at room temperature? Why? (5%)

(b) Answer the same question in (a), but at this time the temperature is above 912 °C. (5%)

3.

(a) Gas carburization is a non-steady state diffusion process. Is this process more sensitive to time or temperature? Explain using appropriate equations. (5%)

(b) Hydrogen embrittlement can be defined as following: "When hydrogen diffuses in ferrous alloys, it will make the material significantly more brittle and susceptible to fracture". The activation energy of hydrogen in steel and carbon in steel are 3.6 Kcal/mol and 30 Kcal/mol, respectively. Should we worry about hydrogen embrittlement of steels (i.e., is it very likely to occur)? Explain using the concept of diffusivity. (5%)

4. A single crystal of copper is oriented so that the (111) plane is perpendicular to an applied stress of 60 MPa. List the slip systems composed of close-packed planes and directions that may be activated due to this applied stress. (10%)

5.

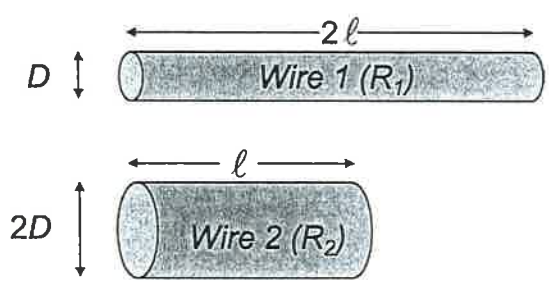
(a) Estimate the AISI-SAE number for a steel having 97% ferrite and 3% cementite. (5%)

(b) A steel contains 93% pearlite. Estimate the carbon content of the sample if it is known to be hypoeutectoid. (5%)

6.

(a) Two pure copper wires are shown as below. What is the relationship of their resistances, R_1 and R_2? (5%)

(b) For wire 1, if $\ell = 50$ m and the conductivity of pure copper is 6.07×10^7 $(\text{Ohm-m})^{-1}$. When a current = 2.5A passing through this wire, what is the minimum diameter (D) of the wire so that $\Delta V < 1.5$ Volts? (5%)



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7.

(a) Anodizing treatment is a general passivation reaction for protecting materials from corrosion. Please describe what is "passivity" and what kind of materials is suitable for such passivation treatment. (5%)

(b) What is the function of "sacrificial anode"? (5%)

8. Thermal expansion is a nature behavior of most materials. Please explain why thermal expansion may happen from the perspective of (a) bond between atoms (5%) and (b) defects in materials (5%).

9.

(a) If no absorption occurs, when a light beam perpendicularly passes through a sapphire substrate (index of refraction, $n_{Al_2O_3}$= 1.75) substrate, what is its transmissivity? (5%)

(b) If a layer of optical coating (n = 1.4) is deposited on the light incident surface, what will the transmissivity be? (5%)

10. The following figure presents three lines about the relationship between electrical conductivity vs. grain size for metals. Which one is more reasonable (5%) and why (5%)?