

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Consider an inverting amplifier with a nominal gain of 1000 constructed from an op amp with an input offset voltage of 4 mV and with output saturation levels of ± 12 V which is shown in Fig. 1.
 - (a) What is the dc offset voltage at the output ? (4%)
 - (b) What (approximately) is the peak sine-wave signal that can be applied at the input without output clipping ? (4%)
 - (c) If $R_1 = 1$ k Ω and $R_2 = 1$ M Ω , find the value of the coupling capacitor C that will ensure that the gain will be greater than 57 dB down to 100 Hz ? (4%)

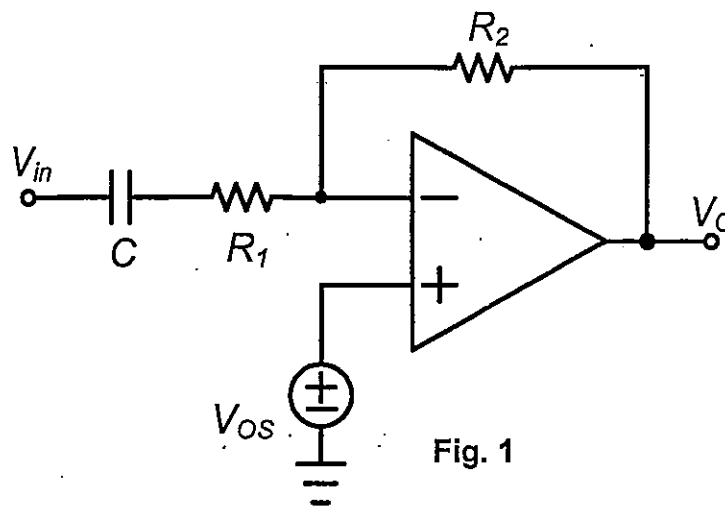


Fig. 1

2. For the bridge-rectifier circuit of Fig. 2, use the constant-voltage-drop diode model with $V_D = 0.7$ V. Consider $V_S = 12$ -V (rms) sinusoid and $R = 100$ Ω .
 - (a) Find the average (or dc component) of the output voltage ? (4%)
 - (b) Find the peak diode current ? (4%)
 - (c) Find the peak inverse voltage (PIV) of diode D_3 ? (4%)

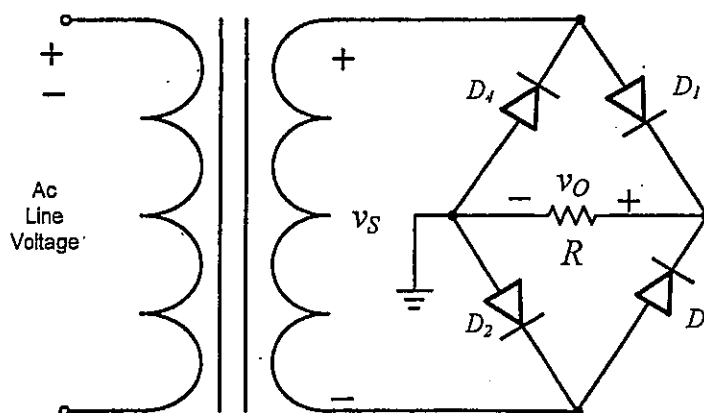


Fig. 2

3. A MOSFET differential amplifier shown in Fig. 3 is biased with a current source $I=400\ \mu\text{A}$. The transistors have $W/L=16$, $k_n=400\ \mu\text{A}/\text{V}^2$, $V_A=20\ \text{V}$, $C_{gs}=40\ \text{fF}$, $C_{gd}=5\ \text{fF}$, and $C_{db}=5\ \text{fF}$. The drain resistors are $10\ \text{k}\Omega$ each. Also, there is a 100-fF capacitive load between each drain and ground.

- (a) Find the transconductance, g_m (4%)
- (b) Find the differential gain, A_d (4%)
- (c) If the input signal source has a small resistance R_{sig} and thus the frequency response is determined primarily by the output pole, estimate the 3-dB frequency f_H . (4%)
- (d) If, in a different situation, the amplifier is fed symmetrically with a signal source of $40\ \text{k}\Omega$ resistance (i.e., $20\ \text{k}\Omega$ in series with each gate terminal), use the open-circuit time-constants method to estimate f_H (4%)

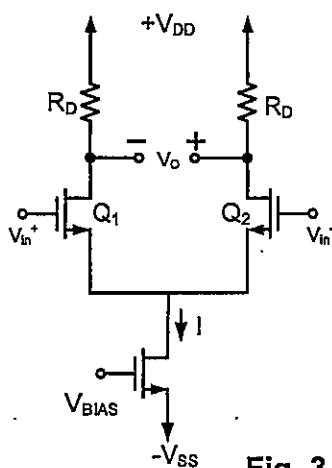


Fig. 3

4. The current-mirror-loaded differential amplifier in Fig. 4 has a feedback network consisting of the voltage divider (R_1 and R_2), with $R_1+R_2=1\ \text{M}\Omega$ and the bias current of $I=200\ \mu\text{A}$. The devices are sized to operate at $|V_{OV}|=|V_{GS}-V_{TH}|=0.2\ \text{V}$. For all devices, $|V_A|=10\ \text{V}$. The input signal source has a zero dc component.

- (a) Find the open-loop gain of A (3%) according to the loop gain $A\beta$
- (b) Find the feedback factor β (3%), the values of R_1 and R_2 that result in a closed-loop gain of exactly $5\ \text{V}/\text{V}$ (4%)

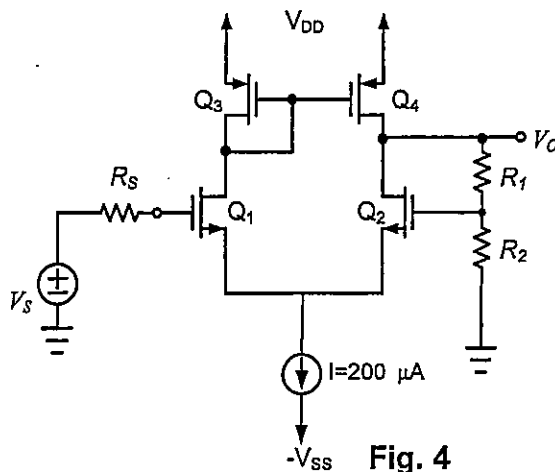


Fig. 4

5. For the circuit shown in Fig. 5, assuming the operational amplifier is ideal with +12V and -12V output saturation levels.
- What are the name and function of this circuit? (4%)
 - Sketch and label the V_O - V_I transfer characteristic of this circuit. (3%)
 - For a 200mV-amplitude sine-wave input with zero average, draw and label the waveform of V_O ? (3%)

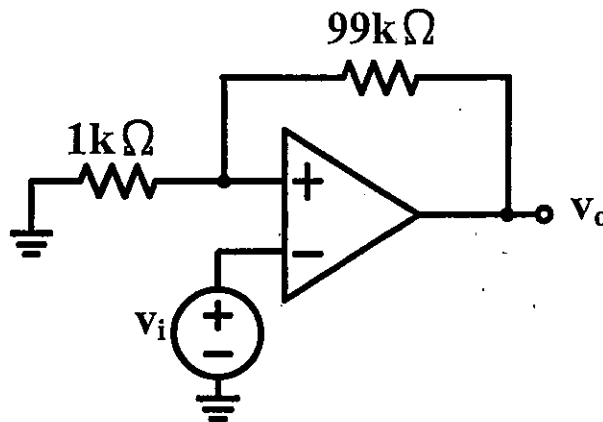


Fig. 5

6. For the circuit schematic of a 2-stage CMOS operational amplifier shown in Fig. 6, assuming $V_{DD}=1.5V$, $-V_{SS}=-1.5V$, $V_{tn}=|V_{tp}|=0.5V$, and all transistors are operated with overdrive voltage of 0.2V magnitude.
- Find its input common-mode range. (3%)
 - Find its allowed range for V_O . (3%)
 - What is the function of capacitor C_C ? (4%)

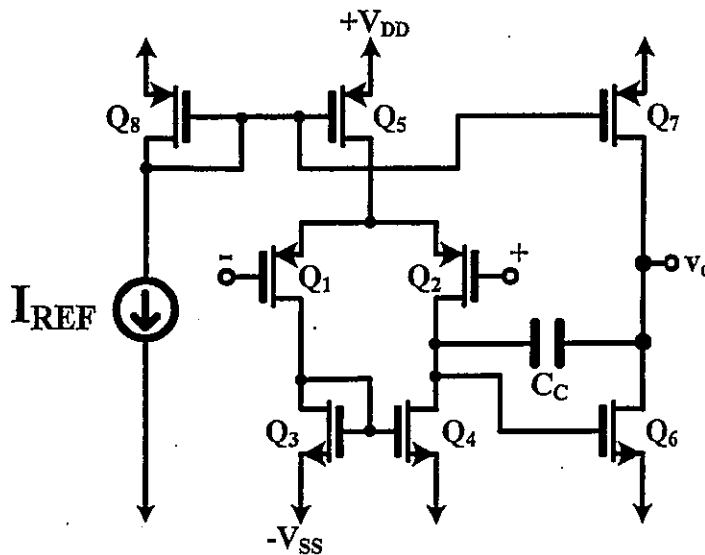


Fig. 6

7. An amplifier has the following voltage transfer function:

$$A(s) = \frac{10000}{(1 + \frac{s}{10^2})(1 + \frac{s}{10^6})}$$

- (a) Draw the asymptotic Bode plots of A (magnitude and phase). (6%)
 - (b) If this amplifier is connected with unity negative feedback (i.e., $\beta=1$), find the resulted phase margin. (4%)
8. For the circuit shown in Fig. 7, assuming the diodes (D_1 and D_2) have the same junction area as the transistors (Q_N and Q_P), $V_{CC}=12V$, $I_{BIAS}=1\text{ mA}$, $R_L=100\Omega$, $\beta_N=50$, and $|V_{CEsat}|=0.2V$.
- (a) What are the name and function of this circuit? (4%)
 - (b) What is the quiescent current (i.e., at $V_o=0V$) of Q_N and Q_P ? (4%)
 - (c) What are the largest possible positive and negative output signal levels? (4%)
 - (d) To achieve a positive peak output level equals to the negative peak level, what value of I_{BIAS} is required? (4%)
 - (e) For the I_{BIAS} value found in (d), what does the quiescent current become? (4%)

