ELC 3414: Electronic Design

Lab 5: AC Small-Signal Amplifiers

Objective

The purpose of this experiment is to explore the behavior of a common emitter amplifier for three different situations. The objective is to identify the effects of negative feedback implemented in the form of an emitter resister on the ac small-signal performance. (Last week we examined negative feedback effects on dc bias stability.)

The PSpice portion will allow you to compare differences between various transistor models, which can then also be compared to actual data.

Procedure

Part 1 – Hardware

From the available supply of npn transistors, choose one 2N2222 and one other transistor having a significantly different dc-beta.

Design two single-stage common emitter amplifiers using both the fixed bias and 4-resistor bias arrangements, as was done for last week's experiment (using the average beta). Let R_C be 4.7 kΩ for each design. For the 4-resistor bias design, let R_E be 1 kΩ. Operate the amplifier from +15 Vdc and set the Q-points to give maximum peak-to-peak voltage swing at the output.

Using the small-signal model and your measured values of beta, compute the expected gain of your amplifiers. For the 4-resistor bias design, compute the gain with and without a 10 µF emitter bypass capacitor. Measure the gain of each amplifier (3 circuits) at a frequency of 10 kHz. Determine the actual <u>undistorted</u> peak-to-peak output signal swing for each case.

Part 2 – PSpice

Model three circuits in PSpice using a Q2N2222 BJT transistor: fixed bias, 4-resistor bias, and 4-resistor bias with an emitter bypass capacitor. Use the same specifications as in Part 1.

Apply an input to the base by connecting a VAC source in series with a 100 kΩ resistor and a 10 µF capacitor. Set the amplitude (ACMAG) of the source to 1 V. To make simulating easier, place voltage markers on your input (base) and output (collector). Run an AC Sweep simulation from 10 Hz to 1 MHz with 101 points per decade.

Use the cursors to measure the input and output values at 10 kHz. To do this, click the cursors icon  . The **Probe Cursor** box will appear which shows the x and y values of each cursor.

Click anywhere on the plot and drag over to 10 kHz. A1 will now display the value of your first trace (either input or output, depending on how you set up your simulation) at 10 kHz. **Right click** on the diamond next to your second trace in the lower right corner of the plot window. It should now look something like 

. Now, **right click** anywhere on the plot window and drag to 10 kHz. A2 will now display the value of your second trace.

Note: left clicking moves A1, right clicking moves A2.

Model the exact same three circuits, but replace the transistor with the small-signal model for a BJT transistor. The current-controlled current source in PSpice is named "**F**". Use the beta value you measured for your 2N2222 transistor in the first part.

Determine the ac small-signal gain (at 10 kHz) of each circuit (6 total) and compare these values to those found in the first part.

Deliverables

Submit an *informal* report as a team for **both parts** of Lab 5.

Include in your report:

- A table that contains both the calculated and measured gain values for the 2N2222 and your other chosen transistor. (i.e. 12 values, 6 for each)
- A table that contains the calculated, measured, and simulated gains for the 3 circuits which use the 2N2222 (i.e. 12 values – 6 from each Part, the calculated and measured values will be the same at those in the 1st table.)
- Two schematics: the emitter-bypassed circuit for the Q2N2222 and small-signal model
- Each of the six simulations you ran
- Comparison of the various gain values you found
- Discussion of the tradeoffs involved in using an emitter resistor, with and without bypassing
- Discussion of any differences between the simulations for the Q2N2222 transistor and the small-signal model