1. A doped silicon sample is 3 mm long and has a rectangular cross section of $50\times100\ \mu m^2$. The donor concentration is $5\times10^{14}\ cm^{-3}$. A steady current of 1 μA exists in the bar. Determine the conductivity and voltage across the bar. (if the related parameters are: μ_n=1500 cm^2/V·s, μ_p=475 cm^2/V·s, and $n_i=1.5\times10^{10}\ cm^{-3}$) (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 V, K_D=90 μA/V^2, V_{TD}=1 V, K_L=30 μA/V^2, and V_{TL}=-2 V. Determine the noise margins (NM_L and NM_H) of this circuit. (20%)

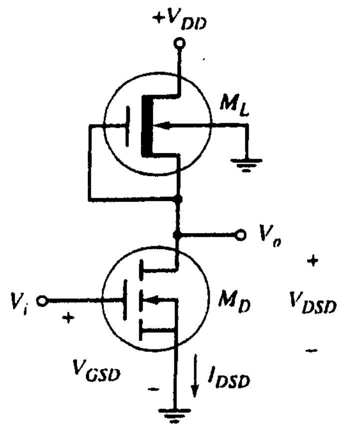

Fig. 1

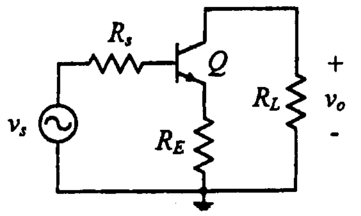

Fig. 2

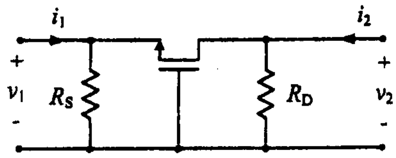

Fig. 3

3. Calculate gain-bandwidth product (GBP) and cutoff frequency of the amplifier shown in Fig. 2 for the case of $R_E = 0\,k\Omega$ and $R_E = 0.1\,\text{k}\Omega$, respectively. Assume $R_s = 0.5\,k\Omega$, $R_L = r_\pi = 1\,k\Omega$, $C_\pi = 50\,pF$, $C_\mu = 1\,pF$, and $\beta = 100$ 。(16%)

4. (a) Find the midband gain in dB and bandwidth in Hz for the amplifier described by $A(s) = \dfrac{2.5\times10^7(s+2\times10^5)}{(s+10^5)(s+5\times10^5)}$. 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 kΩ and R_o=750 Ω. 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
   (a) What type of feedback connection should we use? (4%)
   (b) What value of feedback factor, β, is required? (4%)
   (c) What are the resulting values of the input resistance and output resistance for the feedback amplifier? (4%)
   (d) 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 $-2V \le v_i \le 2V$. (6%)

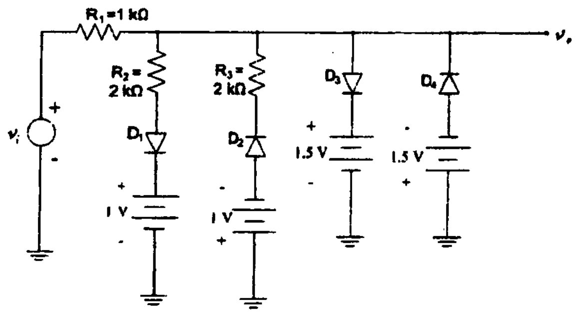

Fig. 4

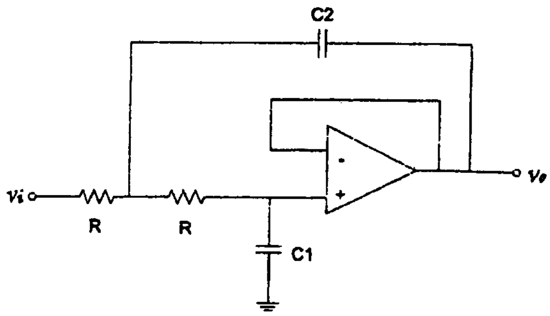

Fig.5

7. Consider the OP-Amp circuit shown in Fig. 5. Assume that the OP-Amp is ideal.
   (a) Find the transfer function, $T(s) = \frac{v_0(s)}{v_i(s)}$. (6%)
   (b) Sketch the Bode plots of the magnitude and phase of the transfer function for R=100 kΩ, C_1=56.3 pF, C_2=113 pF. (6%)