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國立臺灣大學 103 學年度碩士班招生考試試題

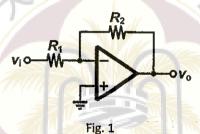
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 (30%) Assume that the frequency response of the op amp is given by a single-pole model with a unity-gain frequency of 10 MHz.

- (1) The op amp is used in the closed-loop amplifier as shown in Fig. 1. If the 3-dB bandwidth is 100 kHz, what is the dc gain of the amplifier? (5%)
- (2) Please design the values of R_1 and R_2 such that the closed-loop amplifier in Fig. 1 has a 3-dB bandwidth of 200 kHz and a dc gain of 43 dB. (5%)
- (3) Given that R_1 = 10 k Ω and R_2 = 400 k Ω for the amplifier in Fig. 1. What is the voltage gain (magnitude and phase) of the closed-loop amplifier at 500 kHz? (10%)
- (4) Consider that two identical closed-loop amplifiers are cascaded. If a minimum bandwidth of 100 kHz is needed, what is the maximum dc gain achievable for the cascaded amplifier. (10%)



- 2. (20%) The circuit in Fig. 2 is used as an amplifier and the circuit parameters are given as $k_n = k_p = 800 \ \mu\text{A}/\text{V}^2$, $V_{tn} = |V_{tp}| = 1 \ \text{V}$, $V_{An} = |V_{Ap}| = 50 \ \text{V}$, $R_1 = 7.5 \ \text{k}\Omega$, $R_2 = 2 \ \text{k}\Omega$, $V_{DD} = 5 \ \text{V}$ and the input common-mode voltage is 3.5 V.
- (1) Find the voltage gain of the amplifier (v_0/v_i) . (10%)
- (2) If V_{DD} is increased by 10%, find the change (%) in the voltage gain. (10%)

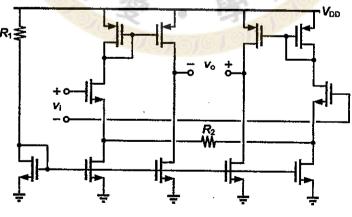


Fig. 2

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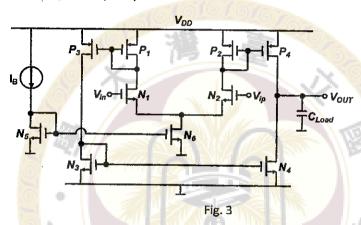
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- 3. (30 %) In Fig. 3, I_B is 0.1 mA and C_{Load} = 2 pF. Transistors $N_1 = N_2 = 10 \mu m/0.2 \mu m$; $N_3 = N_4 = N_5 = 10 \mu \text{m} / 1 \mu \text{m}; N_6 = 20 \mu \text{m} / 1 \mu \text{m}; P_1 = P_2 = 10 \mu \text{m} / 1 \mu \text{m}; P_3 = P_4 = 10 \mu \text{m} / 1 \mu \text{m}; P_4 = 10 \mu \text{m} / 1 \mu \text{m}; P_5 = 10 \mu \text{m} / 1 \mu \text{m}; P_6 = 10 \mu \text{m} / 1 \mu \text{m}; P_8 = 10 \mu \text{m} / 1 \mu \text{m}; P_8 = 10 \mu \text{m} / 1 \mu \text{m}; P_9 = 10 \mu / 1 \mu / 1 \mu \text{m}; P_9 = 10 \mu / 1 \mu / 1 \mu \text{m}; P_9 = 10 \mu / 1 \mu / 1 \mu \text{m}; P_9 = 10 \mu / 1 \mu / 1 \mu / 1 \mu \text{m}; P_9 = 10 \mu / 1 \mu / 1$ 10 μ m/1 μ m. Assume K_n' = 120 μ A/V², K_p' = 40 μ A/V², and λ_n = λ_p = 0.04 V¹.
 - (a) Find the small-signal voltage gain, $V_{OUT} / (V_{ip} V_{in})$.
 - (b) Where is the dominant pole? Please also estimate the dominant-pole frequency.
 - (c) If P_3 and P_4 are changed to $20\mu m/1\mu m$, find the voltage gain and the dominant-pole frequency in this case.



- 4. (20 %) For the two circuits in Fig. 4, the opamp saturation voltages are ±5 V. Assume $R_1 = 100 \text{ k}\Omega$, $R_2 = R_3 = 1 \text{ M}\Omega$, $C_3 = 10 \text{ nF}$.
- (a) For the circuit on the left, plot the waveforms of V+, V-, and Vo1.
- (b) For the circuit on the right, plot the waveforms of V+, V-, and Vo2.

Please label the waveforms and denote key voltage, time, or frequency properly.

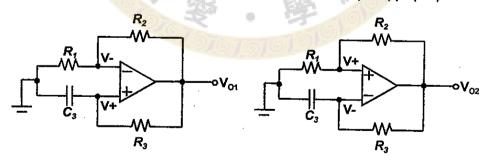


Fig. 4