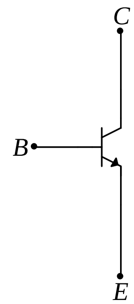
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

6.071 Introduction to Electronics, Signals and Measurement

Spring 2006

Laboratory 19: BJT Biasing and Amplification

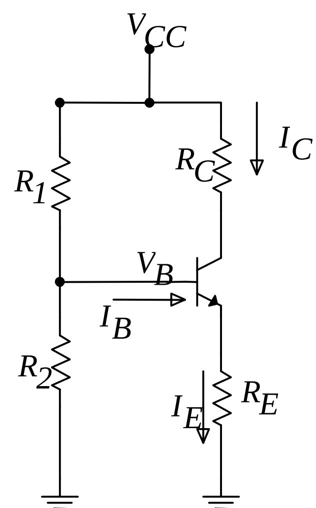
For our experiments we will use the 2N3904 npn BJT whose pinout is



Exercise 1.

For the circuit below calculate the Q-point assuming that the transistor has $\beta = 100$

- Find the Q-point for $R_1 = 20k\Omega,\ R_2 = 5k\Omega,\ R_C = 3k\Omega,\ R_E = 1k\Omega,\ Vcc = 10V$

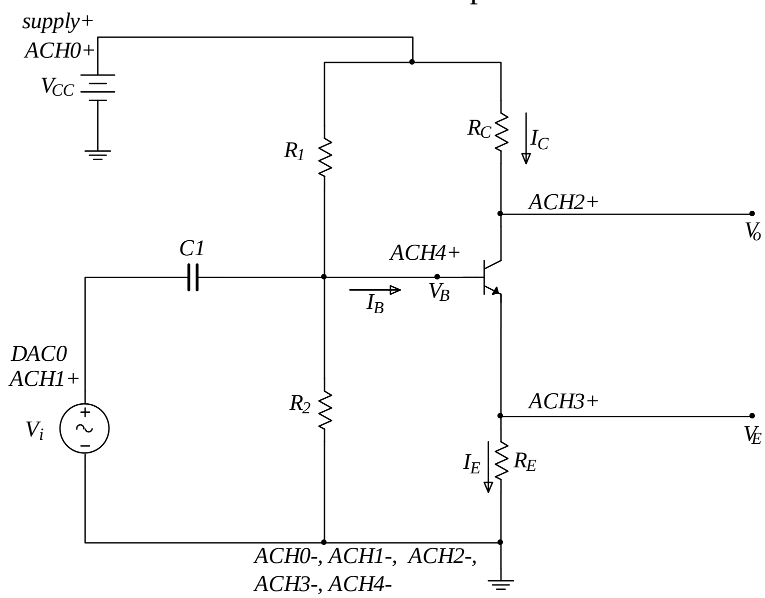


- For $R_1 = 20k\Omega,\ R_2 = 5k\Omega,\ R_E = 1k\Omega,\ Vcc = 10V$ determine R_C so that the collector-emitter voltage is $V_{CE} = V_{CC}/2$

- For $R_1 = 20k\Omega,\ R_2 = 5k\Omega,\ R_E = 1k\Omega,\ Vcc = 10V$, determine resistor R_C so that the transistor enters saturation.

Experiment 1.

Here we will build and test the common-emitter amplifier circuit shown below.



Build the circuit with $R_1 = 20k\Omega,\ R_2 = 5k\Omega,\ R_C = 5k\Omega,\ R_E = 1k\Omega,\ Vcc = 10V$. These values should give a Q-point: $I_{CQ} = 1.3mA,\ V_{CEQ} = 2.5V$ For V_{CC} use the variable power supply and set the voltage to 10 Volts. The signal *Vi* is available at *DAC0*.

What would value would you use for the coupling capacitor *C1* and why?

What is the anticipated small signal gain of this amplifier?

Make the connections as indicated on the schematic and then download from the Labs section the instrument called **BJTamp.vi** and run it.

First set the amplitude and the offset of the input signal to zero. What is the measured value of I_{CQ} and V_{CEQ}? Do they agree with the numbers given above? How close are they? Why the difference?

Now set the offset of the input signal to a non-zero value and observe the results. Compare *VB* for zero and non-zero offset for the input signal. How effective is your coupling capacitor C1 in blocking the DC component in the input signal?

Take measurements for various amplitudes of Vi (0.1V – 1.5V) and record them on the table below. PtP stands for Peak to Peak. PtP=2*Amplitude

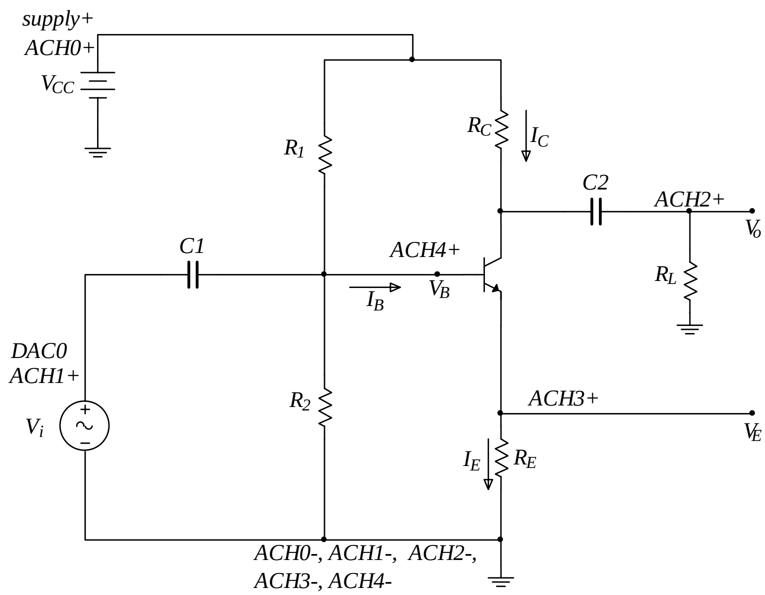
Vi		*VB*		*VE*		*Vo*	
PtP	Offset	PtP	Offset	PtP	Offset	PtP	Offset
0.2							
0.4							
0.6							
0.8							
1.0							
1.5							

What happens to the output *Vo* as the amplitude of *Vi* increases?

Experiment 2.

Now let's modify "slightly" the circuit by adding the load resistor R_L and the output coupling capacitor *C2* as indicated on the following schematic. Use $R_L = 5k\Omega$.

R_L and *C2* form a high pass filter thereby blocking any DC component of the voltage at the collector of the transistor. What value would you use for *C2*?



(Note now that the measurement ACH2+ is taken between R_L and *C2*.)

Start the instrument **BJTamp.vi** and measure the output voltage *Vo* for *Vi=100mV*.

DC component of *Vo* =

Peak to peak value of *Vo* =

By comparing the above measurement with the corresponding one obtained in Experiment 1 estimate the output impedance of the device (i.e the impedance seen by the instrument that measures *Vo* – assume that this instrument is ideal)