1. (a) Sketch v_o versus time for the circuit in Figure 1. The input is a sine wave given by v_i = 10sin100πt V. Assume V_γ = 0 and r_f = 0 for both diodes. (b) Plot the voltage transfer characteristics (v_o versus v_i). （10%）

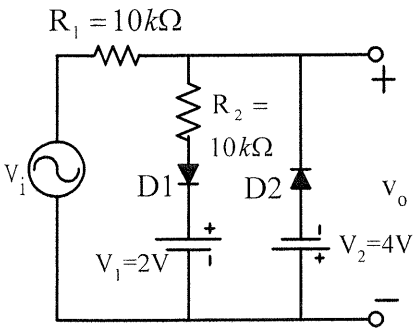

Figure 1.

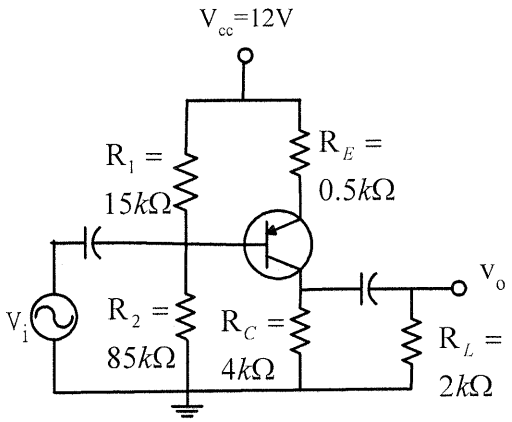

Figure 2.

2. Consider the circuit in Figure 2. The transistor parameters are β=100, $V_{EB(on)}$=0.7V, and V_A= ∞. (a) Find the quiescent collector current I_{CQ} and emitter-collector voltage V_{ECQ}. (b) Find the small-signal parameters g_m, r_π and r_o. (c) Determine the small-signal voltage gain A_v= v_o/v_i. （20%）

3. The transistor characteristics I_D versus V_{DS} for an NMOS device are shown in Figure 3. (a) Is this an enhancement-mode or depletion-mode device? (b) Determine the values for K_n and V_{TH}. (c) Determine the I_{DS} in the circuit. （20%）

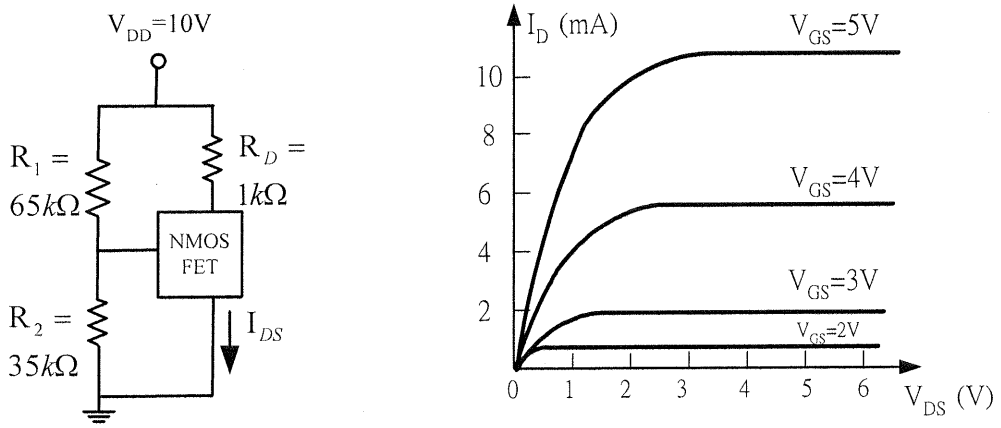

Figure 3.

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4. Assume the op-amp in the circuit in Figure 4 is ideal. (a) Determine i_L as a function of v_I. (b) Let $R_1 = 18\ k\Omega$ and $R_L = 2\ k\Omega$. If the op-amp saturates at $\pm 12\ V$, determine the maximum value of v_I before the op-amp saturates. (10%)

5. In the difference amplifier shown in Figure5, $R_1 = R_3 = 10\ k\Omega$, $R_2 = 30\ k\Omega$, and $R_4 = 31\ k\Omega$. Determine v_O when: (a) $v_{I1} = +1\ V$, $v_{I2} = -1\ V$; and (b) $v_{I1} = v_{I2} = +1\ V$. (c) Determine the CMRR (dB). (15%)

6. Consider a feedback amplifier for which the open-loop gain is given by

$$A(f) = \frac{2\times 10^3}{(1+j\frac{f}{10^4})(1+j\frac{f}{5\times 10^4})(1+j\frac{f}{10^5})}$$

(a) Determine the frequency f_{180} at which the phase of $A(f)$ is -180 degrees. (5%)

(b) For $\beta = 0.0045$, determine the magnitude of the loop gain $T(f)$ at the frequency $f = f_{180}$ and determine the gain margin. (10%)

(c) For $\beta = 0.15$, determine the phase of $A(f)$ when $|T(f)| = 1$. (10%)

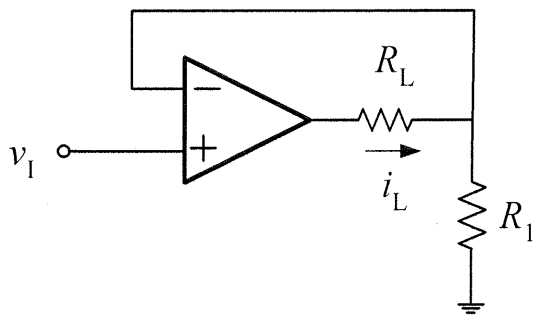

Figure 4.

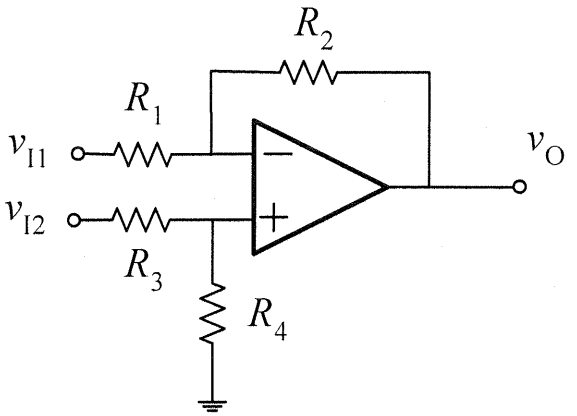

Figure 5.