

國立臺灣師範大學 101 學年度碩士班招生考試試題

科目：電子學

適用系所：應用電子科技學系

注意：1.本試題共 4 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

1. (共 10 分) An op amp having a unity-gain bandwidth of 10 MHz and a slew rate of 20 V/ μ s is connected in a unity-gain buffer, as shown in Fig. 1.

(a) (5 分) Find the output step response $v_{out}(t)$ when a small step voltage V_P is input without causing the buffer slewing.

(b) (5 分) Find the largest possible voltage step for which the slope of output waveform will not exceed the slew rate.

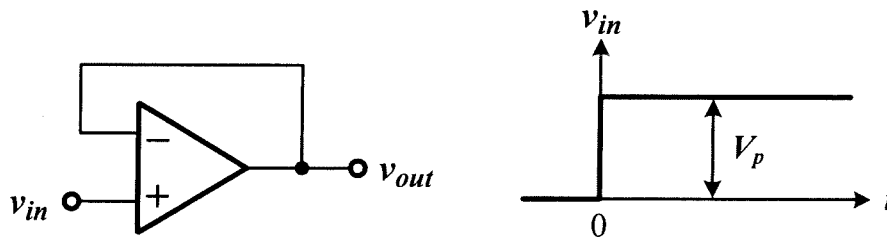


Fig. 1

2. (共 20 分) An emitter follower uses a transistor with $\beta = 100$ and is biased at $I_C = 5$ mA, as shown in Fig. 2. Bias circuit is not shown for simplicity. Assume the thermal voltage $V_T = 25$ mV and neglect the Early effect.

(a) (12 分) Find R_{in} , R_{out} , and $G_v \equiv v_o/v_{sig}$.

(b) (8 分) What is the peak amplitude of signal v_{sig} that results in v_{π} having a peak amplitude of 2 mV? Also find the resulting peak amplitude at the output.

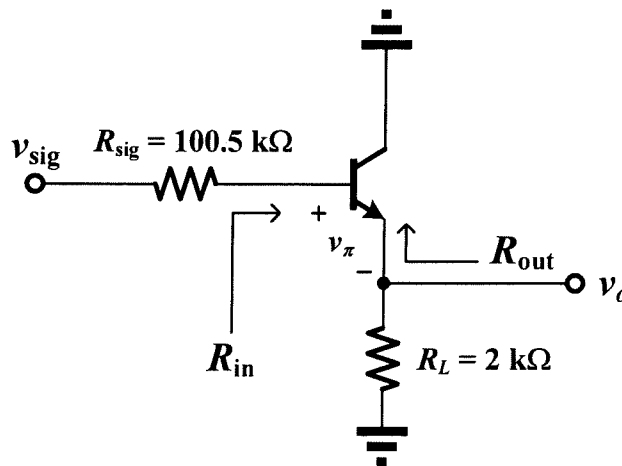


Fig. 2

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3. (共 20 分) The NMOS transistor in the common-source amplifier shown in Fig. 3 has threshold voltage $V_t = 0.6$ V, $k'_n W/L = 10$ mA/V², and $V_A = 100$ V.

(a) (9 分) Neglecting the channel-length modulation, find the overdrive voltage V_{OV} , drain current I_D , and dc voltage at the drain.

(b) (11 分) Find the overall small-signal voltage gain $G_v \equiv v_o/v_{sig}$ with r_o taking into account.

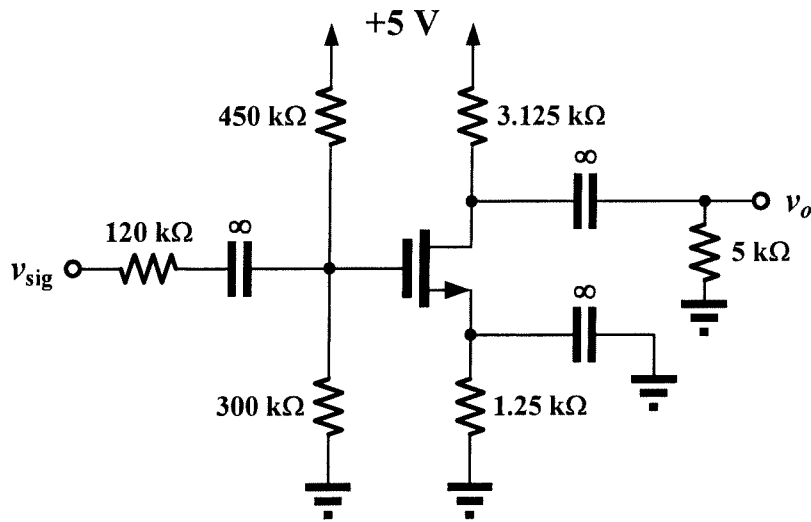


Fig. 3

4. (共 10 分) Consider an active-loaded MOS differential amplifier as that in Fig. 4 when biased at $I = 1$ mA. Let the transistors be specified as follows: $(W/L)_n = 160$, $(W/L)_p = 320$, the process transconductance parameters $k'_n = 0.1$ mA/V², $k'_p = 0.05$ mA/V², the Early voltage $V_{An} = |V_{Ap}| = 20$ V. Calculate the overdrive voltage V_{ov} of Q_1 (5 分) and the differential voltage gain v_o/v_{id} (5 分).

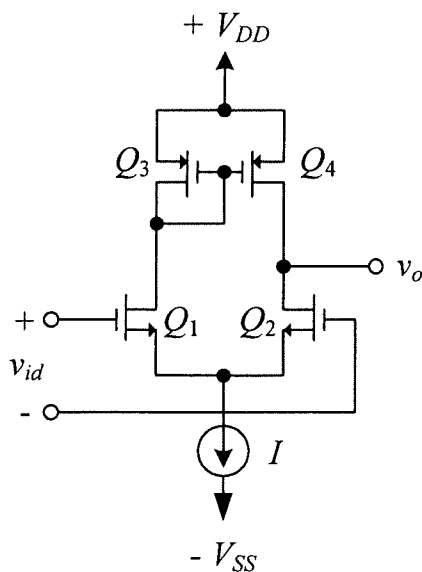


Fig. 4

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5. (共 20 分) Consider a CC-CE amplifier as that in Fig. 5 when biased at $I_1 = I_2 = 0.5$ mA. The transistors are identical and have $\beta = 100$ and $V_{BE} = 0.7$ V. Let $R_{sig} = 10$ k Ω , $R_L = 20$ k Ω , and the thermal voltage $V_T = 25$ mV. Neglecting r_o , find R_{in2} , R_{in} , the voltage gain v_o/v_{b2} , and the voltage gain v_o/v_{sig} . (各 5 分).

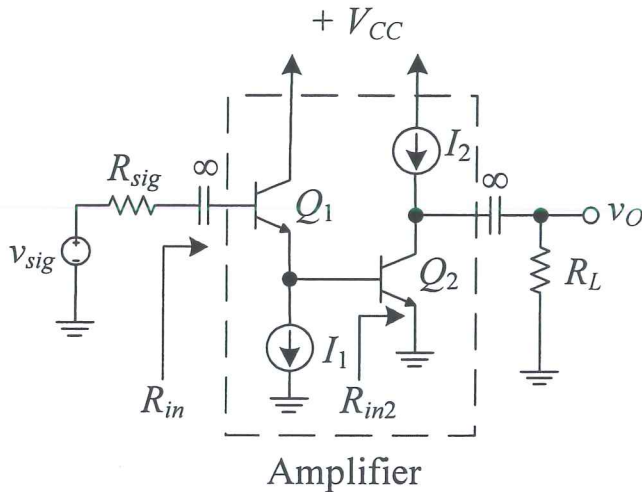


Fig. 5

6. (共 20 分) Referring to the general structure of the feedback amplifier of Fig. 6, answer the following questions.

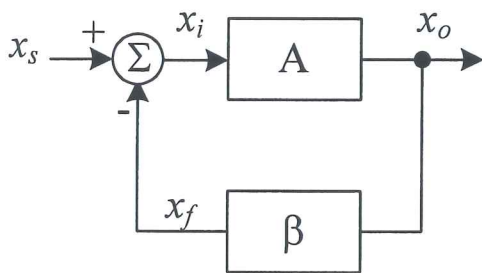


Fig. 6

- (a) (5 分) Assume that the basic amplifier has the open-loop gain

$$A(s) = \frac{10^4}{(1 + \frac{s}{10^3})(1 + \frac{s}{10^4})^2}$$

Sketch the magnitude response (in Bode plot) of the basic amplifier.

- (b) (5 分) Estimate the 3-dB frequency and the unity-gain frequency of the basic

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amplifier.

(c) (5 分) For the feedback factor $\beta = 0.0001$, find the gain margin and phase margin of the feedback amplifier.

(d) (5 分) Find the critical value β_{cr} . (that is, the amplifier is unstable if $\beta \geq \beta_{cr}$)