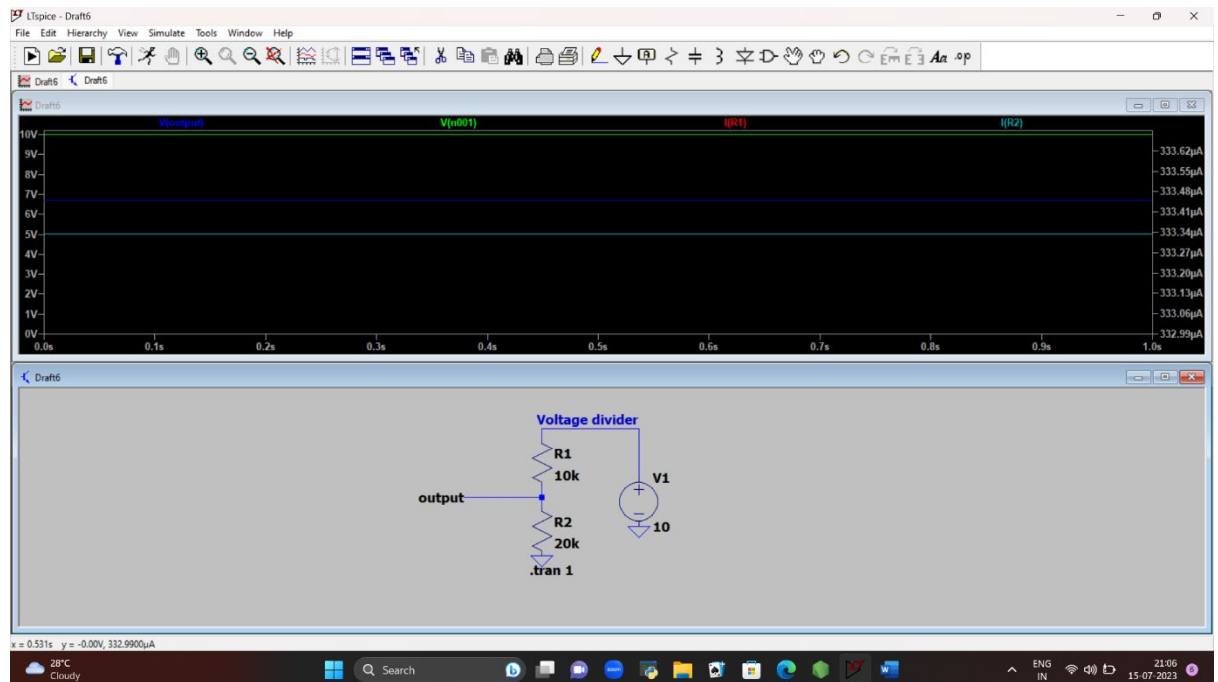# Simulations Using LT Spice :

1. Voltage Divider
   Voltage divider, a fundamental circuit that finds widespread use in electronics, here I had explored its behaviour and performance using LT Spice simulation.
   We use 2 resistors connected in series with a voltage of 10V.



Transient Simulation for Voltage Divider

Power Dissipation in each resistor:
   Total current flowing = V/(R1+R2)
                 I = 0.333mAmp

   Power Dissipated in R1 = $I^2R1$
                 = 1.10mW
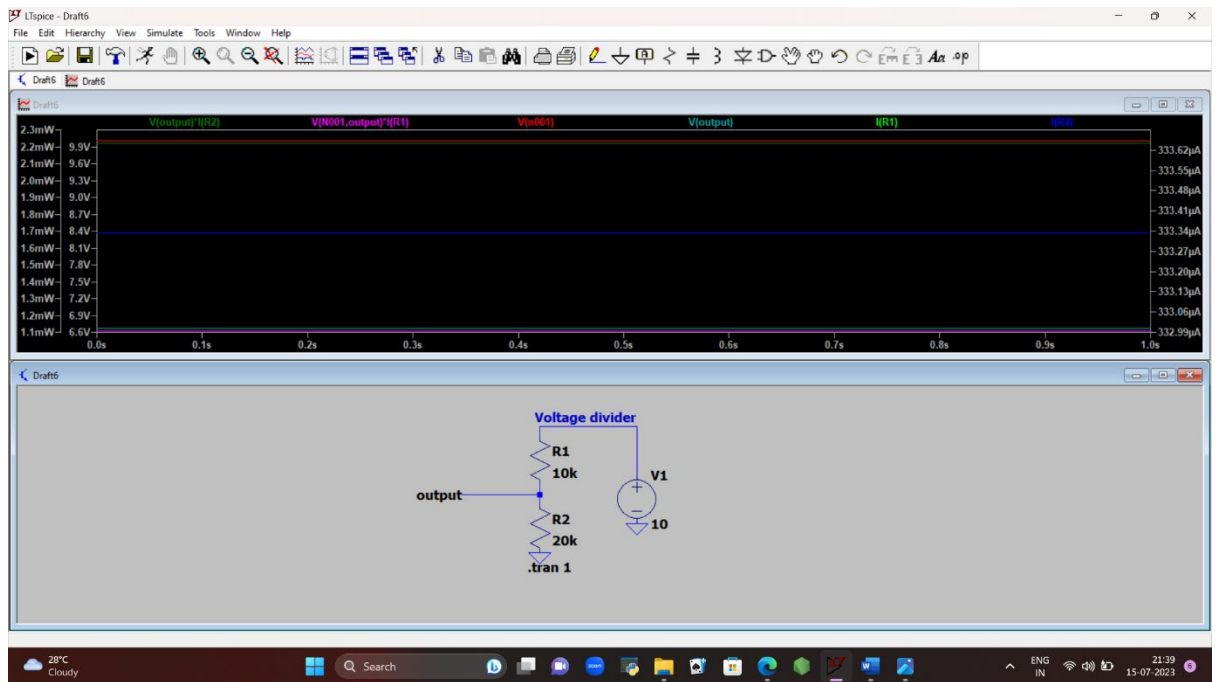   Power Dissipated in R2 = $i^2R2$
                 = 2.21mW

Practical Applications of voltage divider:
Voltage dividers are commonly used for level shifting, biasing, and scaling signals.
The above simulation results can guide us in selecting suitable resistor values for specific applications, ensuring accurate voltage division.
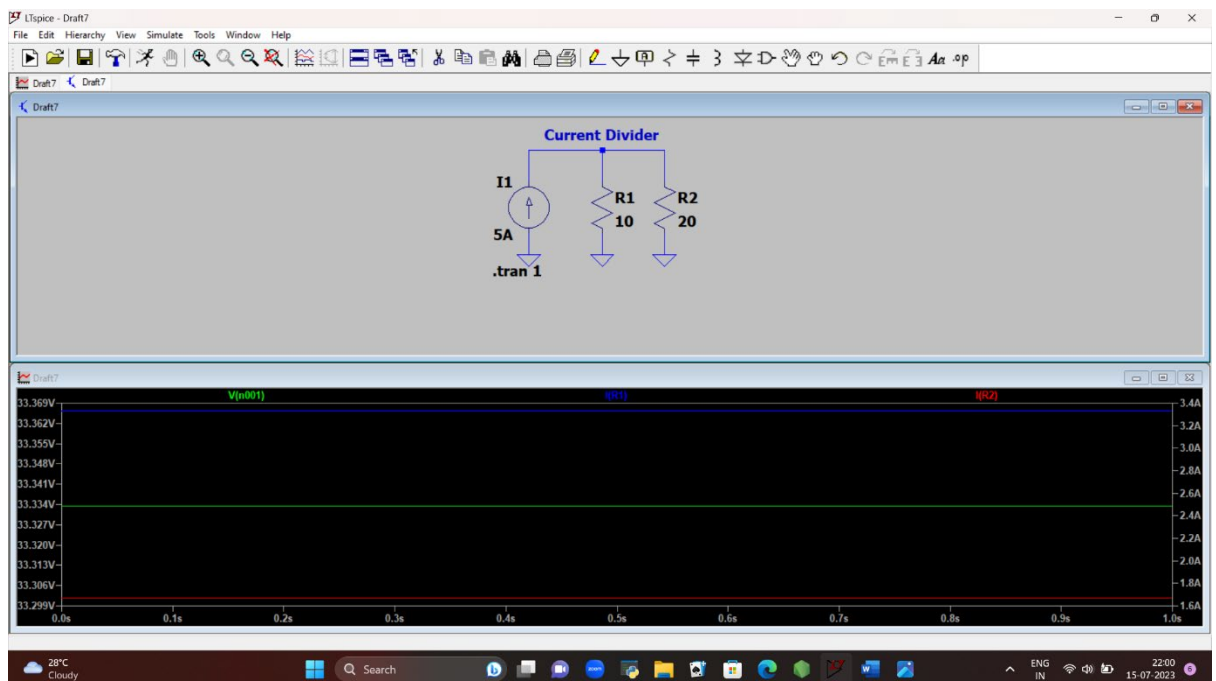
Power Dissipation Simulation

2. <u>Current Divider</u>

The current divider is an essential circuit used in electronic systems to divide a current into multiple branches.

Here we use 2 resistors connected in parallel with a current source of 5A.



Transient Simulation of current divider

Theoretical Analysis:
For this we apply KCL and ohm's law to derive equations governing current division.

$$V/R1 + V/R2 = 5A$$

Putting respective values, we get V= 33.33V

By deriving the theoretical equations and performing simulations using LT Spice, we gained valuable insights into the expected current division ratios and verified them through practical experiments.

Practical Use of Current Divider:
Current dividers are frequently used to bias transistors, distribute currents in parallel circuits and balance loads in power distribution networks.

3. Low Pass Filter
The low pass filter typically consists of a resistor and a capacitor connected in series with the output taken from the junction between them.
The circuit allows low frequency signals to pass through while attenuating higher frequencies. Its purpose is to filter out noise or unwanted high frequency components from a signal.
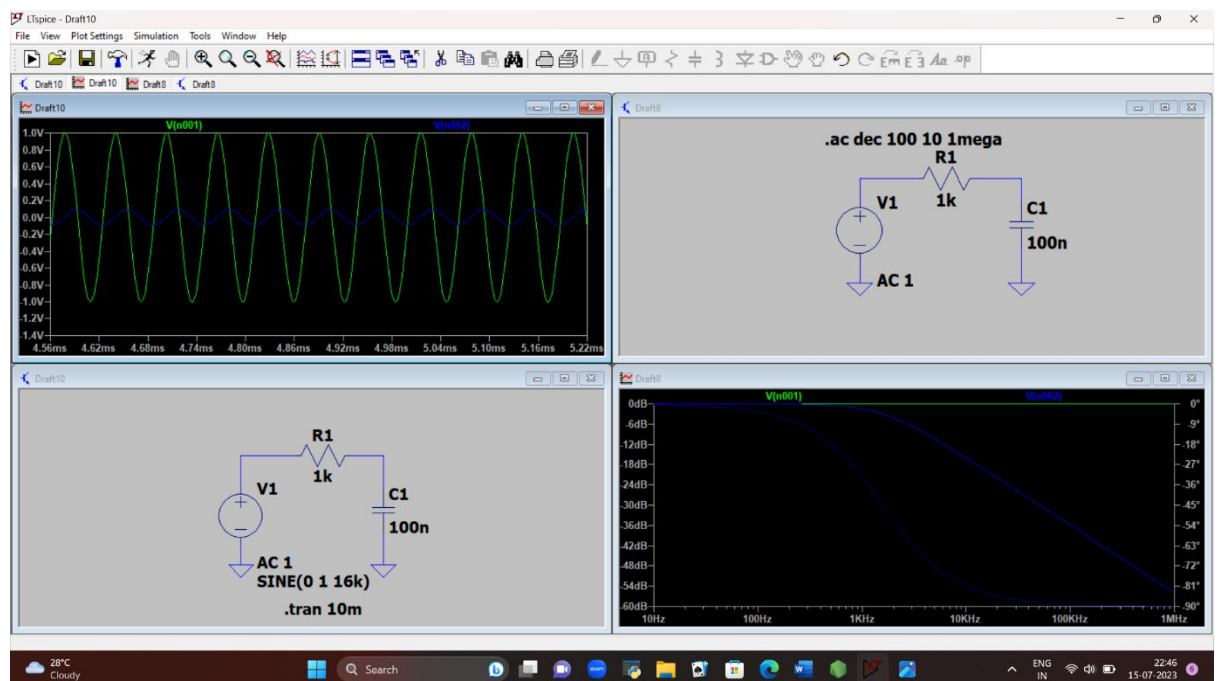


    Transient Analysis           AC Analysis

Theoretical Analysis:
By applying KVL, Ohm's Law and impedance properties of capacitor, we derived the transfer function and the cutoff frequency as follows,

$$H(jw)=1/(1+jwRC)$$

And cut off frequency = 1/(2pieRC)

~=1.59kHz

By systematically varying the resistor and capacitor values within specified ranges, we observed the changes in the frequency response. This analysis helped us understand the impact of component tolerances on the filter's cutoff frequency and attenuation characteristics.
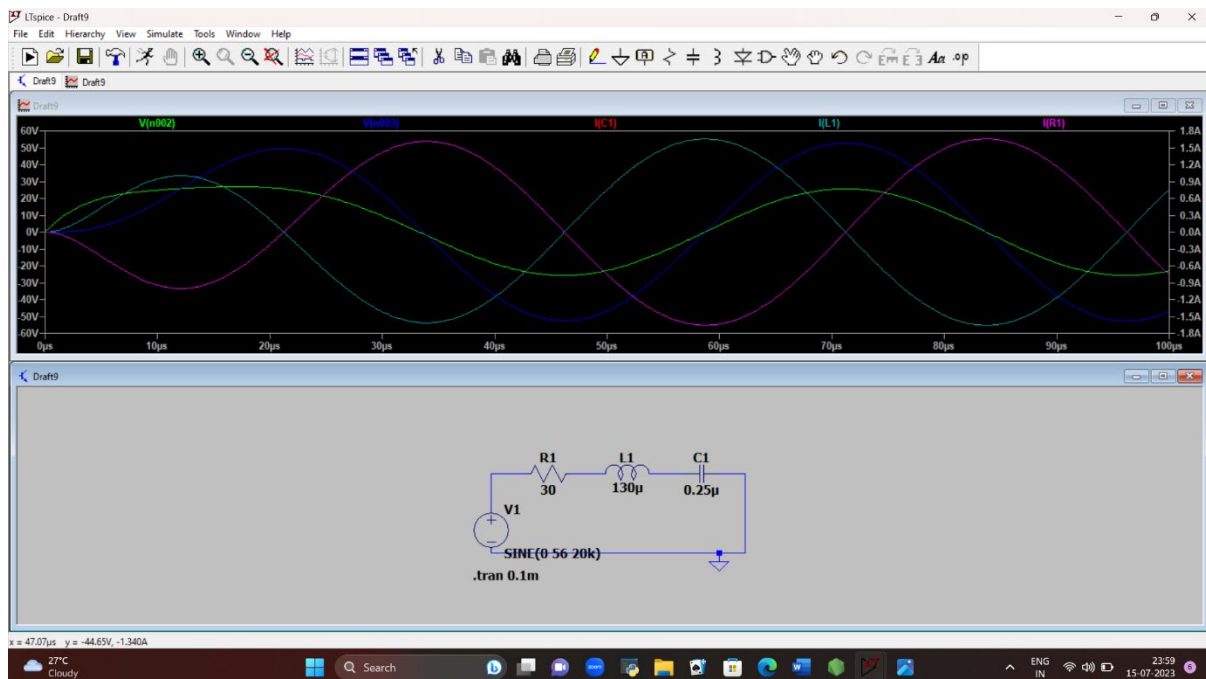
Practical Applications Of low pass filters:

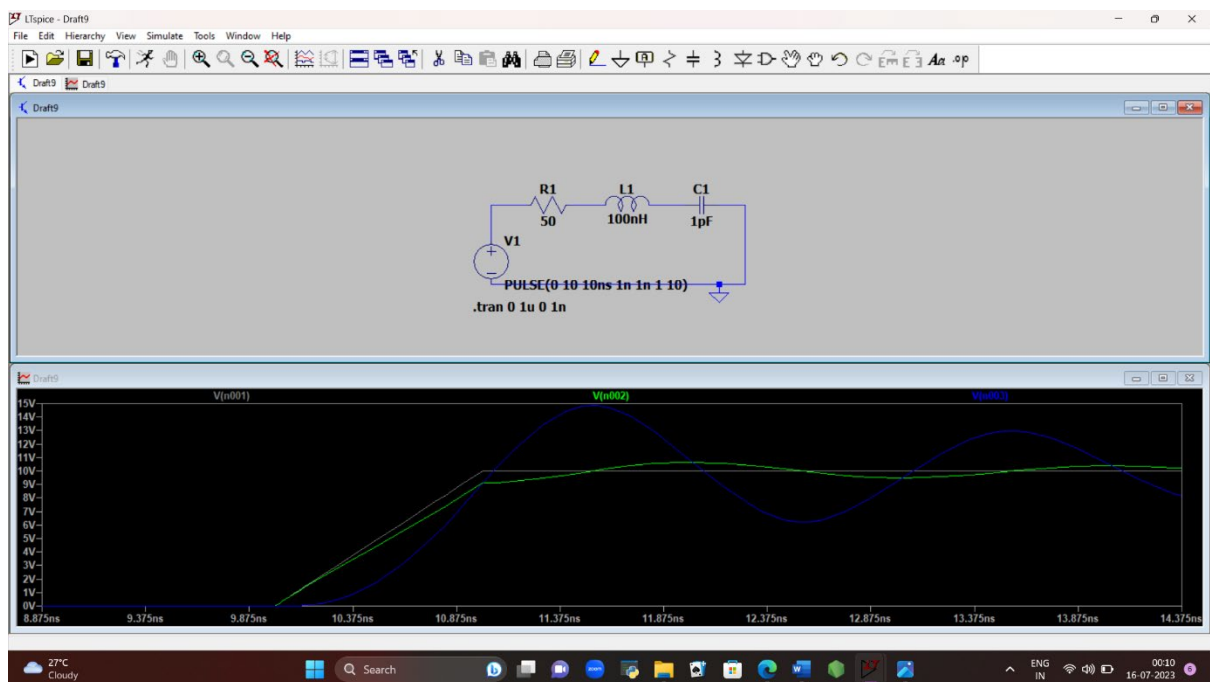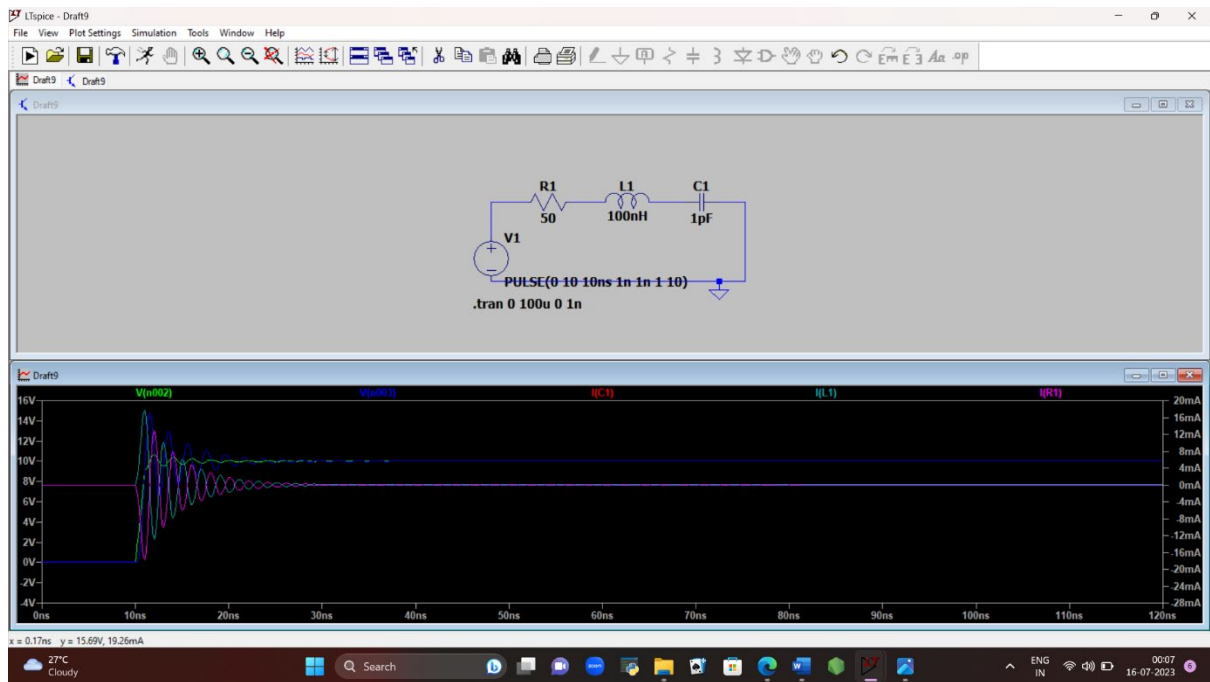Low pass filters are commonly used in audio signals, communication signals.

And also in signal processing to remove high frequency noise, or extract low freq. component

4. RLC Circuit

Simulating steady state voltage and waveforms in a series RLC circuit.



Waveform simulation

RLC circuit comprise a resistor that dissipates energy, an inductor that stores energy in a magnetic field, and a capacitor that stores energy in an electric field.

By applying Kirchhoff's law and ohm's law and the equations governing inductors and capacitors, we derived the differential equations governing the RLC circuit behaviour.

$V - I*R - L*dI/dt - 1/C*(integral)Idt = 0$

Transient Analysis:

The transient analysis allowed us to observe the circuit's response to different input stimuli over time. BY plotting the voltage and current waveforms, we could verify the theoretical predictions and analyze the circuit's behavior during transient events, such as charging and discharging of the capacitor or current buildup in the inductor.

Practical Applications :

RLC circuits have numerous applications, including in filters, oscillators, resonant circuits, and impedance matching networks.

5. <u>Differential Amplifier</u>
   Amplifies the difference between two input voltages but suppresses any voltage common to the two inputs. It is analog circuit with two inputs Vin+ and Vin- and one output Vout in which the output is ideally proportional to the difference between the two voltages:

   Vout=A(Vin+ - Vin-)   for ideal case,   where A is the gain of amplifier\
   Otherwise     Vout=Ad(Vin+ - Vin-) + Ac(Vin+ + Vin-)/2
   
   where Ad is differential gain
   
   Ac is common mode gain

   CMRR=20logAd/Ac\
   In a perfectly symmetric differential amplifier, Ac is zero, and the CMRR is infinite.
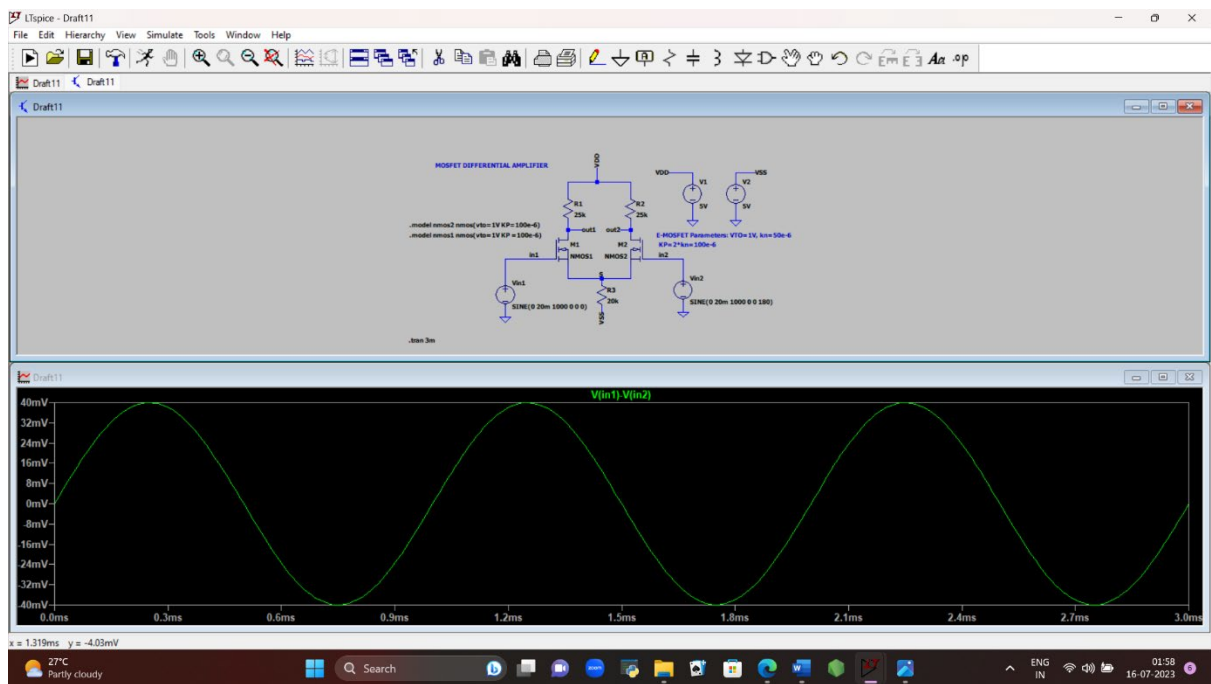
   Input/Output Impedance:
   The input imp. of a differential amplifier refers to the impedance seen by the signal source connected to its input terminals. It is important to have a high input impedance to minimize loading effects. Conversely, the output impedance represents the impedance seen by the load connected to the amplifier's output. A low output impedance ensures efficient power transfer and reduces signal degradation.

   Bandwidth:
   The bandwidth of a differential amplifier determines the range of frequencies over which it can amplify signals effectively. It usually defined as the frequency range where the differential voltage gain remains within a certain specified range.
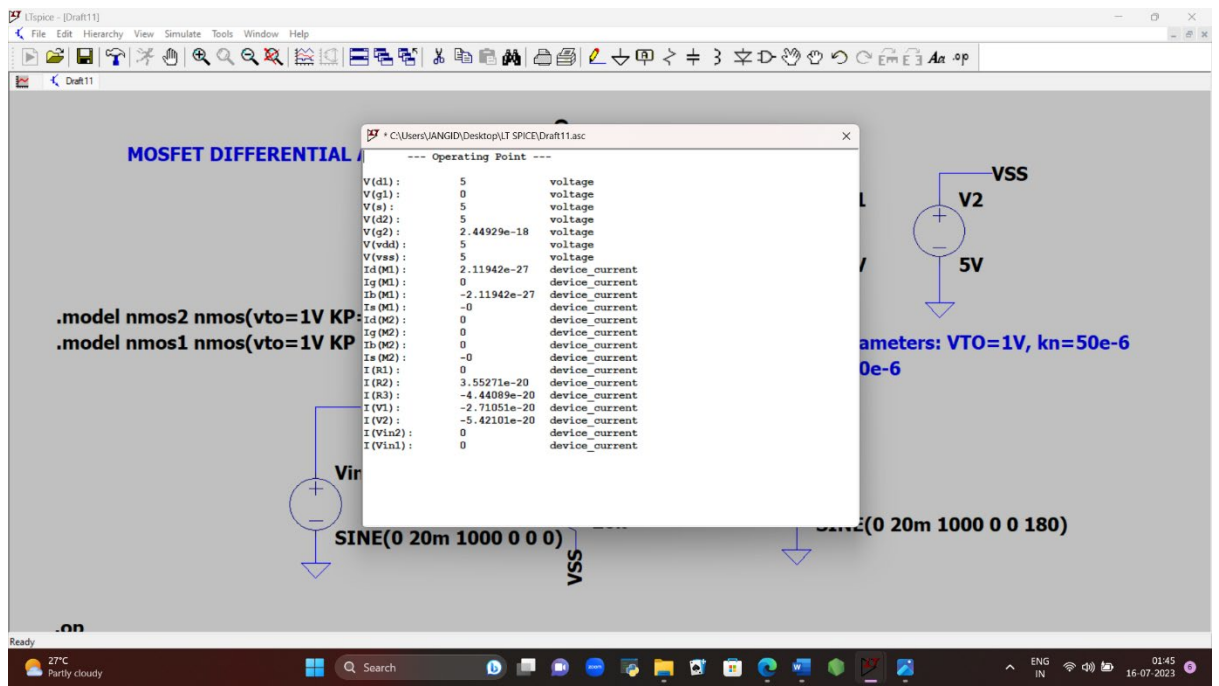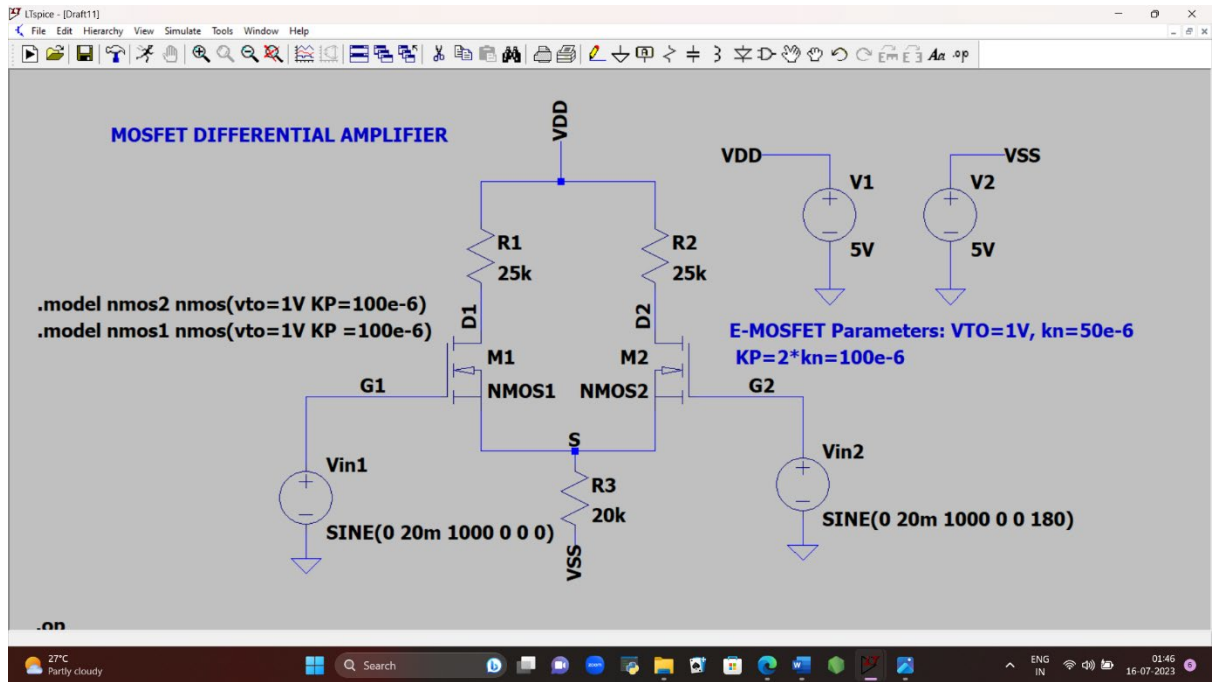
DC Operating Points

AC Analysis