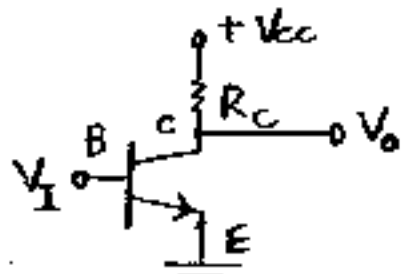
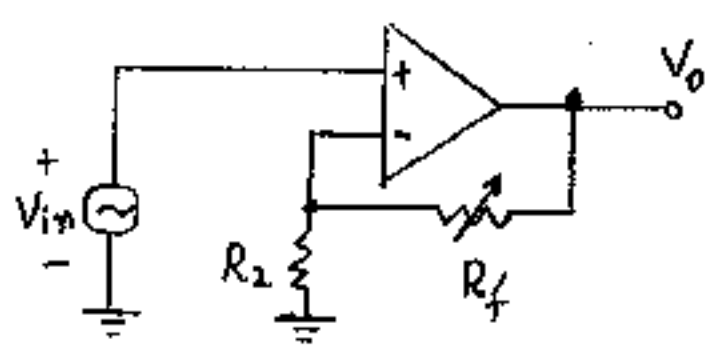
1.(a) Use diodes to implement a two-input AND Gate. (7%) (b) Repeat (a) by using N-MOSFET's. (8%) Write down the truth tables for (a) and (b) to verify your designs.

2.Qualitatively answer the following questions: (a) draw the output characteristics (i_C vs. v_{CE}) of the BJT with v_I as the control parameter. (5%) (b) Draw the load-line of the circuit on the chart you just drew for (a). (5%) (c) Draw the transfer characteristics (v_O vs. v_I) from the results of (a) and (b). (5%) (d) Describe the usage of the circuit for digital and analog applications. Describe as much as you can. (5%)

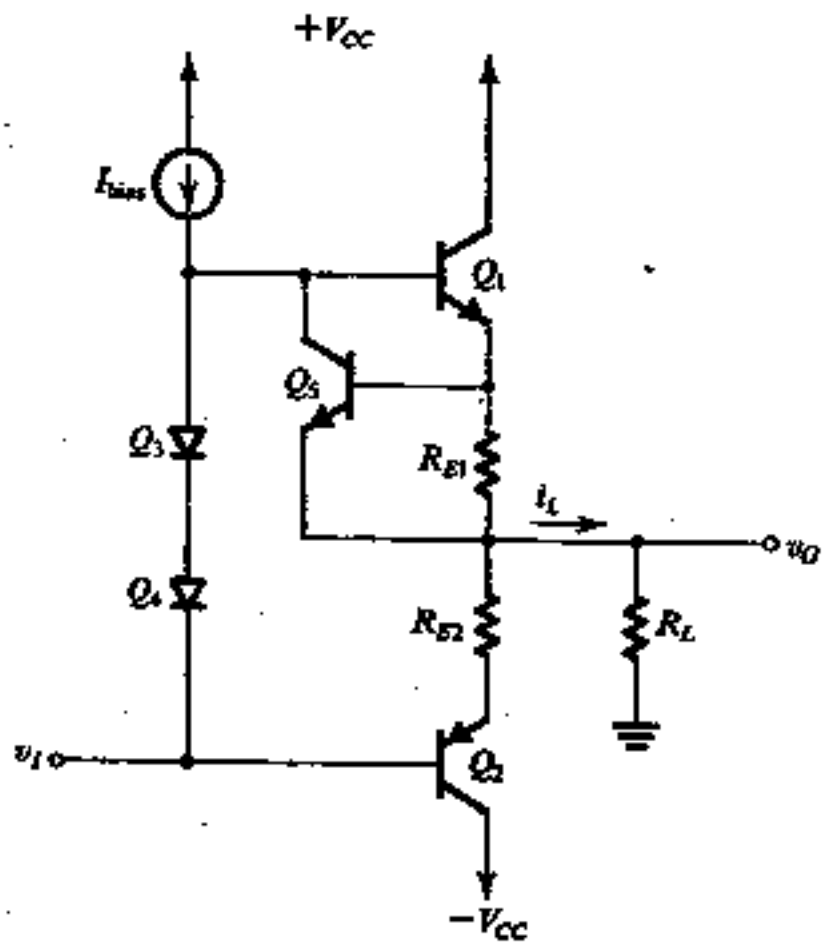


3.An MOS differential amplifier utilizes a current mirror bias with I=25 μA. The devices have V_t=1V, W=120 μm, L=6 μm, and ($\mu_n C_{ox}$) for this technology is 20 μA/V^2. Find V_{GS}, g_m and the input voltage v_{id} for full current switching. (15%)

4.A non-inverting amplifier is constructed with R_2=100Ω and R_f adjustable. The op-amp open-loop gain is $A_{OL}(s)=10\alpha^3/[(s+\alpha)(s+2\alpha)^2]$. (a) Find the value of R_f that will just place one of the closed-loop amplifier poles at $s=-3\alpha$. (10%) (b) For the value of R_f chosen in part (a), what are the locations of the other two amplifier poles? (10%)



5.For the circuit shown below, (a) what is this circuit? (3%) (b) What is the function of the diodes Q_3 and Q_4? (3%) (c) What feature(s) is (are) provided by the transistor Q_5 to this circuit? (3%) (d) Describe the operation principle of Q_5. (3%) (e) What is the advantage and disadvantage of the inclusion of emitter resistors. (3%)



6.Find the natural modes and the transfer function of a Butterworth filter with ω_p=1 rad/s, A_{max}=3dB ($\varepsilon \approx 1$) and N=3. (15%)