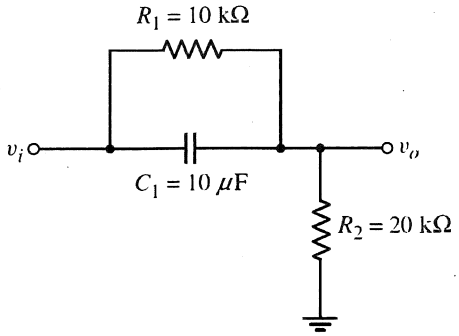
1. (16%) Sketch the approximate Bode plot for the transfer function *T(s)* (include proper label of the frequencies, magnitudes and phases).

(a) $T(s) = \frac{2\times10^4 s}{(s+10^2)(s+10^5)}$　　(b) $T(s) = v_o/v_i$



2. (18%) We want to design a MOSFET amplifier with the configuration in Figure 1. (a) Design R_D such that $I_{DQ} = 0.2$ mA and $V_{DSQ} = 5$ V. (b) The magnitude of the voltage gain should be -10 in the midband range, determine the required value of g_m and K_n (assuming$\lambda = 0$ and ignoring R_{Si}). (c) if midband frequency range from 200 Hz to 3 kHz, and $R_{TH} = R_1||R_2 =$ 50 kΩ, determine the required value of C_C and C_L.

3. (18%) For the common-emitter circuit in Figure 2, assume that $r_s = \infty$, $R_1||R_2 = 5$kΩ, and $R_C = R_L = 1$ kΩ. The transistor is biased at $I_{CQ} = 5$ mA and the parameters are $\beta_0 = 200$, $V_A = \infty$, $C_\mu = 5$ pF, and $f_T = 250$ MHz (unity-gain bandwidth for short circuit current gain). (a) Determine the value of C_π. (b) Determine the equivalent Millar capacitance. (c) Determine the upper 3dB frequency for the small-signal current gain.

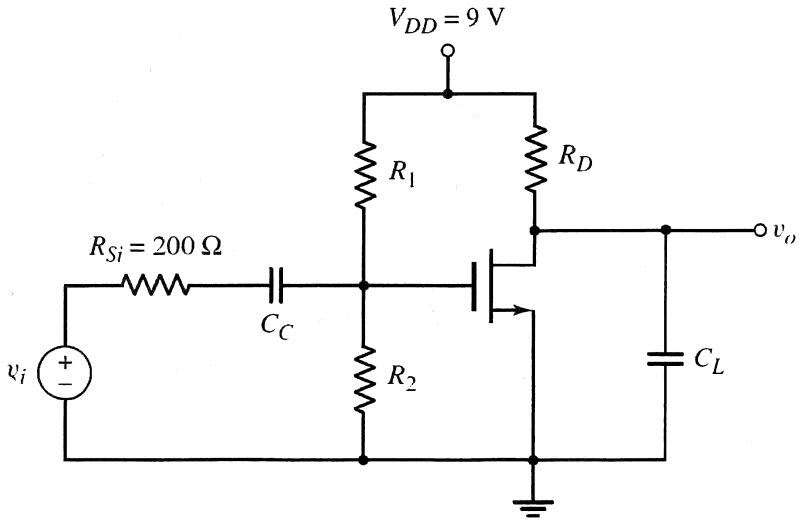


Figure 1

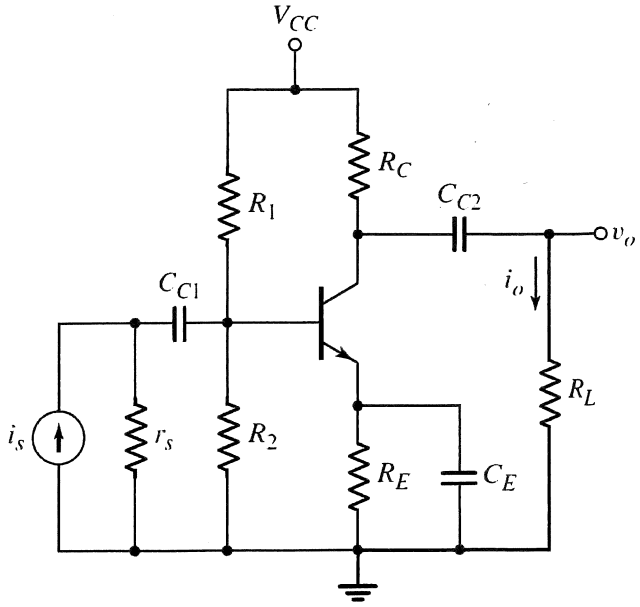


Figure 2

4. (10%) The inverting op-amplifier shown in Figure 3 has parameters $R_1 = 25\ \text{k}\Omega$, $R_2 = 100\ \text{k}\Omega$, and open-loop gain $A_{od} = 10000$. The input voltage is from an ideal voltage source whose value is $v_I = 1\ \text{V}$. (a) Calculate the actual close-loop voltage gain. (b) What is the voltage at the inverting input terminal of the op-amp?

5. (10%) For the circuit shown in Figure 4, (a) plot the voltage transfer characteristic curve of v_O (versus v_I). (b) plot the voltage transfer characteristic curve of v_{O1} (versus v_I).

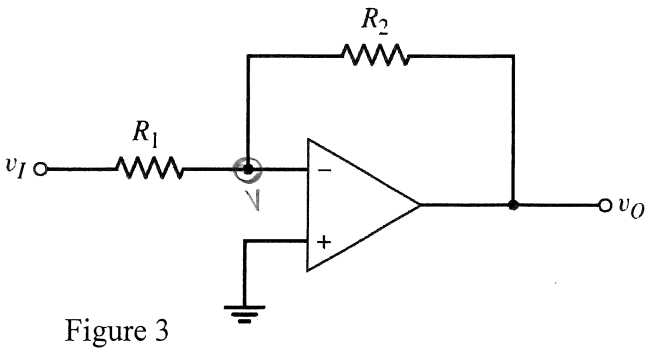


Figure 3

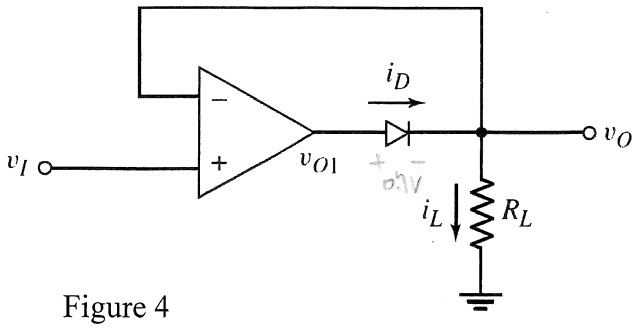


Figure 4

6. (12%) For the circuit shown in Figure 5, (a) derive the voltage transfer function $A_v = v_O/v_I$ as a function of frequency. (b) What is the voltage gain at dc? (c) At what frequency is the magnitude of the gain a factor of $\sqrt{2}$ less than the dc gain?

7. (16%) For the instrumentation amplifier in Figure 6, the parameters are $R_4 = 90\ \text{k}\Omega$, $R_3 = 30\ \text{k}\Omega$, and $R_2 = 50\ \text{k}\Omega$. Resistance R_1 is a series combination of a fixed $2\ \text{k}\Omega$ resistor and a $100\ \text{k}\Omega$ potentiometer. (a) Determine the range of the differential voltage gain. (b) If one of the resistor R_3, which is connected to the inverting terminal of A3, is $R_3' = 30\ \text{k}\Omega + 5\%$. Determine the CMRR.

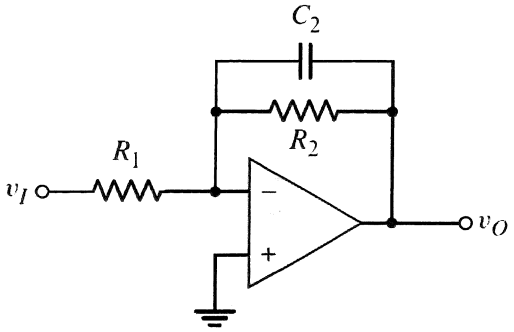


Figure 5

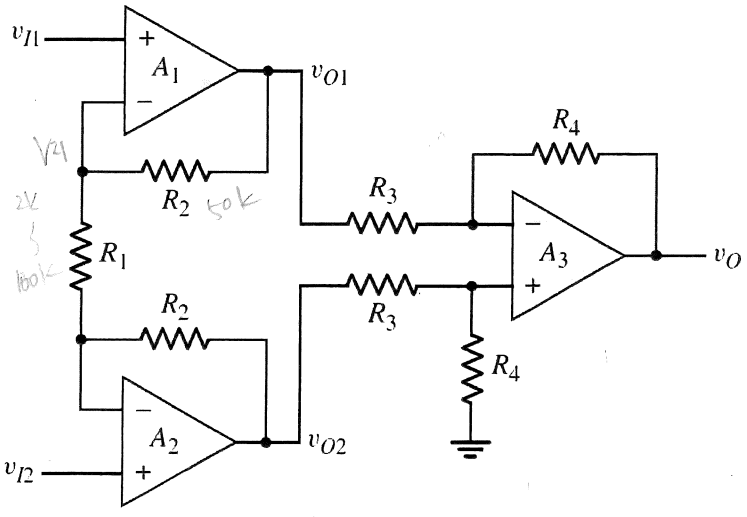


Figure 6