January 30, 2025

ECEN-607: Advanced Analog IC Design

Assignment #1: Transistor Characterization

Due: 02/06/2025

Homework will not be received after due.

Upload your solutions through Canvas

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Use the technology you are using in the lab and characterize a single N-type transistor employing W=4.8μm and L=0.18μm. Use the IBM 0.18 technology you are using in the laboratory; please check it with your TA.

i) Set the drain-source voltage at 1V, and sweep the gate-source voltage from 0 up to 1.5V. Plot i_{ds}, Gm, dG_m/dV_{gs}, and $d^2G_m/dV_{gs}{}^2$ versus gate-source voltage.

ii) For same conditions as i), plot Cgs and Gm/Cgs versus Vgs-VT (overdrive voltage); this parameter represent the transistor's ft, which is quite relevant when designing fast circuits; Gm/Cgs is also known as the transistor's ft.

iii) Set the gate voltage such that the overdrive voltage V_{gs}-V_T=200mV, and sweep the drain voltage in the range 0-1.8V. Extract the transistor's output resistance and plot R_{ds}, dR_{ds}/dV_{ds}, and $d^2R_{ds}/dV_{ds}{}^2$ versus drain-source voltage. Notice that the derivatives of Rds represent output resistor non-linearities. Certainly, Rds is a second order effect and very non-linear, though!

iv) Repeat iii) for temperatures of -50, 27 and 100 degrees (Celsius). Make a table and compare Id, Gm and Rds for the 3 cases. For all these simulations keep constant the gate-source voltage; evidently Vdsat will not be constant due to VT variations.

v) Simulate the transistor and report the input and output referred noise density. Include a screen shot showing the noise density in the frequency range of 1Hz up to 10MHz; use log10 scale in the x-axis and y-axis to visualize the flicker noise level (voltage) and the thermal noise level (current). Check these values with the theoretical values.

The easiest way to do this is by biasing the gate voltage with a DC voltage source such that V_{gs}-V_T=200mV in series with an AC voltage source.

Connect at amplifier's drain terminal a power supply such that V_{DS} is set at 1V. The DC voltage source operates as short circuit for AC analyss and current can be measured.

Add conclusions in your report.