

1. A doped silicon sample is 3 mm long and has a rectangular cross section of $50 \times 100 \mu\text{m}^2$. The donor concentration is $5 \times 10^{14} \text{ cm}^{-3}$. A steady current of $1 \mu\text{A}$ exists in the bar. Determine the conductivity and voltage across the bar. (if the related parameters are: $\mu_n = 1500 \text{ cm}^2/\text{V}\cdot\text{s}$, $\mu_p = 475 \text{ cm}^2/\text{V}\cdot\text{s}$, and $n_i = 1.5 \times 10^{10} \text{ cm}^{-3}$) (12%)
2. An NMOS inverter with a depletion-type load is shown in Fig. 1. The related parameters of this circuit are $V_{DD} = 5 \text{ V}$, $K_D = 90 \mu\text{A}/\text{V}^2$, $V_{TD} = 1 \text{ V}$, $K_L = 30 \mu\text{A}/\text{V}^2$, and $V_{TL} = -2 \text{ V}$. Determine the noise margins (NM_L and NM_H) of this circuit. (20%)

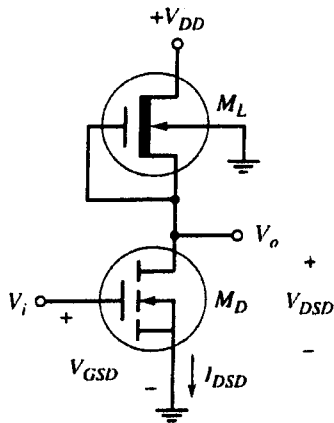


Fig. 1

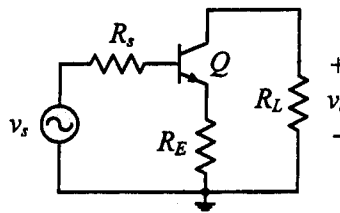


Fig. 2

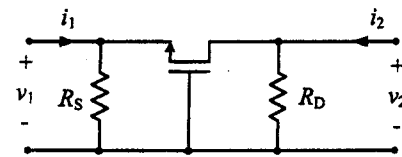


Fig. 3

3. Calculate gain-bandwidth product (GBP) and cutoff frequency of the amplifier shown in Fig. 2 for the case of $R_E = 0 \text{ k}\Omega$ and $R_E = 0.1 \text{ k}\Omega$, respectively. Assume $R_S = 0.5 \text{ k}\Omega$, $R_L = r_\pi = 1 \text{ k}\Omega$, $C_\pi = 50 \text{ pF}$, $C_\mu = 1 \text{ pF}$, and $\beta = 100$. (16%)
4. (a) Find the midband gain in dB and bandwidth in Hz for the amplifier described by $A(s) = \frac{2.5 \times 10^7 (s + 2 \times 10^5)}{(s + 10^5)(s + 5 \times 10^5)}$. What type of amplifier is this? (6%)
 (b) Write the g-parameter description of the common-gate amplifier shown in Fig. 3. What are the values of g_{12} and g_{21} if $R_S = 20 \text{ k}\Omega$, $R_D = 100 \text{ k}\Omega$, $g_m = 400 \mu\text{S}$, and $r_o = 400 \text{ k}\Omega$. (12%)

(背面仍有題目,請繼續作答)

5. An amplifier with a single-pole low-pass transfer function with a DC gain of 400 and a pole at 1 kHz also has $R_i=1\text{ k}\Omega$ and $R_o=750\ \Omega$. We want to use this amplifier in a negative-feedback connection to produce a close-loop amplifier with a gain of 10. We want to achieve the smallest input resistance and largest output resistance possible
- What type of feedback connection should we use? (4%)
 - What value of feedback factor, β , is required? (4%)
 - What are the resulting values of the input resistance and output resistance for the feedback amplifier? (4%)
 - What is the resulting closed-loop bandwidth? (4%)
6. Consider the circuit shown in Fig. 4. Assume that the diodes are ideal. Plot the transfer characteristic of this circuit, v_o/v_i , for $-2\text{ V} \leq v_i \leq 2\text{ V}$. (6%)

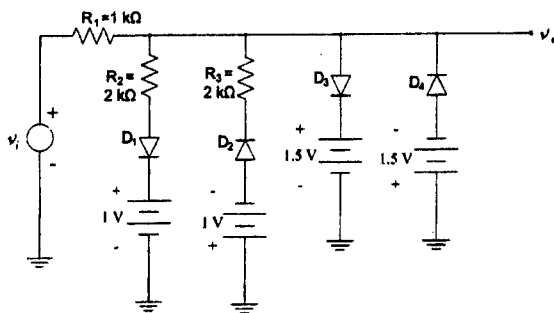


Fig. 4

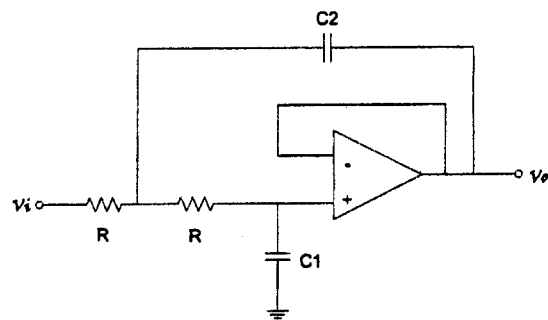


Fig. 5

7. Consider the OP-Amp circuit shown in Fig. 5. Assume that the OP-Amp is ideal.
- Find the transfer function, $T(s) = \frac{v_o(s)}{v_i(s)}$. (6%)
 - Sketch the Bode plots of the magnitude and phase of the transfer function for $R=100\text{ k}\Omega$, $C_1=56.3\text{ pF}$, $C_2=113\text{ pF}$. (6%)