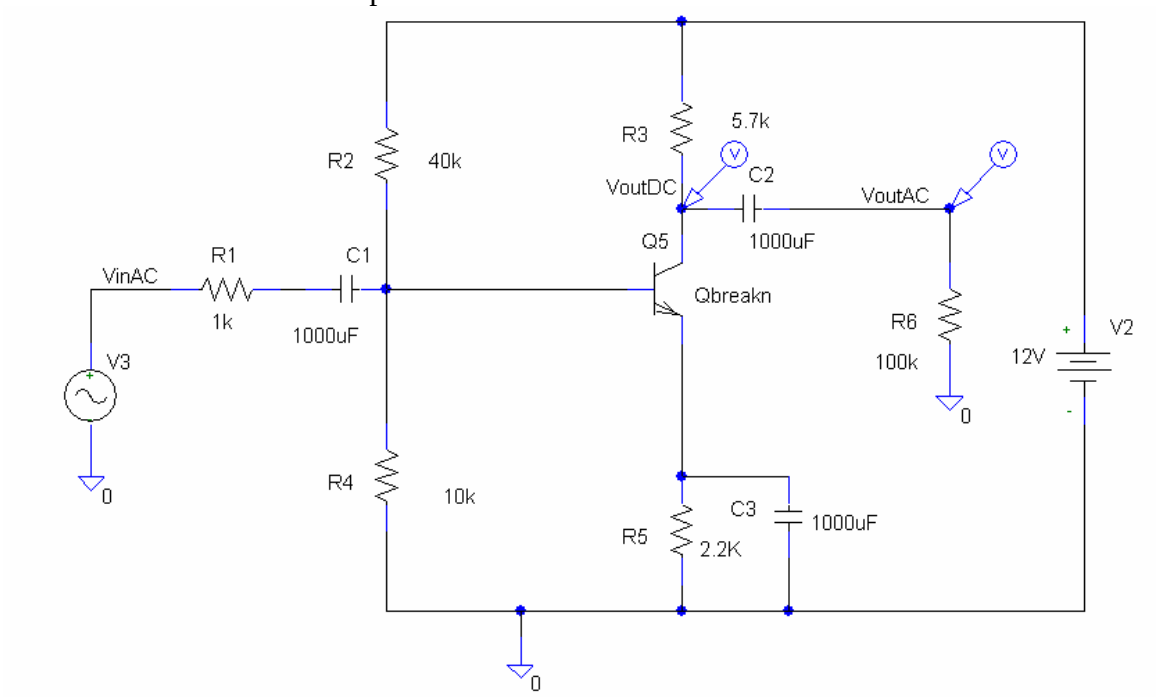
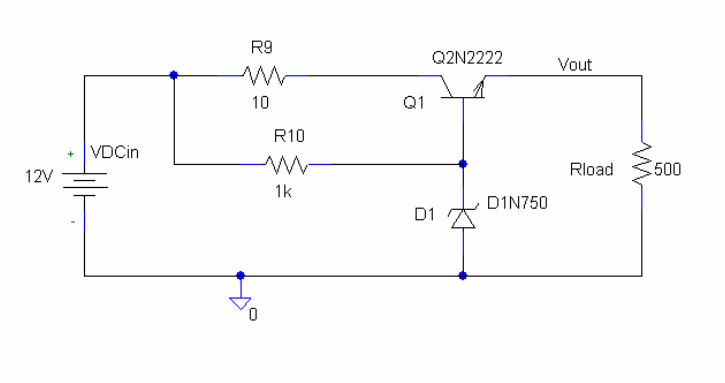
Homework 5

1. For the basic transistor circuit below, solve for the Q-point (all three currents and voltages on the transistor) assuming a β=100, an Early voltage, V_A=100V, a $V_{turn\ on}$=0.7 V for any forward biased Base-emitter junction and a $V_{turn\ on}$=0.3 V for any forward biased base-collector junction (different due to lower doping in CB junction):
    a. Assuming the transistor is biased in cutoff (neglect leakage currents).
    b. Assuming the transistor is biased in saturation.
    c. Assuming the transistor is biased in forward active.
    d. Which assumption is valid?

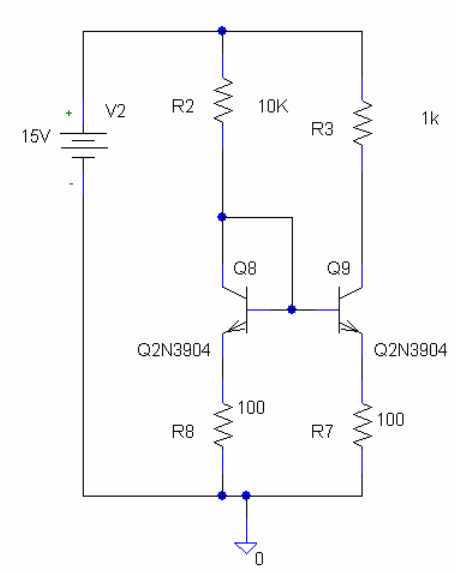


    e. What value of Is would result in 0.7 V for the base emitter voltage?
    f. Determine the voltage gain VoutAC/VinAC.
    g. Plot VoutDC and VoutAC for a 1 kHZ, 1mV VinAC signal.
    h. Note: While I am not asking for it herein, you should be able to determine, β, α, and I_S from the fundamental material parameters.

2. For the circuit below, assume that the transistor is biased in forward active mode and β=255.9 and I_S=14.3fA. Note that the Zener diode and R10 together operate in a similar fashion to the circuit assigned in homework 4 and you can neglect the small base current compared to all other currents. What is the voltage Vout when a) the resistance R_L=500 ohms, b) the resistance R_L=1000 ohms, c) the resistance R_L=2000 ohms. d) for a load resistance RL=500 ohms but with a power supply voltage VDCin=9V and 15 V. e) Explain the function and operation of this "voltage regulator power supply" circuit. Note: in reality , a larger "pass transistor" (as is it called in this type of application would be typically used. A 2N2222 was used only for convenience.



3. Assume Forward active mode bias and find the current flowing in R3 and compare it to the current flowing in R2 for this "current Mirror" circuit. What sets these currents (i.e. how can we change them)? The β=416.4 and I_S=6.734fA. Note: it may be helpful to consider the simplified Ebers Moll model only for determining the collector currents in the two transistors but otherwise use the Beta/CVD method. What happens to the currents if R3 is replaced with a 5K resistor? Why? Note this circuit is often used to implement a current source.



4. Assume forward active mode and solve the Q-point for the following “Darlington configuration” and determine the total current flowing in R3 compared with the base current flowing in Q7. Τηε 2N3906 τρανσιστορ ηασ α β=180.7 and I_S=1.41fA. Sometimes this is called a “Super Beta” transistor configuration. Why is such a term applicable?