- **Calculation of gm:**

Project

Chandan Dwivedi

Roll no ; 22104027 (4N+3)

Given

I/p stage ; PMOS

$C_L = 20pf$

Loop gain (min) = 40dB

$V_{DD} = 1.8V$

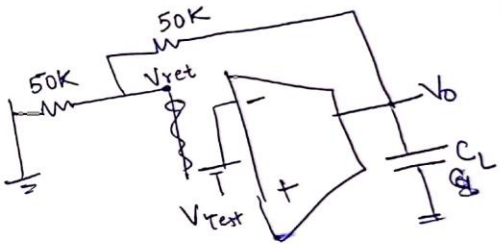
3 dB B.W of $\frac{V_o}{V_i}$ (min) = 25 MHz

CMRR = 80 dB

gm Calculation

$$\frac{0 \times 50 + V_o \times 50}{50 + 50} = V_{ret}$$

$$V_o = 2V_{ret}$$



KCL

$$\frac{V_o}{1/sC_L} + \frac{V_o - V_{ret}}{50} + g_m V_{test} = 0$$

$$2V_{ret} \cdot sC_L + \frac{V_{ret}}{50} = -g_m V_{test}$$

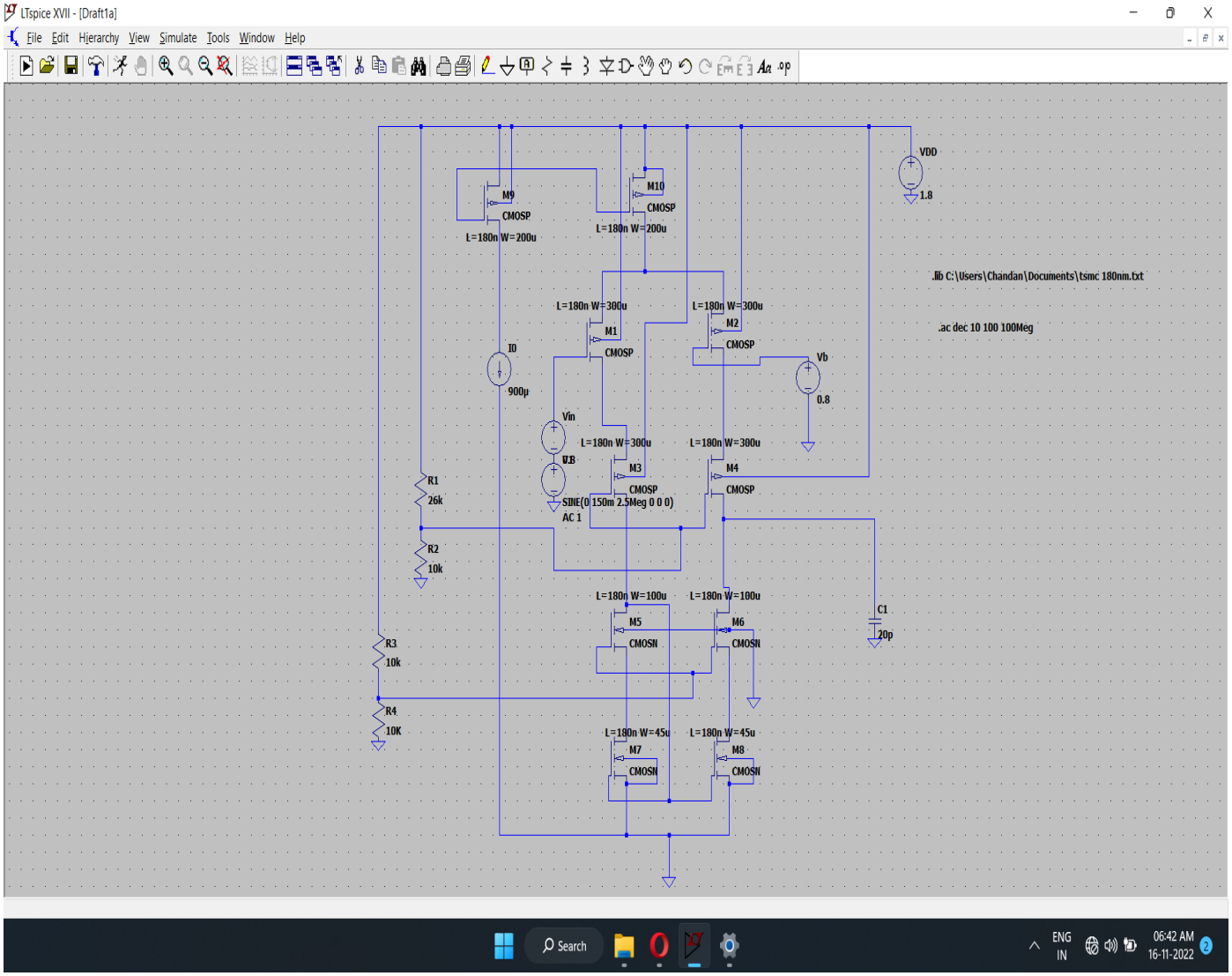
$$1(s) = -\frac{V_{ret}}{V_{test}} = \frac{g_m}{2sC_L + 1/50}$$

$$\omega_{u,loop} = \frac{g_m}{2C_L} \Rightarrow g_m = \omega_{u,loop} \times 2C_L \times (2\pi)$$

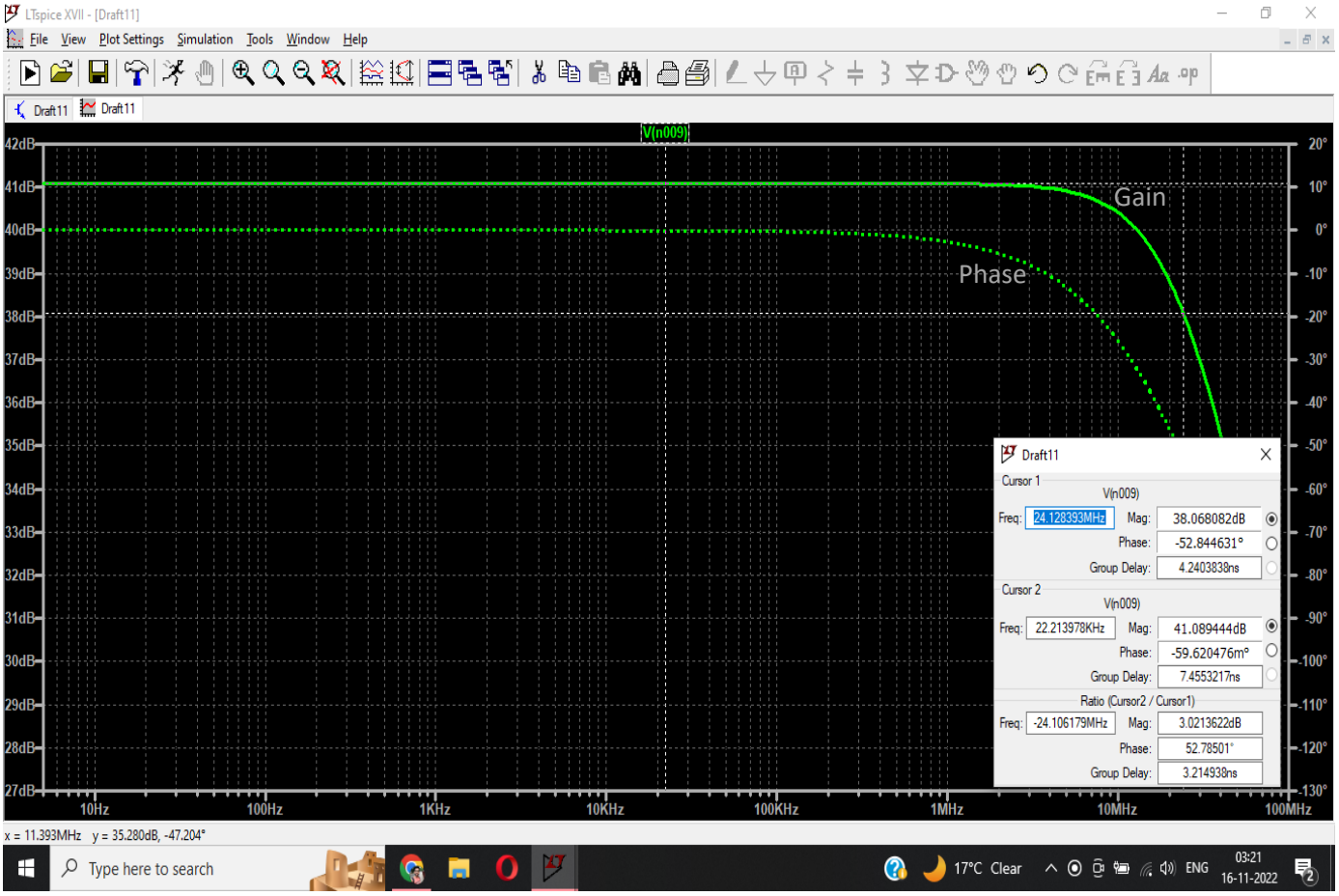
$$= 25MHz \times 2 \times 20p$$

$$g_m = 6.28mS$$

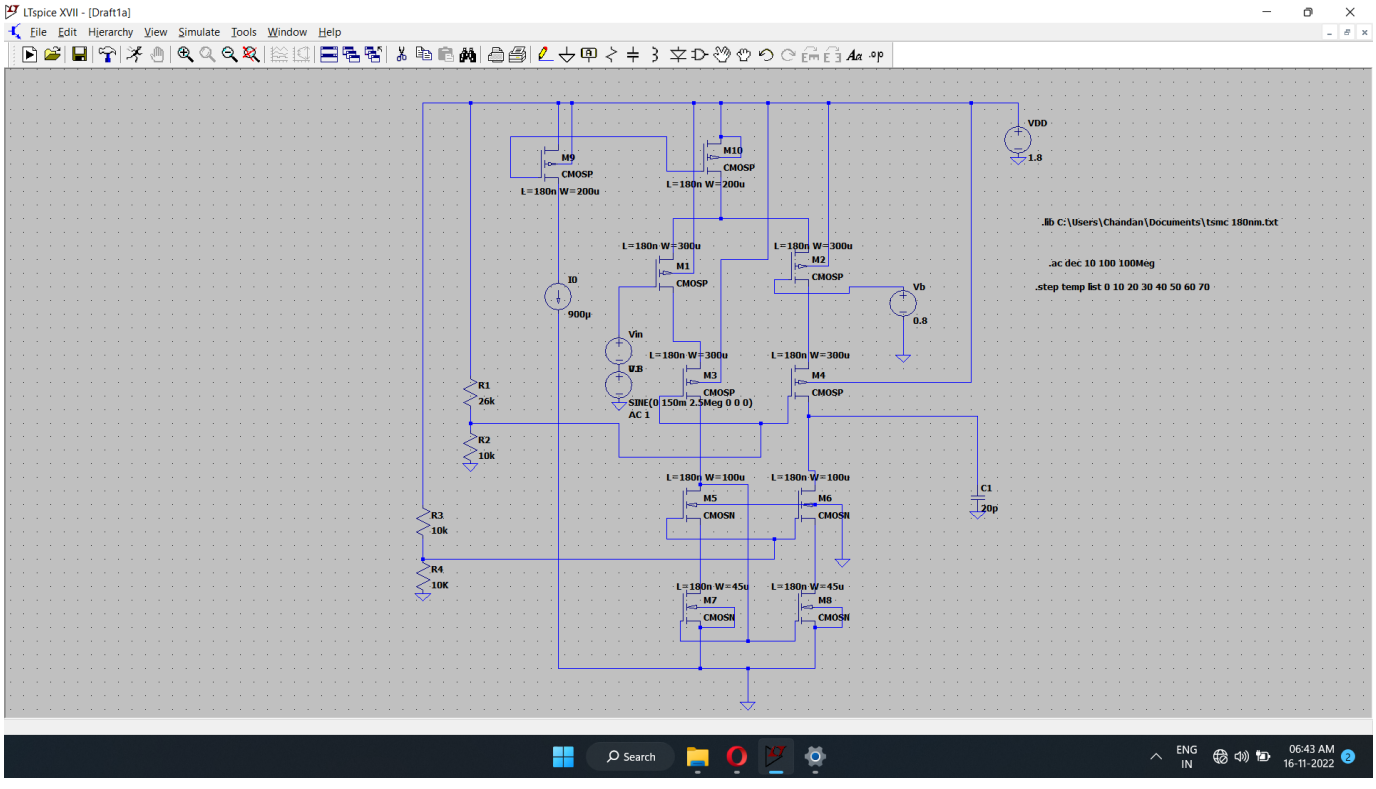
- **Open Loop schematic:**

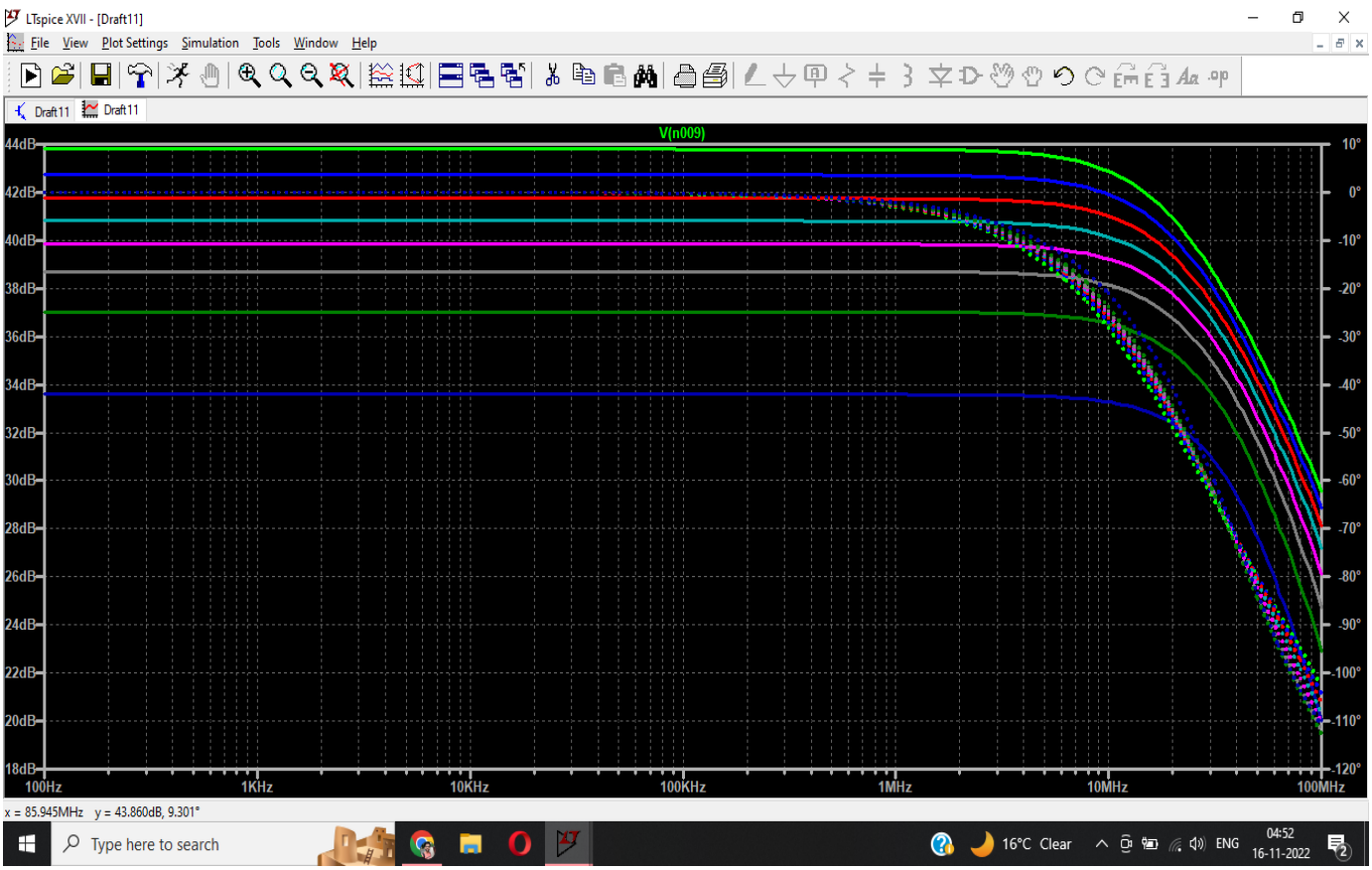


- **Open Loop gain and phase plot:**

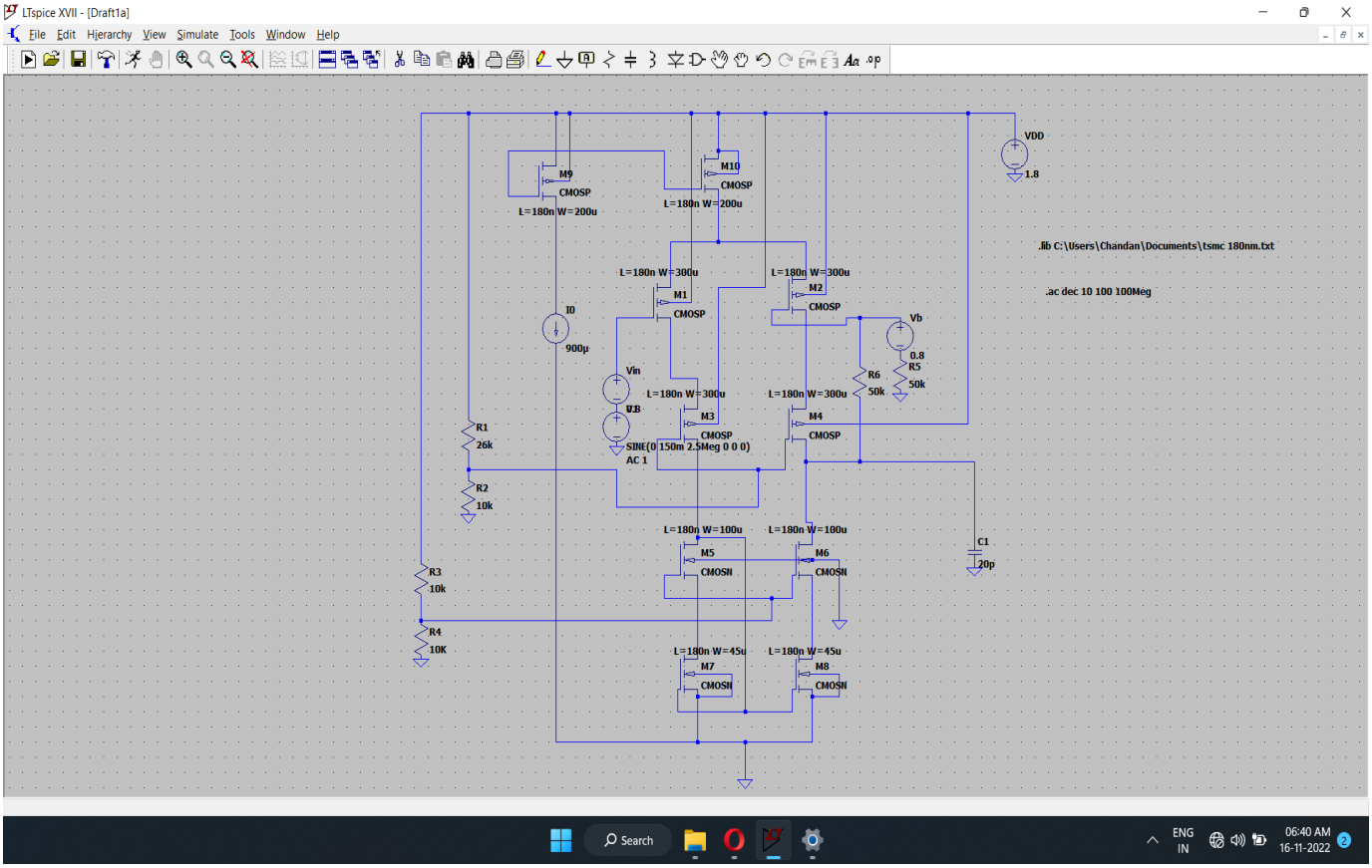


- **Variation of open loop phase and gain w.r.t temperature from 10°C to 70 °C:**

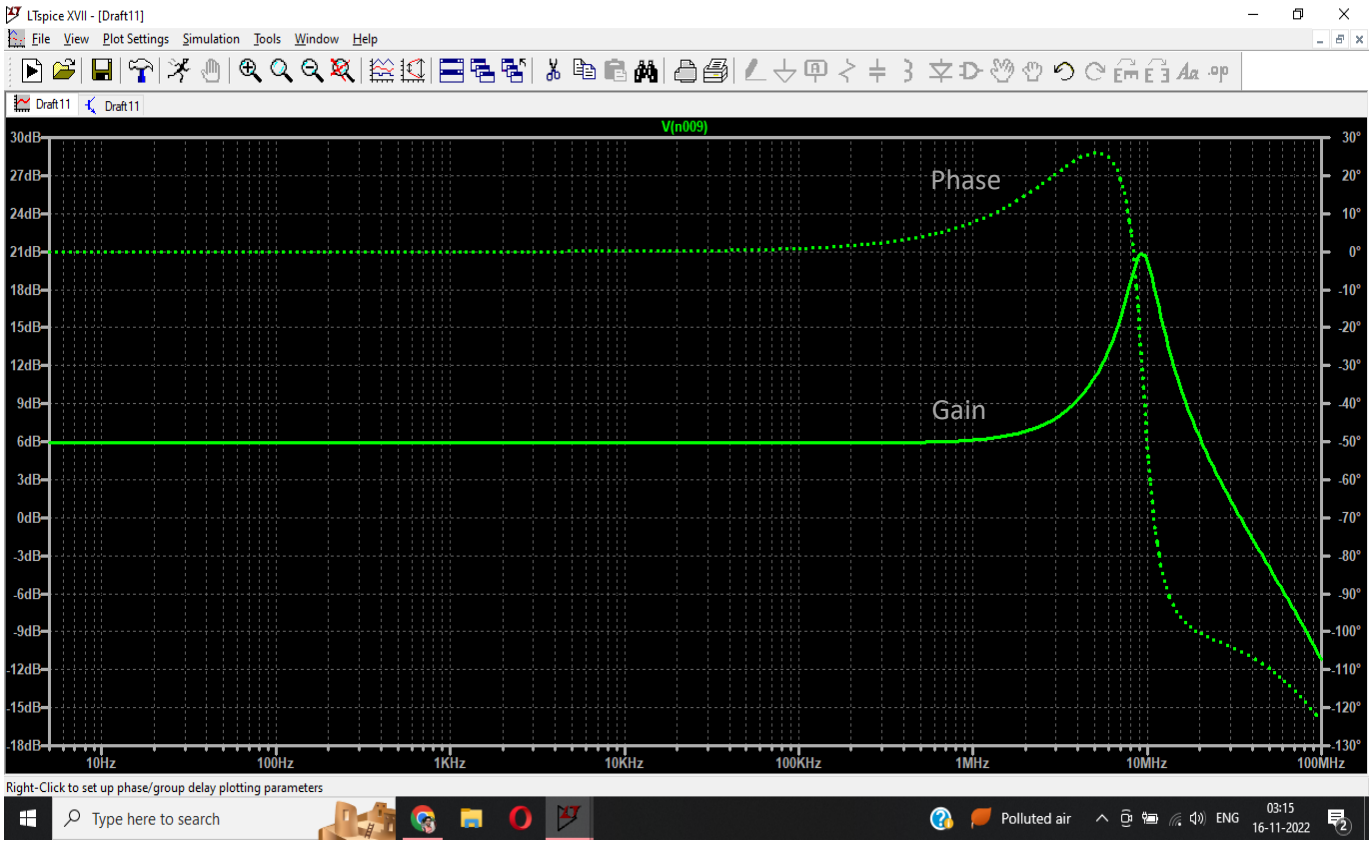




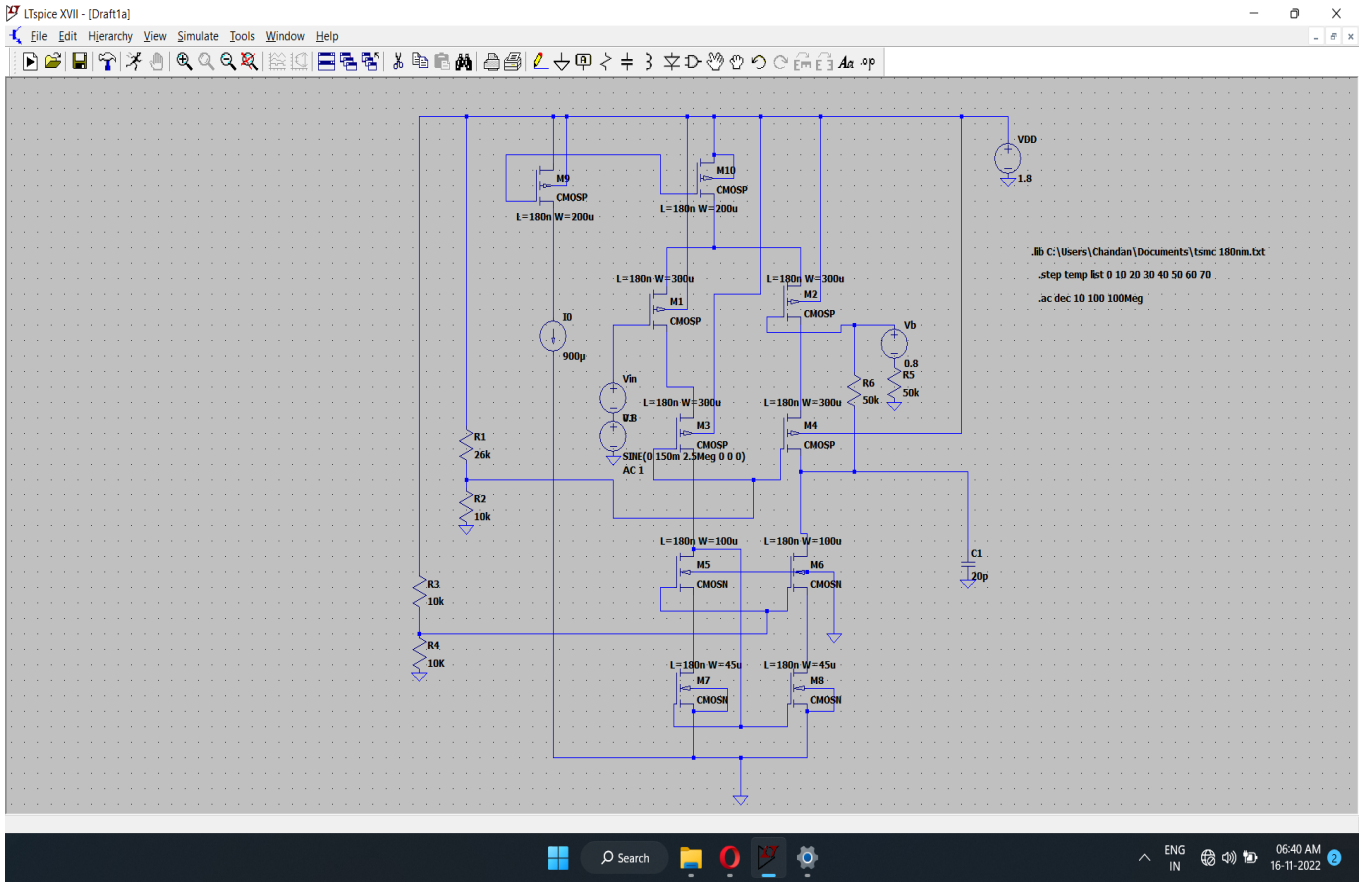
- **Closed loop schematic:**

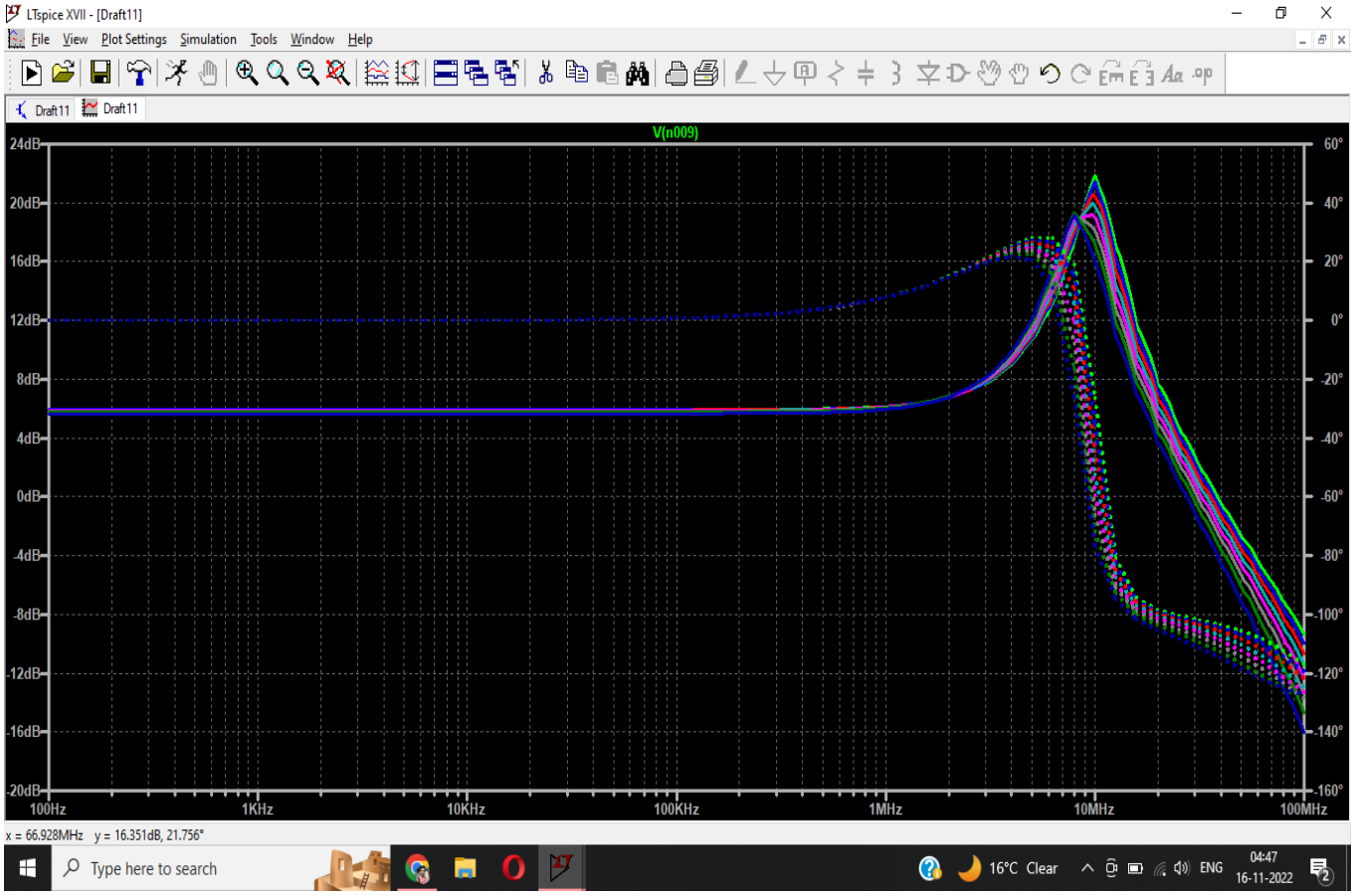


- **Closed loop gain and phase plot:**

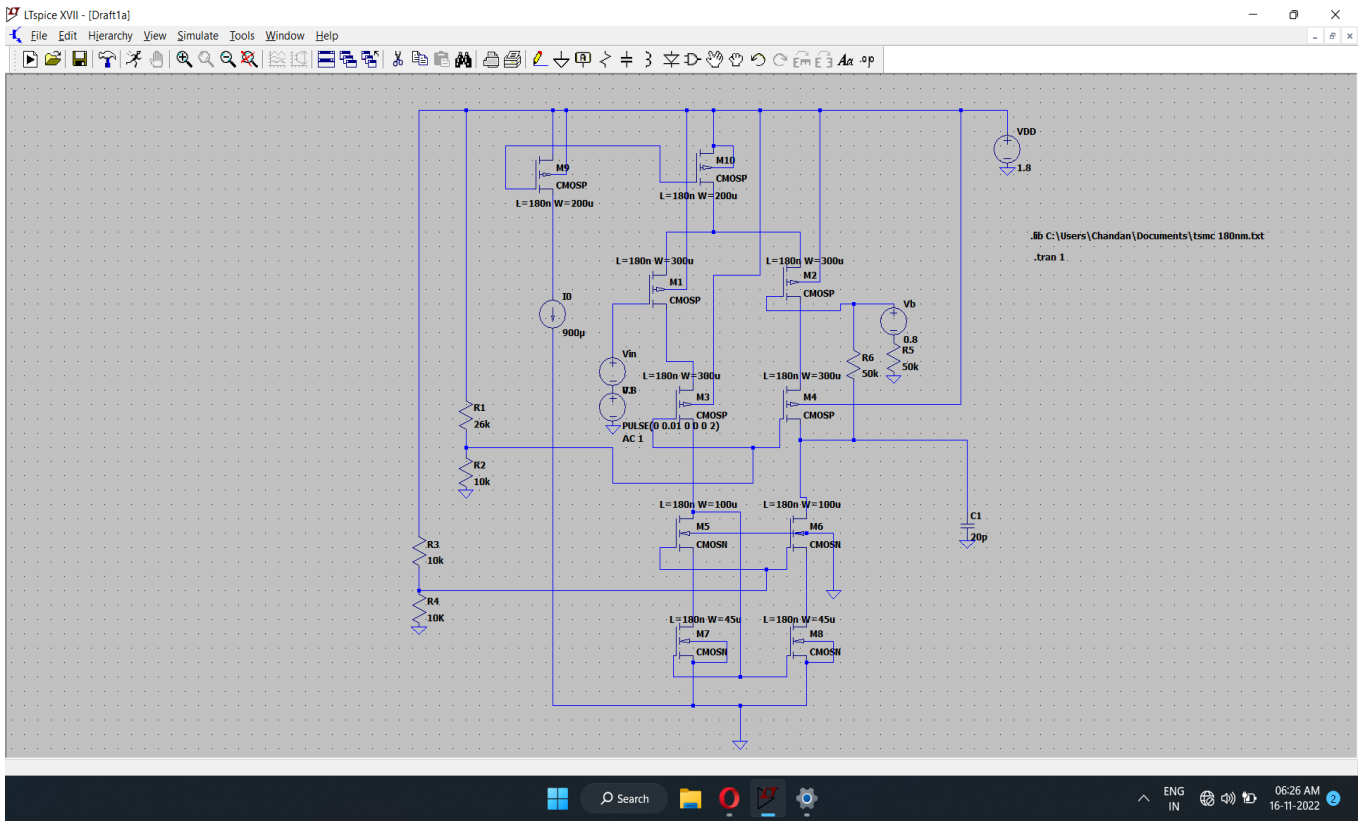


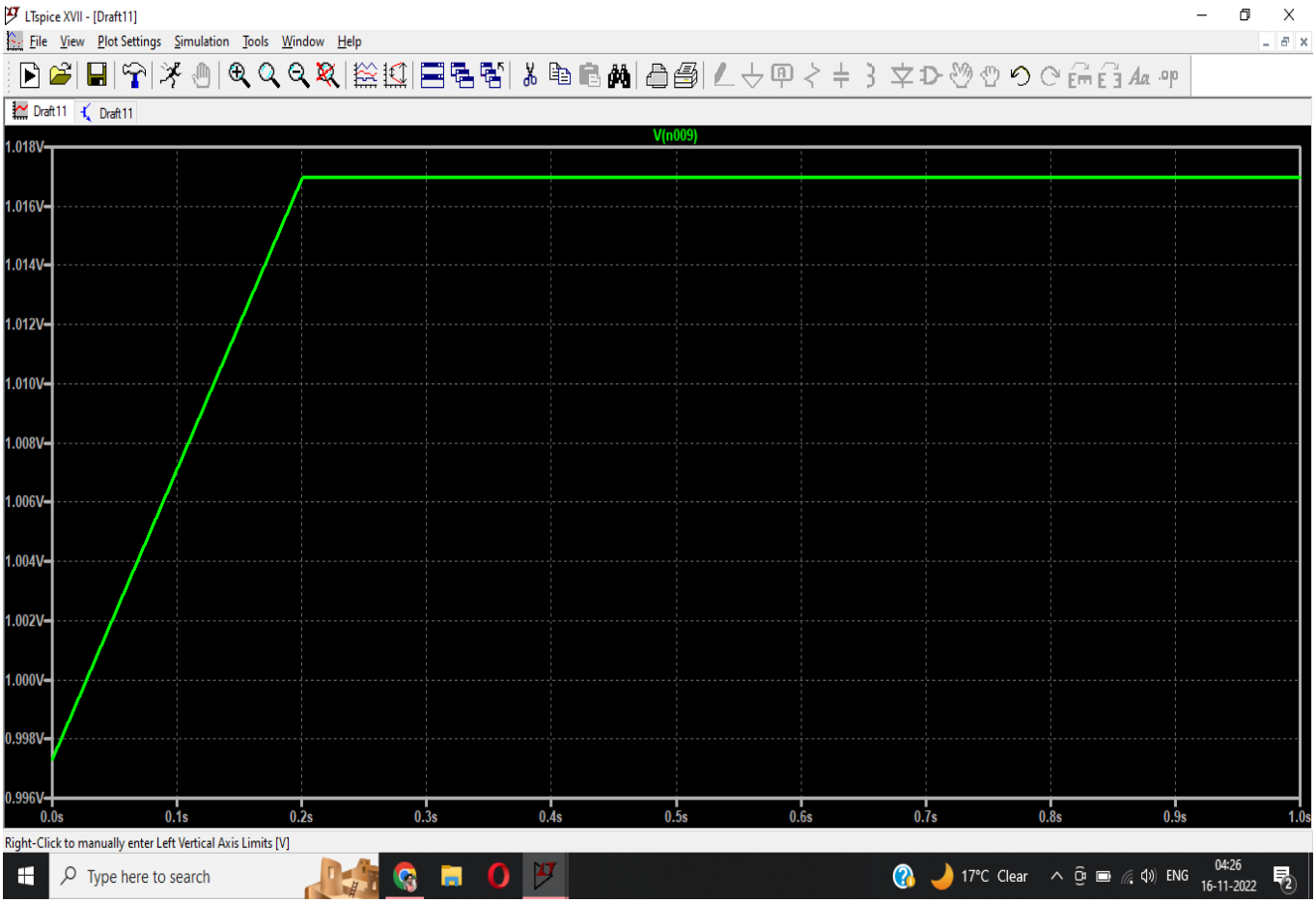
- **Variation of closed loop phase and gain w.r.t temperature from 10°C to 70 °C:**



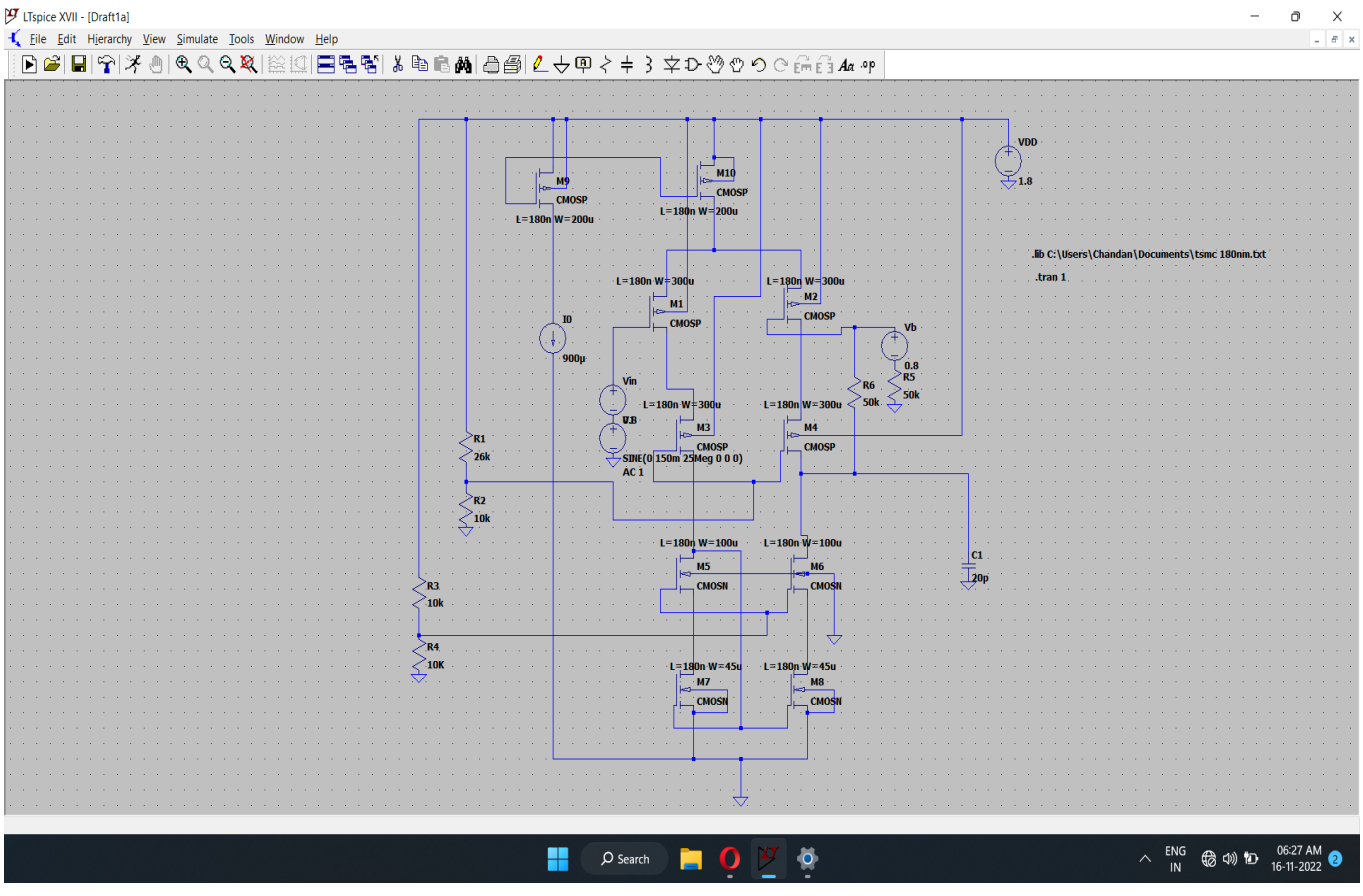


- **TRANSIENT ANALYSIS FOR STEP INPUT:**

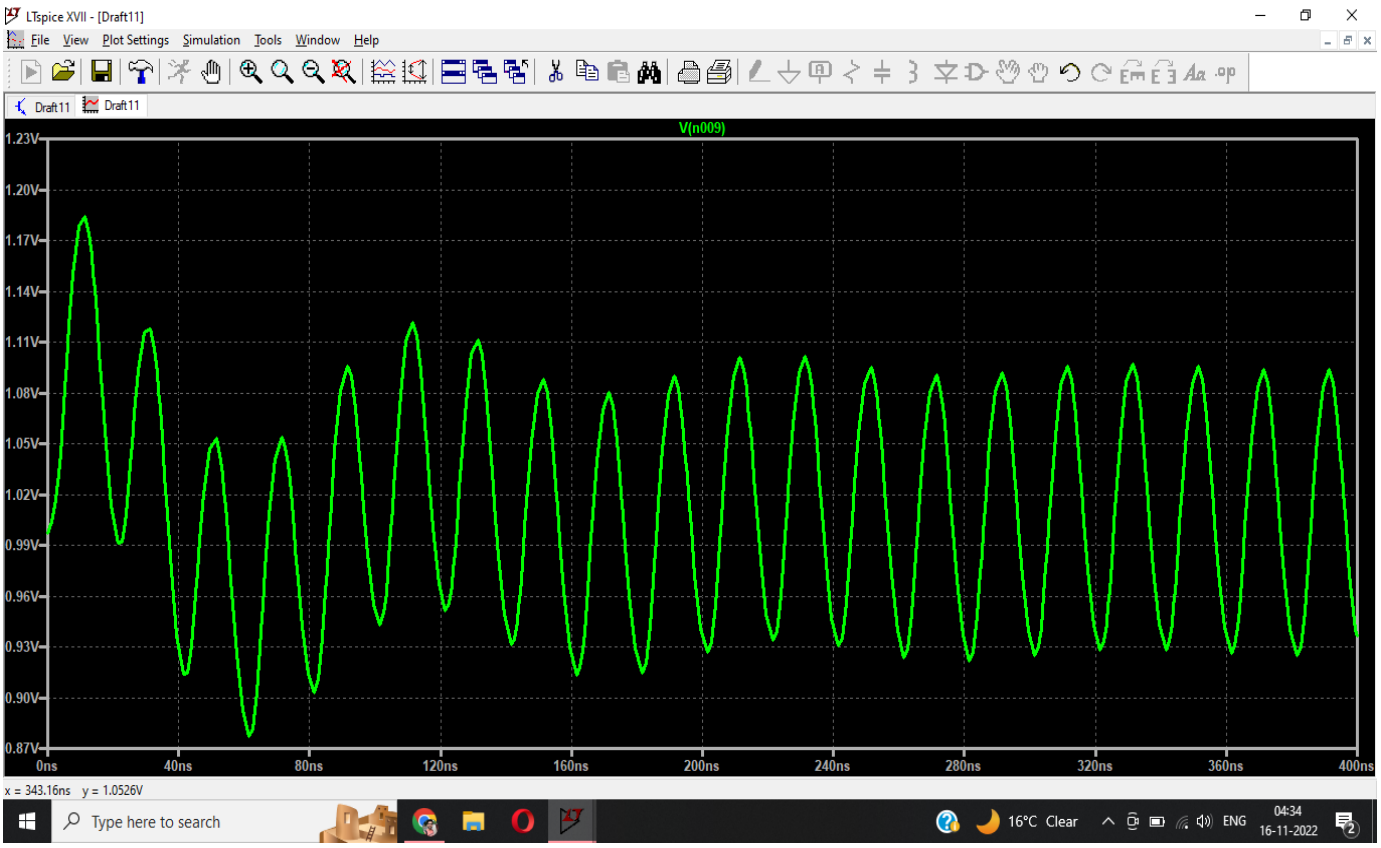




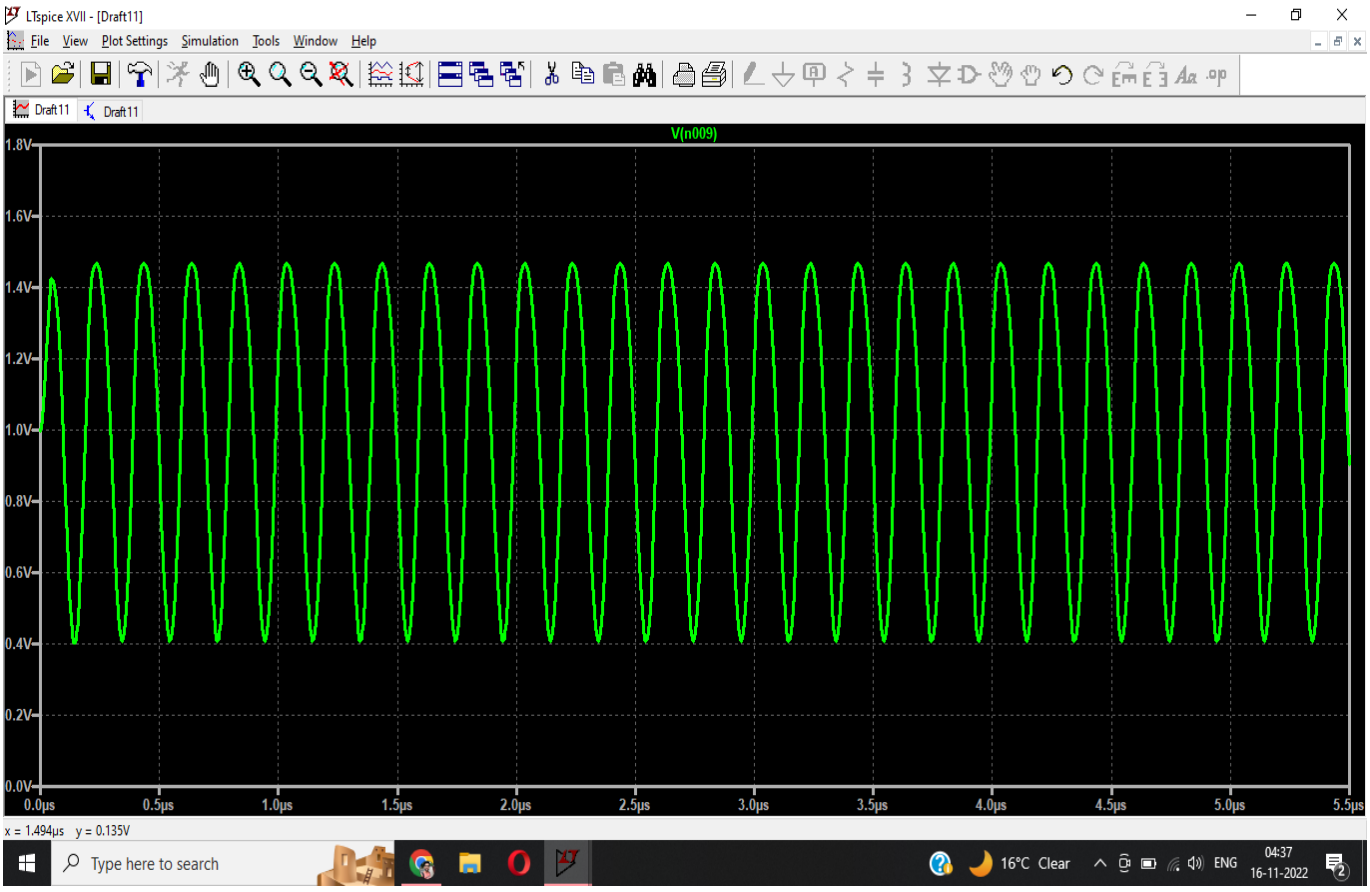
- **TRANSIENT ANALYSIS FOR SINUSOIDAL INPUT:**



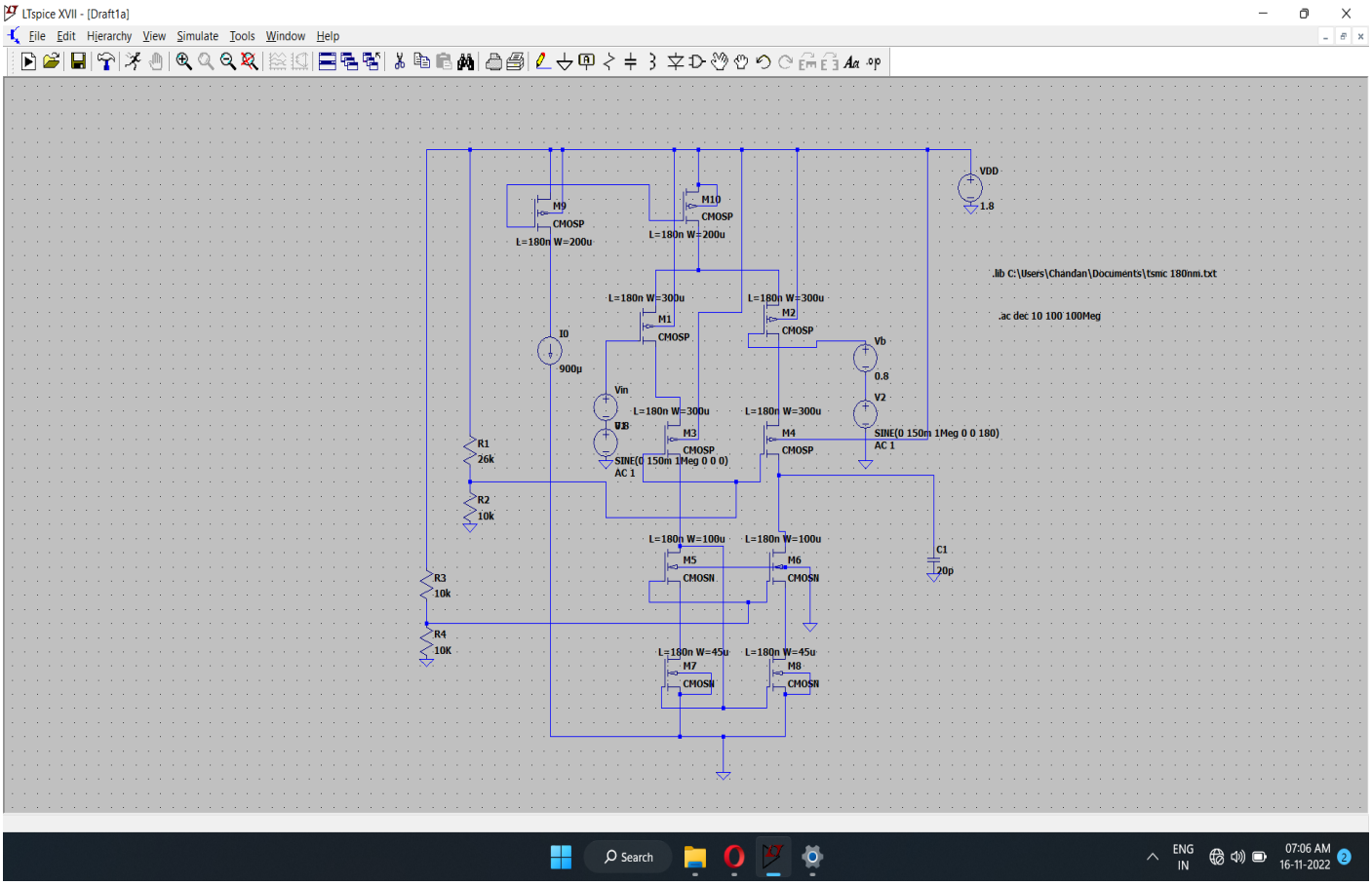
- **TRANSIENT RESPONSE FOR WHEN w= w3db :**

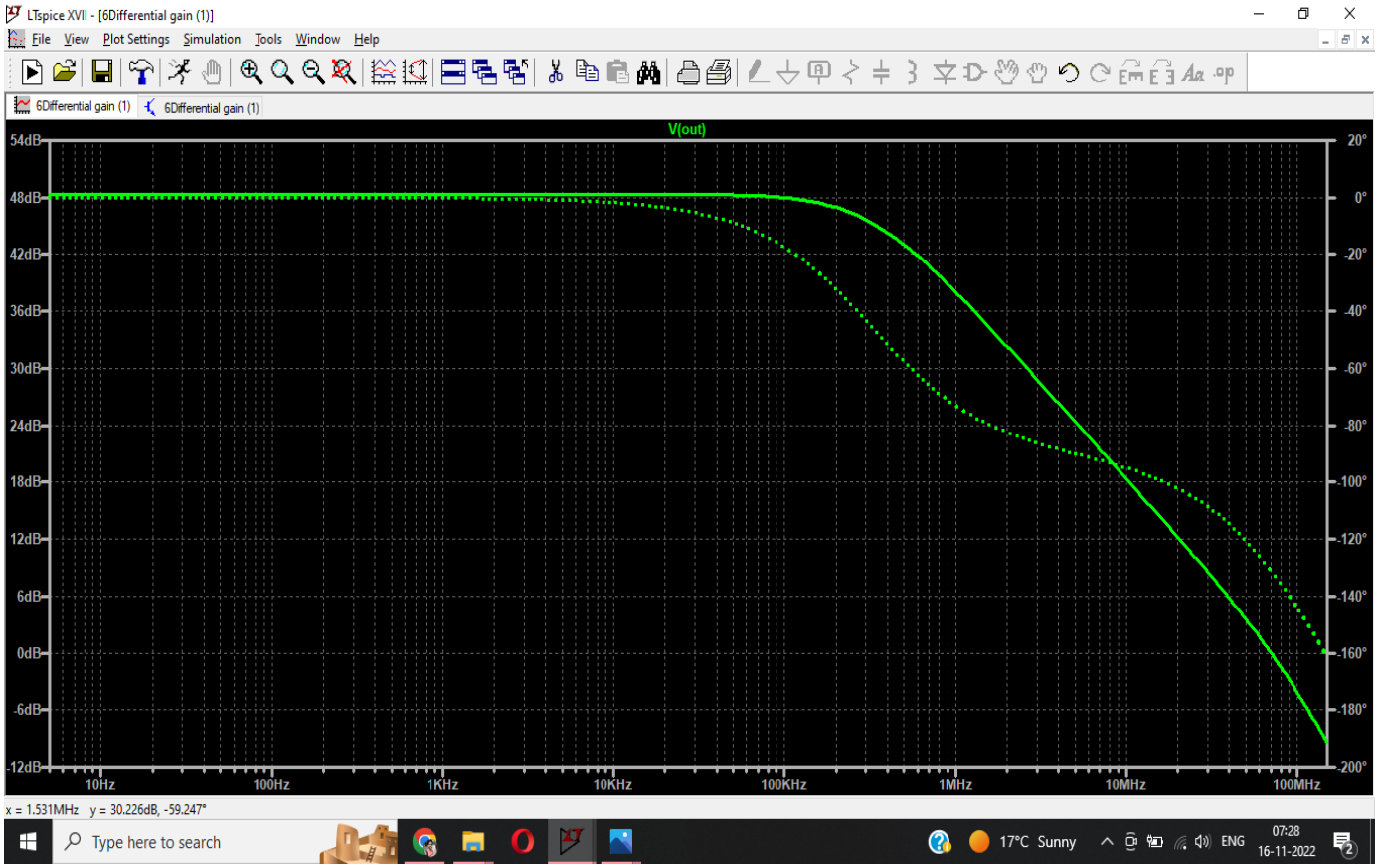


- **TRANSIENT RESPONSE FOR WHEN w= w3db /10:**

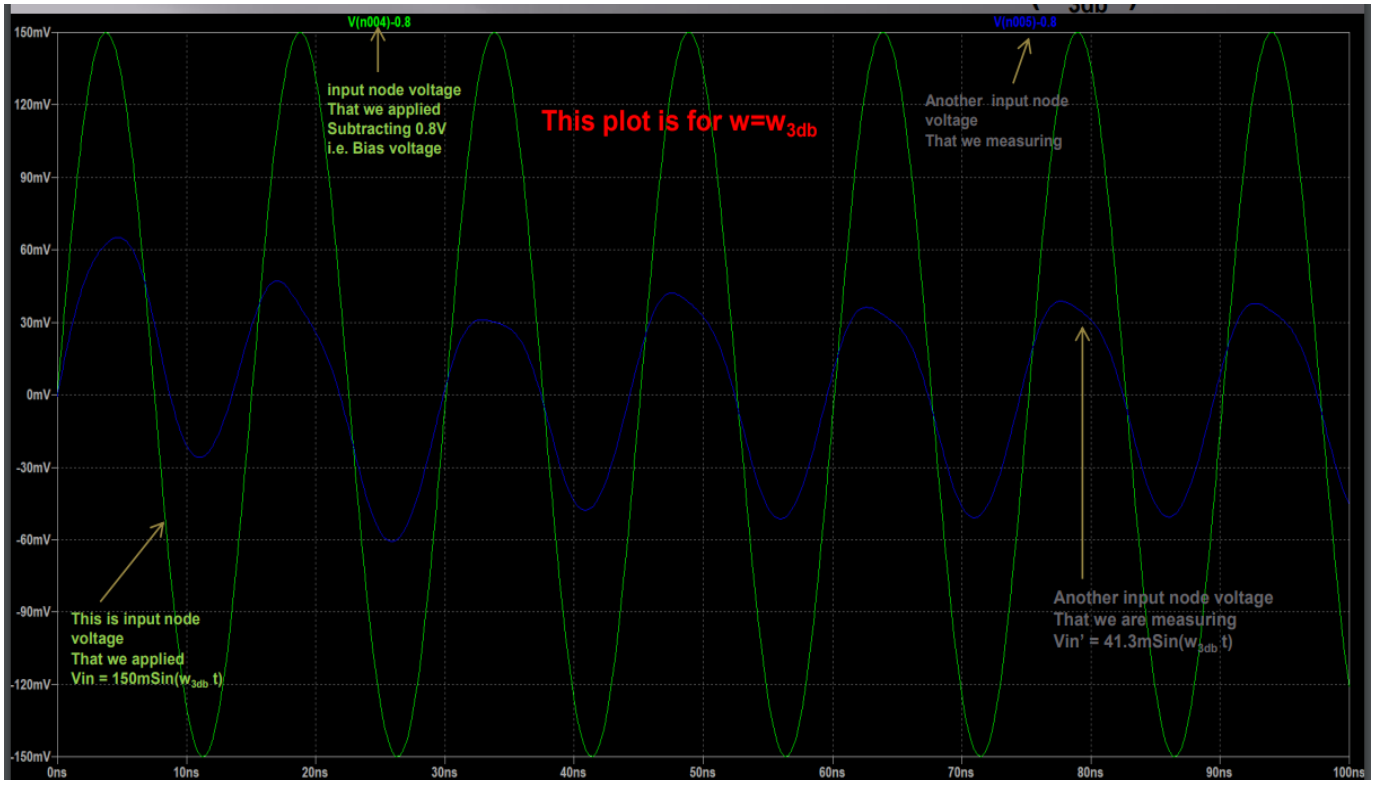


- **SCHEMETIC FOR DIFFERENTIAL MODE GAIN:**

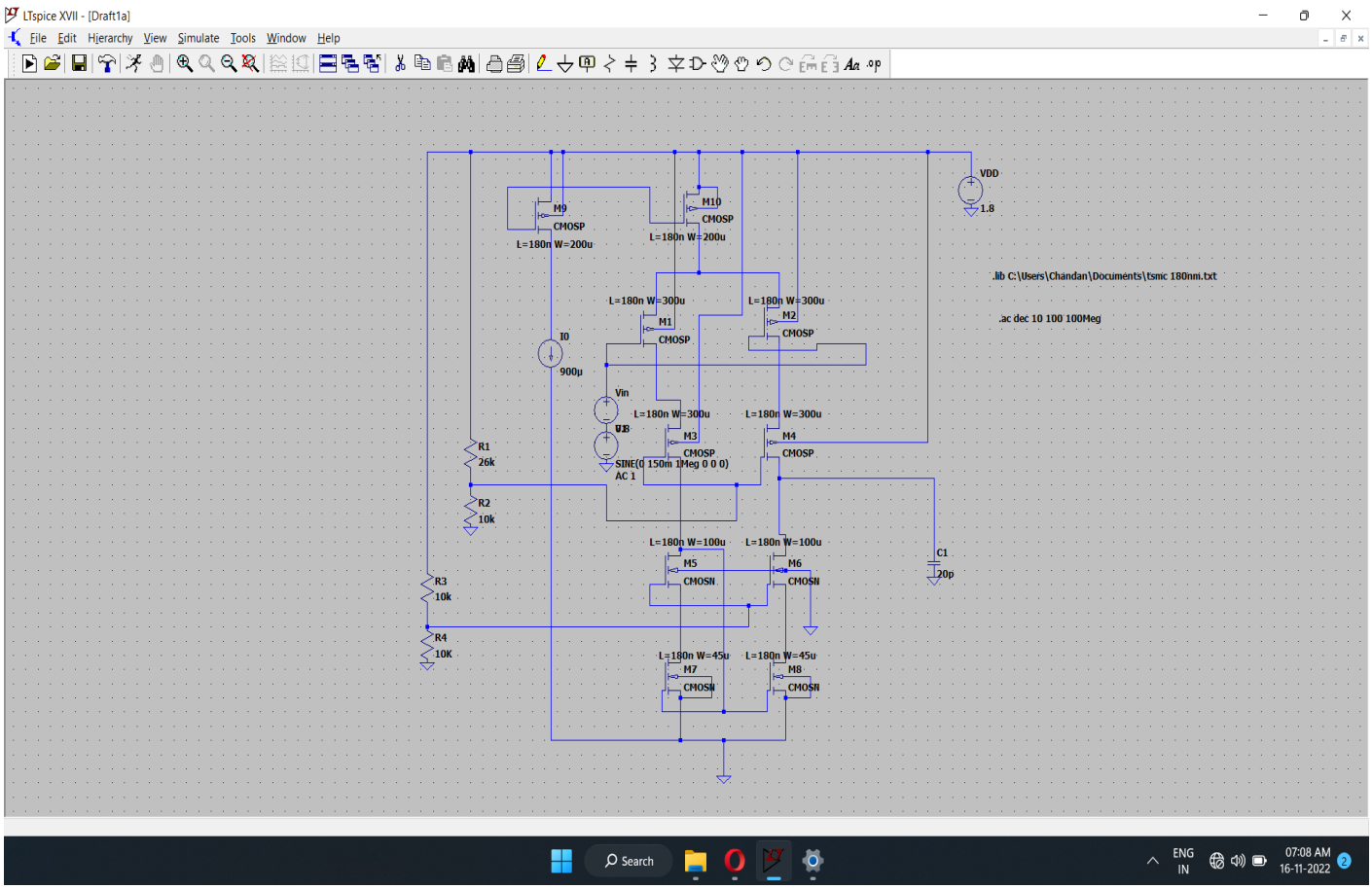


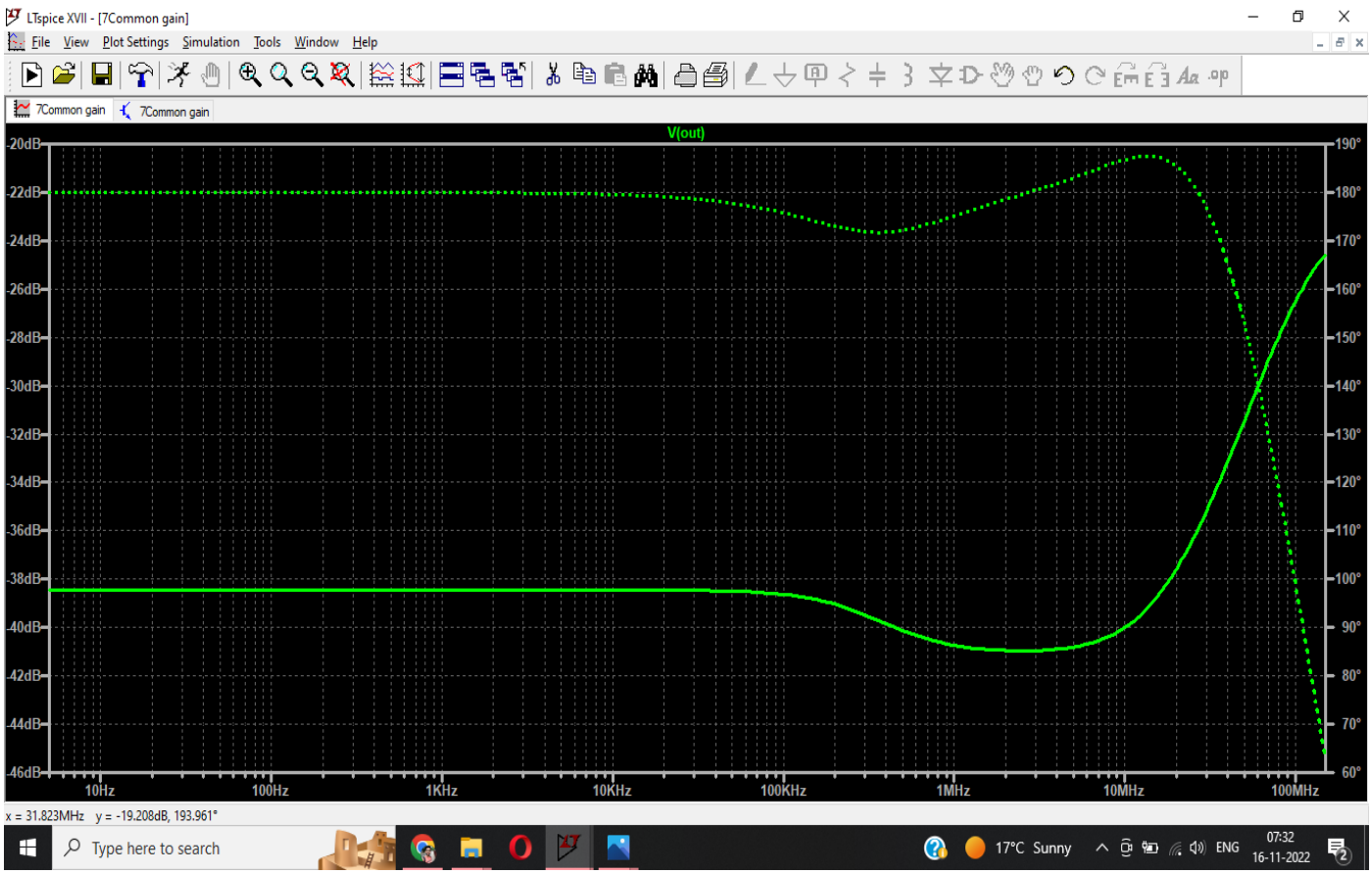


- **DIFFERENCE IN INPUT NODE VOLTAGES WHEN Vi= 150mSin(w3db t):**



- **SCHEMETIC FOR COMMON MODE GAIN:**





Calculation of CMRR

- CMRR of a differential amplifier is a metric used to quantify the ability of the device to reject common mode signals

$$CMRR = \frac{A_d}{A_{CM}}$$

$$(CMRR)_{dB} = 20\log_{10}\left|\frac{A_d}{A_{CM}}\right| = 20\log|A_d| - 20\log|A_{CM}|$$

$$CMRR = 49 - (-38.4)$$

$$\boxed{CMRR \simeq 87.4\ dB}$$

- **ICMR:**
  - It is the range of input common mode voltage for which all transistor work in saturation.
  - For calculation of ICMR- = (Vcm)min = 0.47 simulation result.
  - For calculation of ICMR+ = (Vcm)max = 0.89 simulation result.

- **Table form gm, gds, cgs, cgd, Vov for all transistors:**

Name:	m7	m8	m5	m6	m3	m4	m2	m1
Model:	cmosn	cmosn	cmosn	cmosn	cmosp	cmosp	cmosp	cmosp
Id:	4.50e-04	4.50e-04	4.50e-04	4.50e-04	4.50e-04	4.50e-04	4.50e-04	4.50e-04
Vgs:	5.47e-01	5.47e-01	6.22e-01	6.22e-01	-4.74e-02	-4.74e-02	-2.64e-01	-2.64e-01
Vds:	2.78e-01	2.78e-01	2.69e-01	2.69e-01	7.17e-01	7.17e-01	3.93e-01	3.93e-01
Vbs:	0.00e+00	0.00e+00	-2.78e-01	-2.78e-01	1.25e+00	1.25e+00	5.36e-01	5.36e-01
Vth:	4.09e-01	4.09e-01	4.91e-01	4.91e-01	-5.73e-01	-5.73e-01	-4.64e-01	-4.64e-01
Vdsat:	1.14e-01	1.14e-01	1.17e-01	1.17e-01	-1.71e-01	-1.71e-01	-1.63e-01	-1.63e-01
Gm:	6.03e-03	6.03e-03	6.11e-03	6.11e-03	4.28e-03	4.28e-03	4.33e-03	4.33e-03
Gds:	8.19e-05	8.19e-05	8.83e-05	8.83e-05	3.67e-05	3.67e-05	5.07e-05	5.07e-05
Gmb	1.71e-03	1.71e-03	1.55e-03	1.55e-03	1.14e-03	1.14e-03	1.29e-03	1.29e-03
Cbd:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cbs:	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cgsov:	1.65e-13	1.65e-13	1.65e-13	1.65e-13	2.54e-13	2.54e-13	2.54e-13	2.54e-13
Cgdov:	1.65e-13	1.65e-13	1.65e-13	1.65e-13	2.54e-13	2.54e-13	2.54e-13	2.54e-13
Cgbov:	9.66e-19	9.66e-19	9.66e-19	9.66e-19	9.41e-19	9.41e-19	9.41e-19	9.41e-19
dQgdVgb:	1.67e-12	1.67e-12	1.65e-12	1.65e-12	3.08e-12	3.08e-12	3.11e-12	3.11e-12
dQgdVdb:	-1.65e-13	-1.65e-13	-1.65e-13	-1.65e-13	-2.48e-13	-2.48e-13	-2.53e-13	-2.53e-13
dQgdVsb:	-1.42e-12	-1.42e-12	-1.40e-12	-1.40e-12	-2.78e-12	-2.78e-12	-2.79e-12	-2.79e-12
dQddVgb:	-7.01e-13	-7.01e-13	-7.01e-13	-7.01e-13	-1.31e-12	-1.31e-12	-1.31e-12	-1.31e-12
dQddVdb:	1.66e-13	1.66e-13	1.67e-13	1.67e-13	2.51e-13	2.51e-13	2.55e-13	2.55e-13
dQddVsb:	7.06e-13	7.06e-13	6.83e-13	6.83e-13	1.33e-12	1.33e-12	1.37e-12	1.37e-12
dQbdVgb:	-2.69e-13	-2.69e-13	-2.51e-13	-2.51e-13	-4.64e-13	-4.64e-13	-4.91e-13	-4.91e-13
dQbdVdb:	-3.43e-15	-3.43e-15	-3.49e-15	-3.49e-15	-8.56e-17	-8.56e-17	-3.72e-15	-3.72e-15
dQbdVsb:	-1.59e-13	-1.59e-13	-1.26e-13	-1.26e-13	-1.44e-13	-1.44e-13	-2.16e-13	-2.16e-13