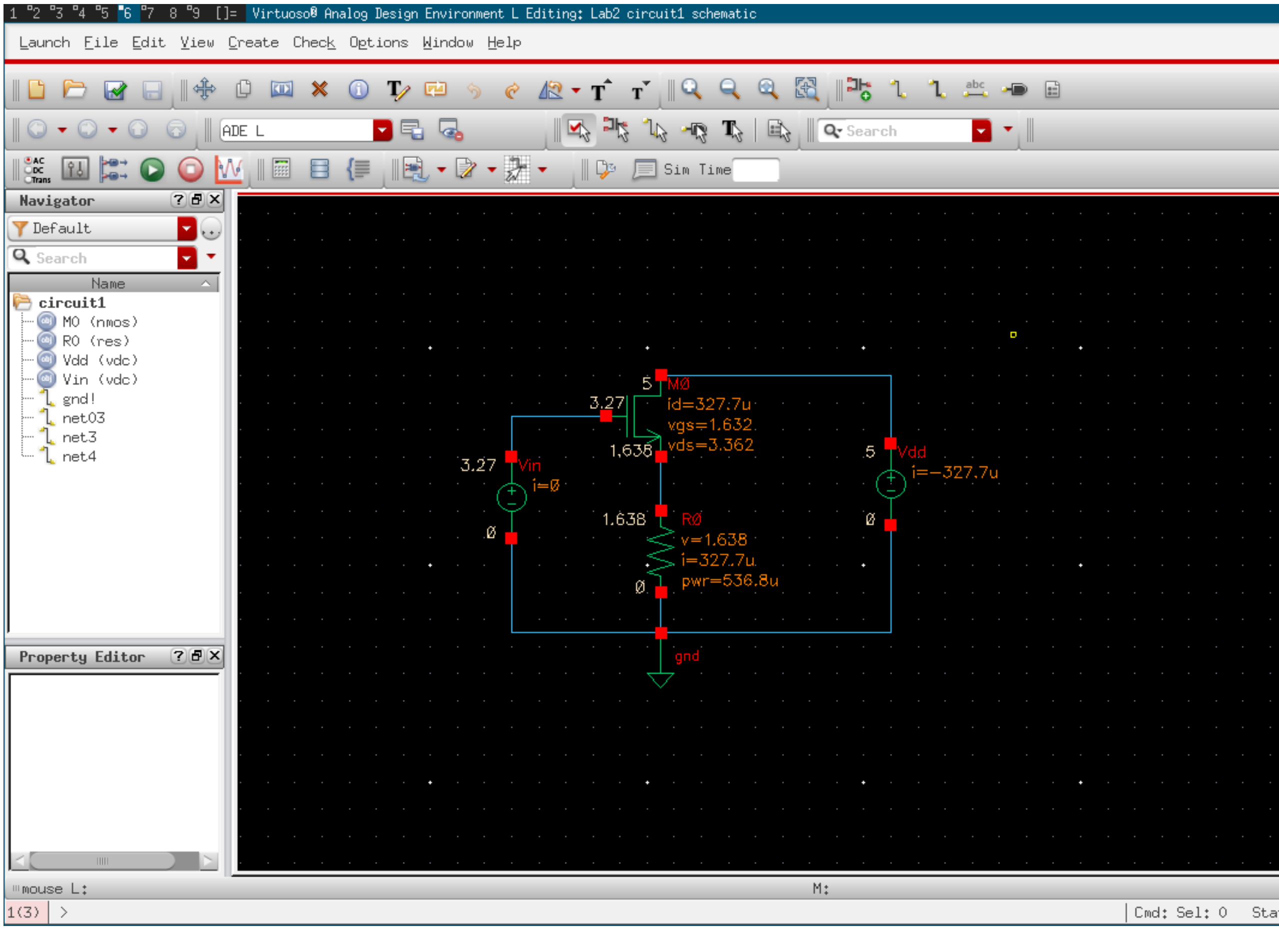

Figure 1: Circuit 1

The circuit in figure (1)'s voltage transfer characteristic is acquired by sweeping V_{in} from 0V to 5V.

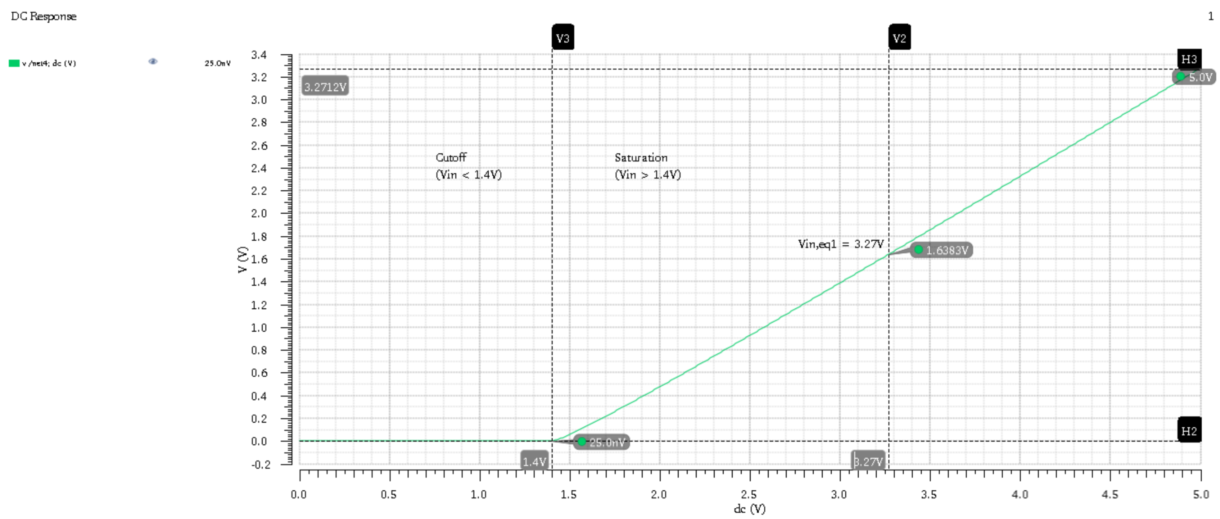

Figure 2: Circuit 1 Voltage Transfer Characteristic

Assume $0 < V_{in} < V_{tn}$. The transistor is in cutoff because the gate voltage is not high enough to form a channel. For $V_{in} > V_{tn}$, the transistor turns on. The transistor operates in saturation so long as $V_{GD} < V_{tn}$ (equivalent to $V_{DS} > V_{GS} - V_{tn}$). Because $V_{GD} = V_{in} - 5\text{V}$, the transistor is in saturation so long as $V_{in} < V_{tn} + 5\text{V}$. Since $V_{tn} > 0\text{V}$ for enhancement-mode NMOSs, the transistor must be in saturation since V_{in} never exceeds 5V, and the transistor is not cutoff. Here, $V_{tn} \approx 1.4\text{V}$ since that is the dividing line between cutoff and saturation.

Taking the average of the maximum and minimum values in the saturation region, $V_{in(eq1)} = 3.27\text{V}$. Note that 3.27V is used to compensate for the fact that V_{out} at $V_{in} = 3.26\text{V}$ is slightly below the midpoint. Figure (1) shows a DC operating point simulation at this bias point. g_m is given by $\frac{2I'_D}{V_{ov}}$, where I'_D is the saturation current not accounting for channel-length modulation and V_{ov} is the overdrive voltage. Here, the approximation $I'_D \approx I_D$ is used.

Table 1: g_m for the Common-Drain Amplifier

gm from Op Point Listing [mA / V]	Calculated gm [mA / V]	Error from Listing
2.83	2.83	0.11%

g_{ds} is simply the slope of the voltage transfer characteristic. A DC operating point listing providing by Virtuoso gives the value of g_{ds} for the transistor. r_o can then be acquired from $r_o = \frac{1}{g_{ds}}$. r_o can be calculated using $\frac{1}{\lambda I'_D} \approx \frac{1}{\lambda I_D}$.

Table 2: r_o for the Common-Drain Amplifier

ro from Op Point Listing [kiloohms]	Calculated ro [kiloohms]	Error from Listing
600.24	610.31	1.68%

An input signal of 10mV amplitude and 1MHz frequency biased at 3.27V is applied to the input of the common-drain amplifier.

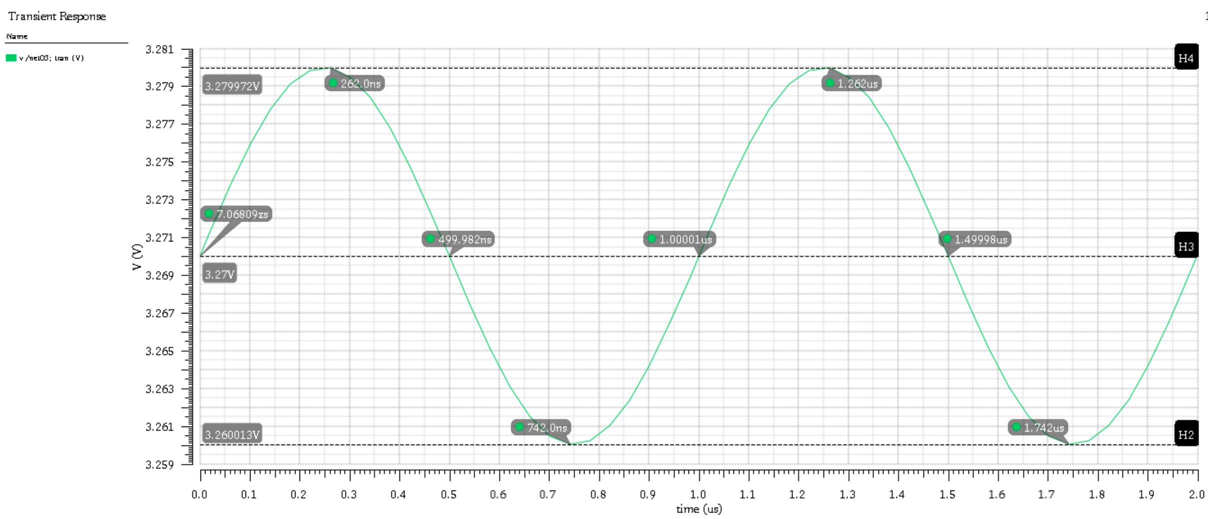

Figure 3: V_{in} for Small-Signal Analysis of Common-Drain Amplifier

A signal is then observed at the output of the amplifier.

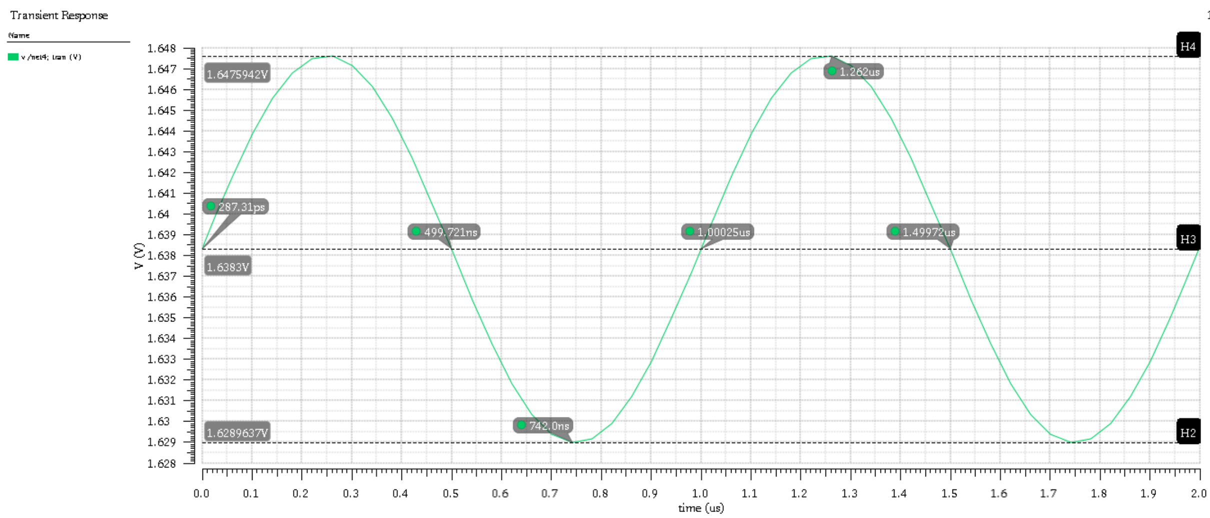

Figure 4: V_{out} for Small-Signal Analysis of Common-Drain Amplifier

The input and the output signals have the same amplitude. This is why the common-drain amplifier is often regarded as a "voltage follower". The bias at the output is simply the output voltage when V_{in} is biased at 3.27V, namely 1.64V.

10mV is then added to the input bias to take it from 3.27V to 3.28V. Again, the output amplitude is the same as the input amplitude. The output bias shifts up by the same amount as expected, specifically from 1.64V to 1.65V. Again, this behavior is expected since the common-drain amplifier acts as a "voltage follower".