ECE 546 HOMEWORK No 10 Due Wednesday, April 24, 2024

In this homework you will exercise the DC analysis features of Virtuoso and use them to properly size the inverter transistors in order to achieve a 50-ohm match.

1. DC analysis tutorial

To enable DC analysis, simply choose '**dc**' from the analysis setup in the ADE environment (see Figure 1).

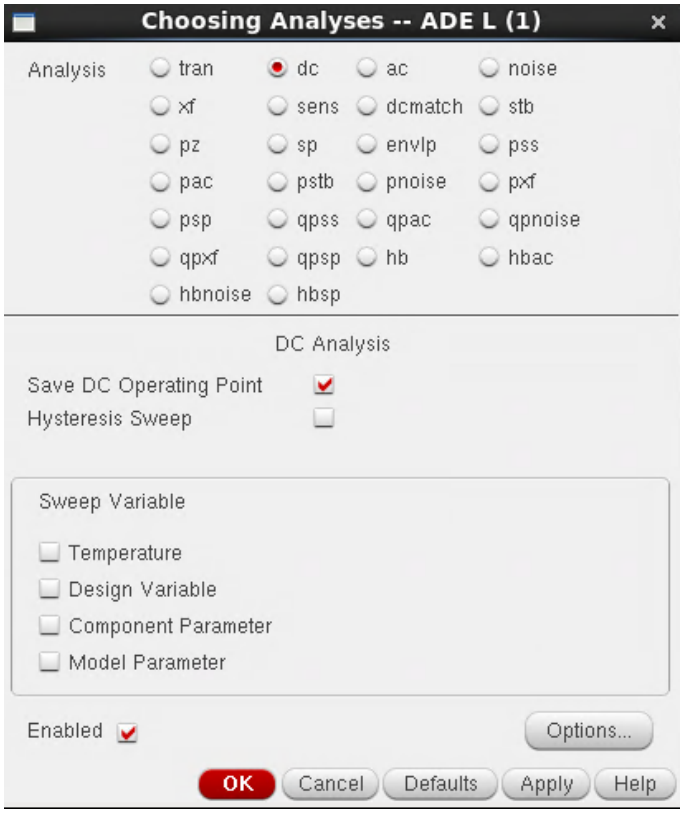

Figure 1. ADE L Analysis dialog box

In order to measure the on-resistance of the transistor, the voltage drop across the transistor, *V* and the current through it, *I* will also need to be measured. The resistance is simply the ratio *V/I*. This can be evaluated using the built-in calculator. You can enter the calculator mode by clicking the '**open**' button from the "**output setup**" dialog box within the ADE environment.

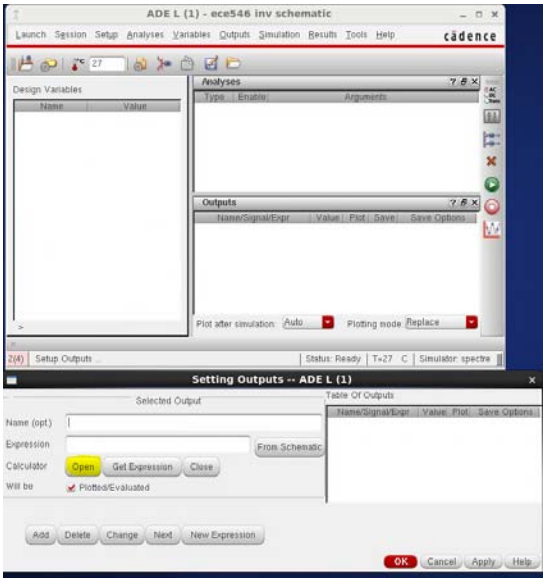

Figure 2. ADE L – Outputs settings dialog box

Next, click '**vdc**' from the upper row of the new window, the schematic will automatically come to the foreground. Click the node for which you want to measure the dc voltage. An expression **VDC("/NOTE_NAME")** will appear in the text box. This will measure the DC voltage of the node. Similarly, clicking on '**idc**' will measure the DC current, '**vf**' and '**if**' will measure the frequency-domain voltage and current respectively, '**vt**' and '**it**' will measure the time domain voltage and current respectively. You can also select functions from the '**Function Panel**' button to perform advanced mathematical manipulations of the signal.

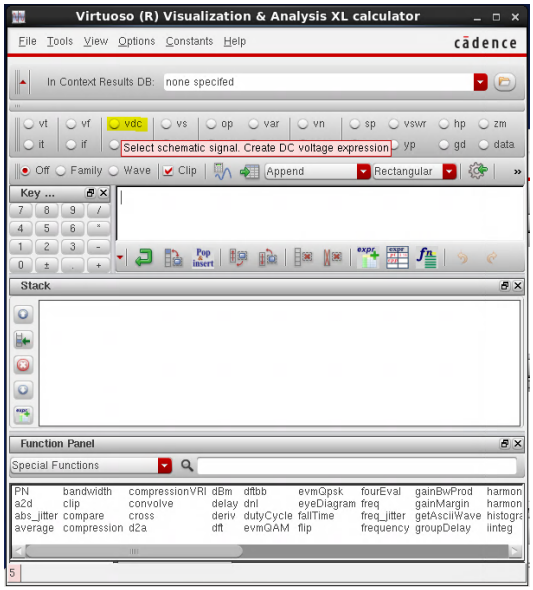

Figure 3. ADE L – Visualization and analysis calculator.

The expression for calculating the on-resistance of the transistor will be '**abs((VDC(source) – VDC(drain))/IDC(drain))**'. Once you finished editing the expression, go back to the output setup window and click '**get expression**', the expression will be automatically copied. A proper name should be given to the expression and then click '**add**'.

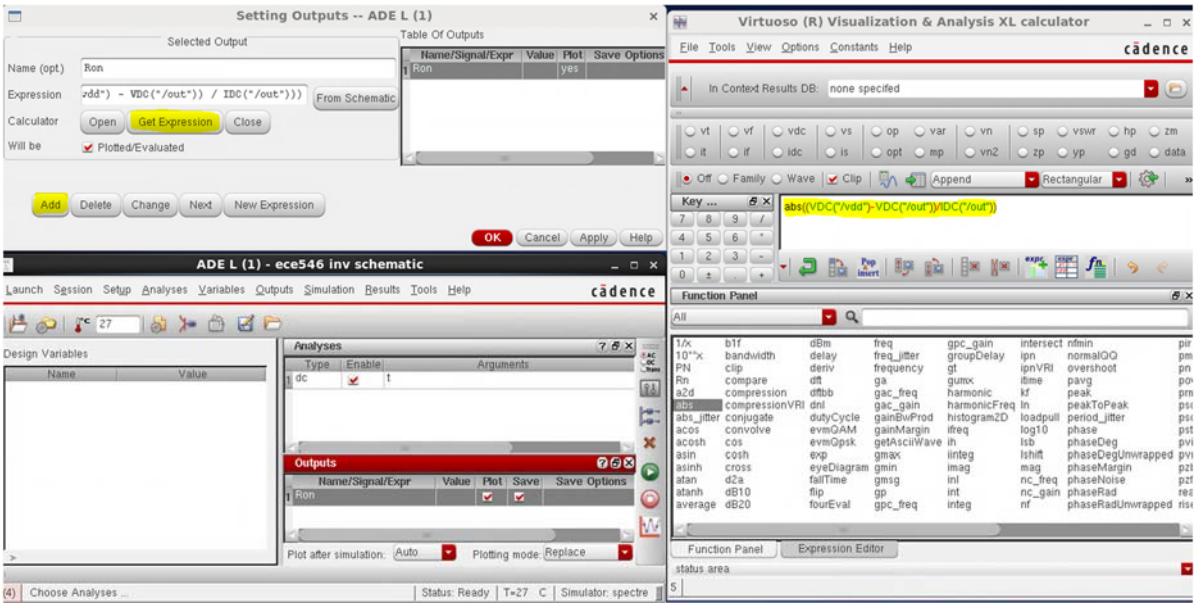

Figure 4. ADE L – Implementing mathematical expressions

2.Transistor model

The transistor in the inverter-based transmitter can be modeled as an ideal switch and a series resistor as shown in Figure 5.

Draw a similar model for the differential transmitter, channel and termination from homework 9. Comment on the target on-resistance of each transistor.

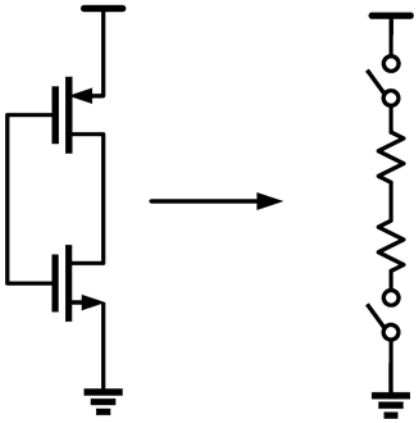
Figure 5. CMOS inverter and switch equivalent-circuit.

3. Sizing the transistor

Note that the on-resistance of the transistor not only depends on the voltage drop across it but also on the absolute voltage of both the source and the drain.

Calculate the source and drain voltages needed to measure the on-resistance of each transistor.

4. Simulation

In Cadence virtuoso, implement the DC analysis and extract the width of each transistor to ensure a 50-ohm match. Run the same step function as in homework 8 for at least 60 ns and comment on the results (input waveform of TX, input waveform of channel and output waveform of the channel).