

- List five characteristics of an amplifier that are modified by negative feedback. (10%)
 - Draw the circuit diagram of a switched-capacitor (SC) integrator. (5%)
 - Derive the time constant of a SC integrator. (5%)
 - Briefly explain why the time constant of a SC circuit can be well controlled. (5%)
- If the collector current of a BJT operated in forward active region is expressed as

$$i_C = (a v_{BE}^2 + b v_{BE})(1 + c v_{CE}) \approx \beta i_B,$$

where a , b , c , and β are constant, derive and sketch its small-signal equivalent circuit for the cases of (a) $c = 0$ and (b) $c \neq 0$. (10%)
- Design a MOSFET current mirror to provide currents of I_o and $I_o/2$ simultaneously, where I_o is a constant. (5%)
 - Derive the transfer characteristics (i.e., $v_O - v_I$ relation) of the circuit shown in Fig. 1. Assume the Op-Amp is ideal. (5%)
 - Draw the load line of the diode D_2 shown in Fig. 2 and find I graphically. Assume D_1 and D_2 are identical diodes, $V_A = 1.5V_\gamma$, where V_γ is the cut-in voltage of the diode. (5%)

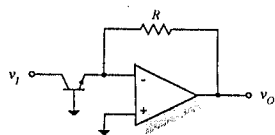


Fig. 1

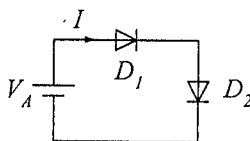


Fig. 2

- As the circuit shown in Fig. 3, design the circuit to obtain a dc gain of 40 dB, a 3-dB frequency of 1.5 kHz., and an input resistance of 1 k Ω . At what frequency does the magnitude of transmission become unity? What is the phase angle at this frequency? Assume op amp is ideal. (10%)
- For the source follower in Fig. 4(a), find the open-circuit voltage gain v_{o1}/v_i and the output resistance R_{o1} , in terms of g_{m1} and χ . Neglect the effect of r_{o1} and that of the output resistance of the bias current source. $g_{mb} = \chi g_m$, g_{mb} is the body transconductance.
 - For the common-gate amplifier in Fig. 4(b), find the voltage gain v_o/v_{i2} and the input resistance R_i , in terms of g_{m2} , χ , and R . Neglect the effect of r_{o2} and that of the output resistance of the bias current source.
 - If the output terminal of the source follower in (a) is connected to the input terminal of common-gate amplifier in (b), find the overall voltage gain v_o/v_i of the cascaded amplifier.
 - If $V_{DD} = 5$ V and the dc bias voltage at the drain of Q_2 is to be 0 V, find the effective voltage ($V_{GS} - V_t$) required for Q_1 and Q_2 so that an overall voltage gain of 25 V/V is realized.
 - For $I = 50 \mu A$ and $k'_n = \mu_n C_{ox} = 50 \mu A/V^2$, find R and the (W/L) required for Q_1 and Q_2 . (15%)

(背面仍有題目,請繼續作答)

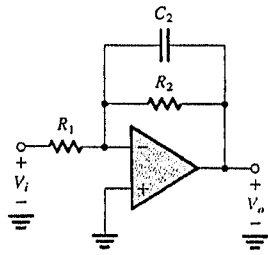


Fig. 3

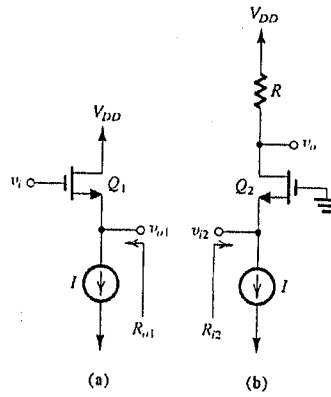
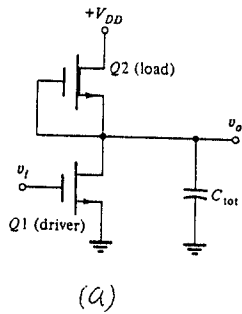
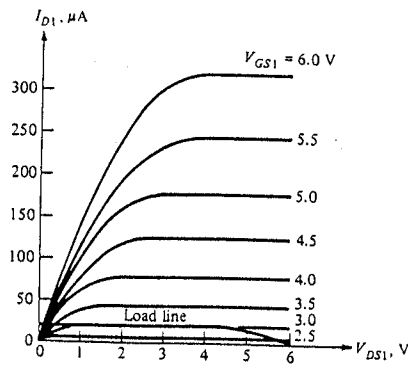


Fig. 4

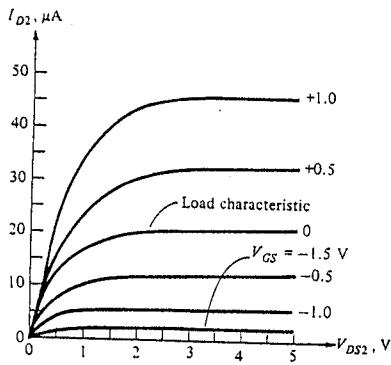
6. An inverter circuit is shown in Fig. a. The output current-voltage characteristics of transistors Q1 and Q2, and the transfer characteristics of this inverter are shown in Fig. b, c, and d, respectively. Assume that $C_{tot}=0.3\text{pF}$ and the input signal has $V(0)=0.3\text{V}$ and $V(1)=6\text{V}$. Please determine the values of the propagation delay t_{PHL} and t_{PLH} . (25%)



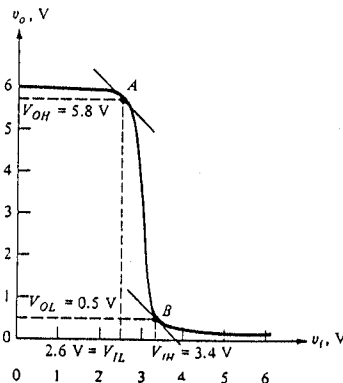
(a)



(b)



(c)



(d)