考試科目：電子學

系所名稱：光電科學研究所碩士班不分組　　　　　＊可使用計算器

1.答案以橫式由左至右書寫。2.請依題號順序作答。

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1. An intrinsic silicon bar is 2 mm long and has a rectangular cross section 80 x 100 μm. At 300 K, determine the electric field intensity in the bar and the voltage across the bar when a steady current of 1 μA is measured. Note: the resistivity of this silicon bar is 2.3×10^5 (Ω·cm). (10%)

2. For the circuit in Fig.1(a), for which the input voltage is the sawtooth waveform displayed in Fig.1(b), sketch (a) the transfer characteristic V_0 versus V_s and (b) the output waveform V_0. The diode parameter are $R_f = 10$ Ω, $V_r = 0.6$ V, and $I_s = 0$. (20%)

3. Explain an *npn* transistor operation mode when consider with the (a) emitter-base and collector-base junction bias. (b) If the transistor is operated under forward active mode with the base-collector are short circuit, determined the *common-base forward short-circuit current gain* α_F when I_E and I_C values are 2×10^{-3} A and 5×10^{-3} A. (10%)

4. The circuit shown in Fig. 2 is a current mirror. The transistors $Q1$ and $Q2$ are identical, (a) Determine I_C in terms of circuit parameters. (b) Evaluate I_C for $V_{CC} = 10$ V, $R = 10$ kΩ and $\beta_F = 100$. (10%)

5. For the circuit in Fig. 3, find the values of v_E, v_{C1}, and v_{C2}. Assume that $|V_{BE}|$ of a conducting transistor is 0.7 V and that common-base current gain $\alpha \simeq 1$. (12%)

6. For the circuit in Fig. 4, the NMOS and PMOS transistors are matched with $k'_n(W_n/L_n) = k'_p(W_p/L_p) = 0.6$ mA/V^2 and $V_{tn} = -V_{tP} = 1$ V. Find the drain current i_{DN}, i_{DP} and the voltage v_o for $v_I = +5$ V and -5 V. Neglect the channel-length modulation effect for both devices (i.e., assume that $\lambda = 0$). (18%)

7. For the circuit in Fig. 5, let $R_1 = 2$ kΩ and $R_2 = 5$ kΩ. Find v_O and the voltage at the amplifier output v_A for $v_I = +2$ V, -20 mV, and -0.2 V. Assume the op amp to be ideal with saturation voltages of ±12 V. The diodes have 0.7-V voltage drops at 1 mA, and the voltage drop changes by 0.1 V per decade of current change. (20%)
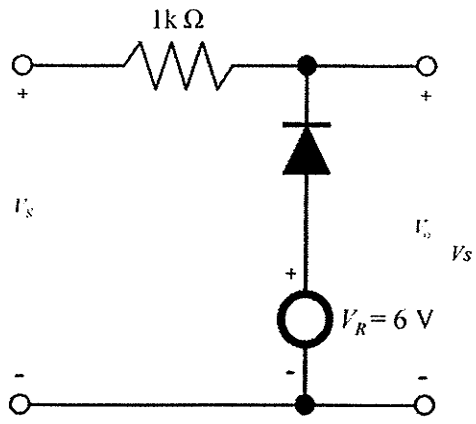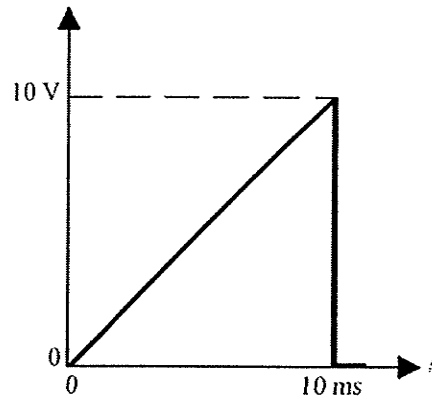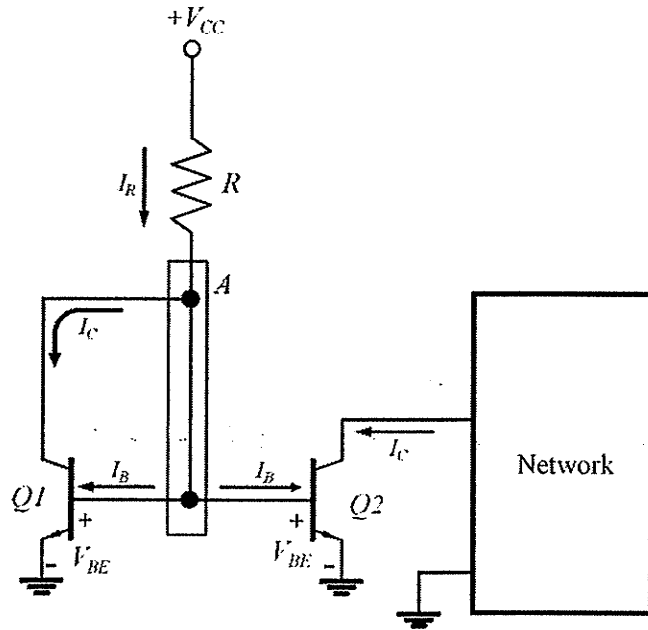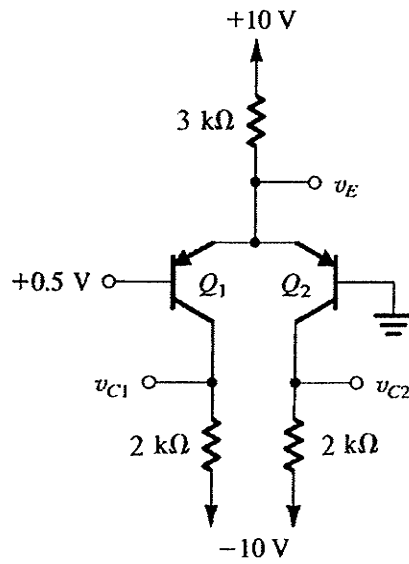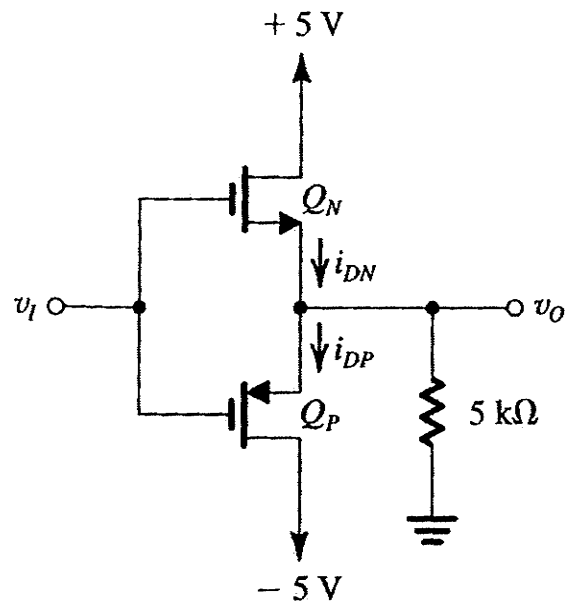
Fig. 1(a)

Fig. 1(b)

Fig. 2

Fig. 3

Fig. 4

Fig. 5