Experiment -8

Aim:

1. Design an inverting and non-inverting amplifier using opamp using an F/B network
2. Determine bandwidth of amplifier using ac analysis
3. Evaluate the open-loop gain. Loop gain and close loop gain of both the amplifier (VFB/VTEST) and do ac analysis
4. Comment on the stability of the feedback amplifier

Apparatus used: LTSpice software

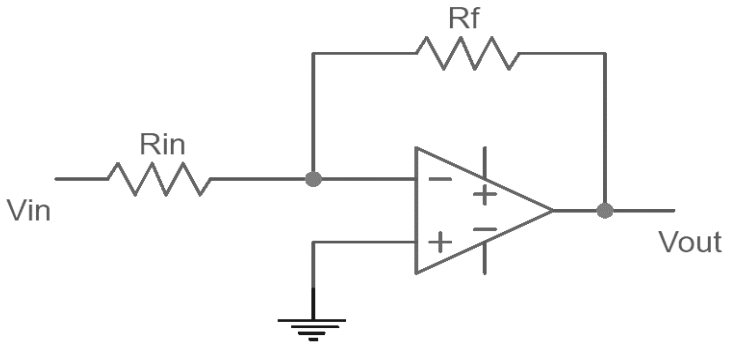
Theory:

An Operational Amplifier**,** or op-amp for short, is fundamentally a voltage amplifying device designed to be used with external feedback components such as resistors and capacitors between its output and input terminals

Op-amp Parameter and Idealised Characteristic

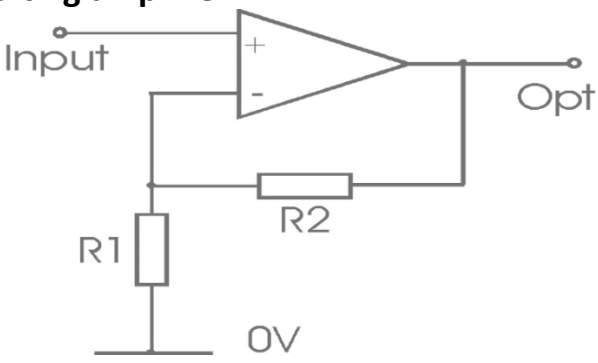
- Open Loop Gain, (Avo): Infinite
- Input impedance, (Z_{IN}): Infinite
- Output impedance, (Z_{OUT}): Zero
- Bandwidth, (BW): Infinite
- Offset Voltage, (V_{IO}): Zero

Inverting amplifier:



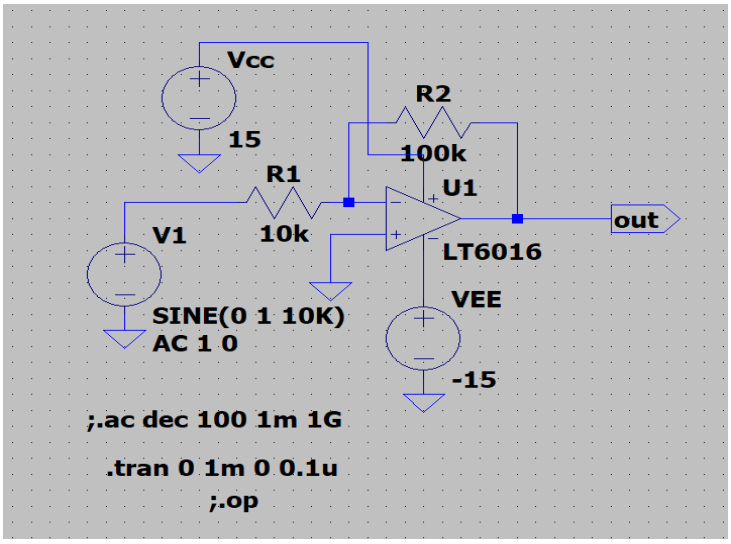
Gain = Vout/Vin = Rf/Rin

Non Inverting amplifier:



$$A_{CL} = \frac{V_{out}}{V_{in}} = \left(1 + \frac{R_1}{R_2}\right)$$

Circuit Schematic: INVERTING AMPLIFIER:



DC operating Point:

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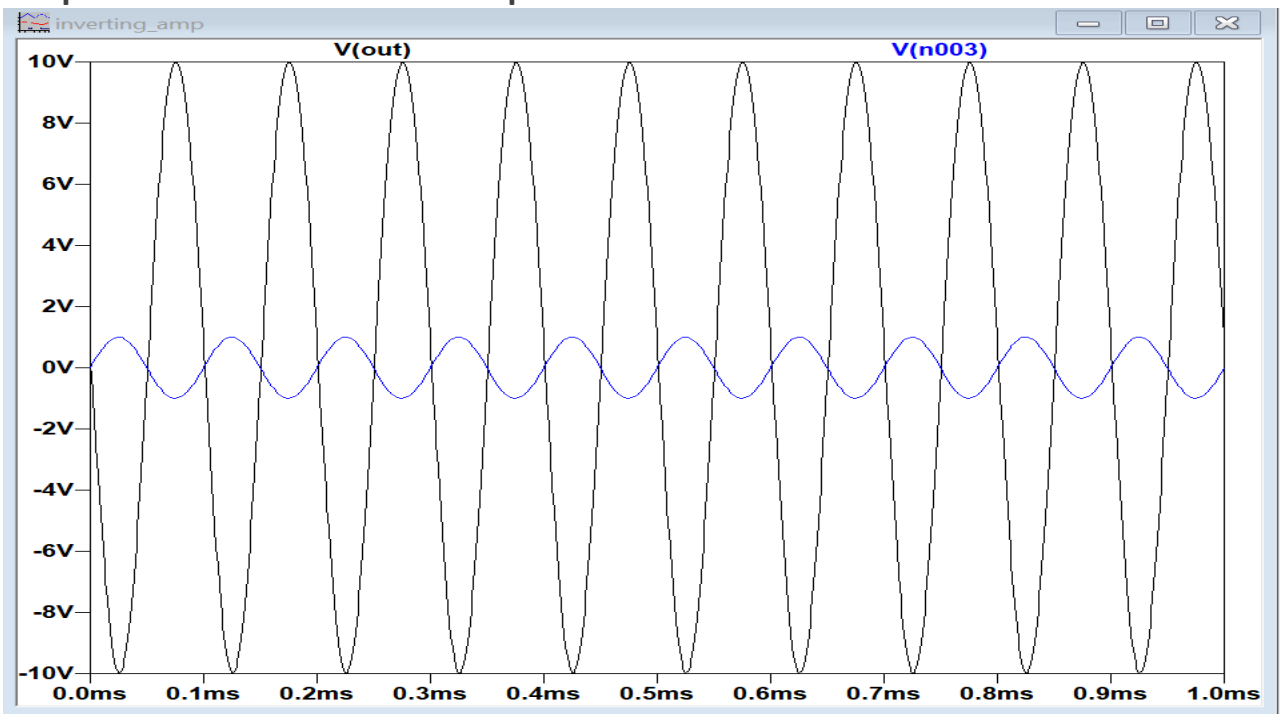
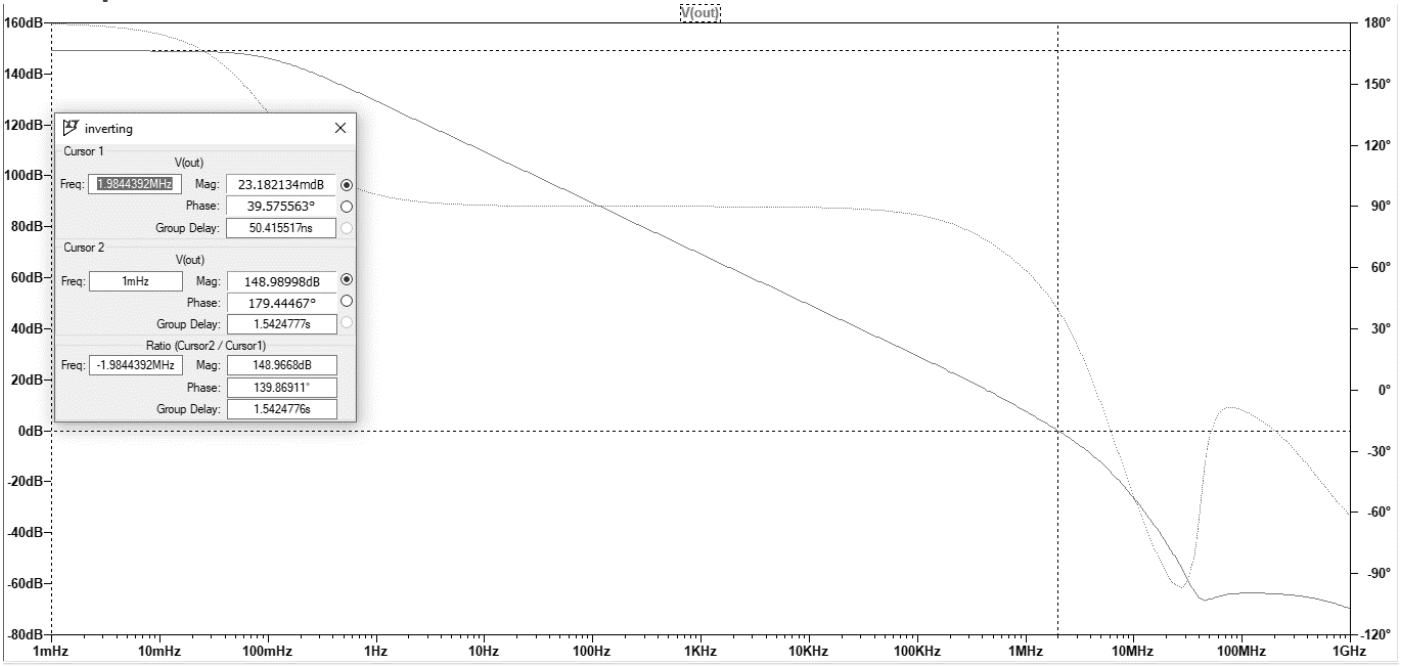
        --- Operating Point ---

V(n004):        -15             voltage
V(n001):        15              voltage
V(out):         0.000176517     voltage
V(n002):        -2.01981e-008   voltage
V(n003):        0               voltage
I(R2):          1.76537e-009    device_current
I(R1):          -2.01981e-012   device_current
I(Vee):         0.000345921     device_current
I(Vcc):         -0.000345919    device_current
I(V1):          -2.01981e-012   device_current
Ix(u1:1):       1.76743e-009    subckt_current
Ix(u1:2):       1.76739e-009    subckt_current
Ix(u1:3):       0.000345919     subckt_current
Ix(u1:4):       -0.000345921    subckt_current
Ix(u1:5):       -1.75084e-009   subckt_current
```

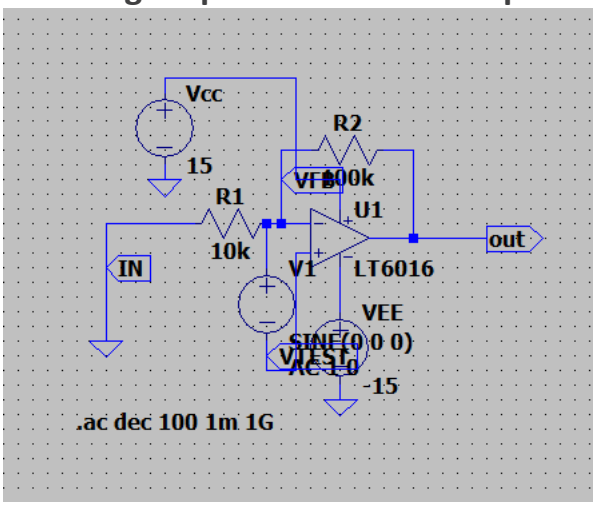
Output Waveform: Transient response:



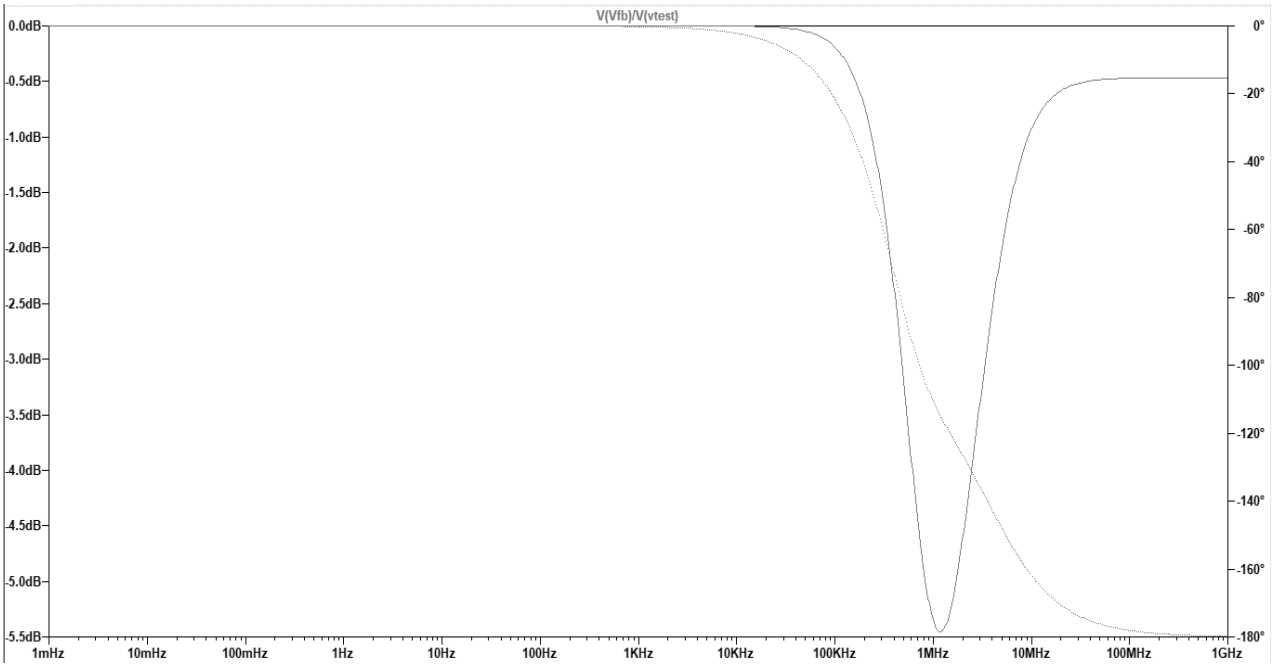
AC response:



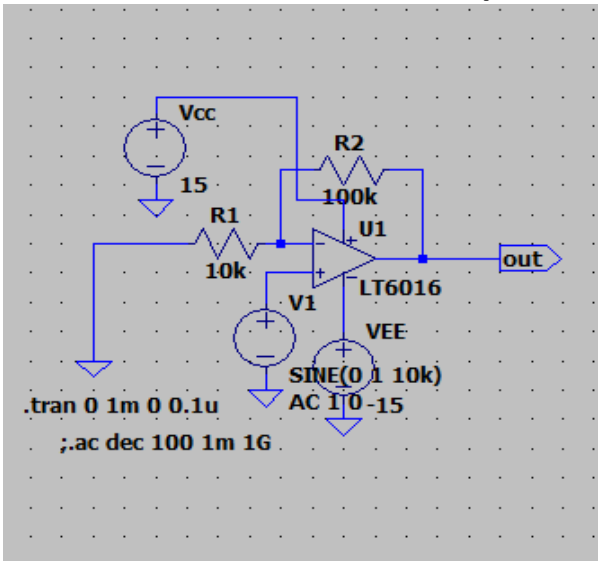
Inverting amplifier with VTest input



Waveform:



NON-INVERTING AMPLIFIER: Open-Loop



Operating point:

* C:\Users\singh\Documents\LTSpice\Analog IC Design Lab\Lab8

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        --- Operating Point ---

V(n004):        -15             voltage
V(n001):        15              voltage
V(out):         0.000176517     voltage
V(n003):        0               voltage
V(n002):        -2.01981e-008   voltage
I(R2):          1.76537e-009    device_current
I(R1):          -2.01981e-012   device_current
I(V1):          -1.76743e-009   device_current
I(Vee):         0.000345921     device_current
I(Vcc):         -0.000345919    device_current
Ix(u1:1):       1.76743e-009    subckt_current
Ix(u1:2):       1.76739e-009    subckt_current
Ix(u1:3):       0.000345919     subckt_current
Ix(u1:4):       -0.000345921    subckt_current
Ix(u1:5):       -1.75084e-009   subckt_current
```
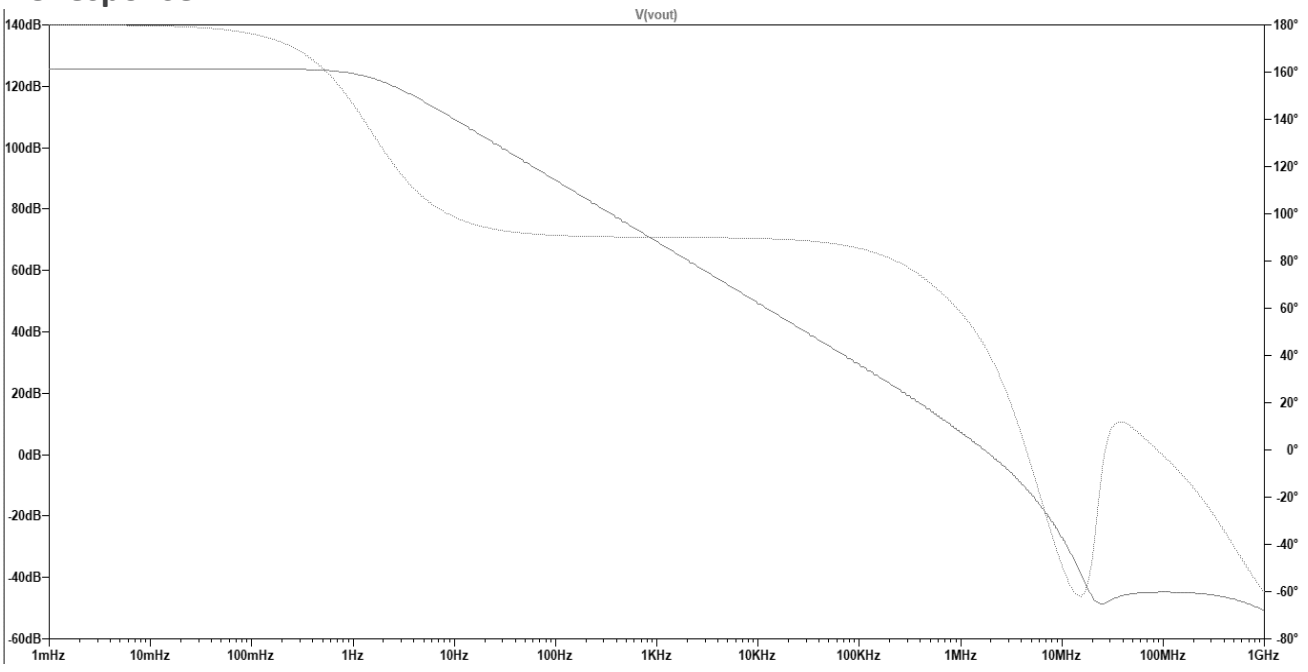
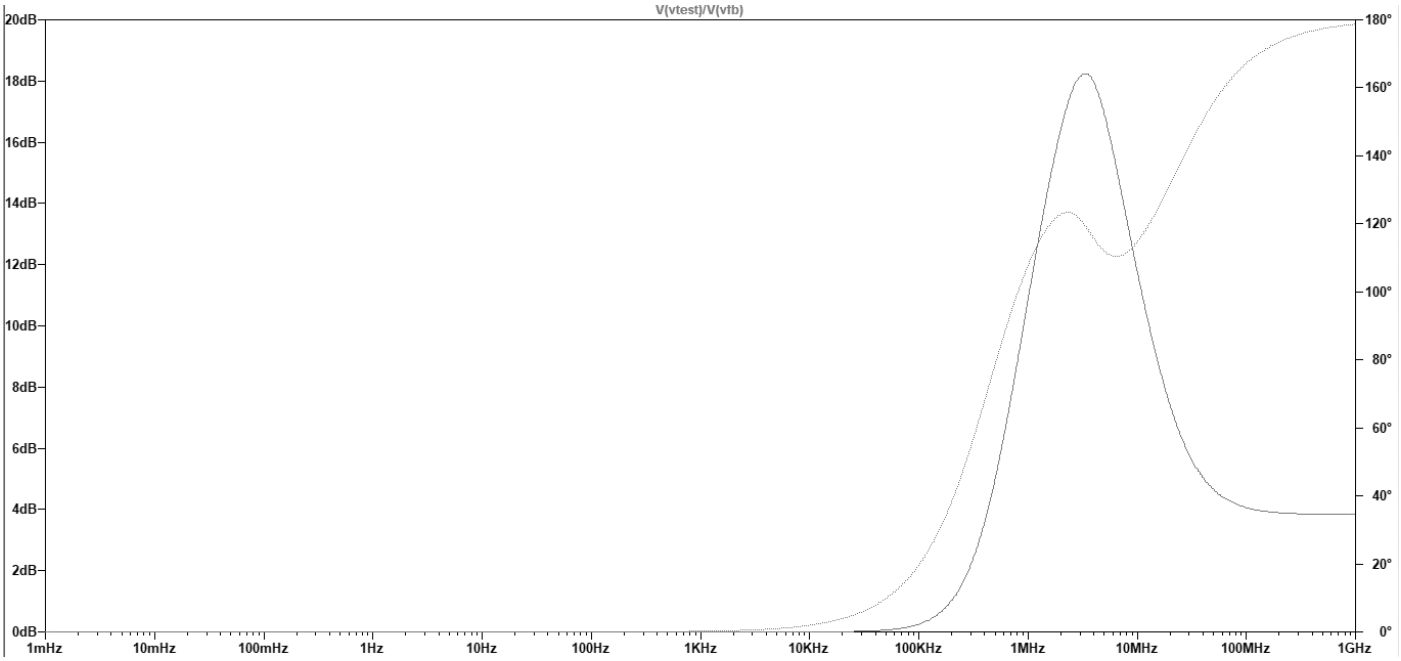

AC response:

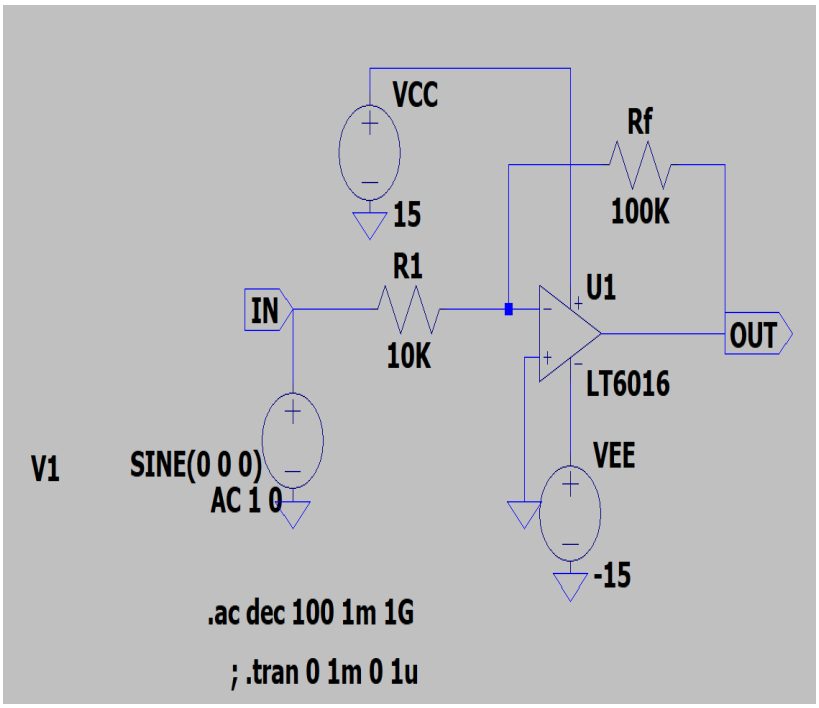


V_{fb} / V_{Test}

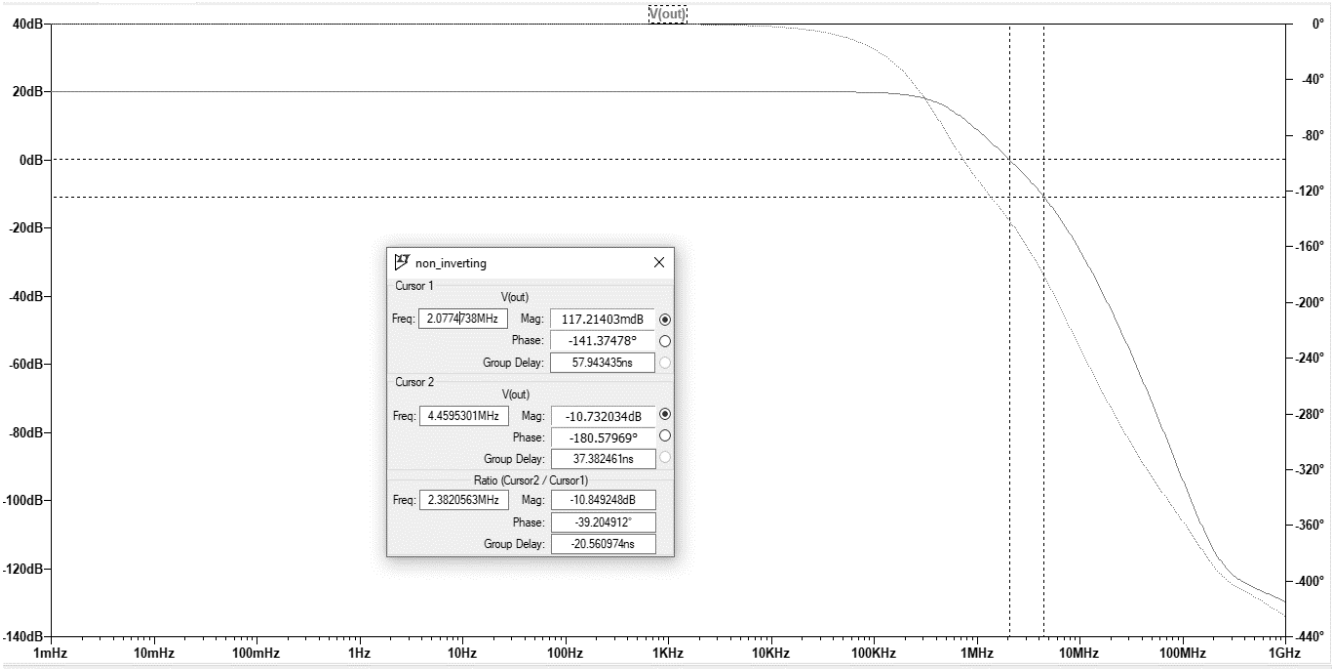


CLOSED-LOOP:

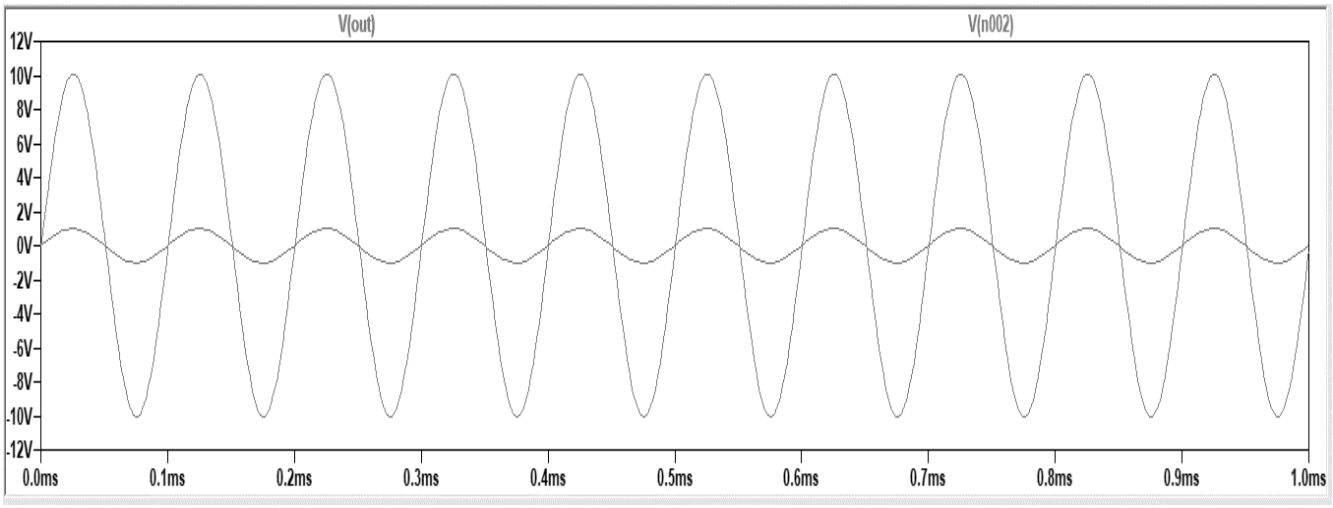
CIRCUIT:



OUTPUT:



TRANSIENT:



Observation:

Open-loop:

Wgc = 1.984MHz. The phase doesn't cross -180 degrees so the system is stable.

Closed loop:

Wgc = 2.07 MHz, Wpc = 4.45 MHz.

Wgc < Wpc, so the system is stable.

Phase Margin = -39.2 degrees

Gain Margin = 10dB

Closed loop gain = 10

Result:

The Experiment has been performed with both configurations of OpAmp and found to be correct.