ستایش اشکی
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امیرعلی پورحشمت
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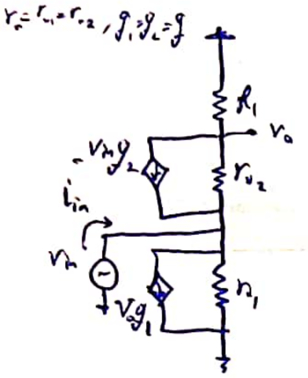
۱. فیدبک shunt — ~~[illegible]~~ shunt است
ولتاژ جریان

$$a = \frac{V_o}{i_s}\Big|_{f=0} = R_1 \quad , f = \frac{i_i}{V_o} = g_1 \longrightarrow A = \frac{V_o}{i_s} = \frac{a}{1+af} = \frac{R_1}{1+g_1R_1}$$

$$R_{in} = \frac{R_{in}|_{f=0}}{1+af} \quad , R_{in}|_{f=0} = r_{o1} \| \frac{1}{g_2} \approx \frac{1}{g_2} \longrightarrow R_{in} = \frac{1/g_2}{1+g_1R_1} = \boxed{\frac{1}{g_2(1+g_1R_1)}}$$

$$A_v = \frac{V_o}{V_s} = \frac{\overset{\to A}{V_o}}{R_{in}\, i_s} = \frac{1}{R_{in}} \times A = \frac{R_1}{1+g_1R_1} \times g_2(1+g_1R_1) = \boxed{g_2R_1}$$


$r_o = r_{o1} = r_{o2} \,,\, g_1 = g_2 = g$

می شد با استفاده از مدل h-π هم به همین نتیج رسید (با نوشتن kcl، kvl):

$$kcl: \frac{V_o - V_{in}}{r_{o2}} + \frac{V_o}{R_1} - g_2 V_{in} = 0 \longrightarrow A_v = \frac{V_o}{V_{in}} = \frac{\frac{1}{r_{o2}} + g_2}{\frac{1}{R_1} + \frac{1}{r_{o2}}} \xrightarrow[r_{o2}^{-1} \ll R_1^{-1}]{r_{o2}^{-1} \ll g_2} \boxed{A_v = \frac{V_o}{V_{in}} = g_2R_1}$$

$$kcl: \frac{V_{in} - V_o}{r_{o2}} + \frac{V_{in}}{r_{o1}} + g_1 V_o + g_2 V_{in} = i_{in}$$

$$\xrightarrow{V_o = g_2R_1V_{in}} V_{in}\left(\frac{1-g_2R_1}{r_{o2}} + \frac{1}{r_{o1}} + g_1g_2R_1 + g_2\right) = i_{in}$$

$$\xrightarrow[\substack{r_{o2} \gg 1 \\ r_{o2} \gg g_2R_1}]{r_{o1} \gg 1} V_{in}(g_1g_2R_1 + g_2) = i_{in} \longrightarrow \boxed{\frac{V_{in}}{i_{in}} = \frac{1}{g_2(R_1g_1+1)} = R_{in}}$$

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$$A_v = g_2R_1 = \frac{2I_D}{V_{GS} - V_{th}} R_1 \quad , (V_{GS} - V_{th})^2 \times \frac{k_n}{2} = I_D \rightarrow V_{GS} - V_{th} = \sqrt{\frac{2I_D}{k_n}}$$

$$r_o = \frac{1}{\lambda I} = 250k\Omega$$

یک خازن ما در سورس بزرگ است
r_o درست است.

$$\longrightarrow A_v = \frac{2I_D}{\sqrt{\frac{2I_D}{k_n}}} R_1 = \sqrt{2I_Dk_n}\, R_1 = \sqrt{2 \times 0.8mA \times 10\frac{mA}{V^2}} \times R_1$$

$$\longrightarrow A_v = 4\, mmho\, R_1 \xrightarrow{A_v > 4} \boxed{R_1 = 1k\Omega}$$

خازن ها باید جوری انتخاب شوند که در فرکانس $f = 500kHz$، اتصال کوتاه شوند.

$$Z = \frac{1}{j2\pi fC} = \frac{1}{j2\pi \times 5 \times 10^5 \times C}$$

$$\rightarrow |Z| = \frac{3.2 \times 10^{-7}}{C} \xrightarrow{C = 100\mu F} |Z| = 3.2 \times 10^{-3}\Omega$$

پس انتخاب $C_1 = C_2 = 100\mu F$ انتخاب خوبی است.

در حالت $\times R_2 = 0$

$$\left.\begin{array}{l} V_{G_2} < 2V \\ V_{G_1} < V_{G_2} - V_{GS} + V_{th} \rightarrow 1.6 < V_{G_2} \end{array}\right\} \rightarrow 1.6 < V_{G_2} < 2$$

$$V_{G_2} = 2 \times \frac{R_3}{R_3 + R_2} = 2 \times \frac{90}{90 + R_{2(k\Omega)}} \xrightarrow{V_{G_2} = 1.8V} \underline{R_2 = 10 k\Omega}$$

شرط توان را بررسی می‌کنیم.

$$P_{M.S} = V_{dc} I_{M.S} = 2V(0.8mA) = 1.6 mW$$

$$P_{R_2} + P_{R_3} = P_{R_{2,3}} = \frac{V_{dc}}{R_2 + R_3} \times V_{dc} = \frac{V_{dc}^2}{R_2 + R_3} = \frac{4V^2}{90^{k\Omega} + 10k\Omega} = 0.04 mW$$

$$P_{tot} = P_{M.S} + P_{R_{2,3}} = 1.6 + 0.04 = 1.64 mW < 1.65 mW \checkmark$$ satisfies

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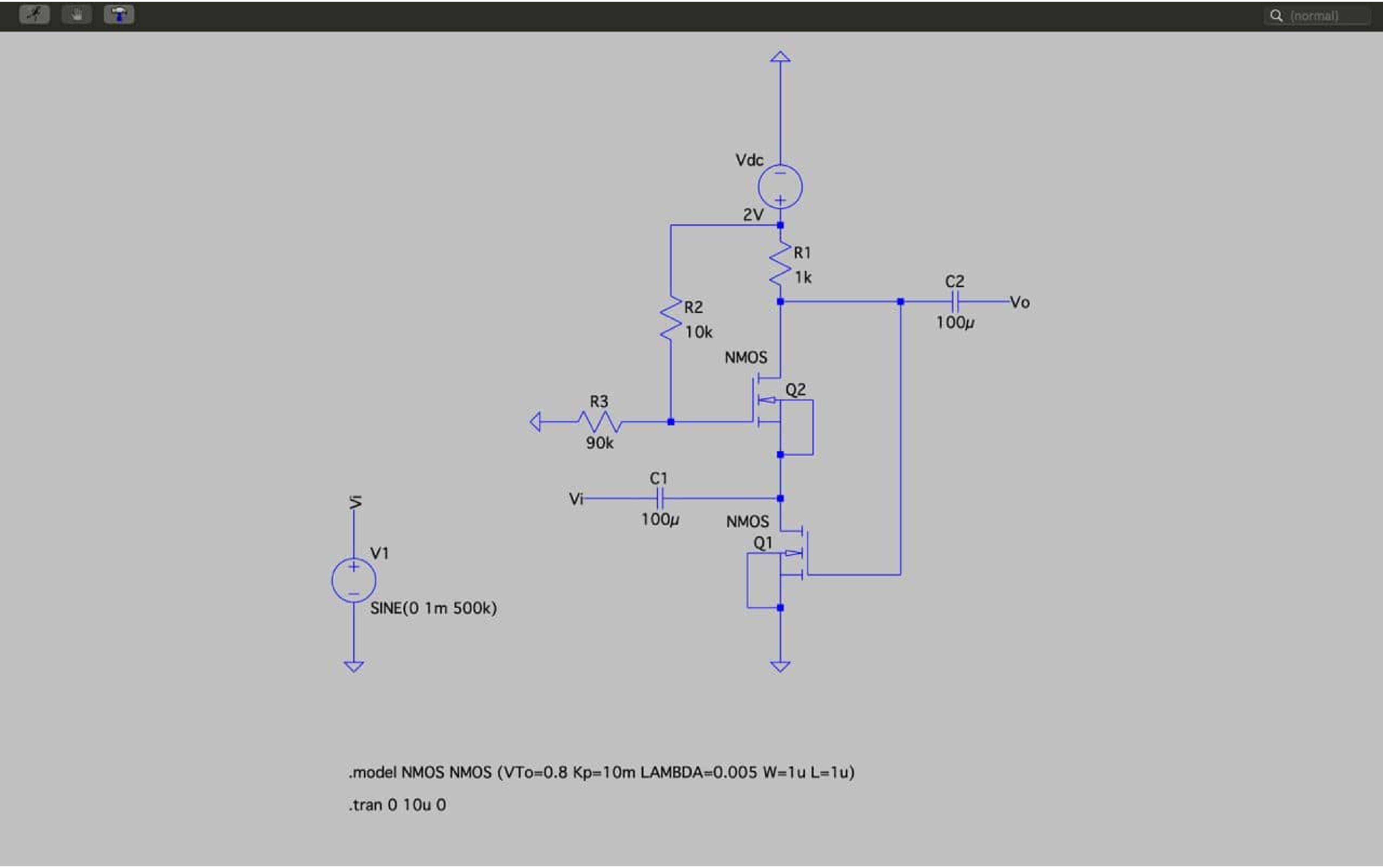
مقدار تقریبی:

$$g = g_1 = g_2 \ , \ r_{o_1} = r_{o_2} \ , \ g = k(V_{GS} - V_{th}) = \sqrt{2 I_D k} = 4 \text{ mmho}$$

$$R_{in} = \frac{1}{g_2(1 + g_1 R_1)} = \frac{1}{4 \text{mmho}(1 + 4 \text{mmho} \times 1 k\Omega)} = 50 \Omega$$

Scanned with CamScanner



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.tran 0 10u 0
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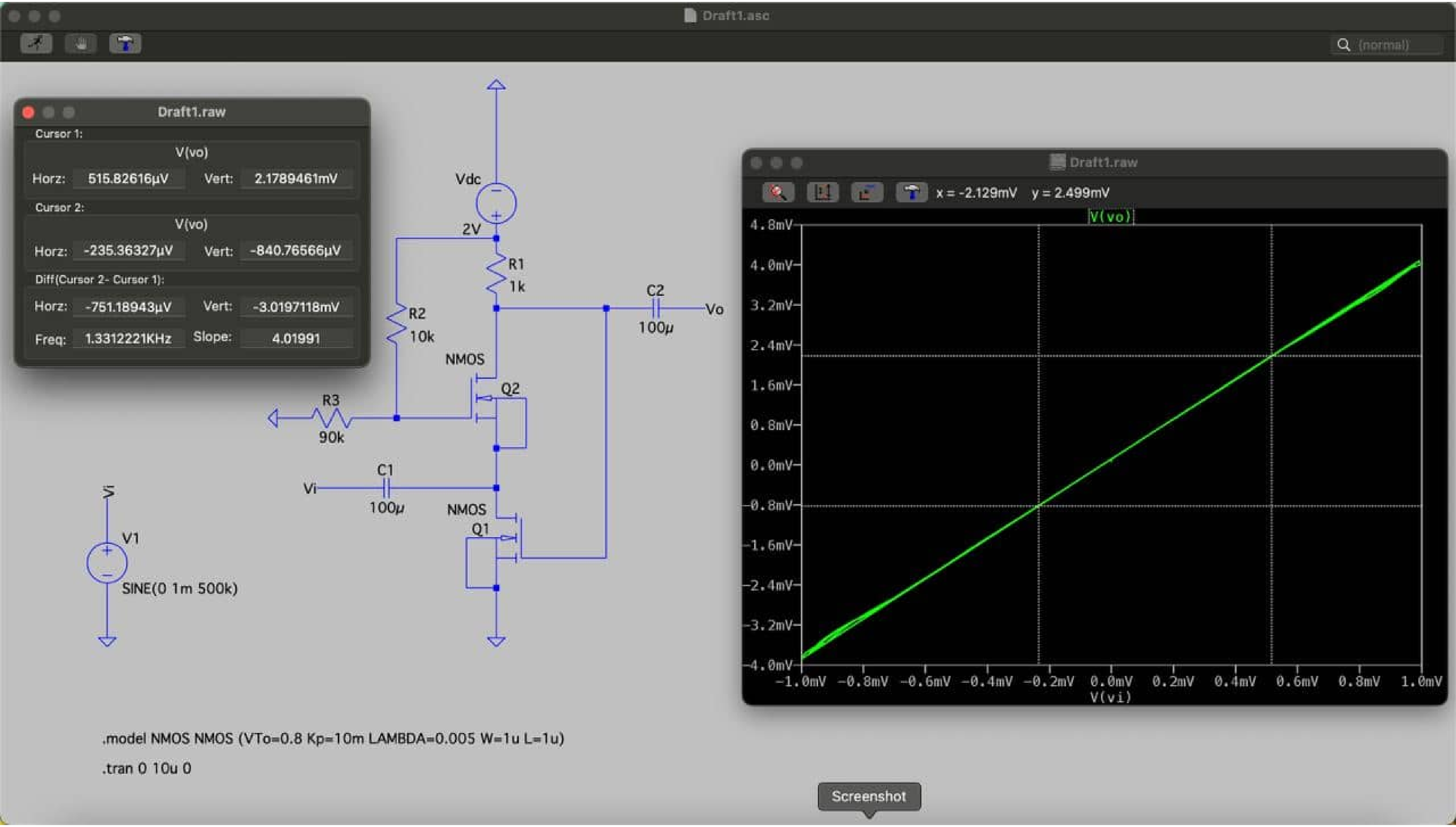
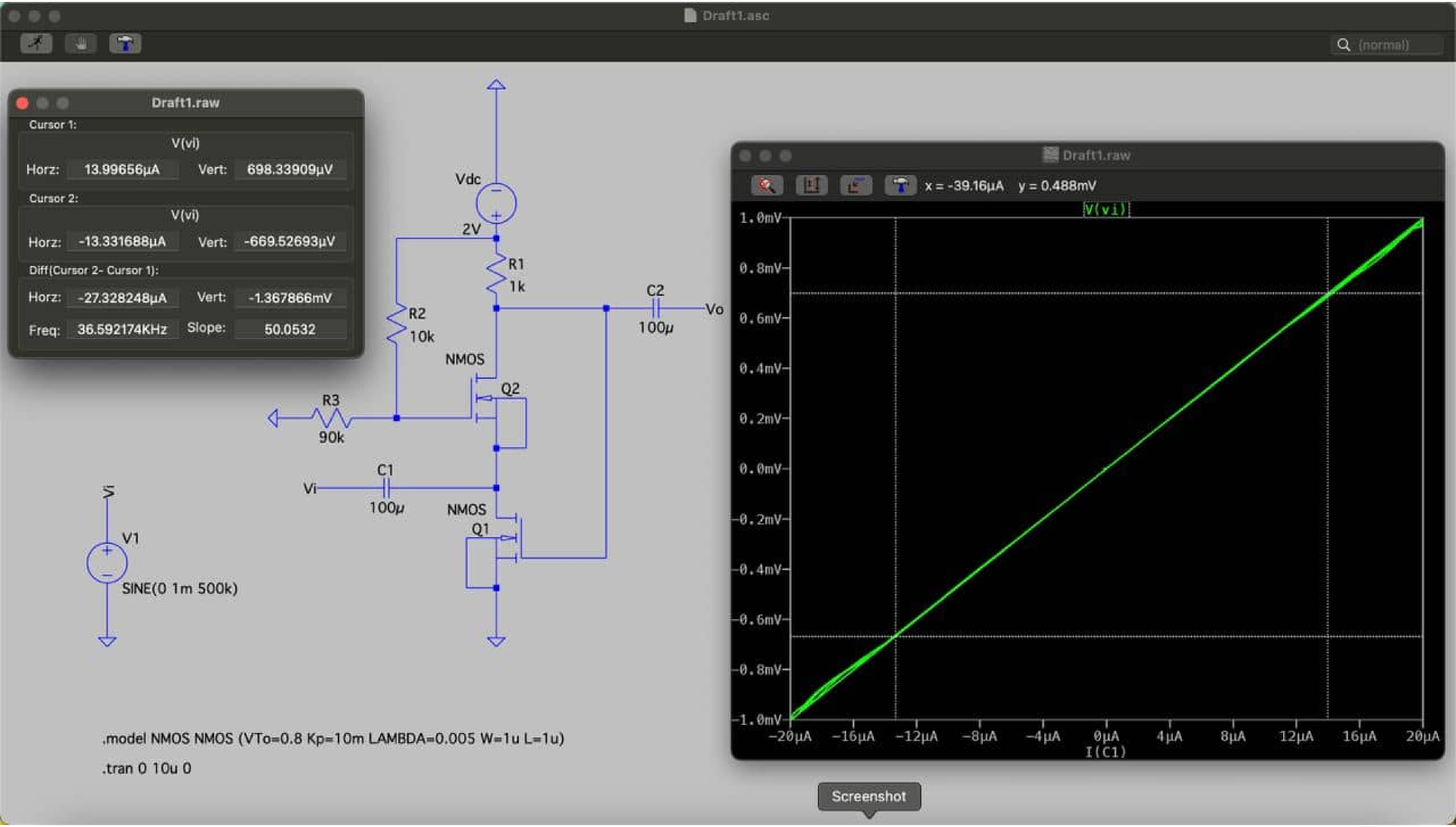


Cursor 1:
V(vo)
Horz: 515.82616µV Vert: 2.1789461mV

Cursor 2:
V(vo)
Horz: -235.36327µV Vert: -840.76566µV

Diff(Cursor 2- Cursor 1):
Horz: -751.18943µV Vert: -3.0197118mV
Freq: 1.3312221KHz Slope: 4.01991

```
.model NMOS NMOS (VTo=0.8 Kp=10m LAMBDA=0.005 W=1u L=1u)
.tran 0 10u 0
```



Draft1.raw

Cursor 1:

V(vi)

Horz: 13.99656μA Vert: 698.33909μV

Cursor 2:

V(vi)

Horz: -13.331688μA Vert: -669.52693μV

Diff(Cursor 2- Cursor 1):

Horz: -27.328248μA Vert: -1.367866mV

Freq: 36.592174KHz Slope: 50.0532

```
.model NMOS NMOS (VTo=0.8 Kp=10m LAMBDA=0.005 W=1u L=1u)
.tran 0 10u 0
```