

1. Consider the circuit in Fig. 1.

- (1) For ideal op-amp, find the transfer function  $T(s) \equiv V_O/V_i$ . (10%)  
 (2) If the op-amp has a finite voltage gain  $A_0 = 100$ , find the transfer function. (15%)

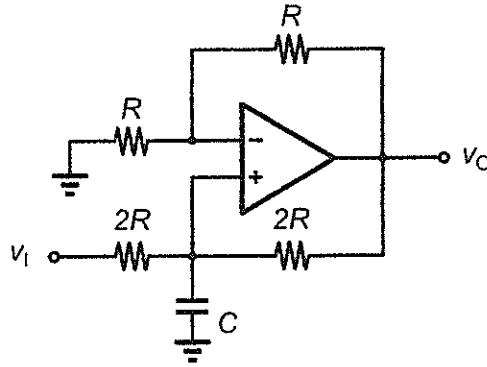


Fig. 1

2. Fig. 2 shows a differential amplifier, where the differential input voltage is defined as  $v_{id} = v_{G1} - v_{G2}$ . The device parameters are given as  $\mu_n C_{ox}(W/L)_n = 2 \text{ mA/V}^2$ ,  $\mu_p C_{ox}(W/L)_p = 1 \text{ mA/V}^2$ ,  $V_{tn} = |V_{tp}| = 0.5 \text{ V}$ ,  $V_{An} = |V_{Ap}| = 20 \text{ V}$ .

- (1) If a differential gain of 34 dB is required, find the value of current source  $I$ . (10%)  
 (2) For a non-ideal current source,  $I$  is 200  $\mu\text{A}$  and the equivalent output resistance is 100 k $\Omega$ . What is the CMRR in dB? (15%)

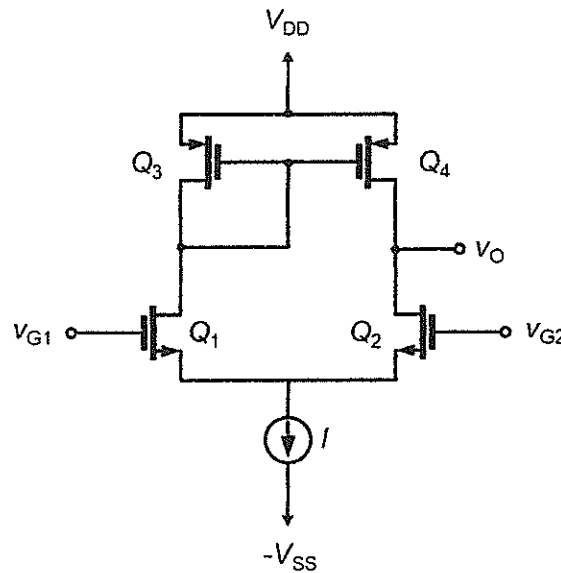


Fig. 2

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3. The circuit in Fig. 3 is a second-order active filter.

- (1) The parameters are given as  $R = 10\text{ k}\Omega$ ,  $R_1 = 10\text{ k}\Omega$ ,  $R_2 = 40\text{ k}\Omega$  and  $C = 10\text{ nF}$ . Find the transfer function of the filter  $T(s) \equiv V_O/V_I$ . (10%)
- (2) The input is given by a 1.6-kHz sinewave with an amplitude of 0.1V. What is the amplitude of the output waveform? (10%)
- (3) If a dc gain of 2 is required, how do you choose the value of  $R_1$ ? (10%)

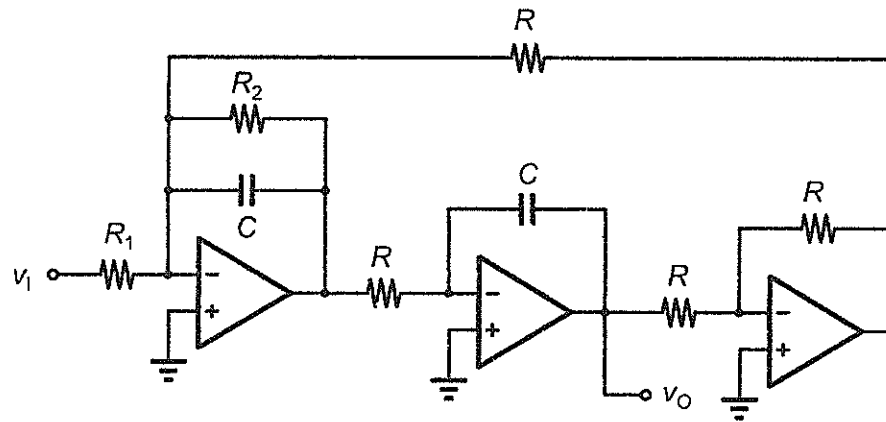


Fig. 3

4. For a complementary CMOS inverter as shown in Fig. 4, the parameters are given by  $\mu_n C_{ox}(W/L)_n = 4\mu_p C_{ox}(W/L)_p$ ,  $V_{tn} = |V_{tp}| = 0.5\text{ V}$ , and  $V_{DD} = 1.8\text{ V}$ .

- (1) Find the input voltage at which  $V_I = V_O$ . (10%)
- (2) Find the ratio of  $t_{PHL}/t_{PLH}$ . (5%)
- (3) If the output capacitance is 50 fF, find the static power dissipation of the inverter. (5%)

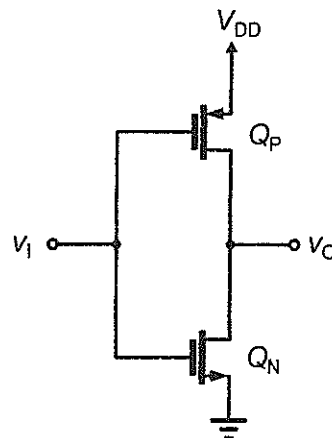


Fig. 4