Lab 7 Report: Common Collector Amplifier

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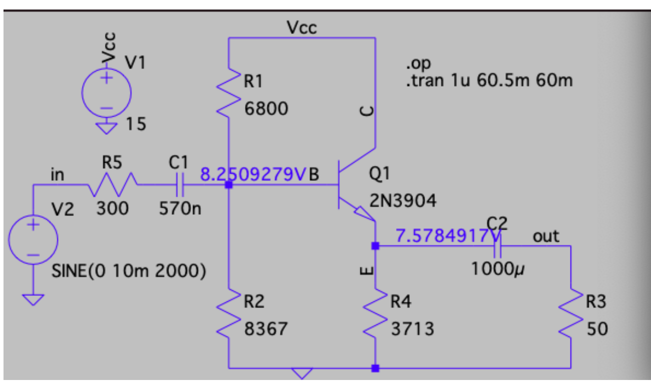
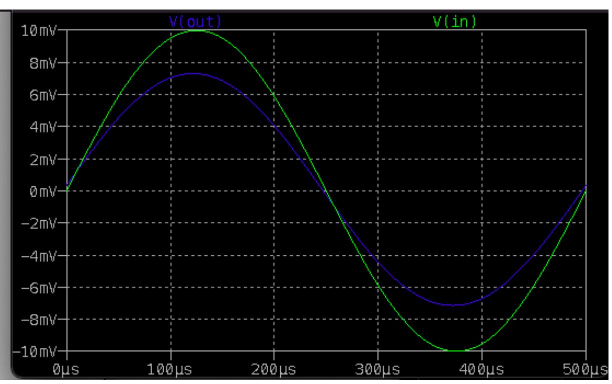
Introduction

This lab sets the operating point the BJT in a common collector amplifier and then uses LTspice simulations to confirm the DC operating point. I did not have enough time to prototype the circuit and measure the DC and AC characteristics.

Design Procedure

Here are the calculated values for this biasing topology:





The formulae for the voltage ratios are:

$$\frac{v_{out}}{v_{in}} = \frac{(\beta+1)R'_E}{r_\pi + (\beta+1)R'_E} \frac{v_{in}}{v_s} = \frac{R_{in}}{R_S + R_{in}}$$

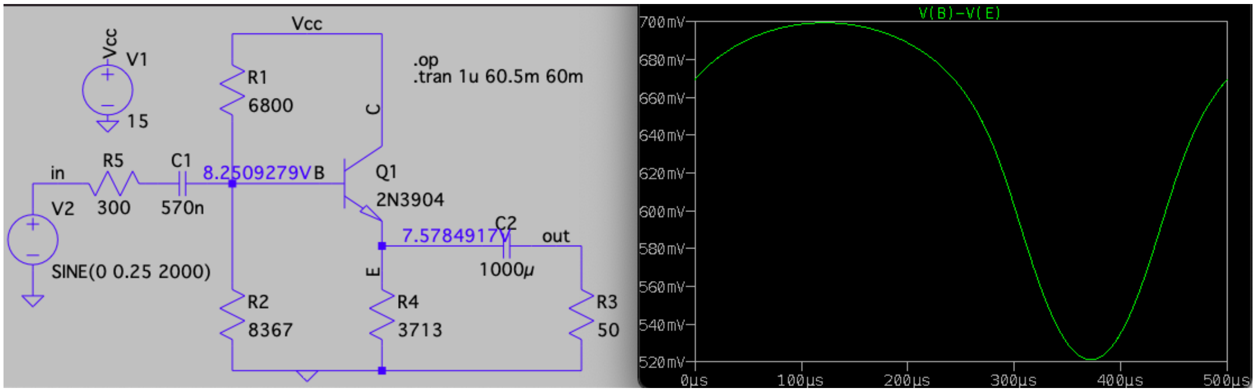
where

$$R'_E = R_E \parallel R_L \parallel r_o R_{in} = R_B \parallel (r_\pi + (\beta+1)R'_E)$$

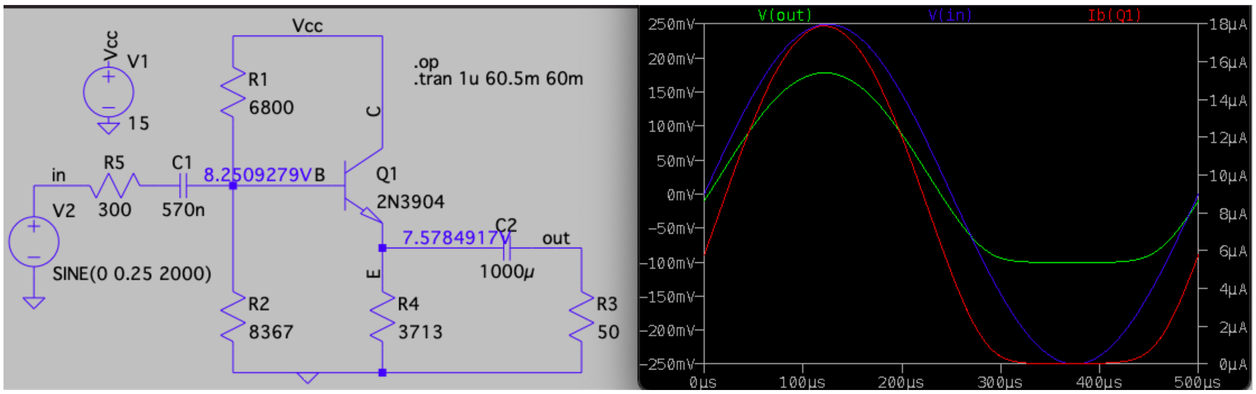
The calculations are $v_{out}/v_s = (v_{out}/v_{in})(v_{in}/v_s) = (0.793)(0.926) = 0.73$ which is confirmed by the operating point plot of v_{out} vs. v_s.

Output waveform being sinusoidal

The output waveform has gain reduction when the base voltage is reduced by a large amount. The amount depends on the load resistor, as $R_L = 1k\Omega$ was able to tolerate a larger negative voltage. The reason for this is the v_{out}/v_{in} equation and its $r_\pi = \frac{\beta V_T}{I_C}$ in the denominator. Look at how V_{BE} changes greatly when the base voltage decreases:



This change for V_{BE} explains why the current changes so much (and goes to zero if V_B is greatly reduced):



As r_π is inversely proportional to I_C, the reduced V_B kills the collector current which caused the voltage ratio v_{out}/v_{in} to be greatly reduced.