1. Design the following circuit so that $V_o=3V$ when $I_L=0$, and V_o changes by 40mA per 1mA of load current. Find the value of R and the junction area of each diode (assume all four diodes are equal) relative to a diode with 0.7V drop at 1mA current Assume n=1. (15%)
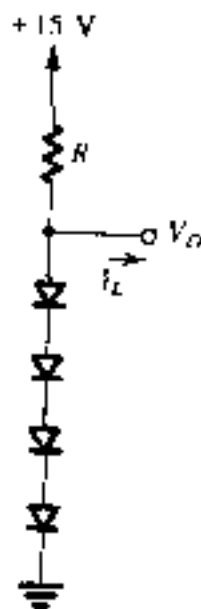
2. The current mirror circuit has $L_1=L_2=W_1=6\,\mu m$, $V_t=1V$, $\mu_n C_{ox}=20\,\mu A/V^2$, $V_A=50V$, and $I_{REF}=10\,\mu A$. (a) Calculate the value of V_{GS}. (b)Find the value of W_2 that will result in an output current of $100\,\mu A$ when the output voltage is equal to the voltage at the gate. (C) If the output voltage increases by 5V, find the resulting value of I_O. (15%)
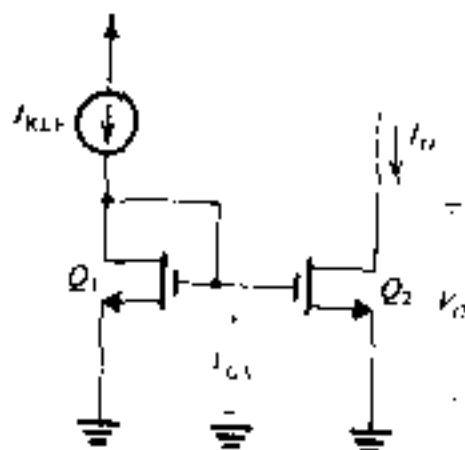
3. A differential amplifier as shown in Figure A has an ideal current source I with infinite internal resistance. Apply a small signal v_d to the differential input terminals, derive the expressions for

   (a) the small signal transconductance of the transistor g_m

   (b) the small signal emitter current i_e

   (c) the input differential resistance R_{id}

   (d) the differential voltage gain when the output is taken differentially A_d
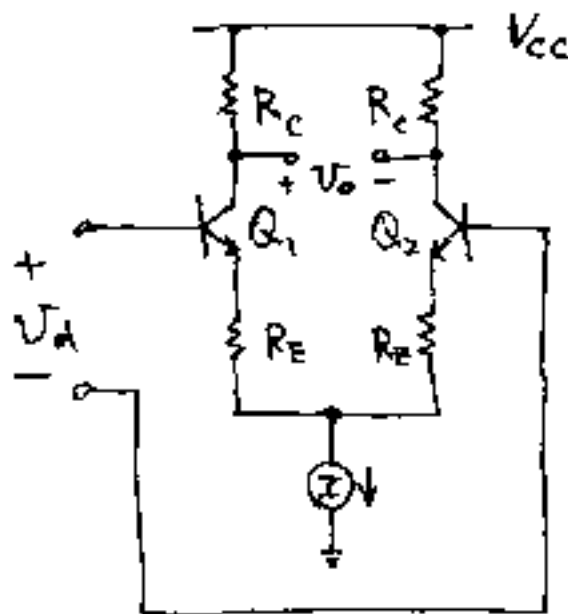
   (20%)

Figure A

4. A output stage amplifier as shown in figure C.

   (a) Is this a class A. B. or C amplifier?

   (b) What is the main problem of this class of amplifier as far as signal quality is concerned?

   (c) Propose a modified circuit to eliminate the problem you stated in part (b).
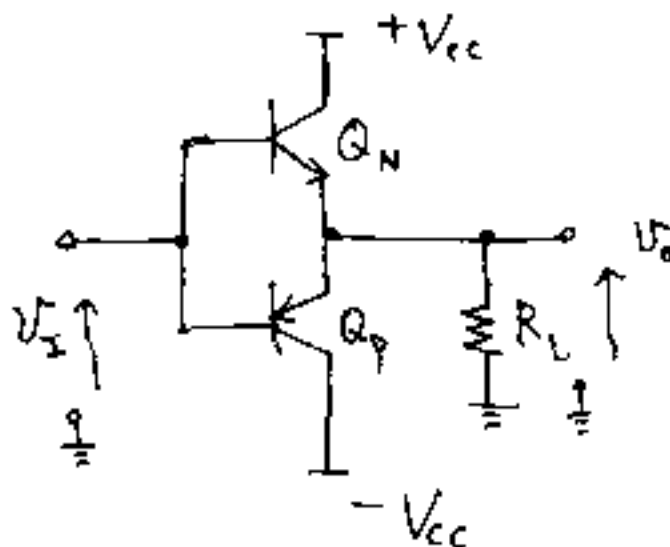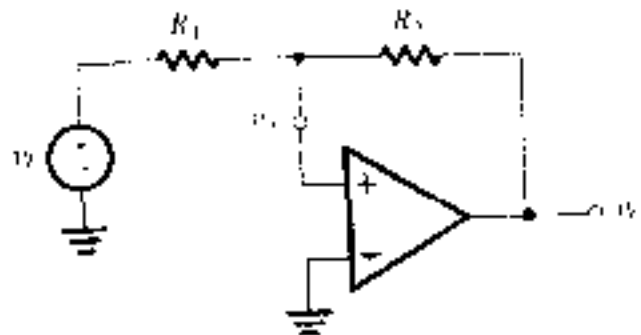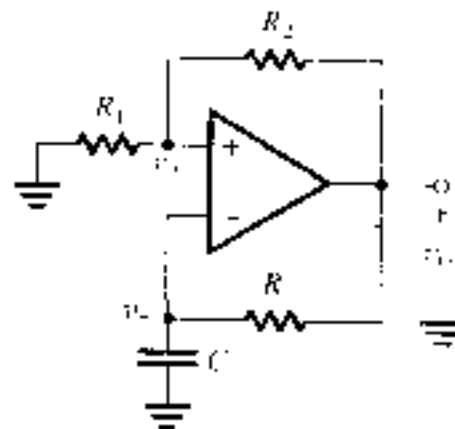
   (15%)

Figure C

5. Give the transfer function of a second order bandpass filter with a center frequency of 10^3 rad/s, a center frequency gain of 10, and a 3-dB bandwidth of 10^2 rad/s (10%)

6. The circuit has $\pm$ 10V output saturation levels and $R_1 = 1k\Omega$. Find a value for R that gives hysteresis of 100mV width. (10%)

7. For the circuit shown below, let the op amp saturation voltages be $\pm$ 10V, $R_1 = 100k\Omega$, $R_2 = R = 1M\Omega$, and $C = 0.01 \mu F$. Find the frequency of oscillation. (15%)

Natural logarithm e = 2.718

ln 2=0.6931, ln 3=1.0986, ln 5=1.6094