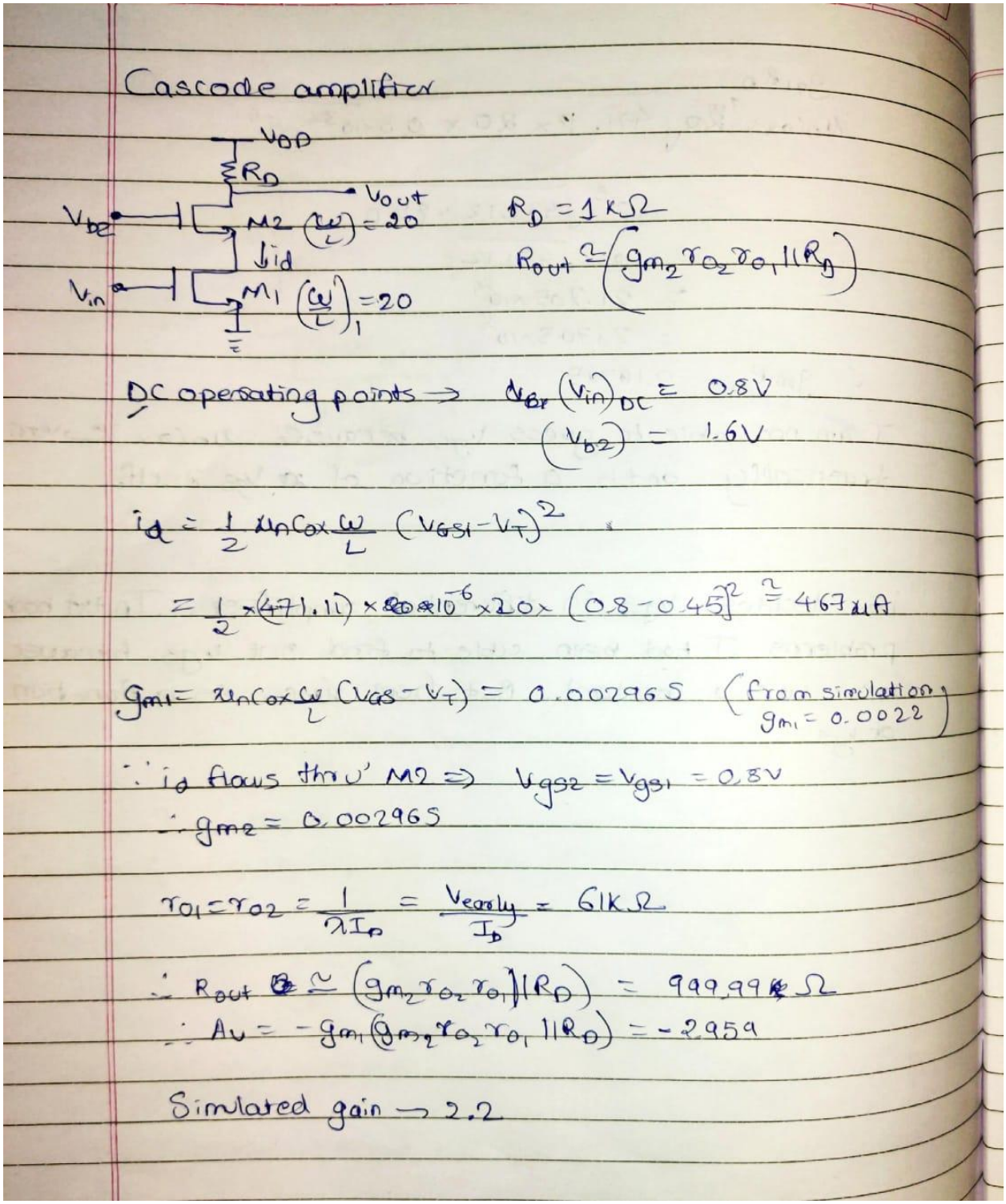
Cascode Device:

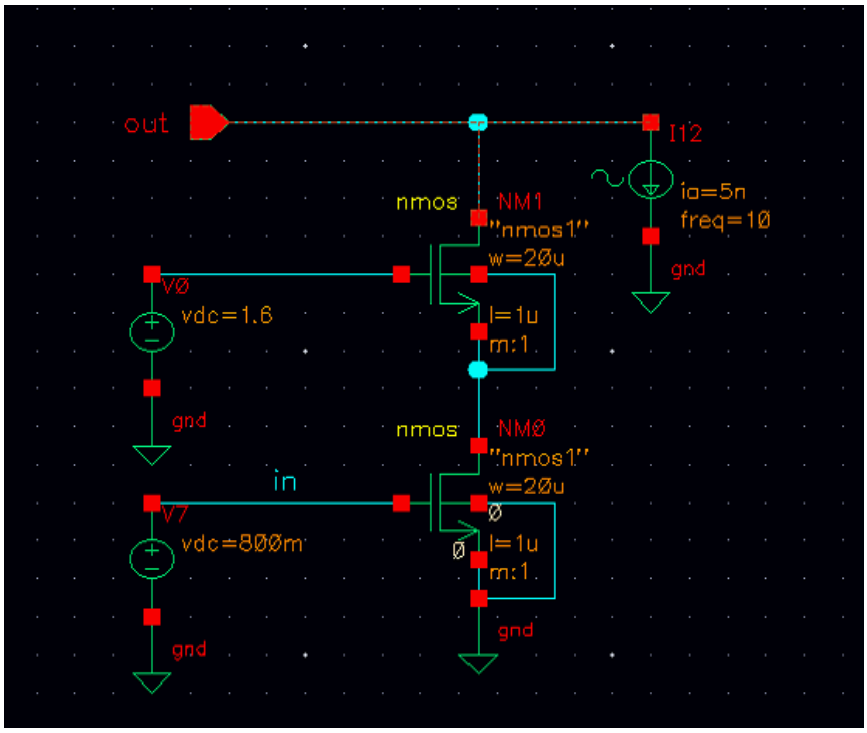
Calculation of output impedance of cascode device:

Current flowing through cascode structure: 422uA



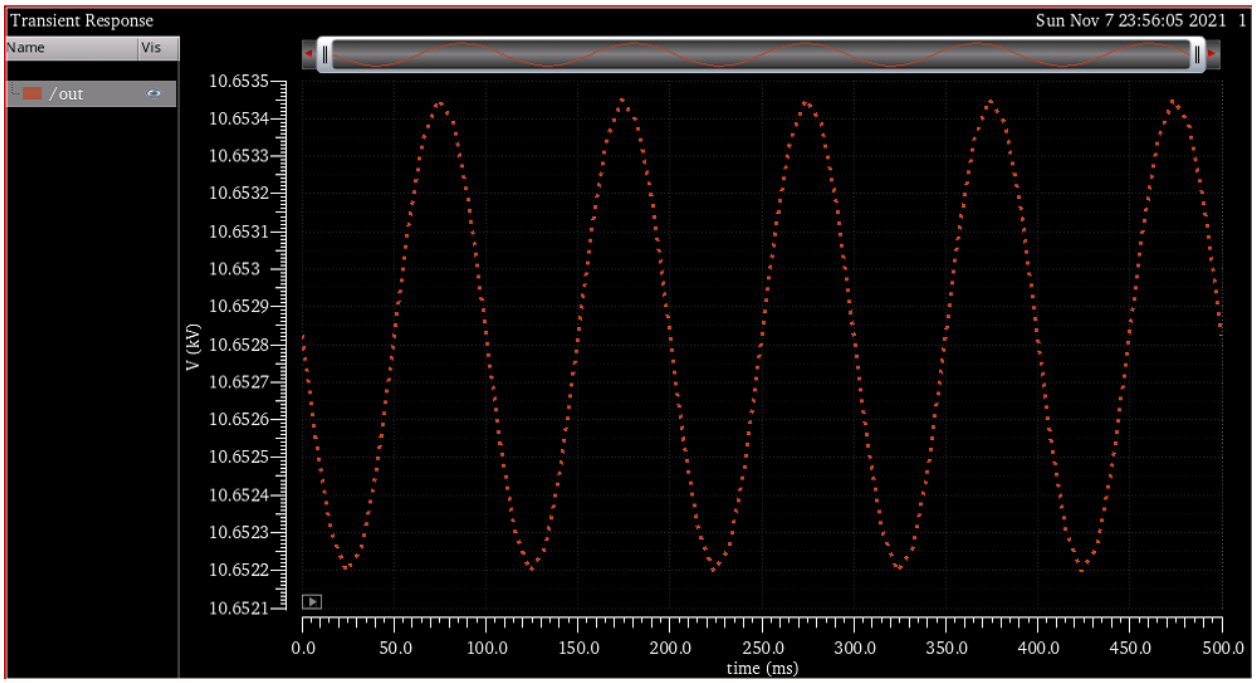
Rout (for cascode only) by calculation is : gm2*ro1*ro2 = 11 MOhms

Setup:



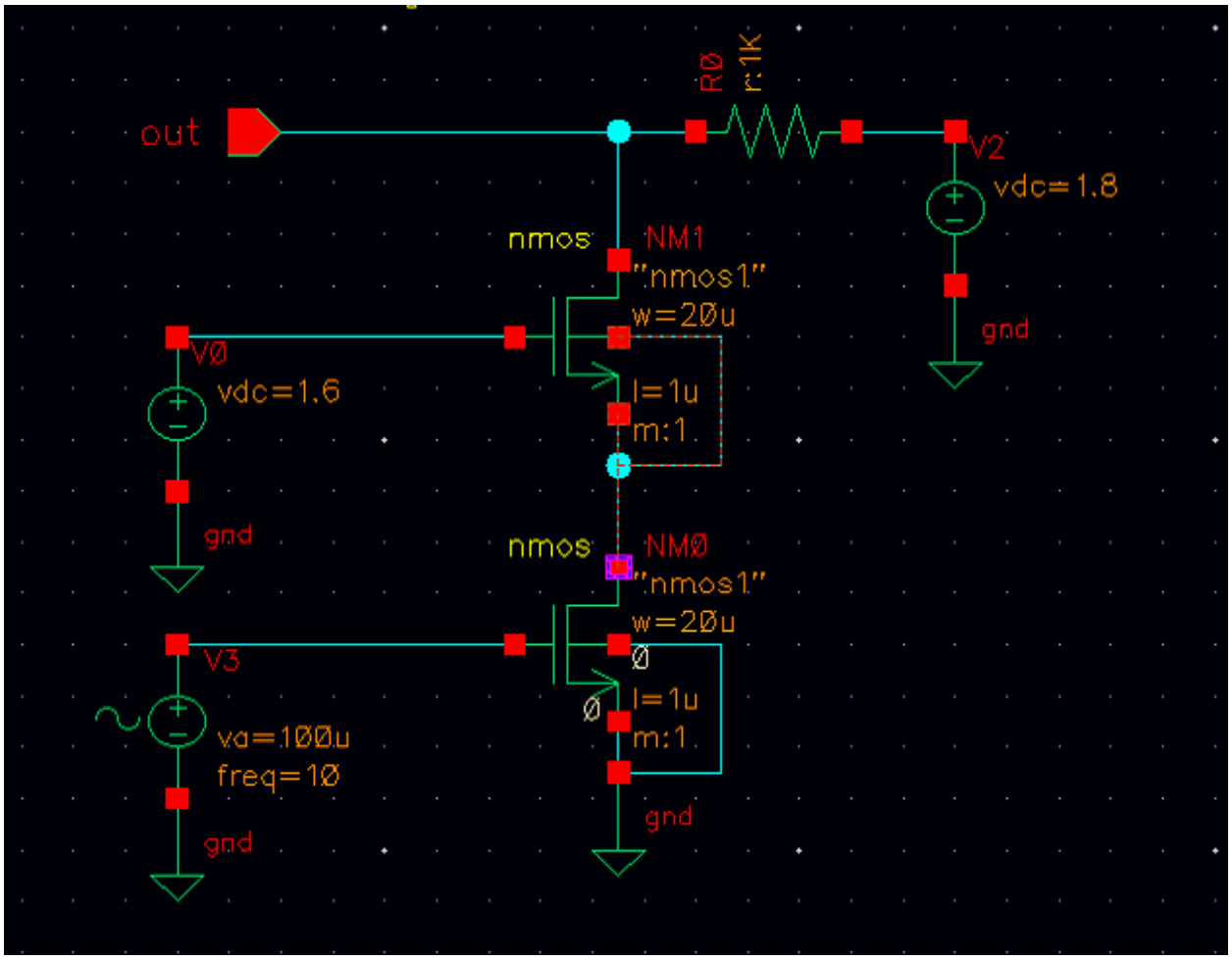
From analysis: Input current => DC: 467uA,AC: 5nA 10Hz

Output voltage: dV = 0.6V

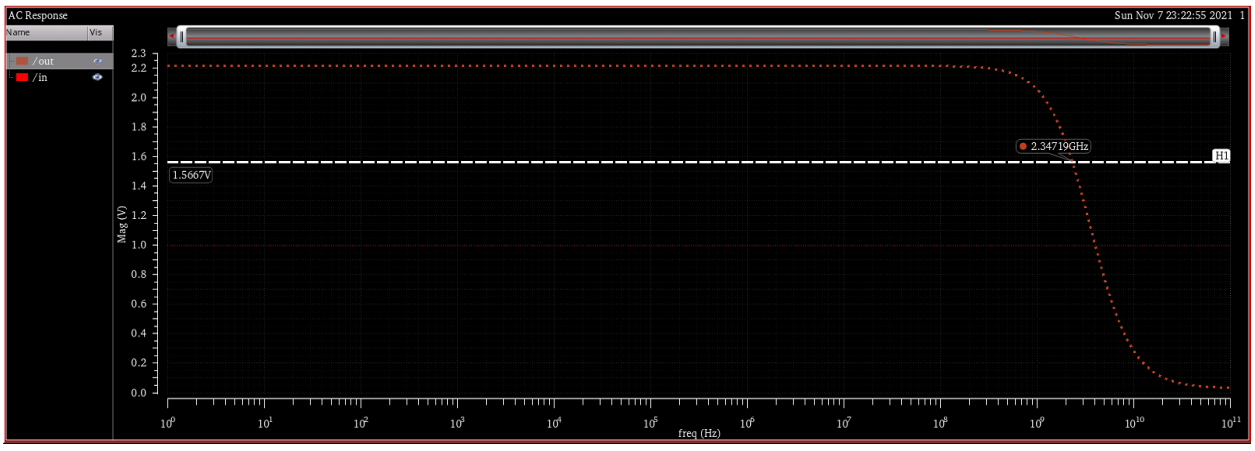


According to simulation => 120 MOhms (error by a magnitude of 10)

Frequency Analysis:

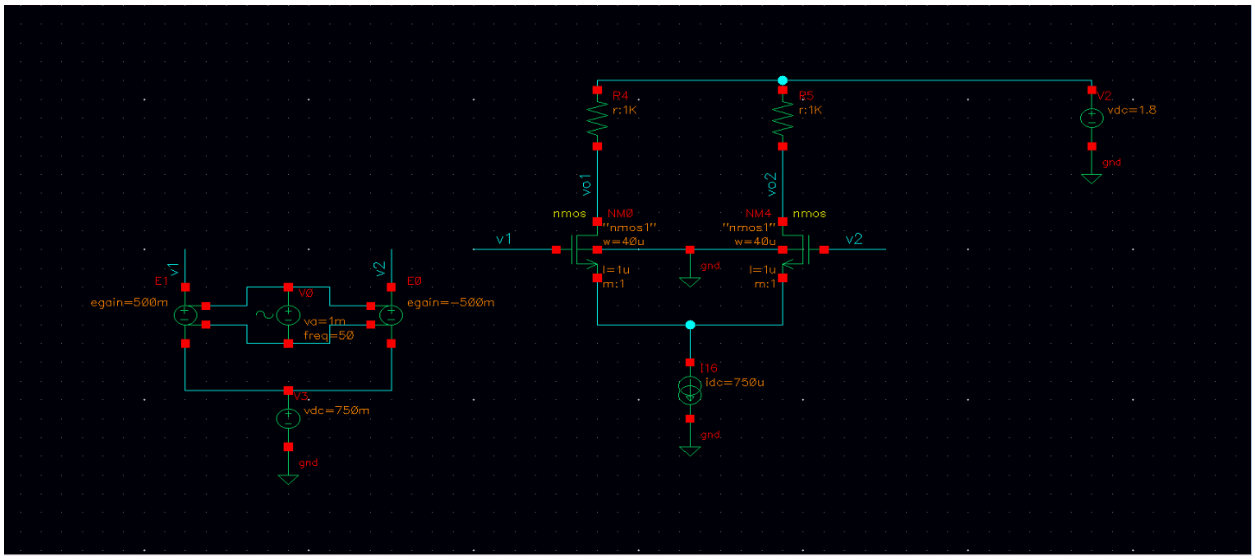


Magnitude of output: (Magnitude of input is 1, hence output magnitude is gain)

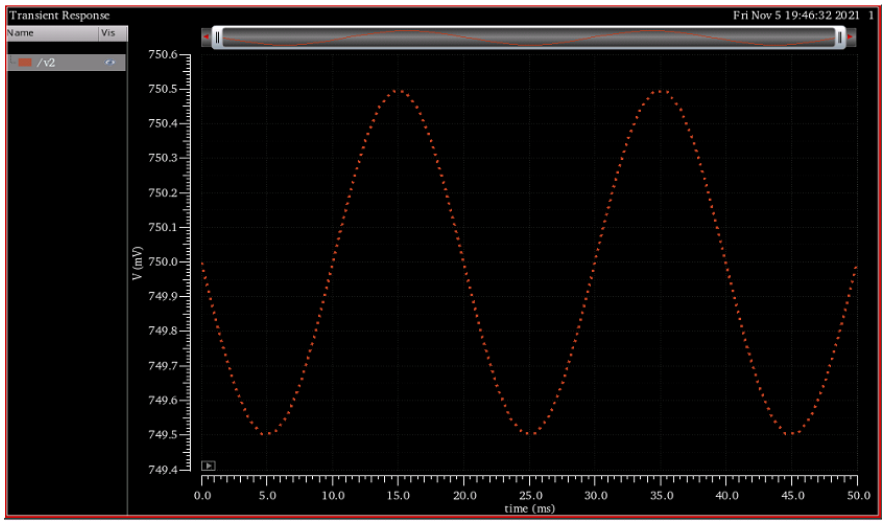


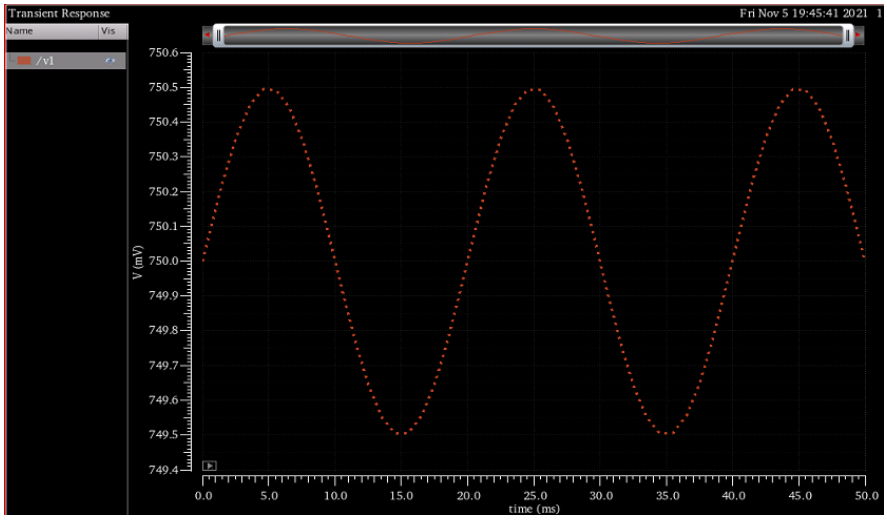
3dB frequency is 2.34 GHz

Differential amplifier:

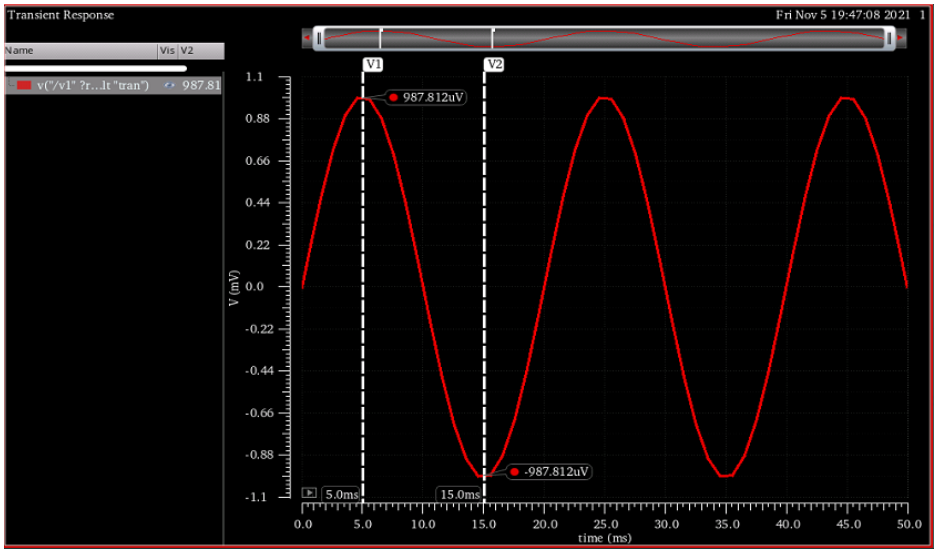


Inputs:

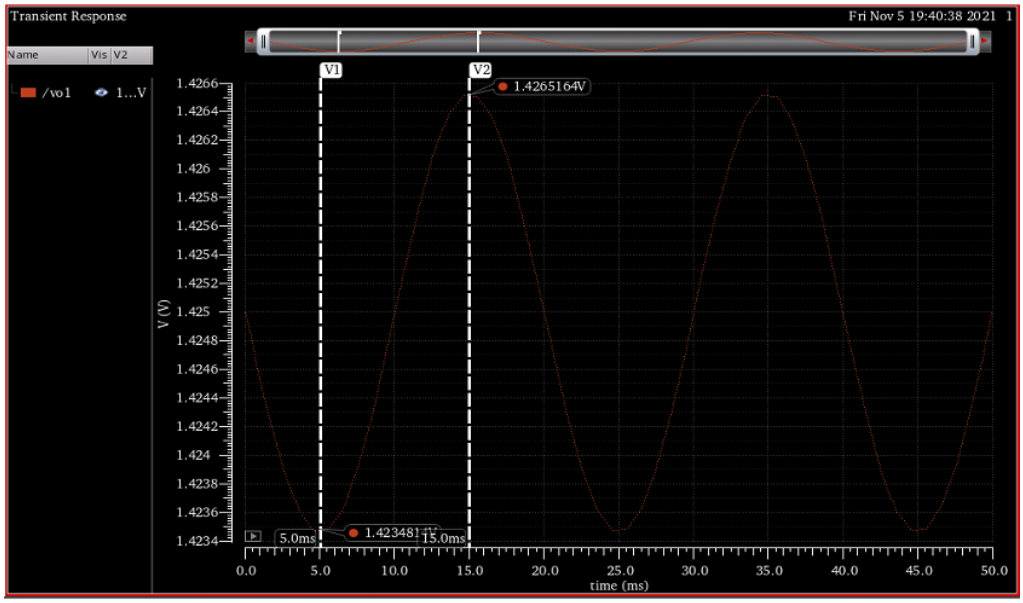


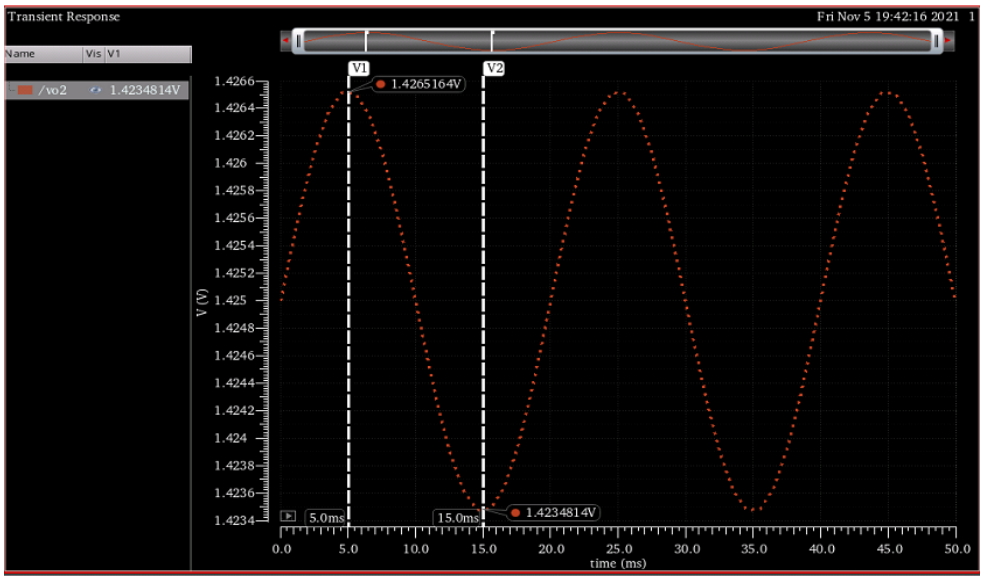


Differential input: approximately 1mV 50Hz

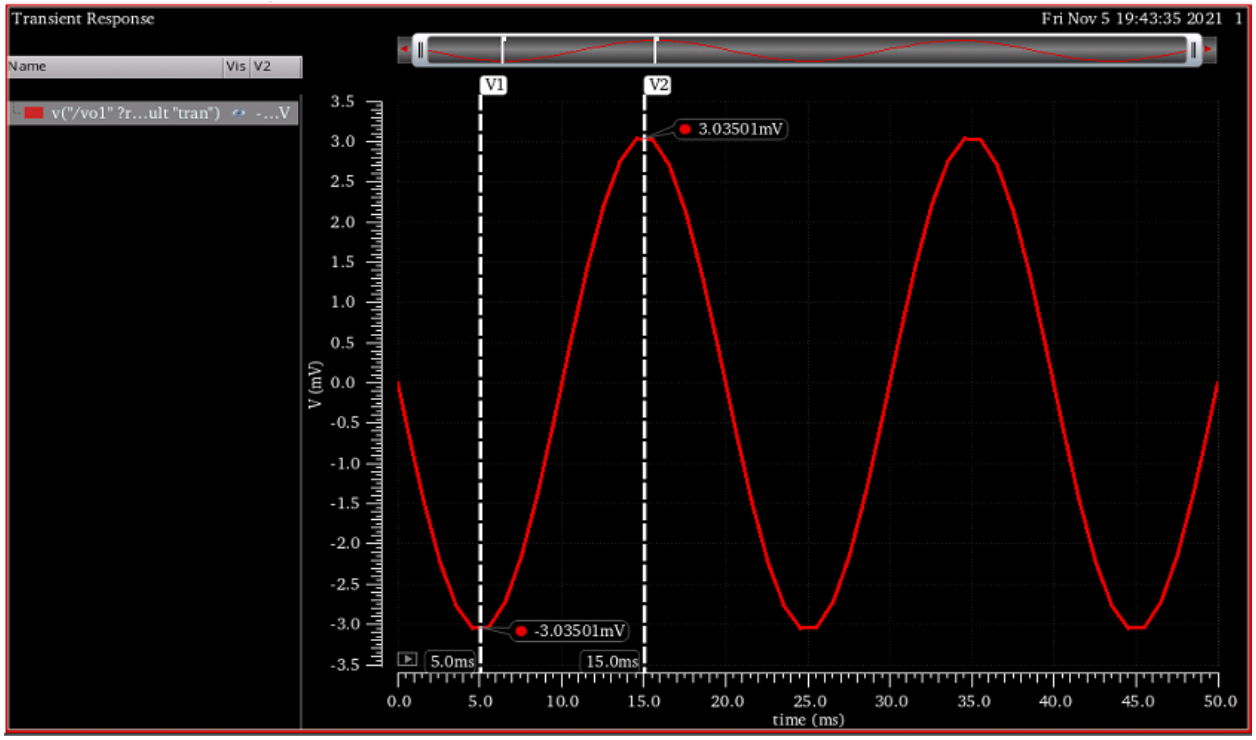


Outputs:



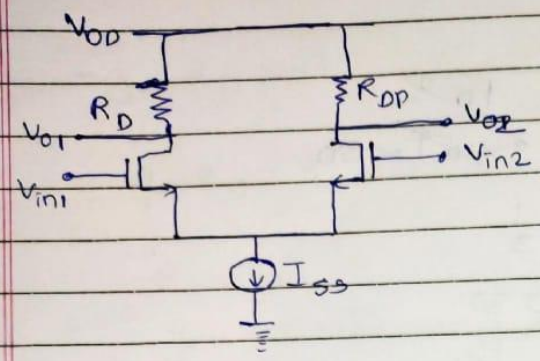


Differential output: Gain of approximately 3V/V



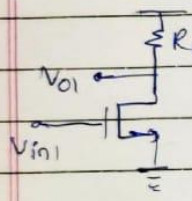
Hand calculations:

Calculation



$$I_{D1} = I_{D2} = \frac{I_{SS}}{2} \quad \left(\text{if } (V_{in1})_{cm} = (V_{in2})_{cm} > V_{th}\right)$$

Using half circuit analysis ($\because$ they are identical)



$$\frac{V_{o1}}{V_{in1}} = -g_m R_D$$

$$\text{also} \rightarrow \frac{V_{o2}}{V_{in2}} = -g_m R_D \quad \left(\because I_{D1} = I_{D2} = g_m = g_s\right)$$

$$\therefore \frac{V_{o1} - V_{o2}}{V_{in2} - V_{in2}} = -g_m R_D$$

$$R_D = 1\,k\Omega \qquad g_m = \sqrt{\mu_n C_{ox} \frac{W}{L} I_{SS}}$$

$$3 = 10^3 \times \left(\sqrt{300 \times 10^{-6} \times \frac{W}{L} I_{SS}}\right)$$

Chosen $\rightarrow I_{SS} = 0.75\,mA \Rightarrow \frac{W}{L} = 40$

$$V_{GS} = V_{th} + \sqrt{\frac{I_{SS}}{\mu_n C_{ox} \frac{W}{L}}} = 0.485 + 0.25 = 0.735\,V$$