E3-277 Introduction to Integrated Circuit Design

Lab Assignment 3

Submitted

by

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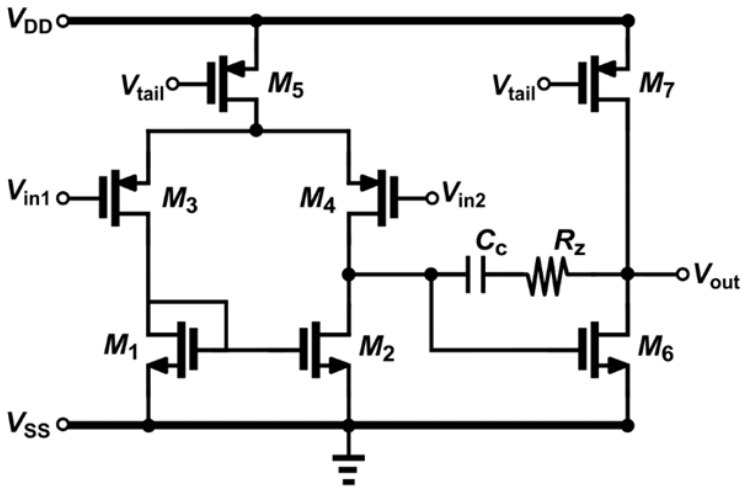

FIGURE 1: A basic two-stage operational amplifier.

TABLE 1: Design specifications @ supply voltage = 1.2V, Load = 100pF, and temperature = 27°C

S.N.	**Parameter**	**Symbol**	**Value**
1.	Open-loop, differential-mode, DC voltage gain	A_0	$\geq 100\ V/V\ (40\ dB)$
2.	-3dB-Bandwidth	f_{-3dB}	$\geq 5\ MHz$
3.	Phase margin	PM	$\geq 60°$
4.	Common-mode rejection ratio	$CMRR$	$\geq 30\ dB$
5.	Power dissipation	P_d	$\leq 800\ \mu W$

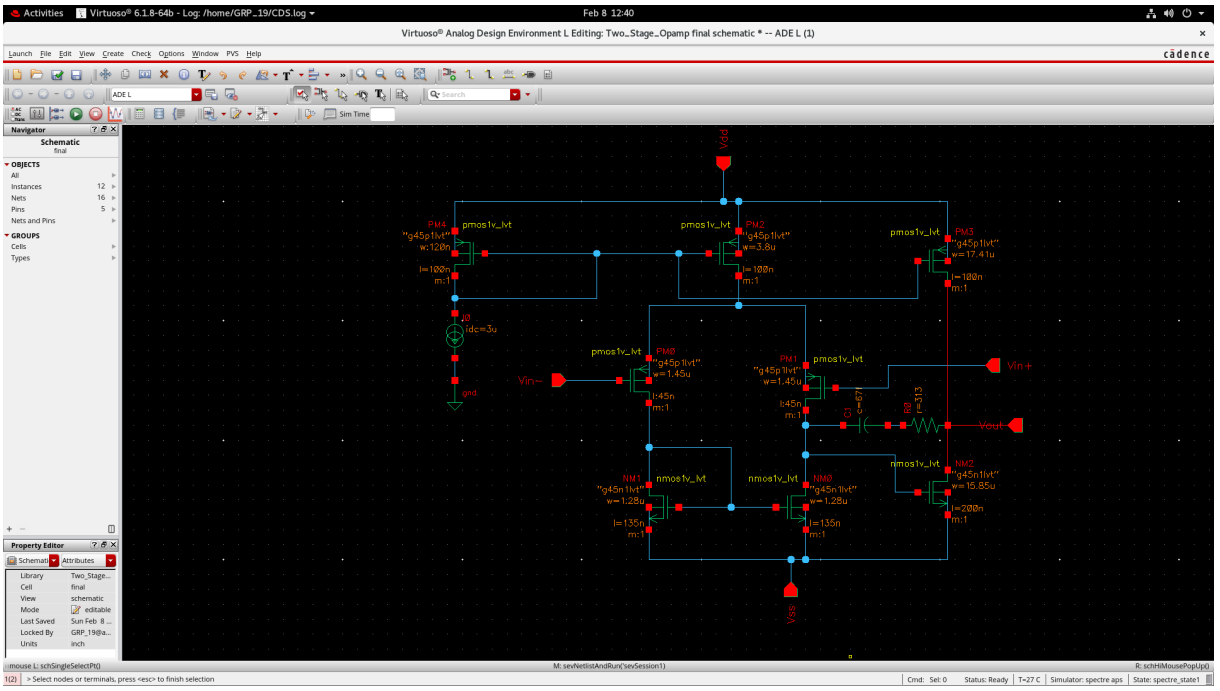

FIGURE 2: Two-stage Opamp

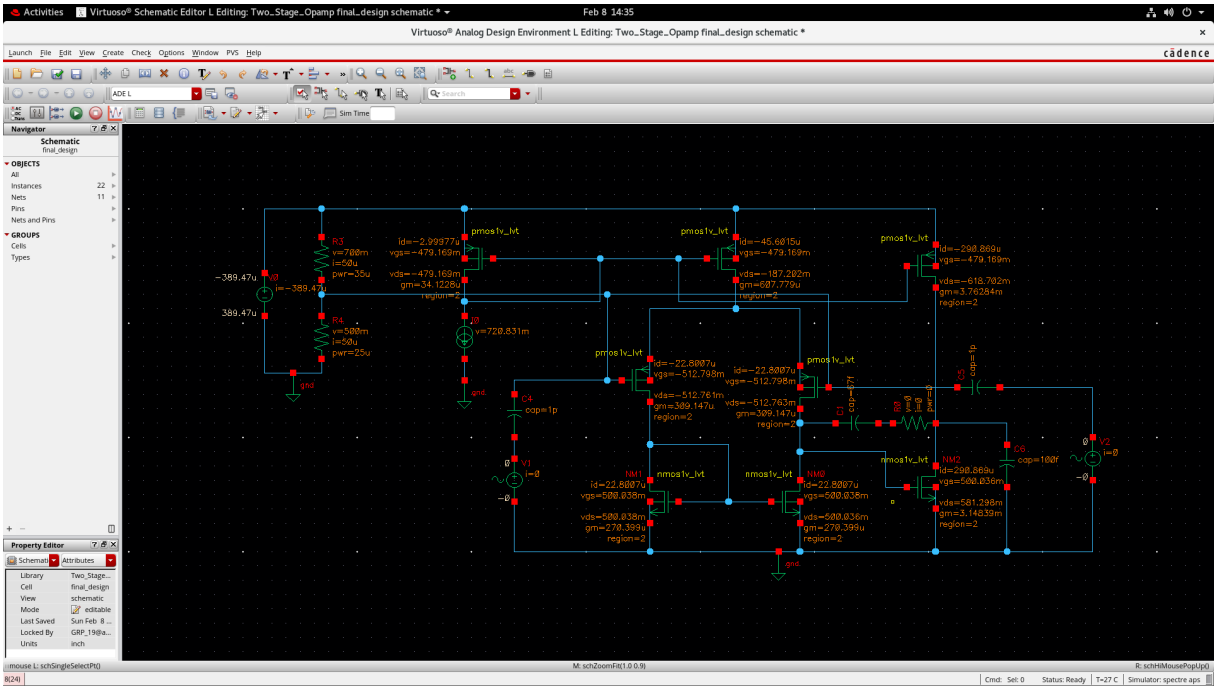

FIGURE 3: DC operating points

0.1 DC Testbench results

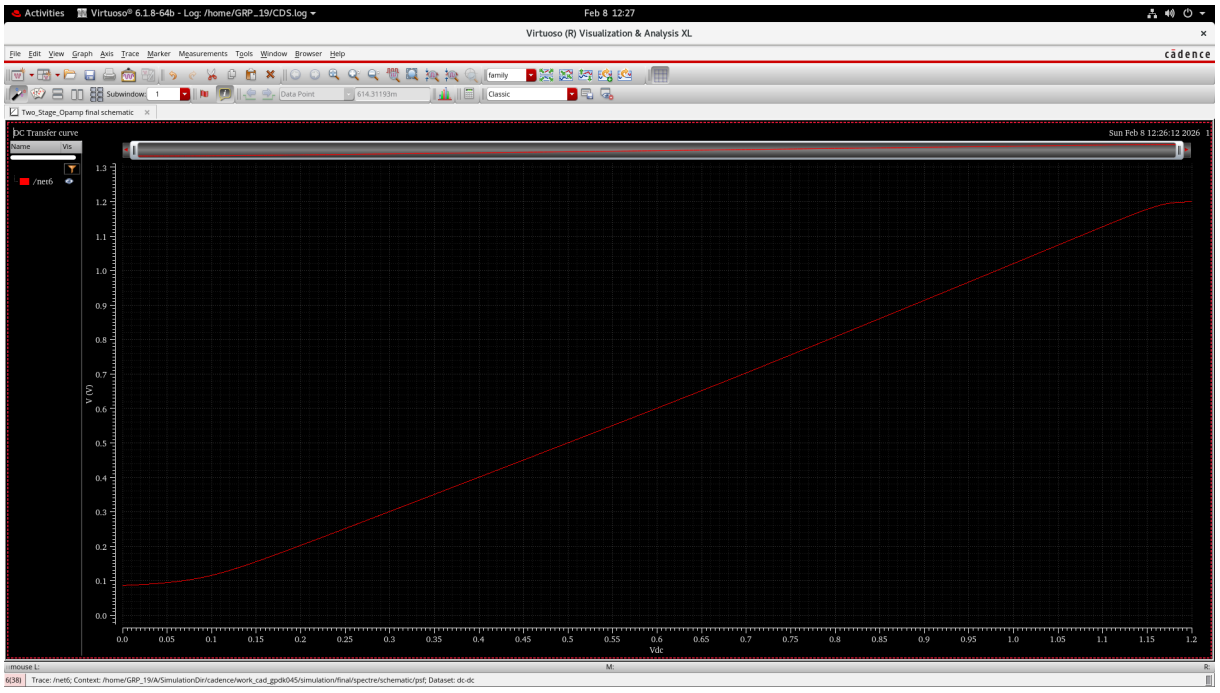

FIGURE 4: DC Transfer curve

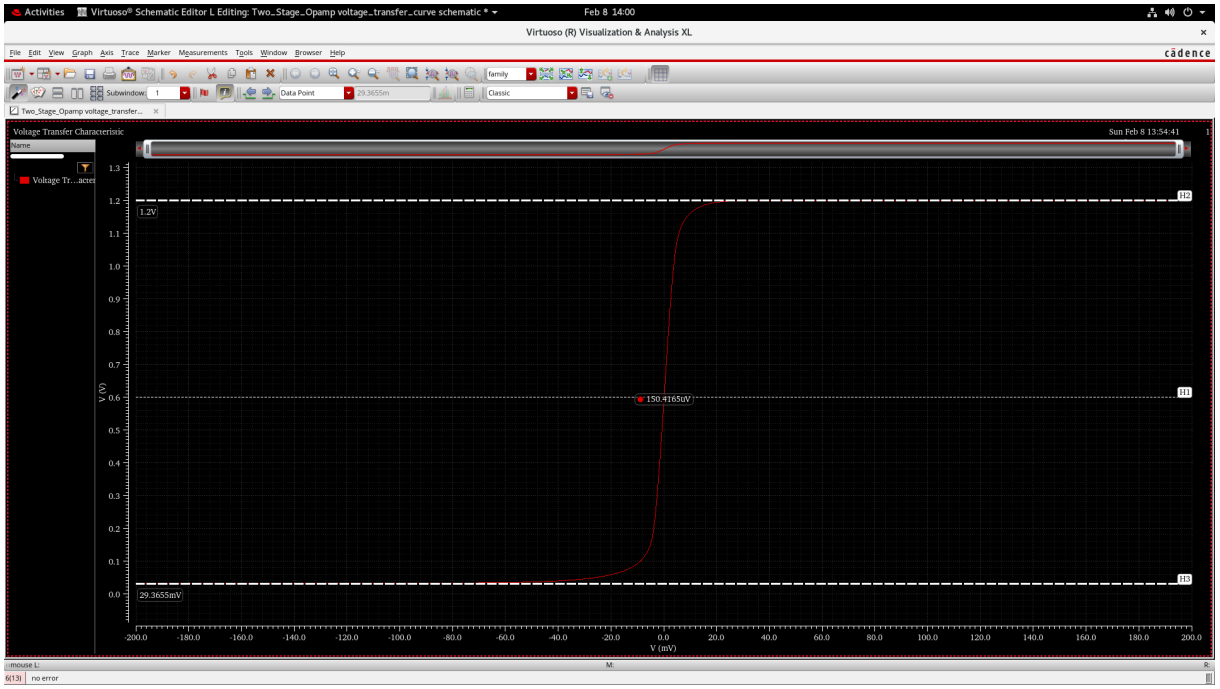

FIGURE 5: Voltage Transfer Characteristic

- Voffset = Vid at which Vout = Vdd/2 = 600m
- Voffset = **150.4165uV** ...from VTC
- Power dissipation = 1.2V x 389uA = **467.364 uW**

0.2 AC Testbench results

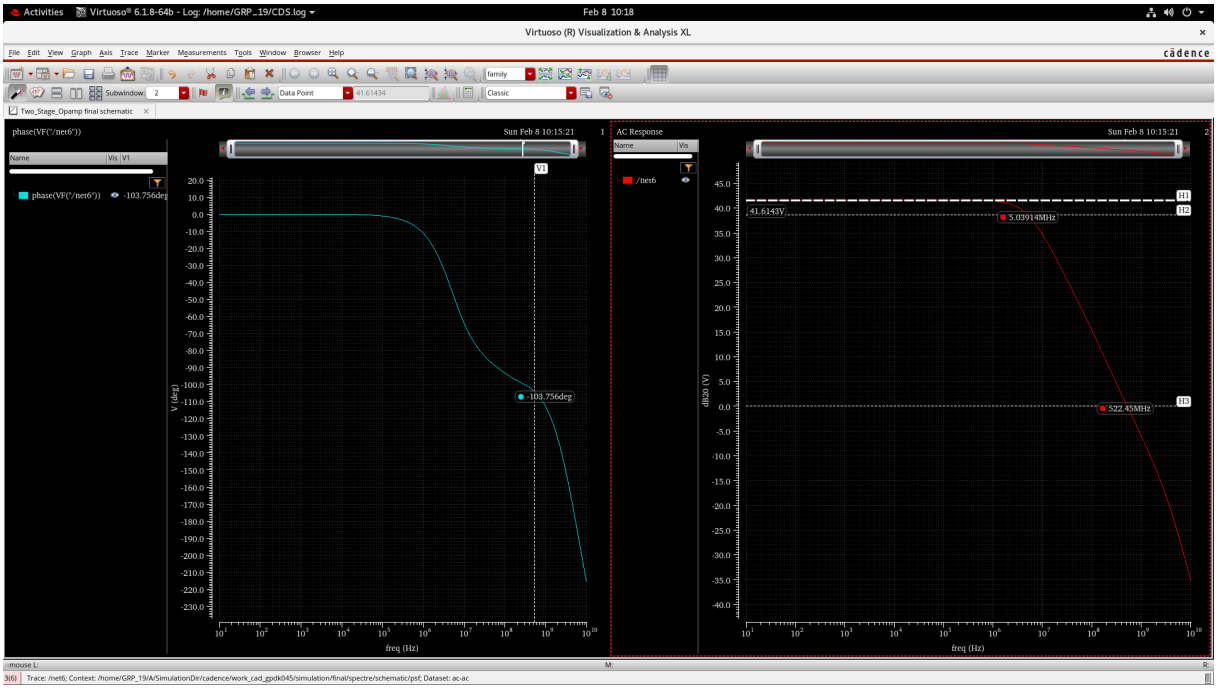

FIGURE 6: AC response of compensated opamp

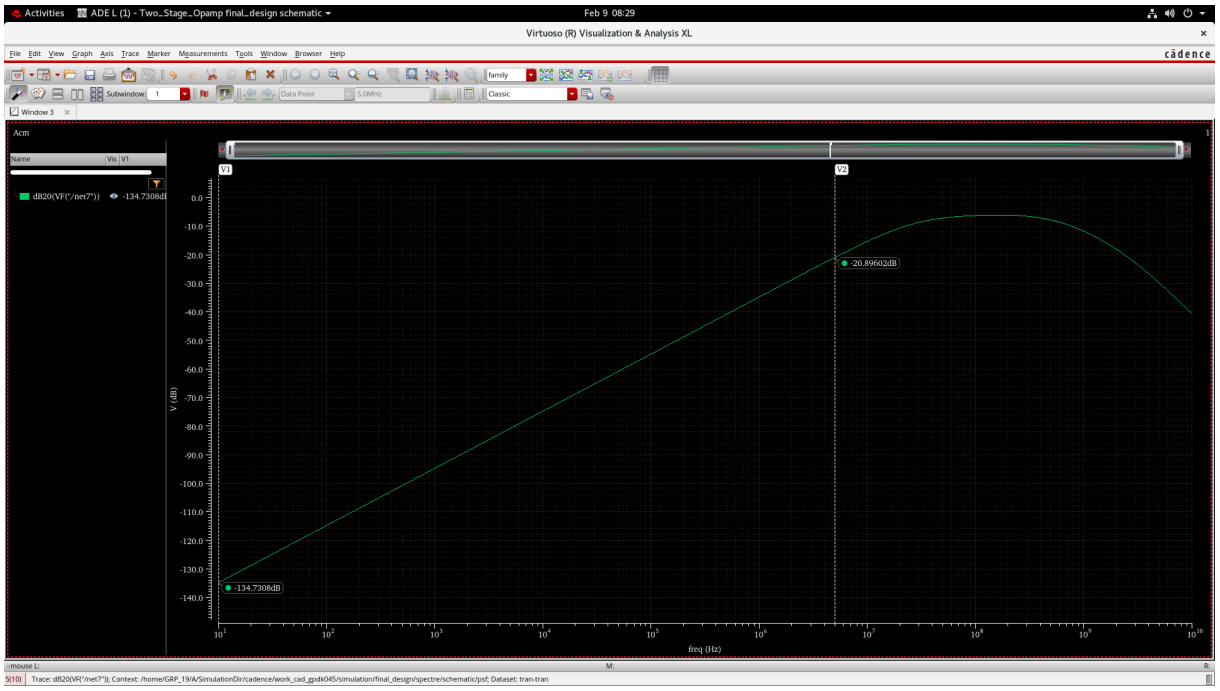

FIGURE 7: Common mode gain

- DC Voltage gain (Ao) = **41.6143dB**
- -3dB Bandwidth (f-3db) = **5.039MHz**
- Acm at 5MHz = -20.89602dB
- CMRR at 5MHz = Ad - Acm = 41.6143 - (-20.8960) = **62.5103 dB**
- Gain Bandwidth product (GBW) = **522.45MHz**
- Phasef0db = $-103.765°$
- Phase Margin = 180 - 95.58 = 76.235°

0.3 Transient Testbench analysis

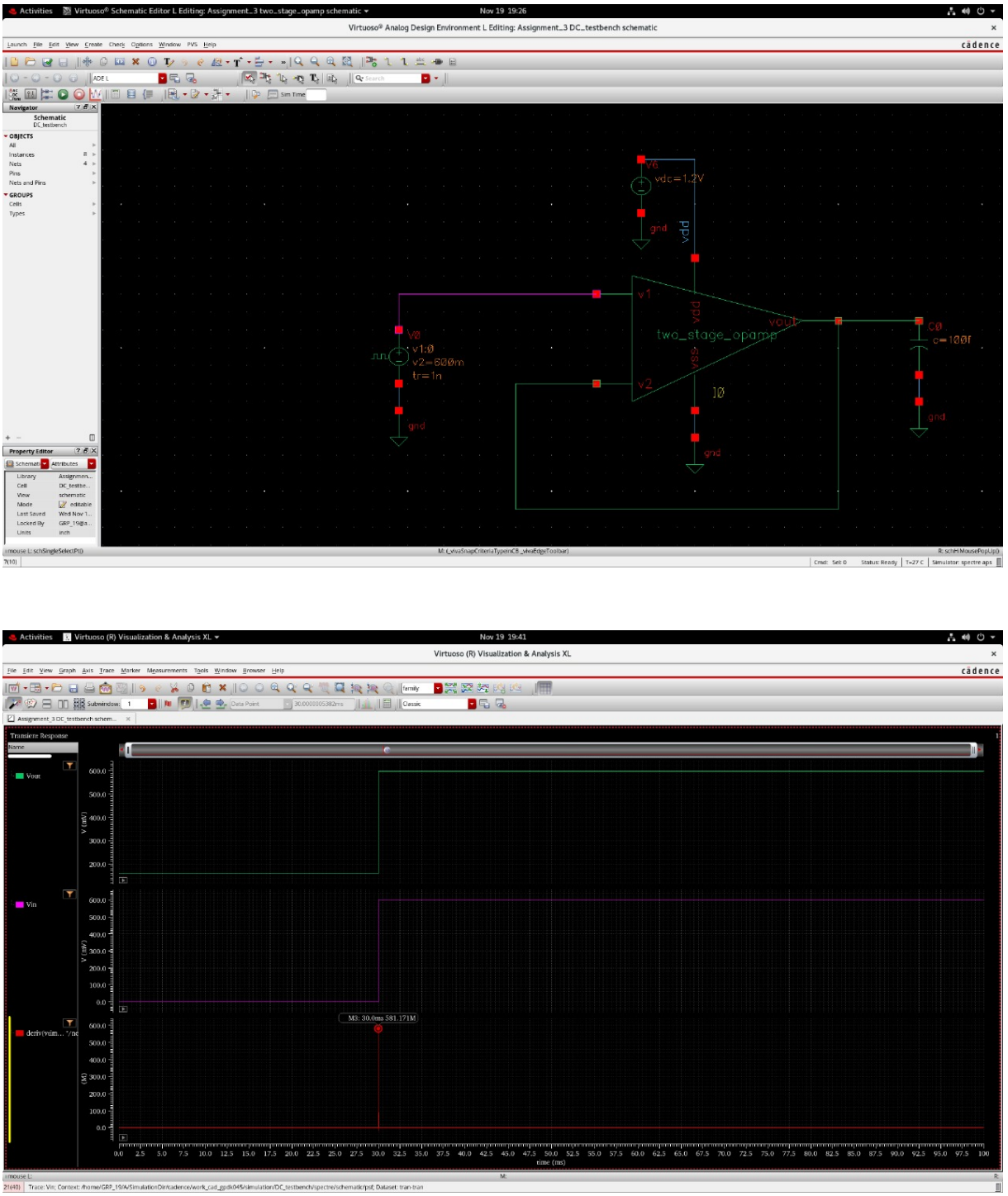

FIGURE 8: Positive step response of compensated opamp

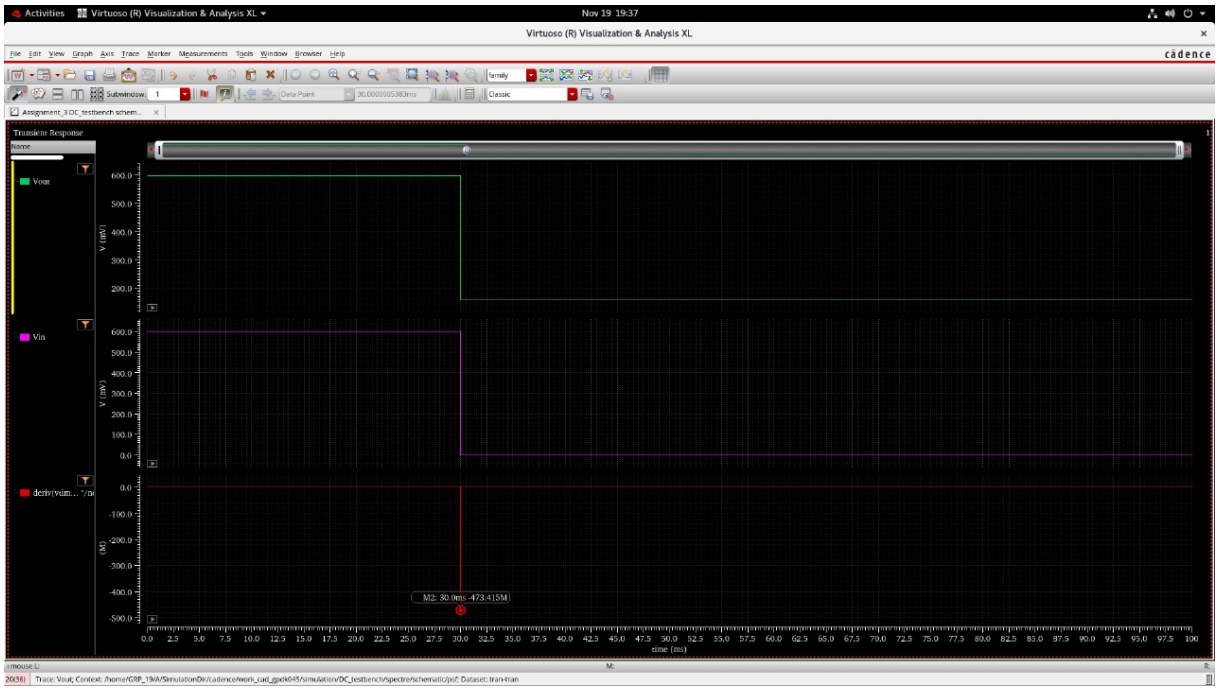

FIGURE 9: Negative step response of compensated opamp

- **SR+ = 581.171 V/us**
- **SR- = 473.415 V/us**

TABLE 2: Performance parameters of designed two stage op-amp @ [$V_{DD} = 1.2\ V$, $C_L = 100\ fF$, $T = 27°C$, $V_{ic} = 0.6\ V$].

S.N.	Parameter	Symbol	Value
1.	Open-loop, differential-mode, DC voltage gain	A_0	41.6143d
2.	Open-loop, –3 dB bandwidth (with frequency compensation)	f_{-3dB}	5.039 MH
3.	Unity-gain frequency or magnitude crossover frequency	f_T or f_{0dB}	522.45 MI
4.	Phase margin	PM	76.235°
5.	Low-frequency common-mode rejection ratio (10Hz to 5MHz)	$CMRR$	$>$ 61.51 d
6.	Power dissipation	P_{diss}	467.364 μ
7.	Input-referred offset voltage (systematic)	V_{offset}	150.4165 u
9.	Slew rate @ 600 mV step	SR^+ SR^-	581.171 $V/$ 473.415 $V/$