國立臺灣科技大學

九十一學年度碩士班招生考試試題

系所組別： 電子工程系丙組

科　目： 電子學

(總分 100 分)

1. (10%) For the circuit shown in Fig. 1 derive an expression for the transfer function V_o/V_i. Find expressions for the magnitude and phase of the response. Note: This circuit functions is a first-order all-pass filter.

2. (15%) The 6.8-V zener diode in the circuit of Fig 2 is specified to have V_z=6.8V at I_z=5mA,r_z=20Ω,and I_{zk}=0.2mA. The supply voltage V^+ is nominally 10V but can vary by ±1V.
   (a)Find the change in V_o resulting from the ±1-V change in V^+.
   (b) Find the change in V_o resulting from connecting a load resistance R_L=2kΩ.
   (c) What is the minimum values of R_L for which the diode still operates in the breakdown region ?

3. (15%) In the circuit of Fig. 3, v_s is a small sine-wave signal with zero average. The transistor β is 100.
   (a) Find the value of R_E to establish a dc emitter current of about 1mA.
   (b) Find R_c to establish a dc collector voltage of about +5V.
   (c) For R_L=5 kΩ and the transistor r_o=100 kΩ, draw the small-signal equivalent circuit of the amplifier and determine its overall voltage gain.

4. (10%) Figure 4 shows an N-output current mirror. Assuming all transistors to be matched and have finite β and ignoring the effect of finite output resistances, show that $I_1 = I_2 = \ldots\ldots = I_N = \frac{1}{1+(N+1)/\beta}$ For β=100 find the maximum number of outputs for an error not exceeding 10%.

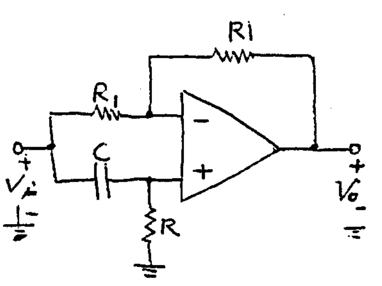

Fig.1

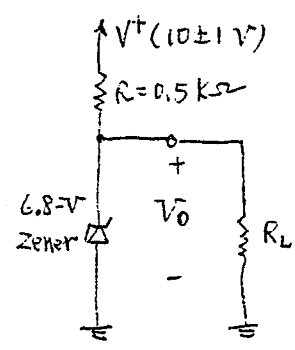

Fig.2

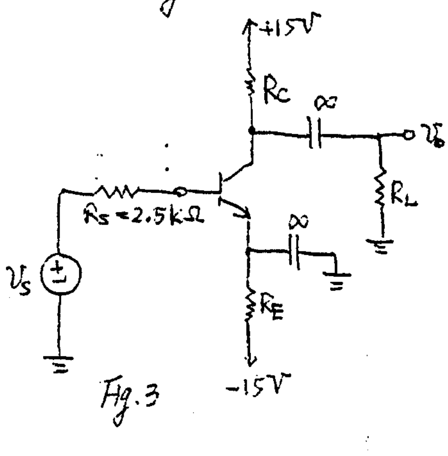

Fig.3

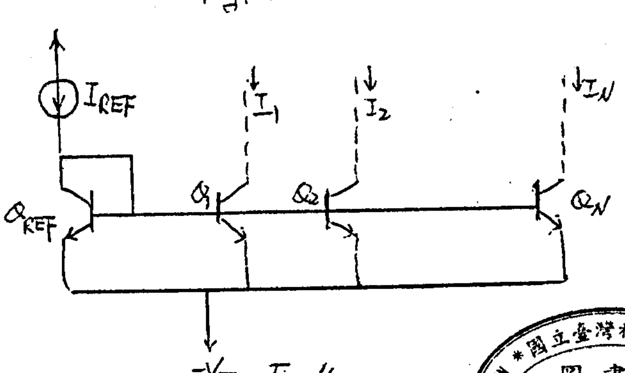

Fig 4

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5. (10%) (1) What is a common-collector amplifier? Please draw an example.
(2) What is a common-emitter amplifier? Please draw an example.

6. (10%) An amplifier has the voltage transfer function $T(S)=\frac{10s}{(1+s/10^2)(1+s/10^5)}$ .Find the poles and zeros and sketch the magnitude of the gain versus frequency. Find approximate values for the gain at ω=10, 10^3, and 10^6 rad/s.

7. (10%) Fermi-Dirac probability function：Assume that the Fermi energy level for a particular is 6.25 eV and that the electrons in this material follow the Fermi-Dirac distribution function. Calculate the temperature at which there is a 1 percent probability that a state 0.30eV below the Fermi energy level will not contain an electron.

8. (10%) Consider a three-dimensional infinite potential well. The potential function is given by V(x) =0 for 0 < x < a , 0 < y < a, 0 < z < a, and V(x)=∞ elsewhere. Start with Schrodinger's wave equation, use the separation of variables technique, and show that the energy is quantized and is given by

$$E_{n_x n_y n_z}=\frac{\hbar^2\pi^2}{2ma^2}\left(n_x^2+n_y^2+n_z^2\right)$$

where n_x=1,2,3,…., n_y=1,2,3,….., n_z=1,2,3,…..

9. (10%) Consider an n-type silicon semiconductor at T =300°K in which $N_d=10^{16}\ cm^{-3}$ and N_a =0. The intrinsic carrier concentration is assumed to be $n_i=1.5\times10^{10}\ cm^{-3}$. Please determine the thermal equilibrium electron and hole concentrations.