NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY

Electronic Circuit Design (EE-313)

Assignment # 2

Analysis of BJT Current Mirrors and Cascaded Amplifiers

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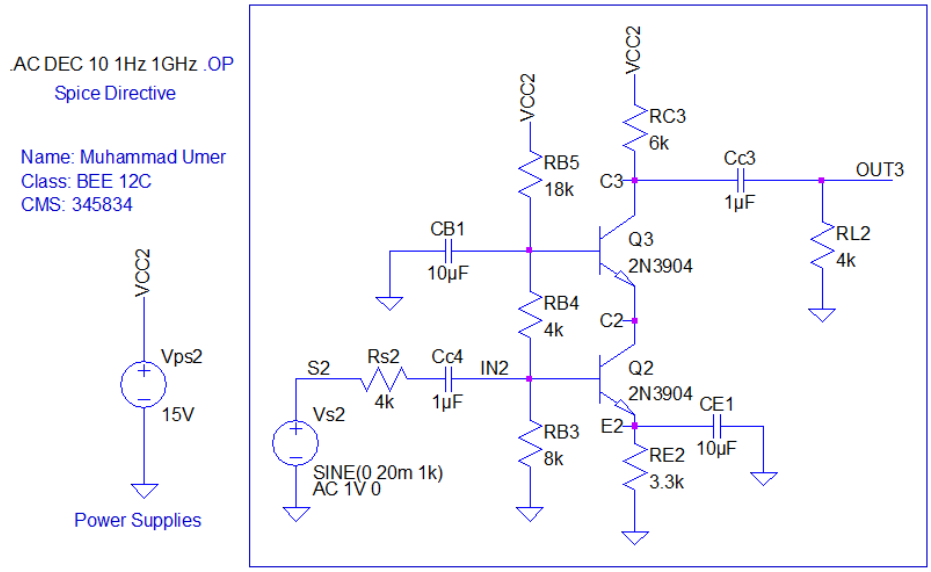
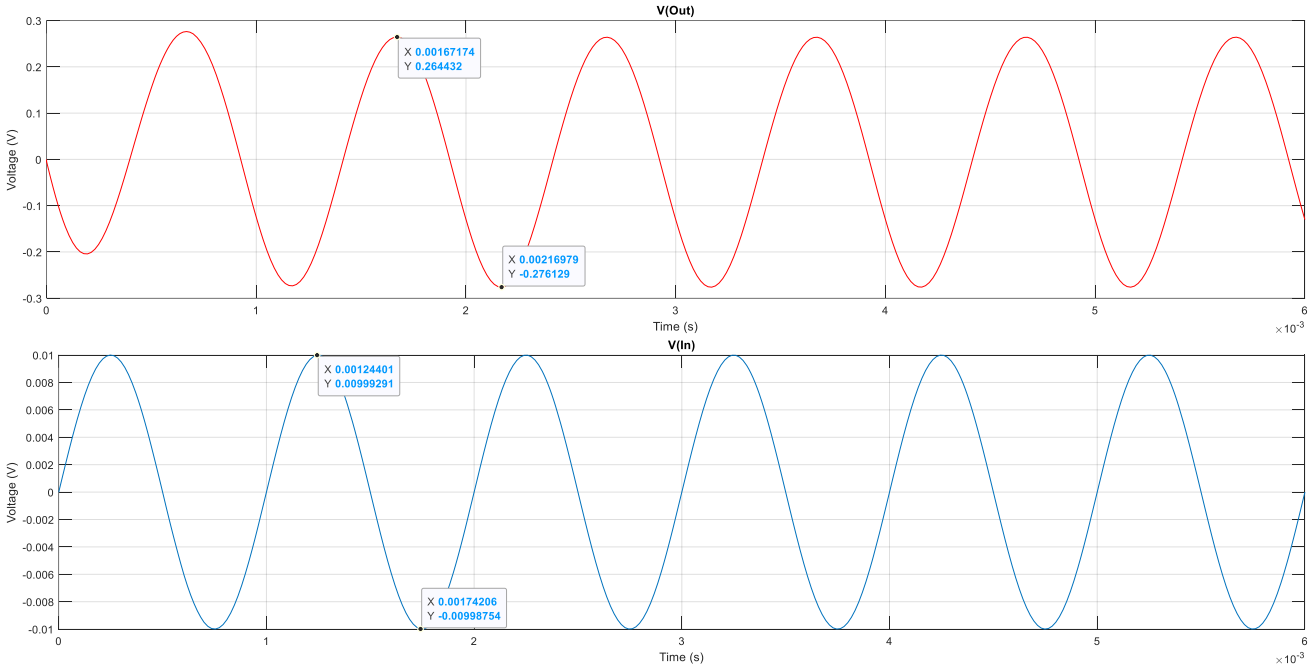
1 Assignment Solution

1.1 BJT Cascode



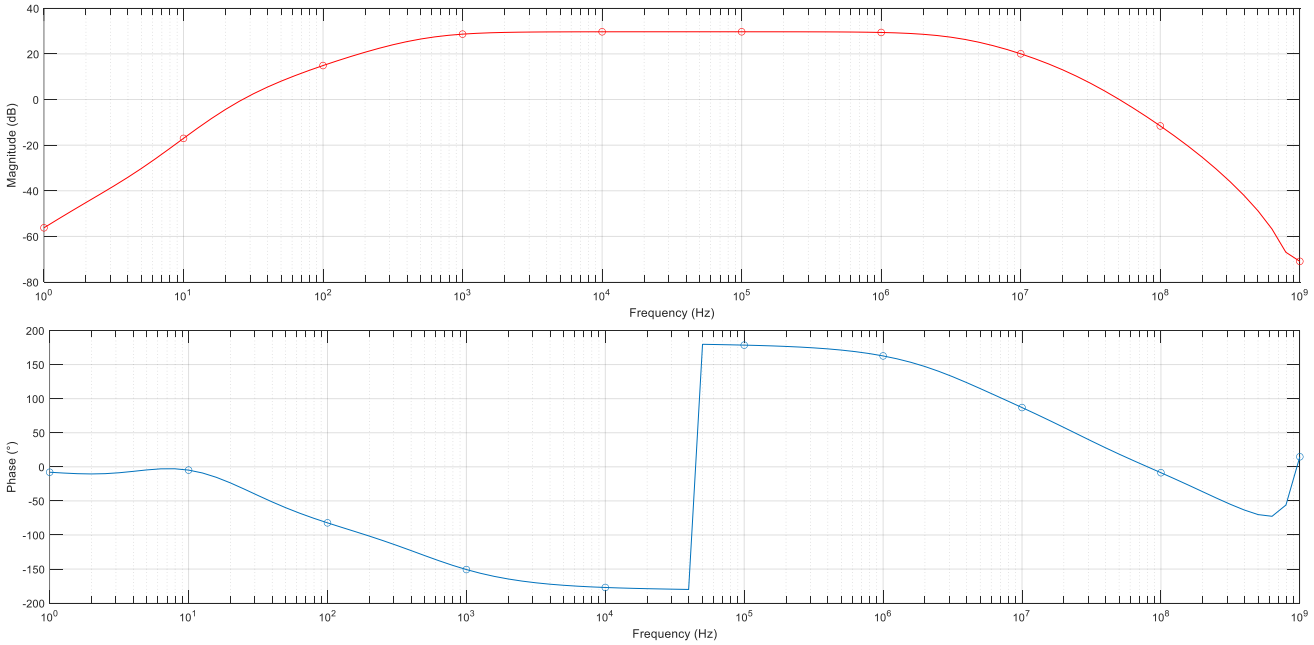
1.1.1 Gain



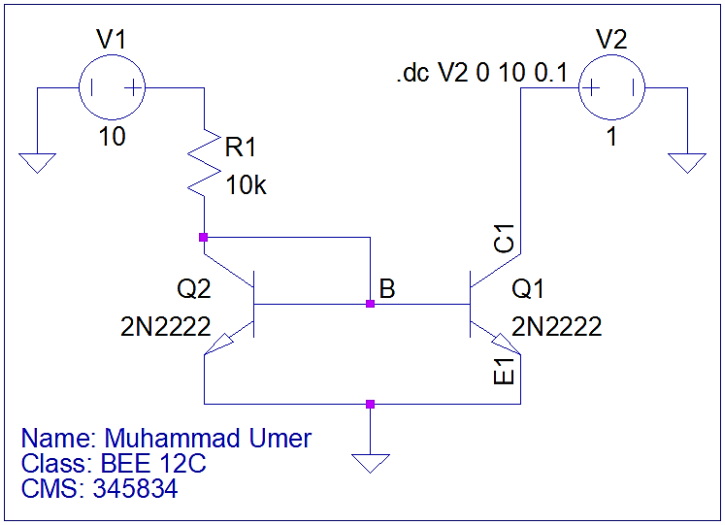
$$Gain\ of\ Cascoded\ Amplifier:\ G_V = \frac{V_{OUT}}{V_{IN}}$$

$$Calculations:\ \frac{V_{OUT_{P-P}}}{V_{IN_{P-P}}} = \frac{(264.4-(-276.1))\times10^{-3}}{19.99\times10^{-3}} = \mathbf{27.297\,\frac{V}{V}}$$

1.1.2 Bode Plot



1.2 BJT Mirror for R_{OUT} Calculations



As there is no load at the collector of Q_1 transistor, $R_{out} = r_o$

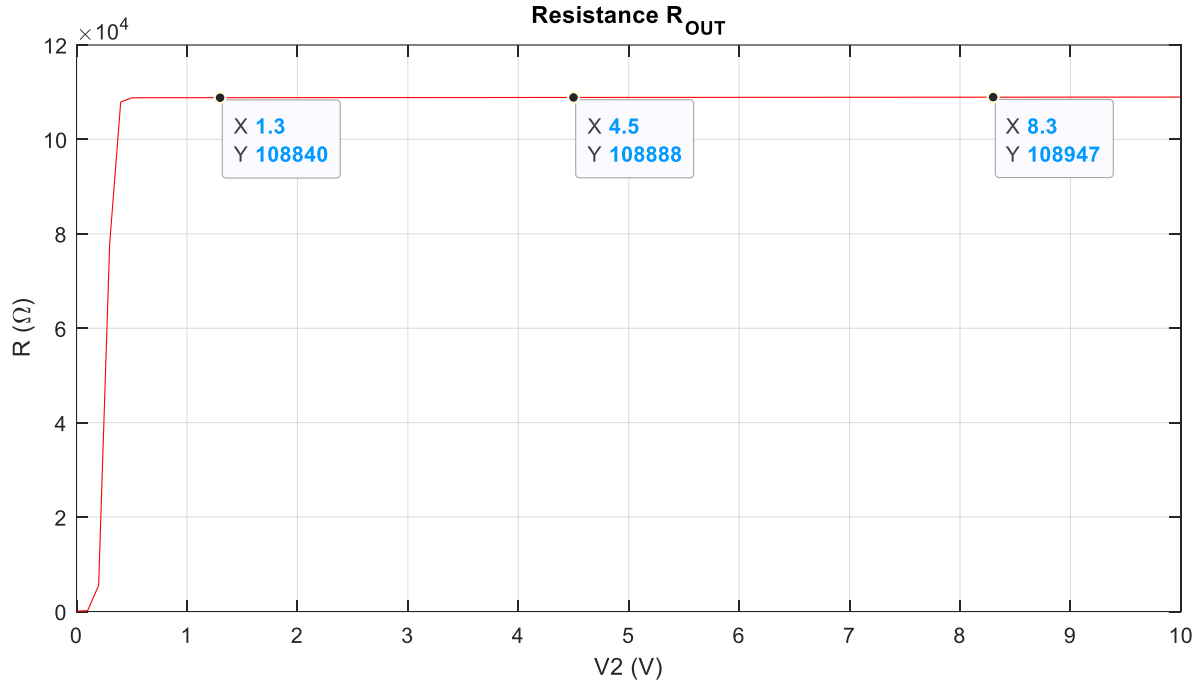
For BJT circuits, r_o can be calculated using the relation:

$$r_o = \left(\frac{\nabla I_c}{\nabla V_{CE}}\right)^{-1}$$

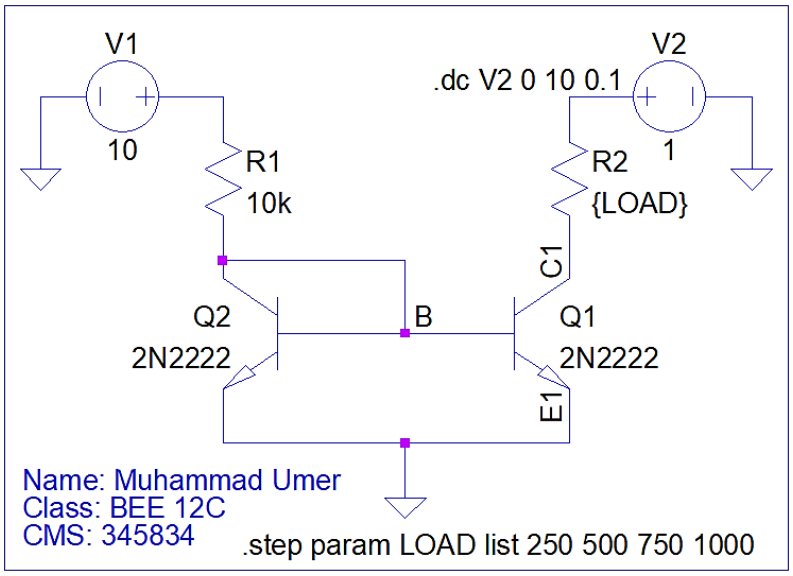
For the present case, emitter is grounded (0 V); the relation, thus, transforms to:

$$r_o = \left(\frac{\nabla I_c}{\nabla V_C}\right)^{-1}$$

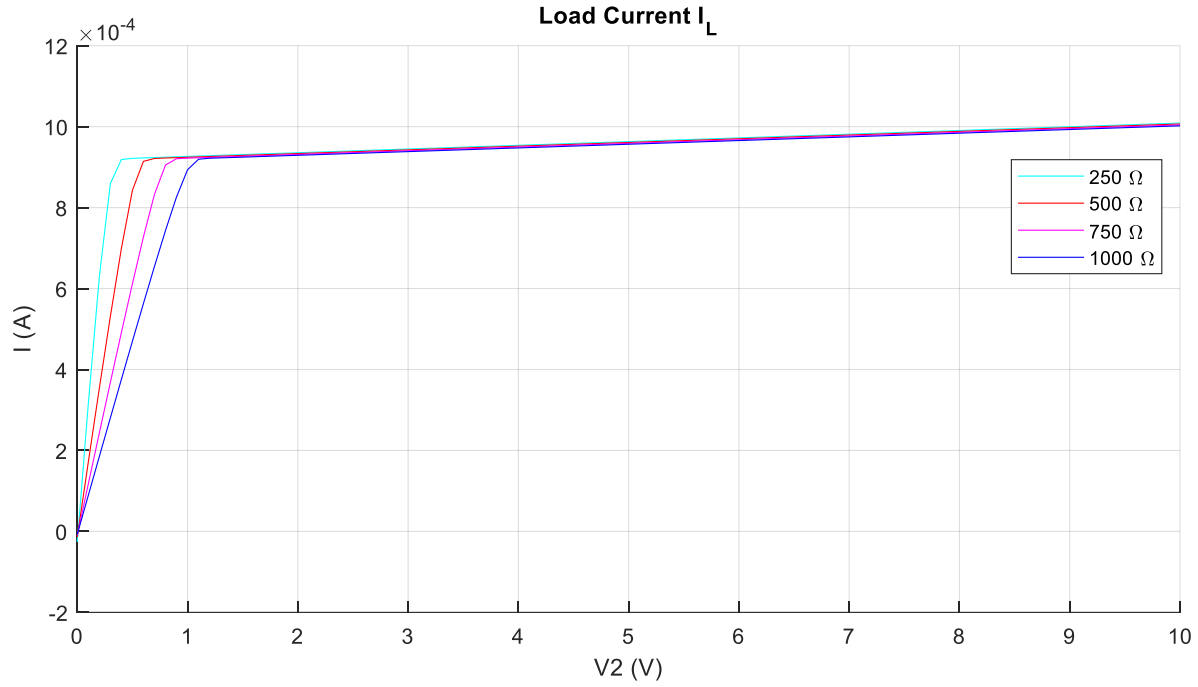
In LTSpice, one can plot the derivative (change) of a variable with respect to another, by using the notation D(). To plot r_o, we use $\frac{D(V(c1))}{D(Ic(Q1))}$ as the trace in the expression editor.



1.3 BJT Mirror with Changing Load



To verify that current remains constant for various loads, we perform parametric sweep on the load resistor R_2. Stepping it up from 250 to 1000 Ω in steps of 250, we can get a plot showcasing the respective currents passing through the load resistor, and, as is expected, current mirror keeps the current constant even under different load conditions.



2 Conclusion

In this assignment, we learned two important configurations of BJTs; cascoded common emitter amplifier as well as the current mirror. We observed that we can achieve a relatively stable gain as well as bandwidth with a cascoded configuration (with one stage focused towards gain, and the other towards bandwidth) than a simple BJT amplifier where trade-offs are inevitable. Lastly, we proved the fundamental property of current mirrors, i.e. constant characteristics of load current under various loads, by applying parametric sweep analysis on the current mirror.