(甲乙丁己庚)

1. (a) A one-sided p^+-n Si junction diode, if $N_D=1\times10^{16}$cm^{-3} and $N_A=1\times10^{18}$cm^{-3}, please calculate the depletion region width of the diode with zero bias (assuming $n_i=1.45\times10^{10}$cm^{-3}) (5%)

(b) In a silicon crystal, which one is larger, μ_n or μ_p? What are the factors that might influence the electron mobility μ_n and the hole mobility μ_p, why? (4%)

(c) Please draw the small signal model of a bipolar junction transistor (3%), derive the transconductance $g_m=\dfrac{\Delta i_c}{\Delta v_{BE}}\Big|_{v_{CBQ}}=\dfrac{|I_{CQ}|}{\eta V_T}$ (3%)

(d) Please state in your own words, what are the advantages of BJT and FET, respectively. (5%)

2. (a) 簡述射極隨偶器電壓增益小於 1 之原因。(3%)
   (b) 頻率補償之主要目的爲何？(3%)
   (c) 試簡述振盪器之工作原理。振盪條件爲何？如何決定振盪頻率？(4%)

3. (a) 試推導圖 1 所示電路之電壓增益 $A_v(=v_o/v_i)$。設兩電晶体之輸出電阻均爲 r_o。(5%)
   (b) 試繪出圖 2 所示(a)、(b)兩電路之移轉特性曲線。於電路應用上何者較佳？簡述其原因。(5%)

4. A TTL gate circuit is shown in Fig. 3, Both of the inputs are tied together. The transistors are identical and have $\beta_R=0.5$
   (a) Determine $\beta_{F(min)}$ for proper operation. Assume that Q2 and Q3 saturate for $v_s=V(1)$. (12%)
   (b) What is the fan-out? (8%)

圖 1

圖 2

圖3

（背面仍有題目,請繼續作答）

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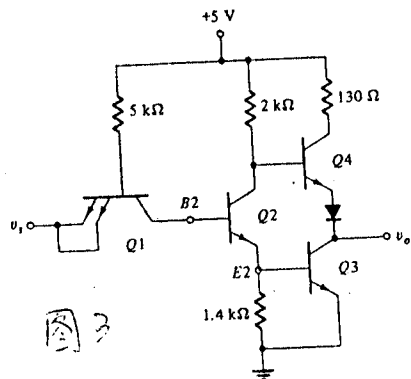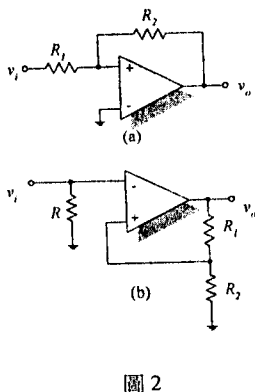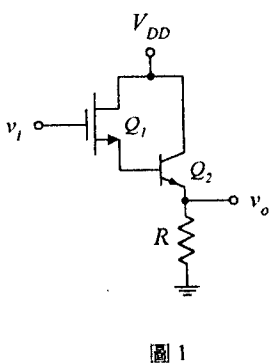
5. An amplifier circuit is shown in Fig. 4, NPN transistors are identical. PNP transistors are identical. All transistors operate in the active region. Base current can be ignored. $V_{BE}=0.7V$, Early voltage $V_A=100V$, thermal voltage $V_T=kT/q=25mV$. Calculate (a) $I_1=?$ (3%), (b) $I_2=?$ (3%), (c) output resistance $R_o=?$ (3%) (d) low frequency gain $v_{out}/v_{in}=?$ (3%)

6. For a two stage OPAMP, explain (a) Miller compensation. (3%) (b) slew rate. (3%)

7. A single-pole amplifier as shown in Fig. 5(a) is assigned to have a low-frequency gain of 100 and a pole at 10^5Hz (i.e. $2\pi \times 10^5$ rad/sec). The single-pole amplifier (transfer function=A(S)) is used to design a feedback amplifier (transfer function=A_F(S)) as shown in Fig. 5(b). (a) Derive A(S) and draw its Bode plot. (3%) (b) What's the feedback type of the internal stage of the feedback amplifier? β for the internal stage =? (3%) (c) Derive A_F(S) and draw its Bode plot. (3%) (d) If the gain of the single-pole amplifier is decreased by 20%, what is the corresponding gain decrease in the feedback amplifier? (3%)

8. (a) For a Butterworth filter that meets the following low-pass specifications: $f_p=3KHz$, 20dB attenuation at $f_s=6KHz$, calculate N=? (5%)

(N_{th} order Butterworth transmission: $\left|\dfrac{H(f)}{H_o}\right|^2 = \dfrac{1}{1+(f/f_p)^{2N}}$)

(b) Draw the circuit diagram of an universal biquad filter and show how lowpass can be achieved (5%)0
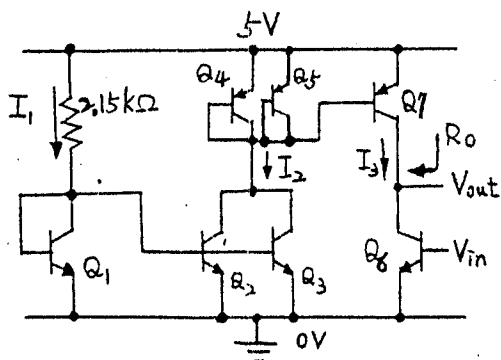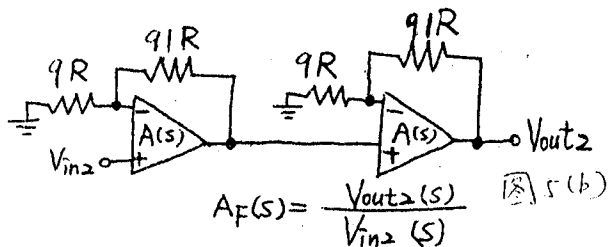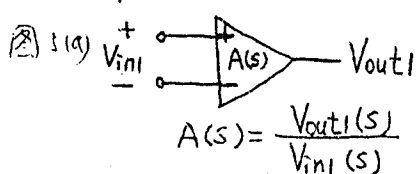

圖 4

圖 5(a) $A(S) = \dfrac{V_{out1}(S)}{V_{in1}(S)}$

$A_F(S) = \dfrac{V_{out2}(S)}{V_{in2}(S)}$ 圖 5(b)