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ECE 311
Lab #9

Objective

The objective of this lab was to design a common source amplifier with source degeneration. We'll test this component with an AC input at various frequencies with and without a coupling capacitor. We'll then test it with a strain-gage resistor in our biasing signal being used to simulate an AC signal.

Procedure

First, we ran a simulation of our circuit and took measurements of the gain of our signal, as well as calculated the necessary resistor values for proper biasing and source degeneration. This preliminary work showed that R_S was 200 Ω, R_2 357.295 Ω, and R_D was 2,350 Ω.

After finishing the preliminary work, we constructed the provided circuit of a common source amplifier. To begin, we used a 200 Ω resistor as our source degenerator. Despite the preliminary work, we used a 10 kΩ trimmer in parallel with a 470 Ω resistor as our top resistor in the biasing network meaning we set our R_2 to 1,489.9 Ω, and then another 10 kΩ resistor as R_D on the transistor's drain side set to 234.4 Ω.

Measuring the voltage drop across the 200 Ω resistor allowed us to measure the current through the transistor. We then adjusted the dropping-transistor until the voltage drop equated to 1 mA through the transistor (which was our given condition). With all the DC components properly set, we added in our input and output 10 μF coupling capacitors as well as a 1 MΩ load resistor on the output of the amplifier.

At these conditions, our output voltage was 2.5924 V, input voltage 2.284 V, and I_{DS} current set to 1.02 mA.

Setting our AC signal to 20 mV_{PP}, we started incrementally adjusting the input frequency to values between 10 Hz and 10 MHz. At each frequency increment, we measured the output voltage signal. After completing this test, we adding a capacitor in parallel with the source-side resistor (we chose a 336 μF capacitor), and repeated the tests once again.

The purpose of these two separate trials was to see how the gain changed with the addition of this capacitor. We suspect that our initial circuit had a poor quality transistor, because when we added the capacitor to the source we also replaced our transistor and got significantly higher values (a change much higher than expected).

The final part of the experiment was to remove our AC source, and replace the 120 Ω with a strain gage sensor. We took measurements of the resistance at a rest, down, and up positions. By putting the sensor in the circuit, we were able to 'pluck' the sensor and change the biasing voltage of the transistor with an oscillatory amplitude. This effectively simulated an AC input, and we were thus able to measure the change in output voltage. This was once again repeated without the resistor in parallel with the source of the transistor.

Questions & Calculation

$$V_{in-DC} = V_{AA} \cdot \frac{R_1+R_S}{R_1+R_S+R_2}$$

$$V_{in-DC}(down) = 5 \cdot \frac{50+120.863}{50+120.863+\frac{470\cdot 1,489.9}{470+1489.9}} = 1.61755\ V$$

$$V_{in-DC}(up) = 5 \cdot \frac{50+119.43}{50+119.43+\frac{470\cdot 1,489.9}{470+1489.9}} = 1.60835\ V$$

$$\Delta V_{in-DC} = V_{in-DC}(down) - V_{in-DC}(up)$$

$$\Delta V_{in-DC} = 1.61755\ V - 1.60835\ V$$

$$\Delta V_{in-DC} = 0.00902\ V = 9.20232\ mV$$

Results

Voltage	***ΔV$_{in}$ (V)***	***ΔV$_{out}$ (V)***
No Capacitor	0.0128	0.0825
Capacitor	0.0128	0.289

Conclusion

The fact that changing the biasing resistors using a strain-gage simulates an AC signal is a very interesting piece of information. I can easily see a situation where we wanted to observe the physical movement of a sensor, and the amplifier allows us to convert that very small change in impedance to a larger change in output voltage.