系　　所：機械工程學系
考試科目：機械製造及材料

考試日期：0223，節次：2

※ 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。

1. (a) Draw a typical stress-strain diagram for a metal and illustrate (1) proportional limit, (2) elastic limit, (3) yield strength, (4) tensile strength, (5) fracture point, and (6) Young's modulus. (12%)
   (b) What are the engineering strain and true strain? (4%)

2. (a) What is the composition, in atom percent, of an alloy that contains 45.2 kg of copper, 46.3 kg of zinc, and 0.95 kg of lead? (molecule weight of Cu: 63.55g/mol, Zn: 65.41g/mol, Pb: 207.2g/mol)? (6%)
   (b) Calculate the number-average molecular weight of a random nitrile rubber copolymer [poly(acrylonitrile(C_3H_3N)$_m$-butadiene (C_4H_6)$_n$)] in which the fraction of butadiene repeat units is 0.30; assume that this concentration corresponds to a degree of polymerization of 2600. (8%)

3. Referred to the binary Cu-Zn phase diagram below. For a 30 wt% Zn-70 wt% Cu alloy, make schematic sketches of the microstructure that would be observed for conditions of very slow cooling at the following temperatures: 1100 °C, 950 °C, 900 °C, and 700 °C. Label all phases and indicate their approximate compositions. (20%)
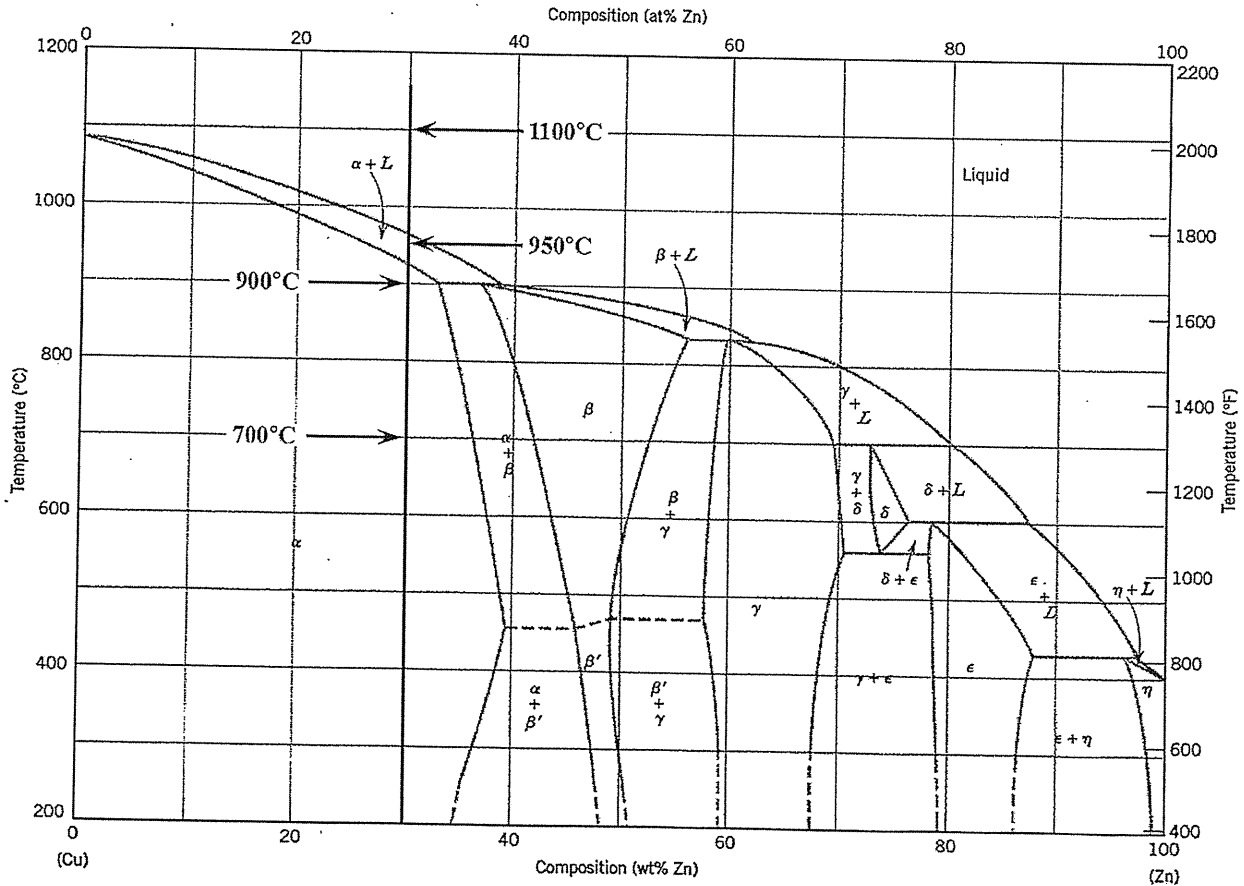
4. Explain the following casting processes

　　(a) Sand casting (5%)

　　(b) Investment casting (5%)

　　(c) Die casting (5%)

5. In an orthogonal cutting test, the tool rake angle is $\alpha = 5°$, cutting speed is $V = 30$ m/min, chip width is $b = 3$ mm, uncut chip thickness is $t_0 = 0.2$ mm, and the chip thickness is $t = 0.4$ mm. The measured cutting force $F_c = 1300$ N and thrust force $F_t = 600$ N. Based on the Merchant's force circle, please calculate the following values.

　　(a) Material removal rate (3%)

　　(b) Specific energy u_t (3%)

　　(c) Friction angle β (3%)

　　(d) Shear angle ϕ (3%)

　　(e) Average shear stress τ in the shear plane (3%)
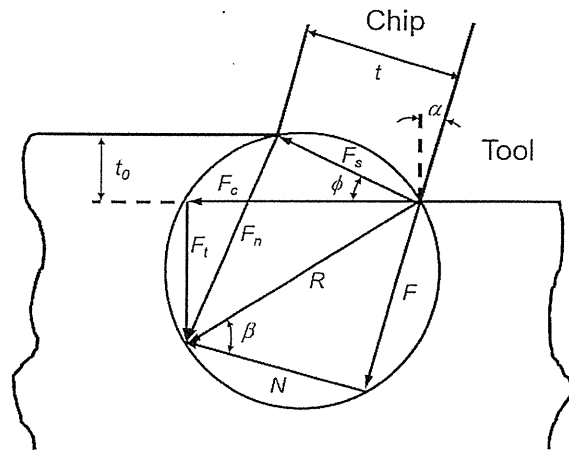
6. Discuss the advantages and disadvantages of forging, machining, and additive manufacturing processes. (10%)

7. Explain and compare electrical-discharge machining and laser machining processes. (10%)