ECE 3040
Dr. Doolittle

Homework 5

1. Purpose: Understanding the common-emitter amplifier.
In the circuit below, assume the *npn* BJT is operating in forward-active mode. Let β = 130, V_A = 60 V, and V_{BE} = 0.7 V. Assume the capacitors have negligible impedance at the frequency of the ac signal.

Given, V_{CC}=12V, R_{sig}=1kΩ, R_1=240kΩ, R_2=160kΩ, R_C=15kΩ and R_L=100kΩ

(a) What are the purposes of capacitors C_1, C_2, and C_3 in this circuit?

(b) Determine all DC terminal voltages and currents as well as the small-signal voltage gain A_v (=v_o/v_{sig}) of the amplifier circuit if R_E = 12 kΩ.

(c) Repeat part (b) with R_E = 80 kΩ.

(d) If the goal is to maximize the voltage gain, what general design rule for common-emitter amplifiers can you infer from the results of parts (b) and (c)?

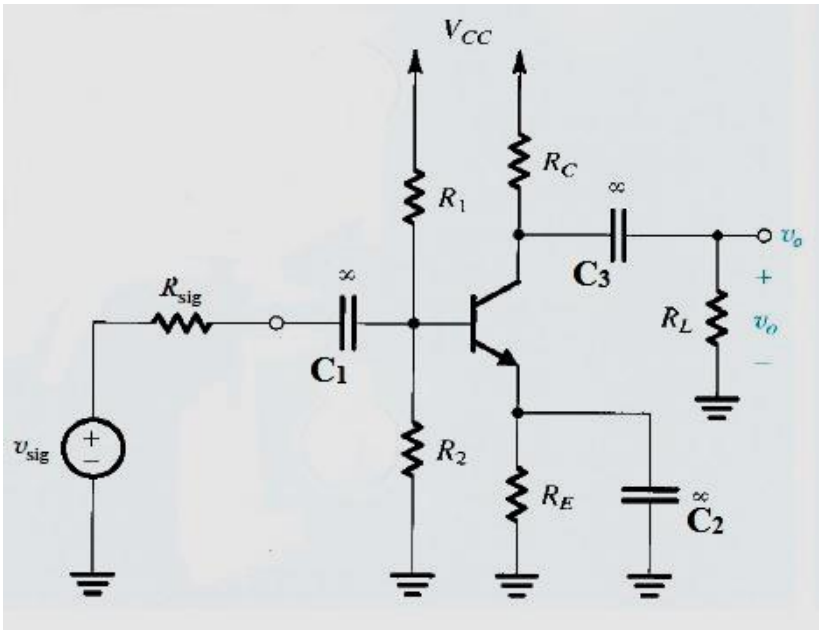

Figure 1. BJT amplifier circuit.

2. Purpose: Coupling diodes and BJTs

In the circuit below, find the Q-point of both the Zener diode and BJT. Assume the BJT is biased in the forward-active regime, that $V_Z = 5V$, $R_Z = 0\ \Omega$, $\beta=100$ and $V_{BE} = 0.7V$.

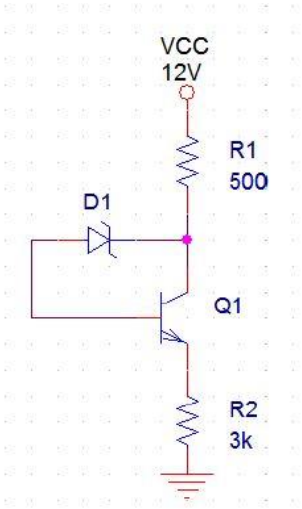

Figure 2. Zener diode with BJT.

3. Purpose: BJT application in circuit designing

Assume forward active mode bias and identical BJTs Q_1 and Q_2 in the following "current mirror" circuit.

Given, R_2= 10kΩ, R_3= 1kΩ, R_7= 100Ω, R_8= 100Ω, β=416.4, and I_S = 6.73 fA.

(a) Find the current flowing in R_3 and compare it to the current flowing in R_2. *Note: it may be helpful to use Ebers Moll model only for determining collector currents in the two transistors, but otherwise use Beta/CVD model.*

(b) What happens to the currents if R_3 is replaced with a 5kΩ resistor?

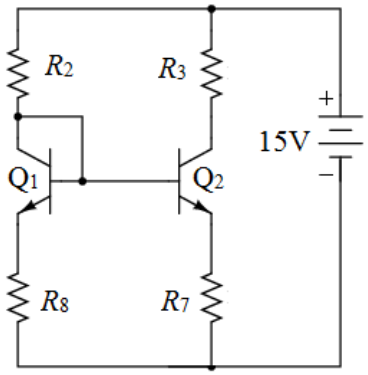

Figure 3. Current mirror circuit.