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From...
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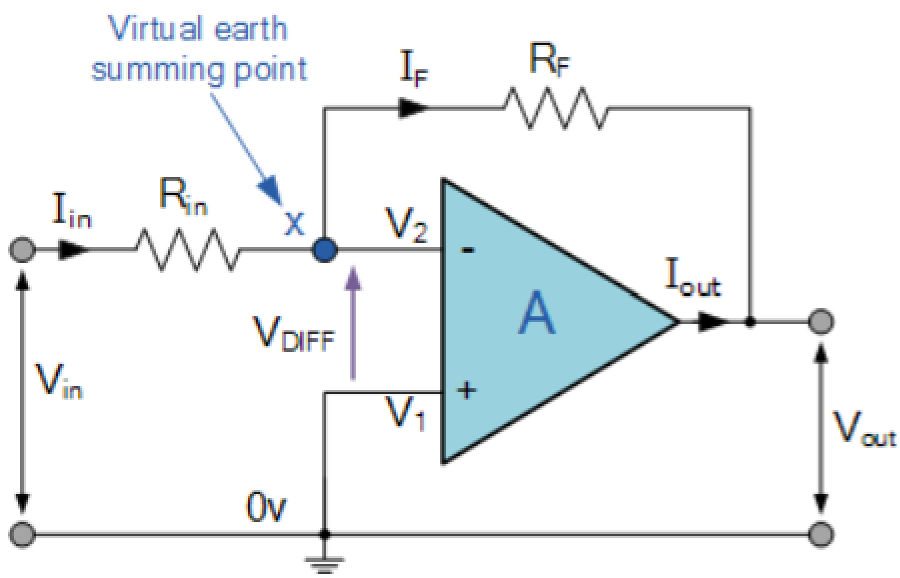
EXPERIMENT 1

AIM

To simulate the output of an inverting amplifier from a sinusoidal input.

THEORY

In this Inverting Amplifier circuit the operational amplifier is connected with feedback to produce a closed loop operation. When dealing with operational amplifiers there are two very important rules to remember about inverting amplifiers, these are: “No current flows into the input terminal” and that “V1 always equals V2”. However, in real world op-amp circuits both of these rules are slightly broken.



$$\text{Gain (Av)} = \frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}}$$

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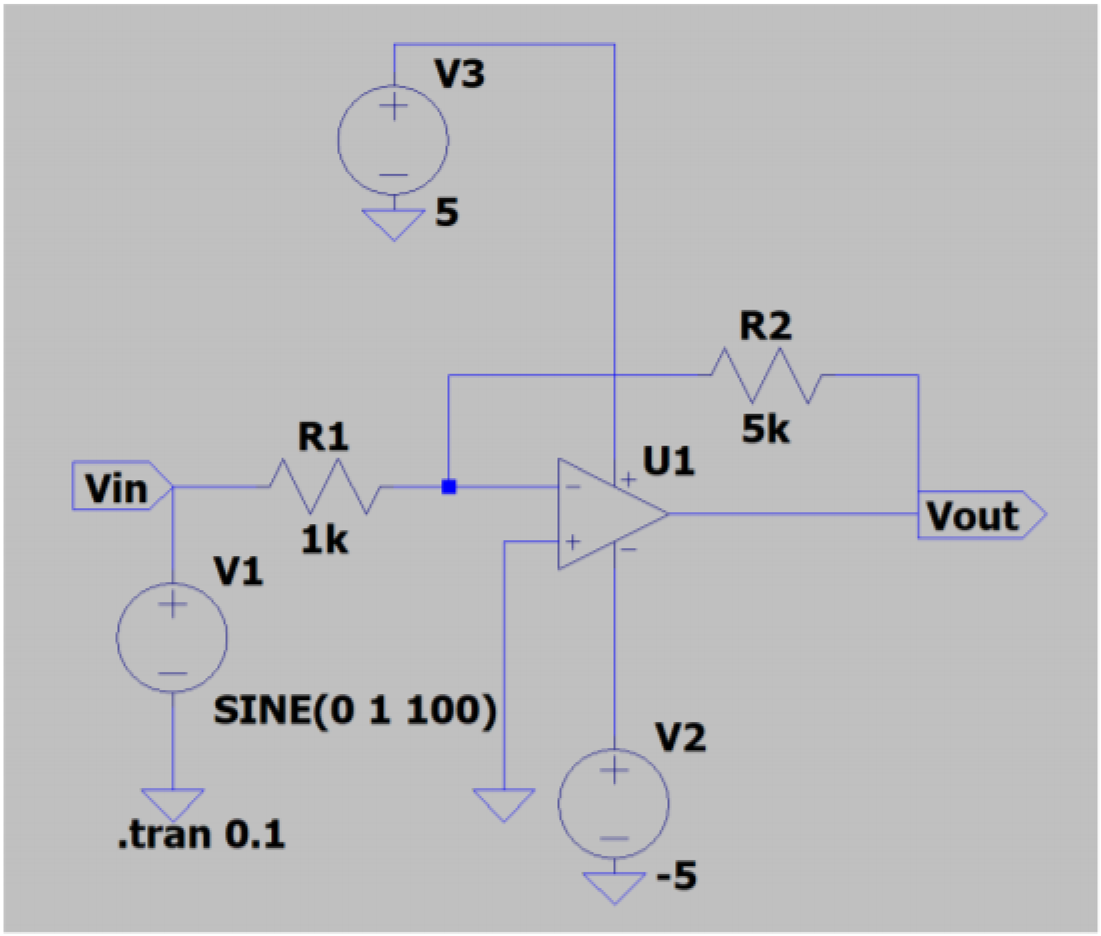
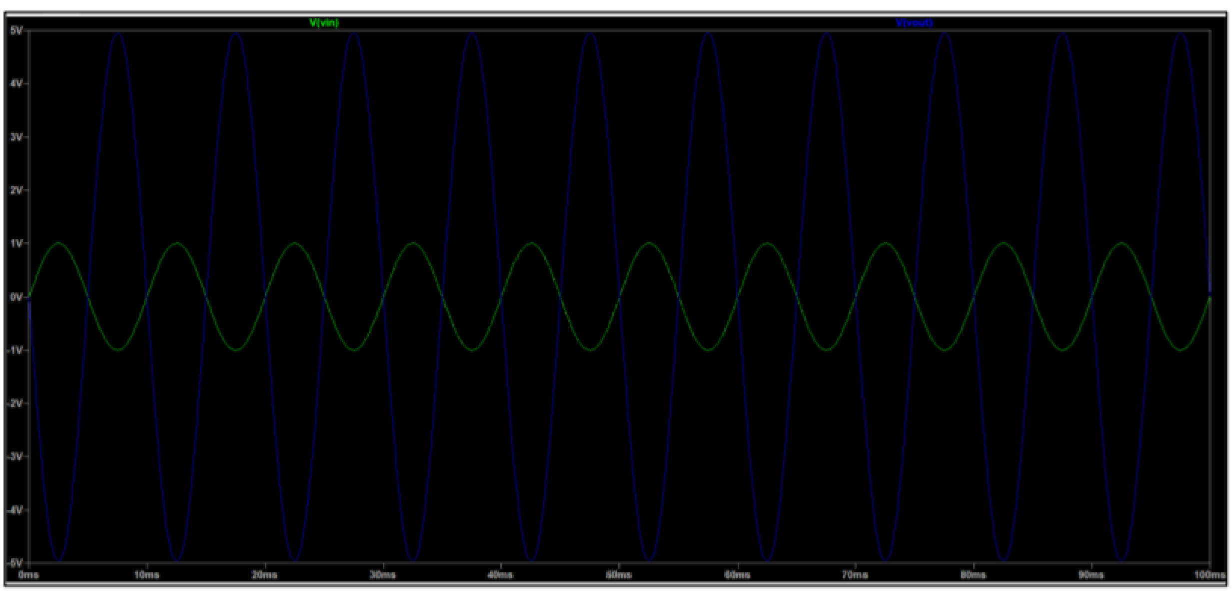
OBSERVATIONS





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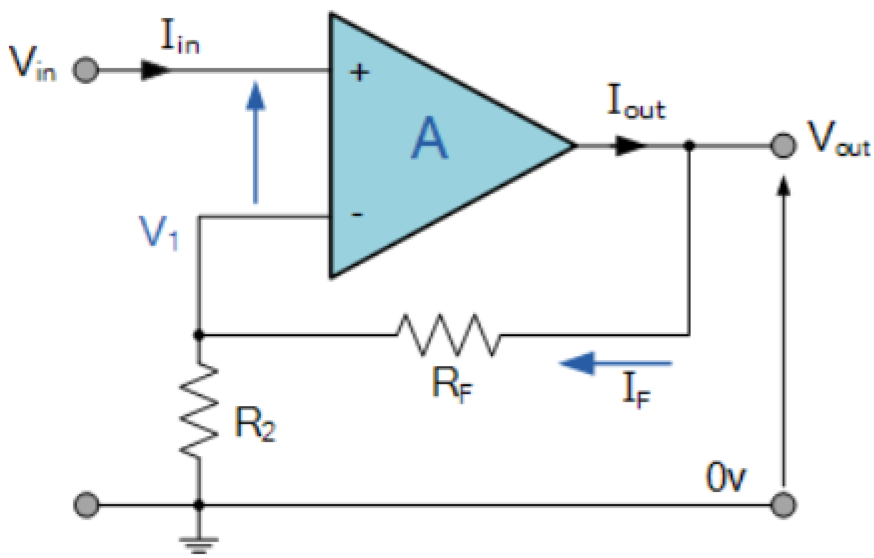
AIM

To simulate the output of a non-inverting amplifier from a sinusoidal input.

THEORY

In this configuration, the input voltage signal, (VIN) is applied directly to the non-inverting (+) input terminal which means that the output gain of the amplifier becomes “Positive” in value in contrast to the “Inverting Amplifier” circuit we saw in the last tutorial whose output gain is negative in value. The result of this is that the output signal is “in-phase” with the input signal.



$$A_{(v)} = 1 + \frac{R_F}{R_2}$$

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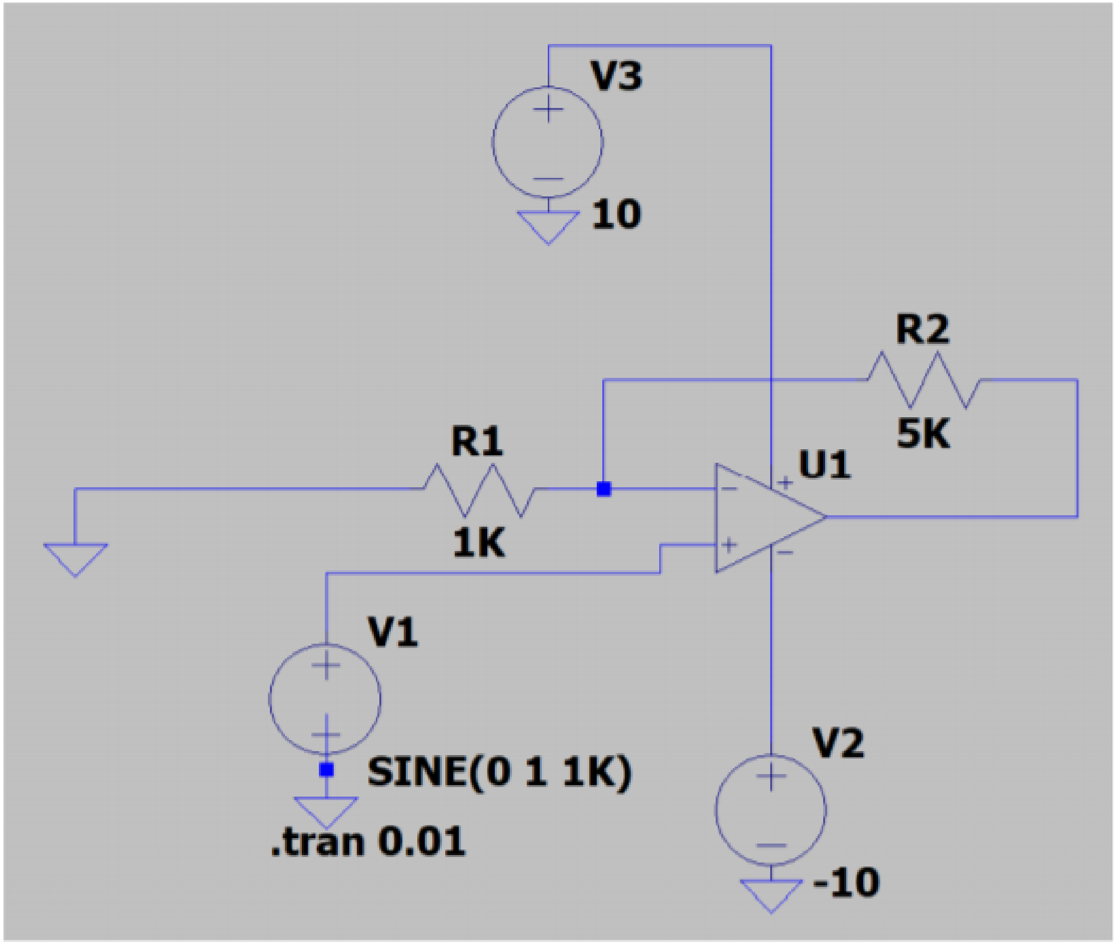

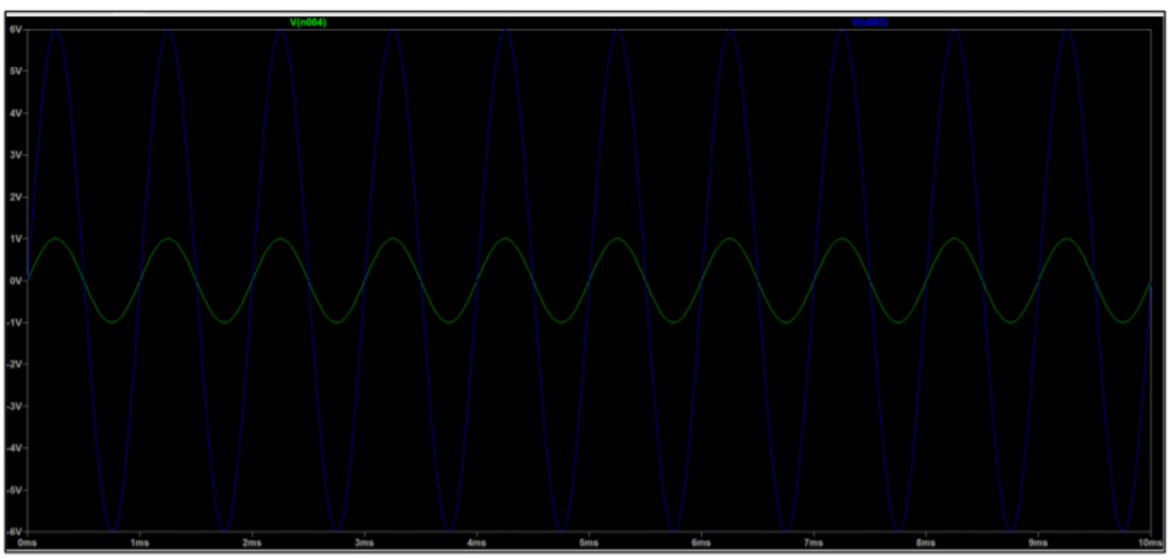

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EXPERIMENT 2

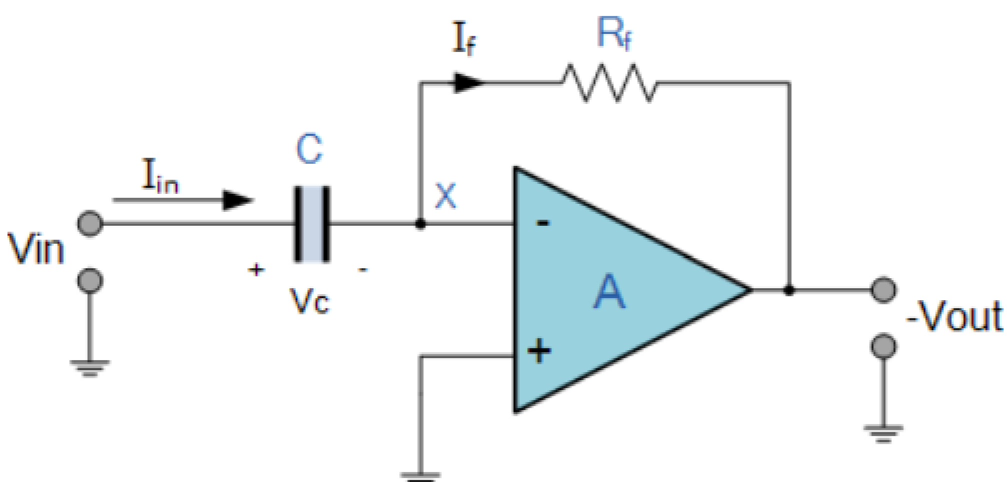
AIM

To simulate the output of a Differentiator amplifier from a sinusoidal input.

THEORY

The input signal to the differentiator is applied to the capacitor. The capacitor blocks any DC content so there is no current flow to the amplifier summing point, X resulting in zero output voltage. The capacitor only allows AC type input voltage changes to pass through and whose frequency is dependent on the rate of change of the input signal.

At low frequencies the reactance of the capacitor is “High” resulting in a low gain (Rƒ/Xc) and low output voltage from the op-amp. At higher frequencies the reactance of the capacitor is much lower resulting in a higher gain and higher output voltage from the differentiator amplifier.



$$V_{OUT} = -R_F C \frac{dV_{IN}}{dt}$$

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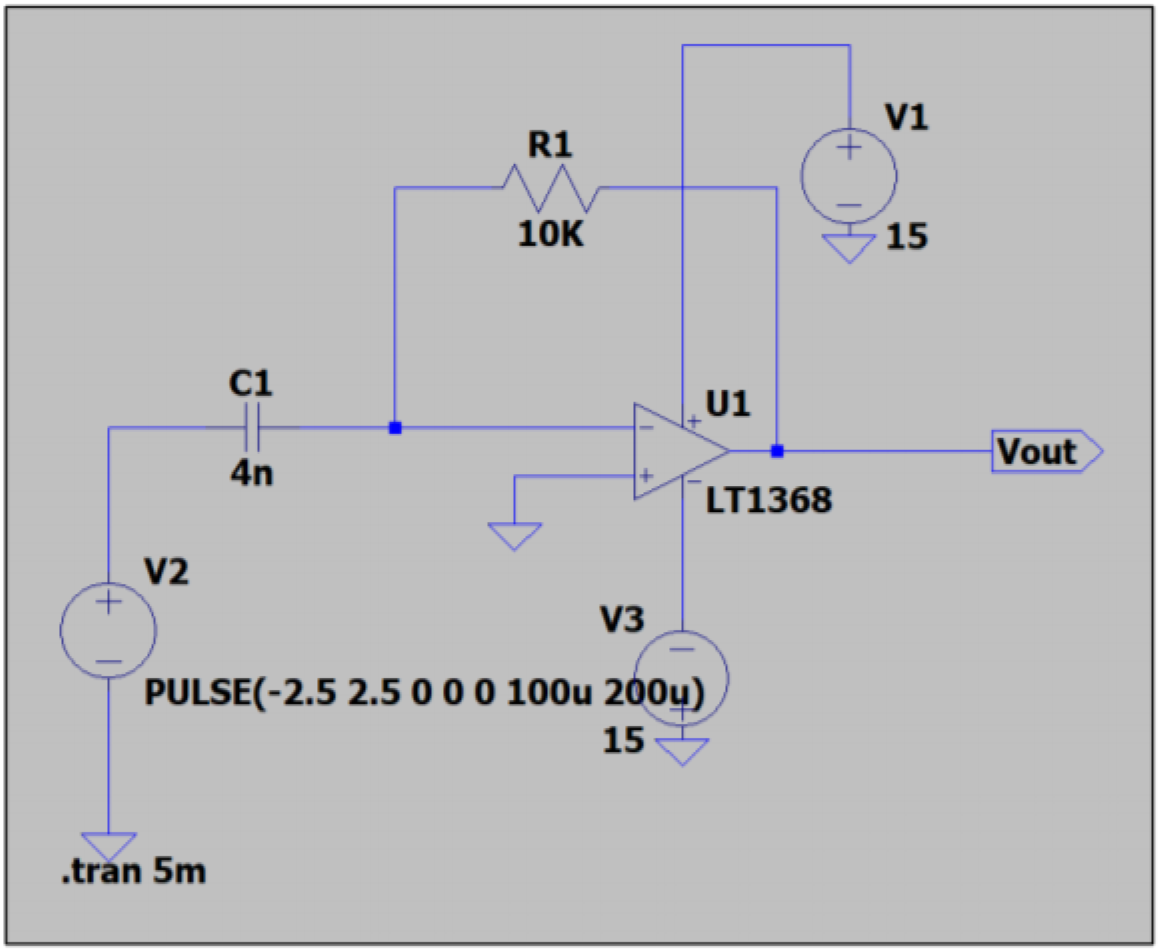

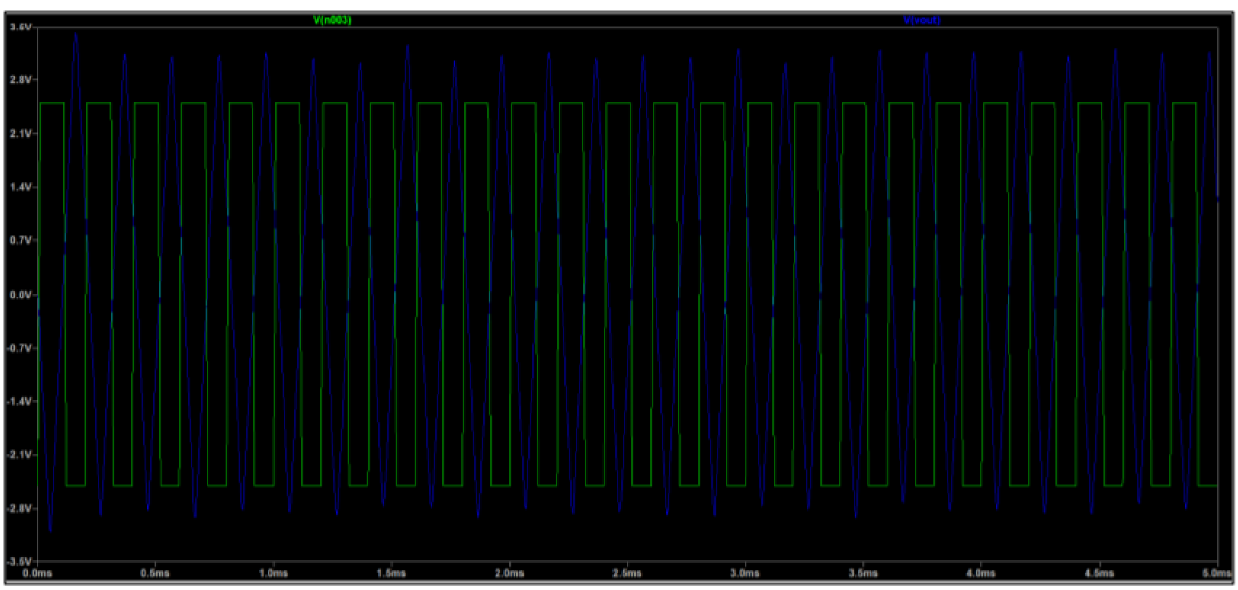

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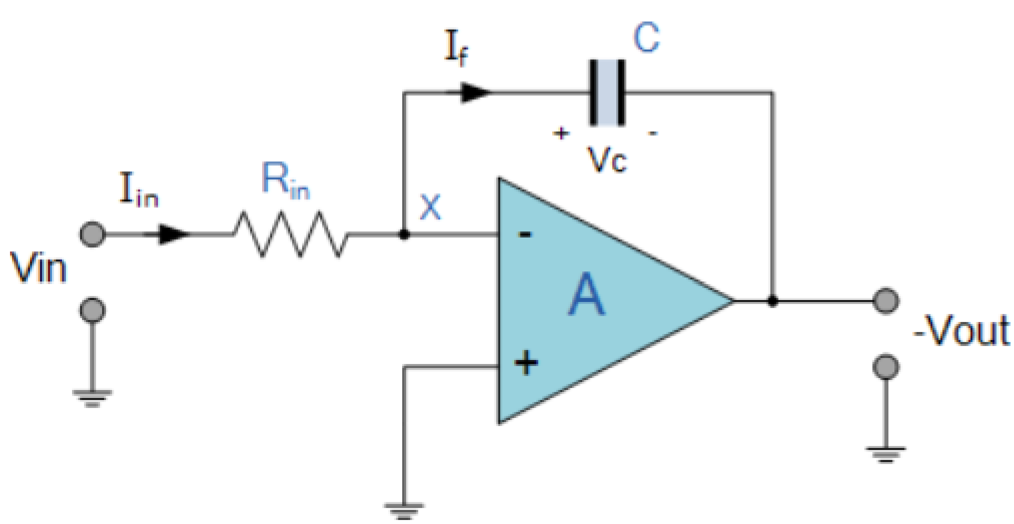
AIM

To simulate the output of an integrator amplifier from a sinusoidal input.

THEORY

As its name implies, the Op-amp Integrator is an operational amplifier circuit that performs the mathematical operation of Integration, that is we can cause the output to respond to changes in the input voltage over time as the op-amp integrator produces an output voltage which is proportional to the integral of the input voltage.

At low frequencies the reactance of the capacitor is “High” resulting in a low gain (R*ƒ*/Xc) and low output voltage from the op-amp. At higher frequencies the reactance of the capacitor is much lower resulting in a higher gain and higher output voltage from the differentiator amplifier.



$$V_{out} = -\frac{1}{R_{in}C}\int_0^t V_{in}\,dt = -\int_0^t V_{in}\frac{dt}{R_{in}.C}$$

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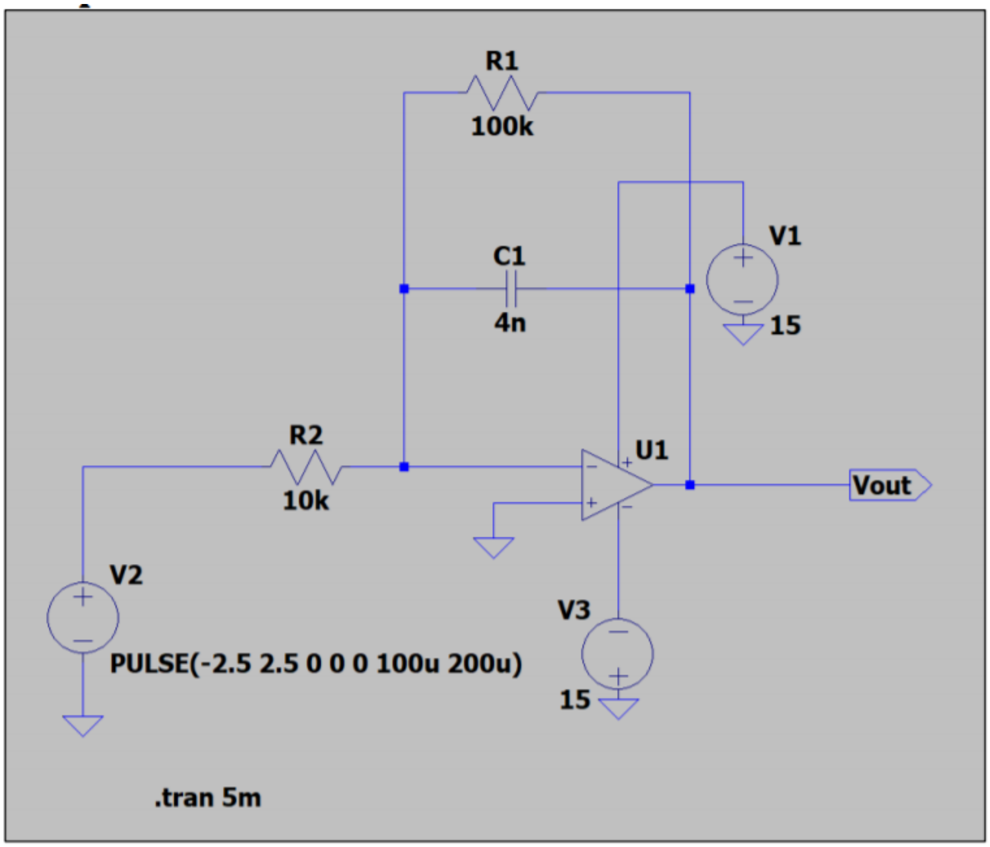

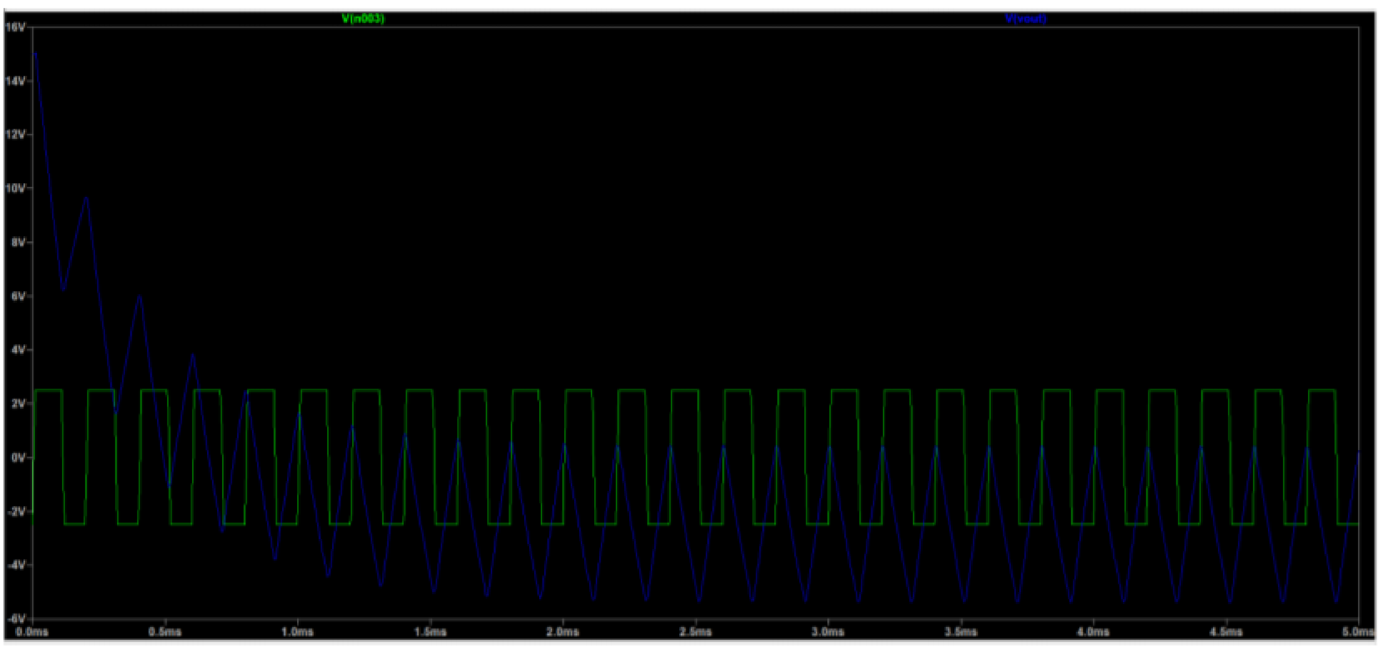

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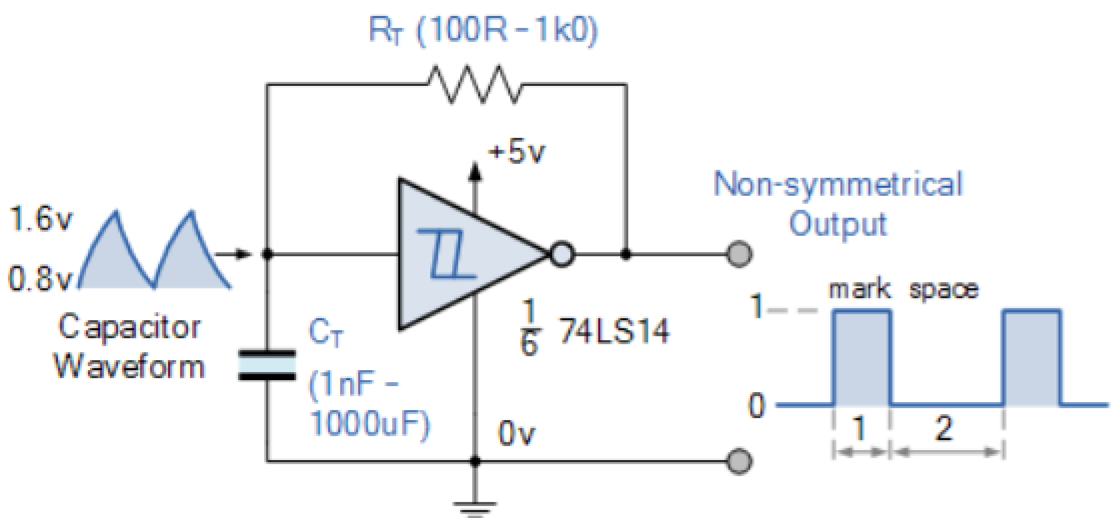
EXPERIMENT 3

AIM

To simulate the output of Schmitt trigger using op-amp from a sinusoidal input.

THEORY

In electronics, a Schmitt trigger is a comparator circuit with hysteresis implemented by applying positive feedback to the non inverting input of a comparator or differential amplifier. When the input is higher than a chosen threshold, the output is high. When the input is below a different (lower) chosen threshold the output is low, and when the input is between the two levels the output retains its value.



$$f = \frac{1}{1.2RC}$$

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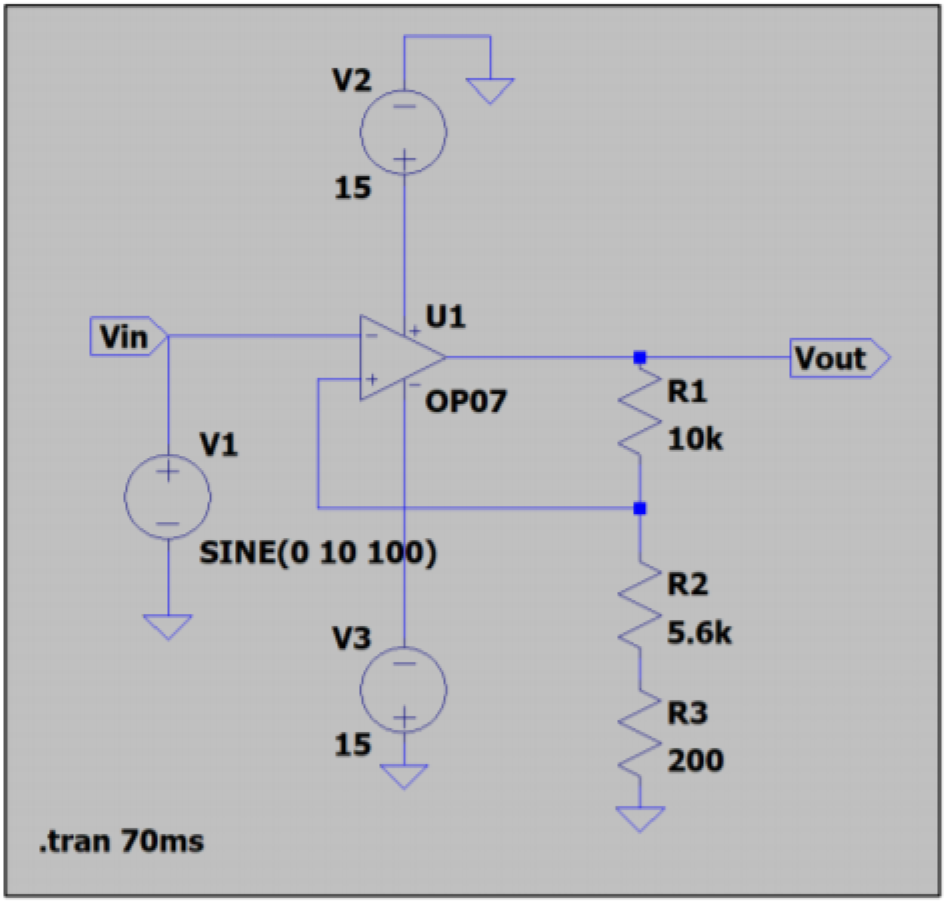

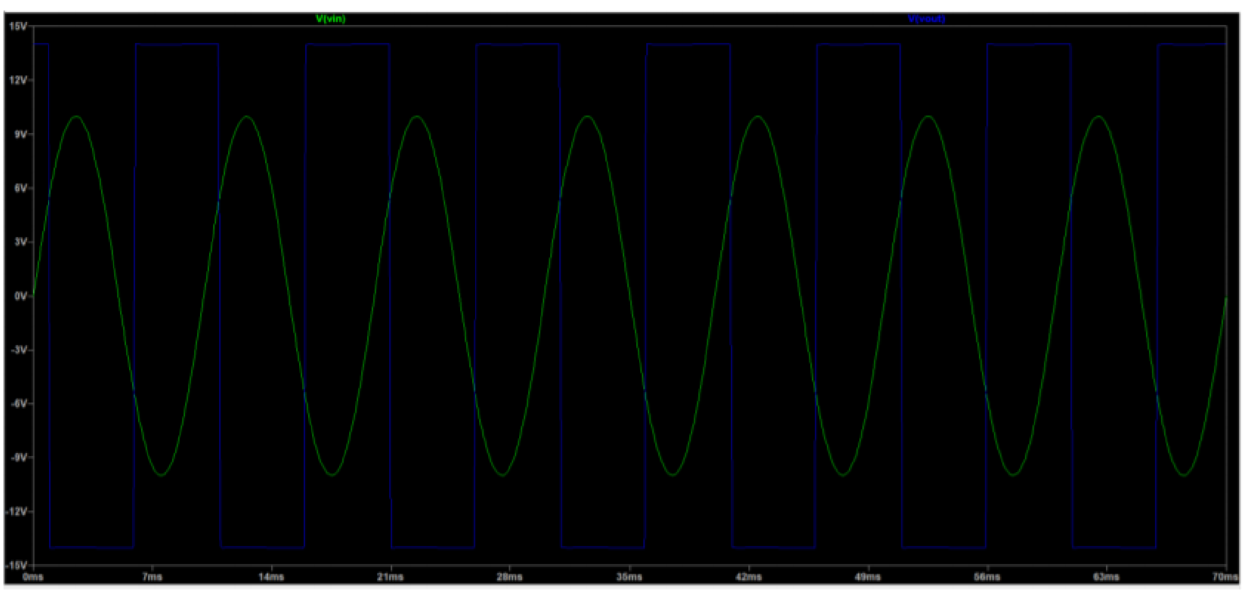

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EXPERIMENT 4

AIM

To simulate the output of an Astable Multivibrator using op-amp from a sinusoidal input.

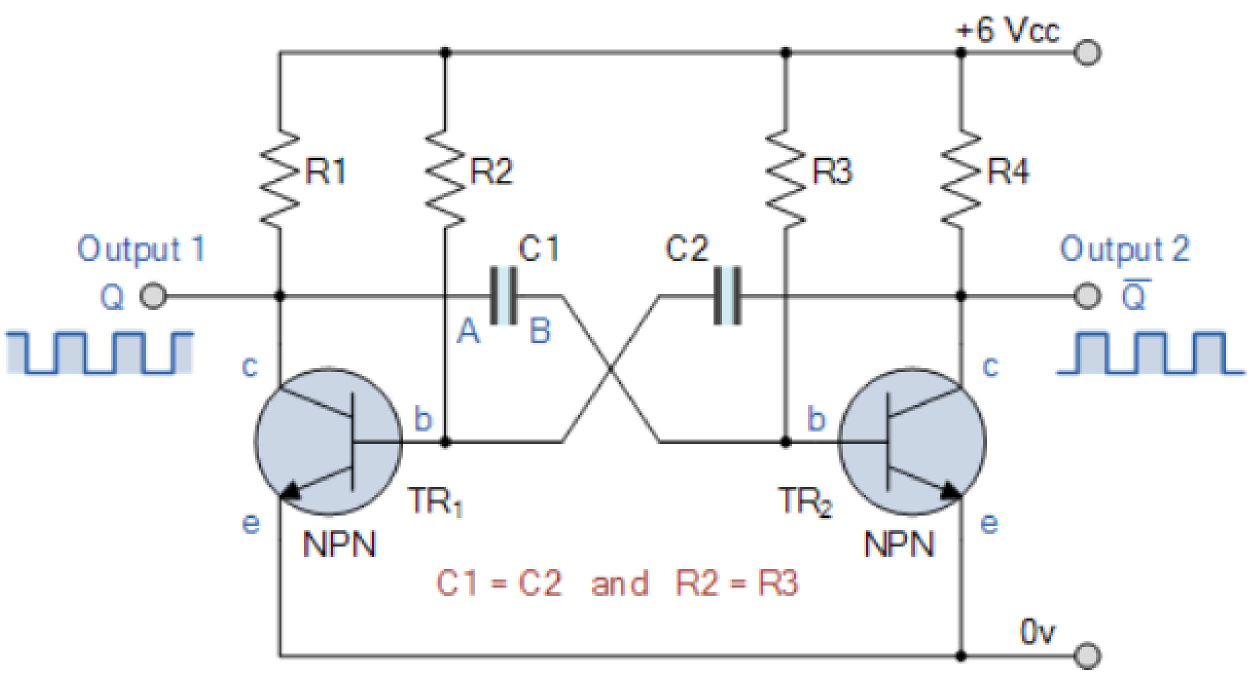
THEORY

$$\text{Periodic Time, } T = t_1 + t_2$$

$$t_1 = 0.69 C_1 R_3$$

$$t_2 = 0.69 C_2 R_2$$

$$f = \frac{1}{T} = \frac{1}{1.38RC}$$



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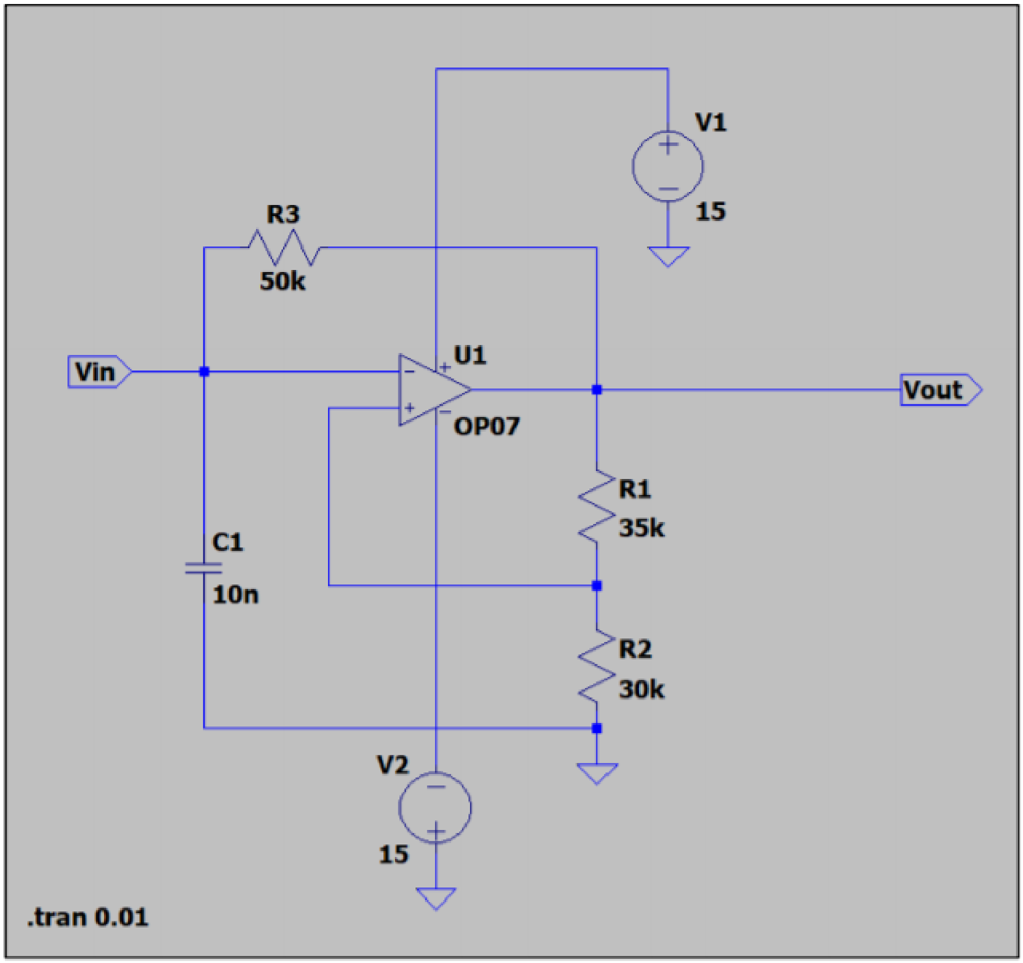

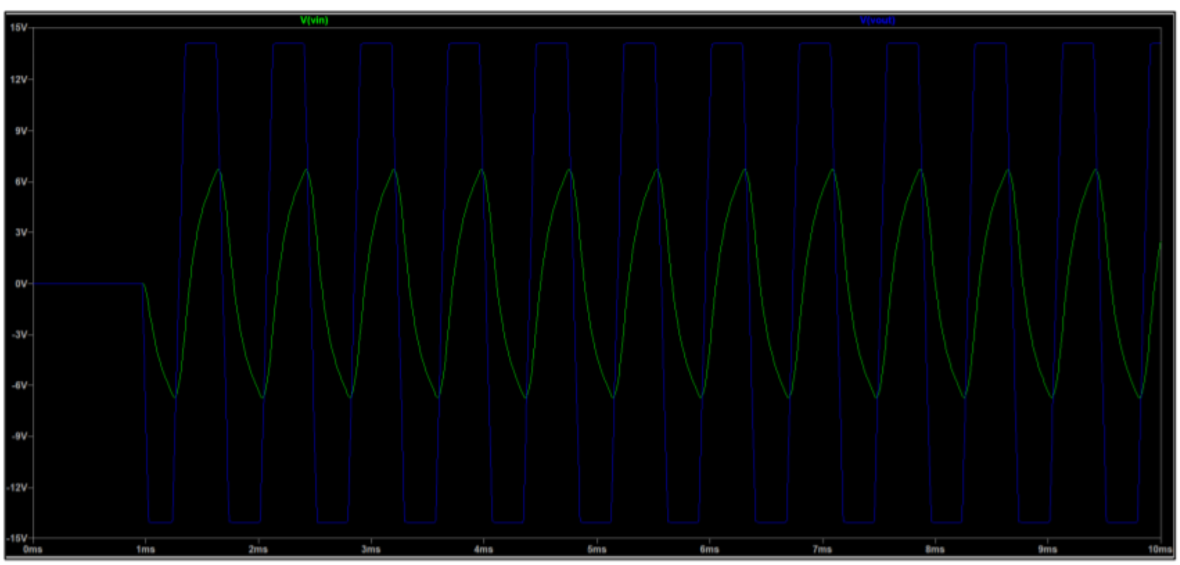

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EXPERIMENT 5

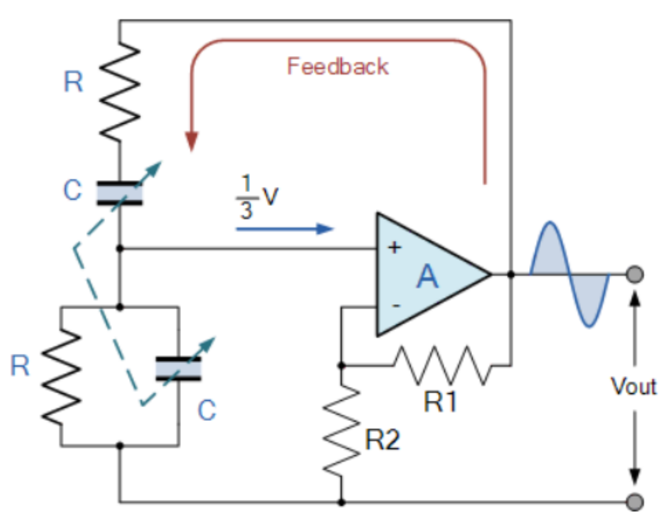
AIM

To simulate the output of the Wien Bridge Oscillator using an op-amp.

THEORY

It is the commonly used audio frequency oscillator which employs both positive and negative feedback. The feedback signal is connected in the non-inverting input terminal so that the amplifier is working in non-inverting mode. The Wien bridge circuit is connected between the amplifier input terminal and output terminal. The bridge has a series RC network in one arm and a parallel RC network in the adjoining arm. In the remaining two arms of the bridge, resistor R1 and Rf are connected. The phase angle criterion for oscillation is that the total phase shift around the circuit must be zero. This condition occurs when the bridge is balanced. At resonance, the frequency of oscillation is exactly the resonance frequency of balanced Wien bridge and is given by:

$$f_r = \frac{1}{2\pi RC} \qquad \textbf{Gain} = 1 + (R_f/R_1) = 3$$



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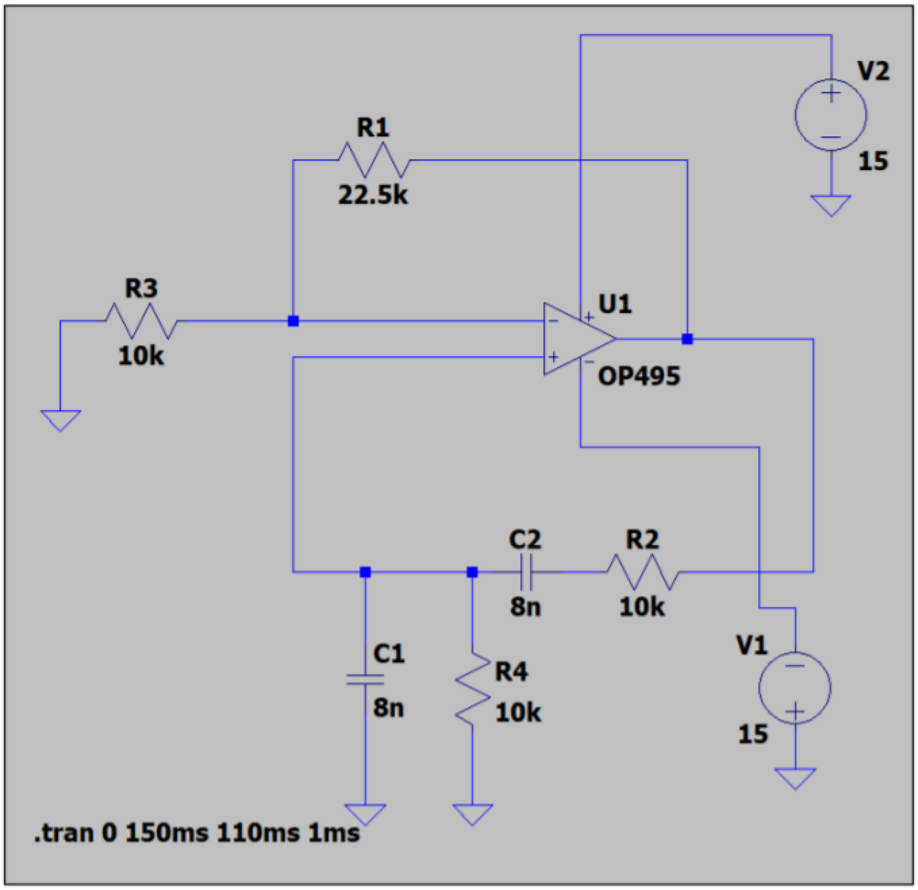

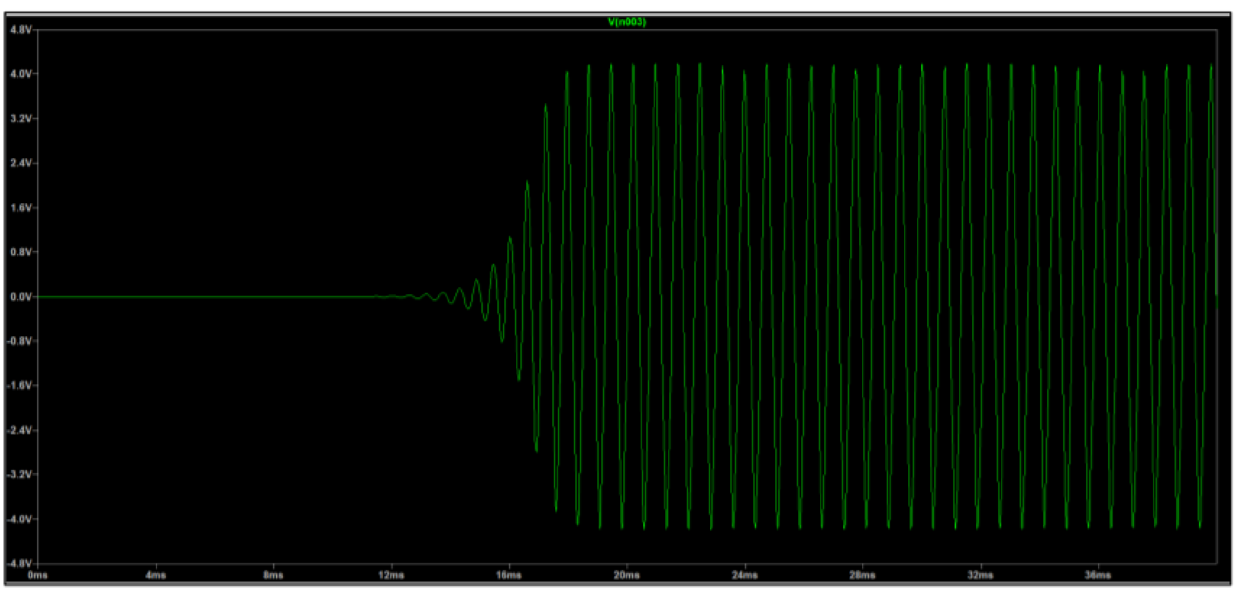

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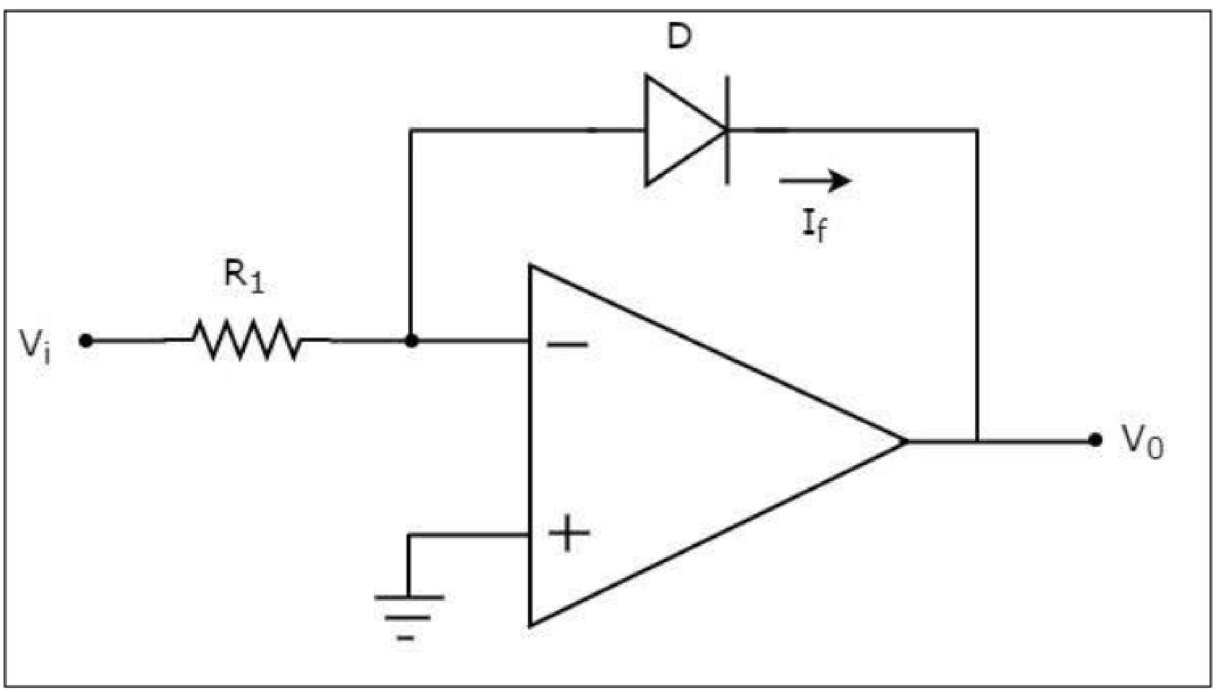
EXPERIMENT 6

AIM

To simulate the output of the Logarithmic Amplifier using an op-amp.

THEORY

A logarithmic amplifier (or a log amplifier) is an electronic circuit that produces an output that is proportional to the logarithm of the applied input. Other applications for log/anti-log amplifiers include signal compression and process control. Signals are often compressed in order to decrease their dynamic range (i.e., the difference between the highest and lowest level signals). In telecommunications systems, this may be required in order to achieve reasonable voice or data transmission with limited resources. An op-amp based logarithmic amplifier produces a voltage at the output, which is proportional to the logarithm of the voltage applied to the resistor connected to its inverting terminal.



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$I_E = (e^{(qV_E/kT)} - 1)$

Since $I_C = I_E$ for a grounded base transistor,

$I_C = I_s(e^{(qV_E/kT)} - 1)$,

Where

I_S = emitter saturation current ≈ 10^{-13} A

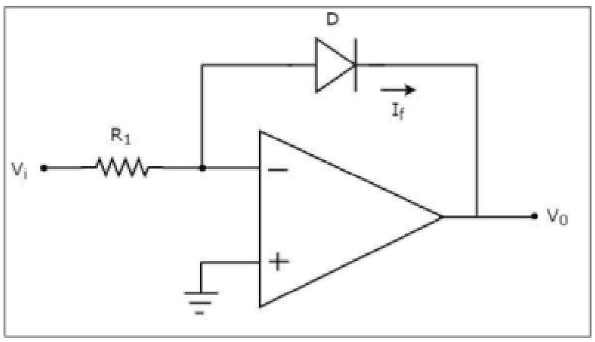
k = Boltzmann's Constant

T = absolute temperature (in K)

Therefore, $e^{(qV_E/kT)} = (I_C/I_S)+1 = I_C/I_S$(nearly equal)

Taking natural log on both sides, we get

$V_E=(kT/q)^* \ln(I_C/I_S)$, also $V_E=-V_0$



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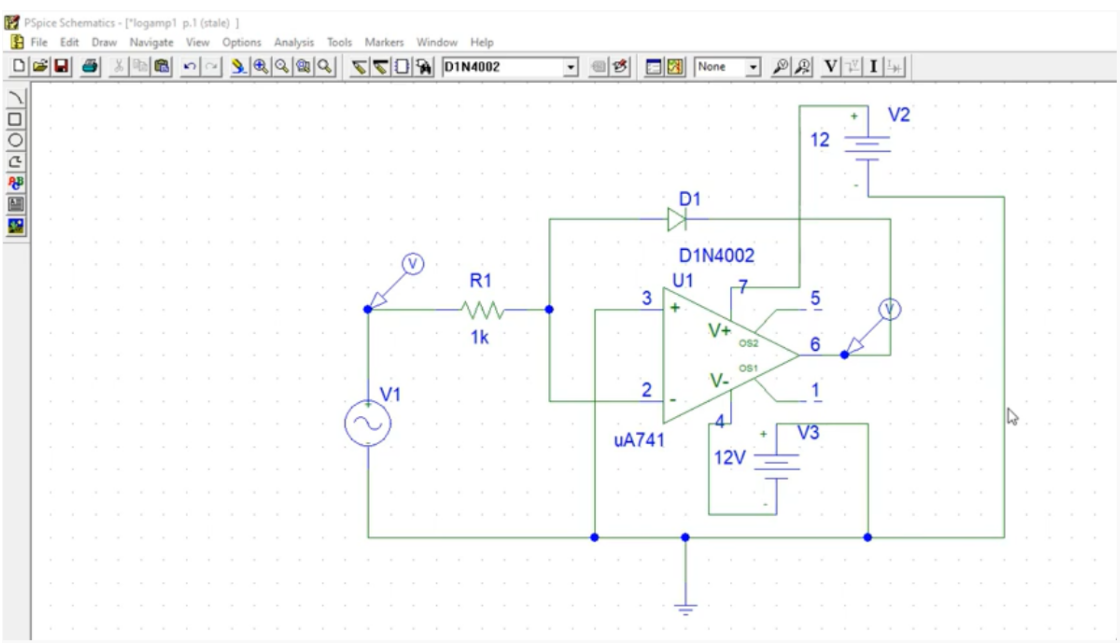

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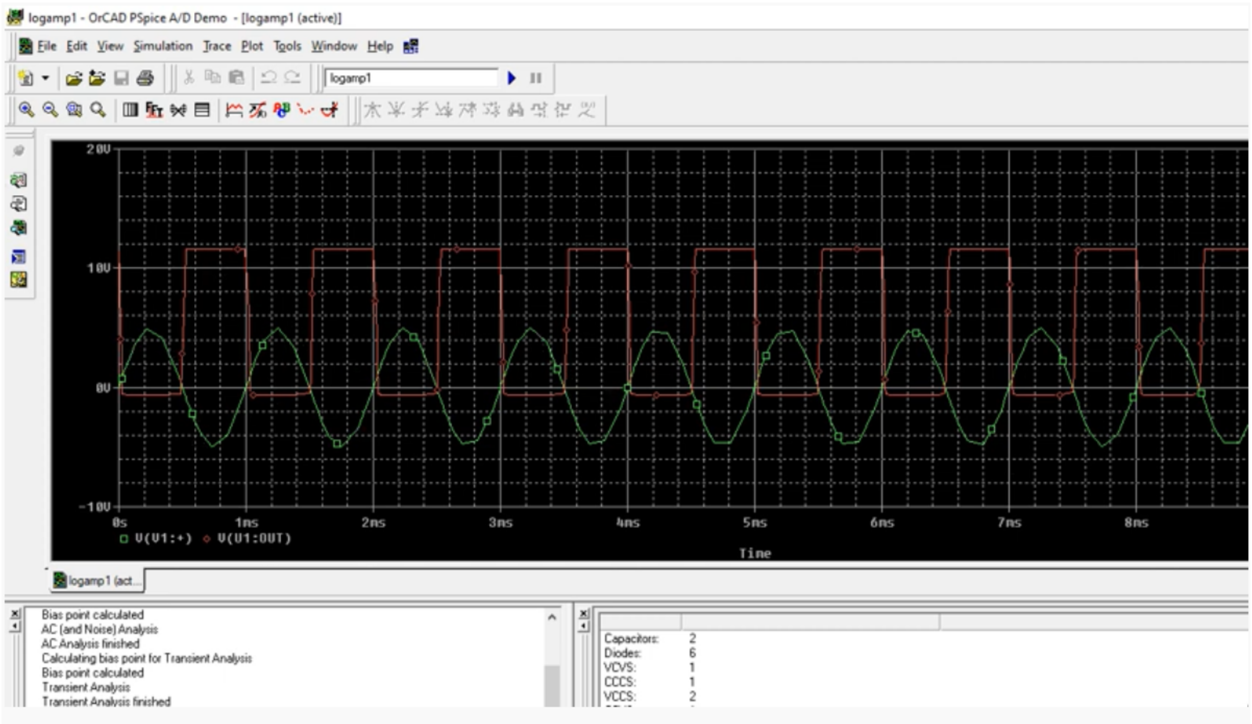

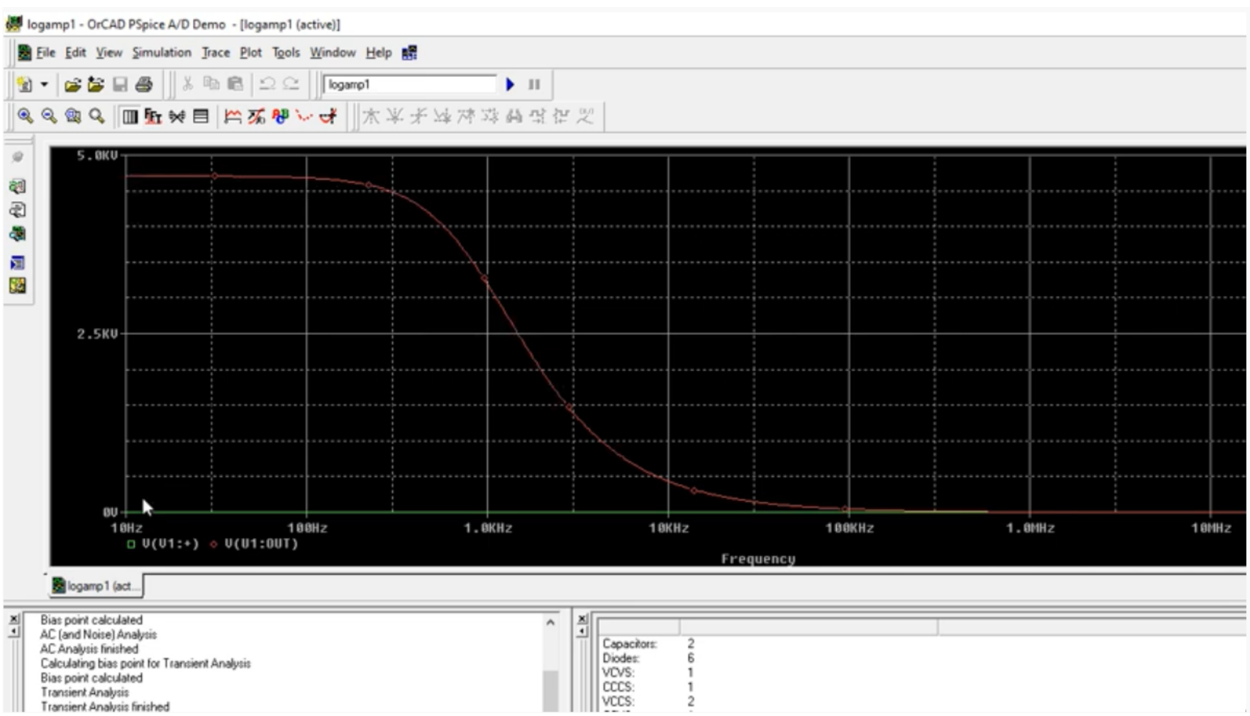

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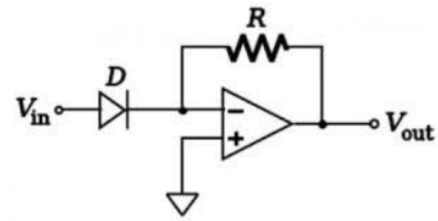
AIM

To simulate the output of the antilog Amplifier using an op-amp.

THEORY

An anti-logarithmic amplifier, or an anti-log amplifier, is an electronic circuit that produces an output that is proportional to the anti-logarithm of the applied input. This section discusses about the op-amp based anti-logarithmic amplifier in detail. An op-amp based anti-logarithmic amplifier produces a voltage at the output, which is proportional to the anti-logarithm of the voltage that is applied to the diode connected to its inverting terminal.

The circuit diagram of an op-amp based anti-logarithmic amplifier is shown in the following figure −



$$V_O = -R_f I_s e^{(V_{in}/V_T)}$$

Note that, in the above equation the parameters n, V_T and I_s are constants. So, the output voltage V_0 will be proportional to the anti-natural logarithm(exponential) of the input voltage V_i, for a fixed value of feedback resistance R_f.

Applications

Two voltages A and B can be multiplied using a log and antilog amplifier. Firstly, log of both the voltages is taken and added.

log(A) + log(B) = log(AB)

Then antilog is taken and the output obtained is AxB.
Similarly, two voltages can be divided using a log and antilog amplifier.

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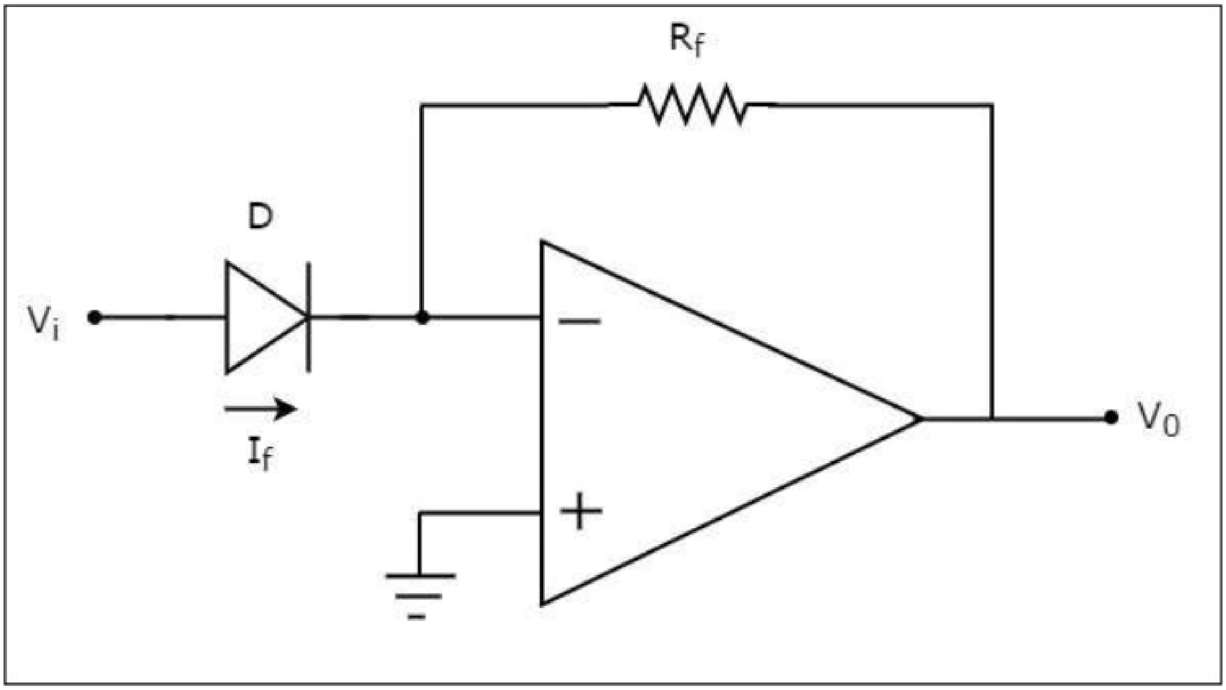

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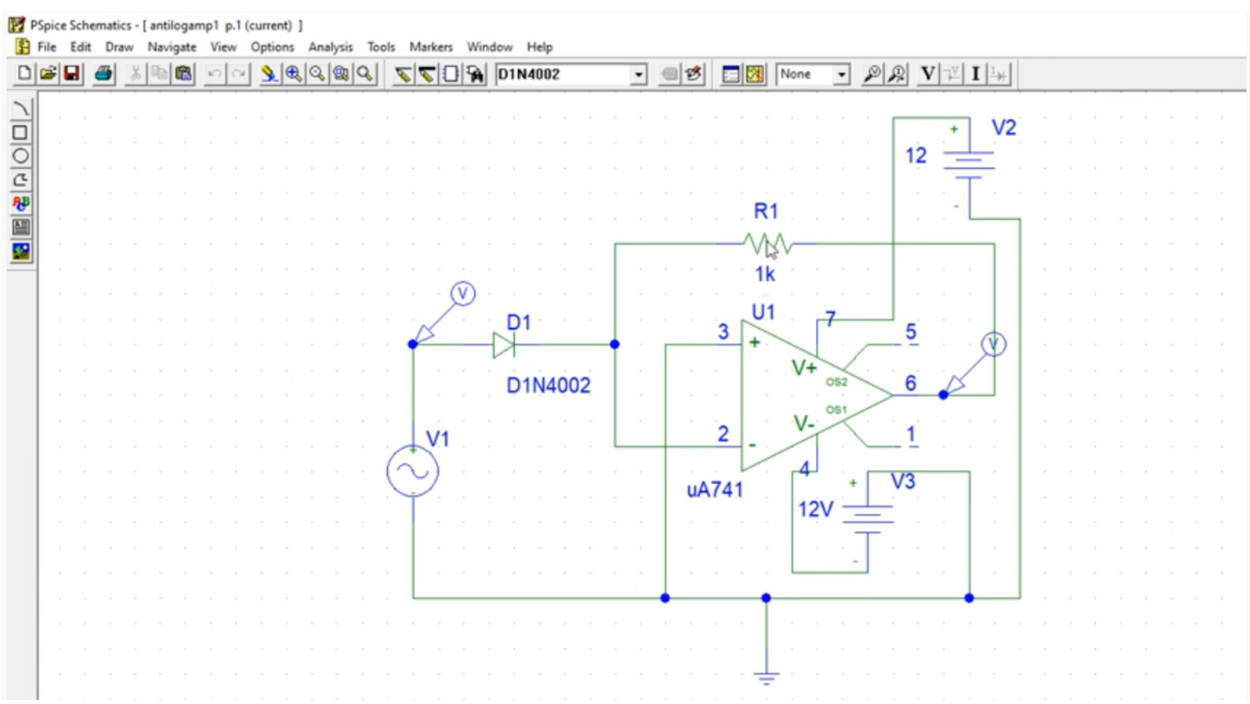

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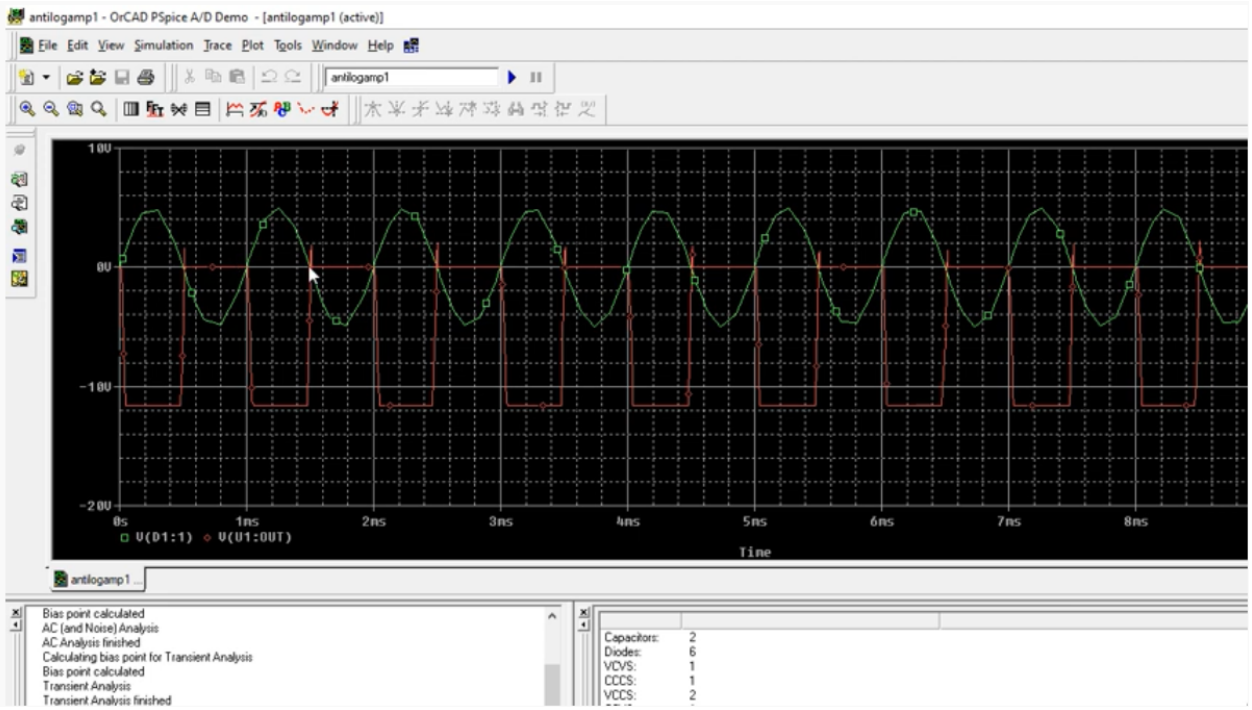

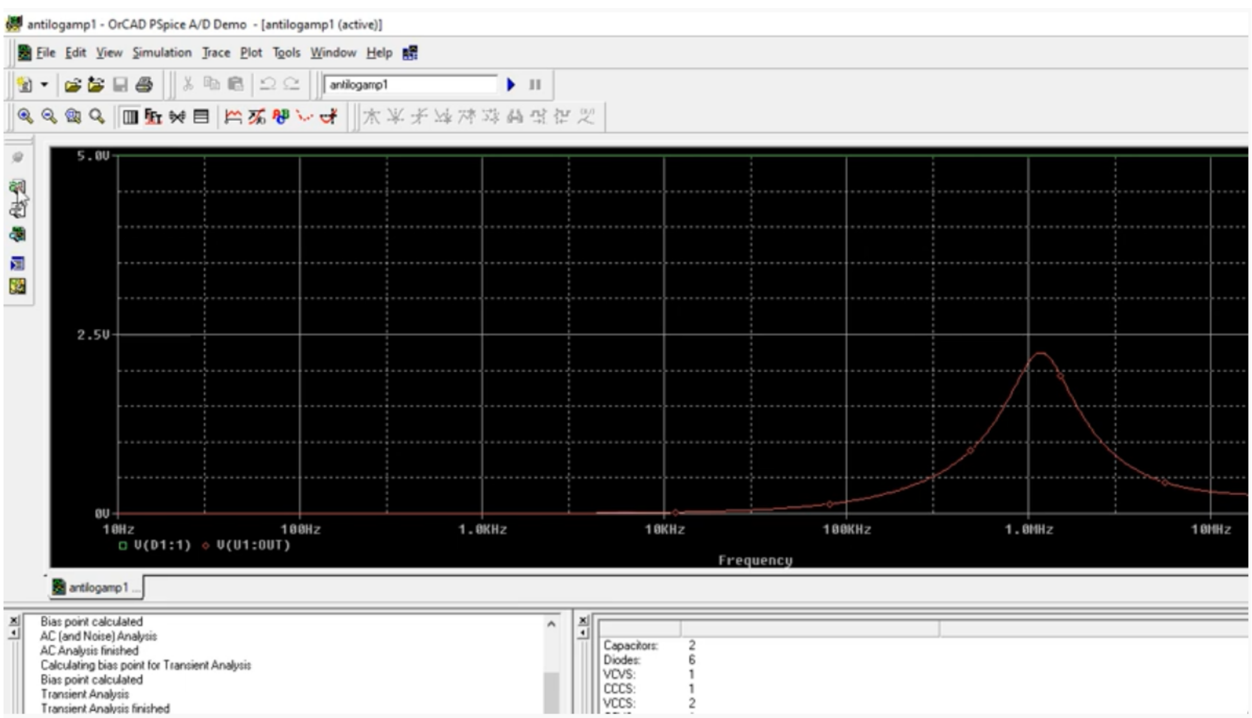

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EXPERIMENT 7

AIM

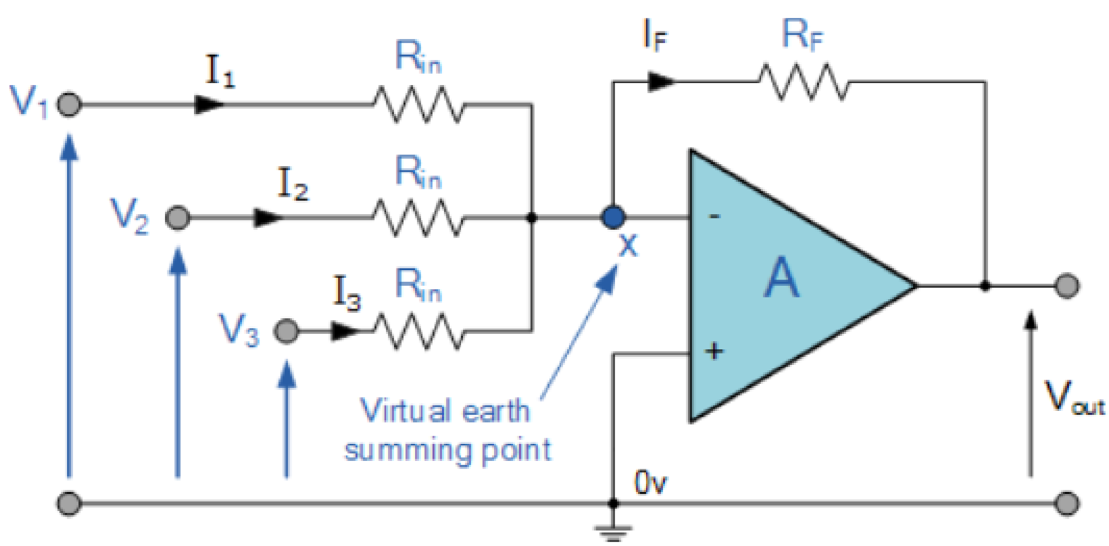
To simulate the output of the adder circuit using an op-amp.

THEORY

$$I_F = I_1 + I_2 + I_3 = -\left[\frac{V1}{Rin} + \frac{V2}{Rin} + \frac{V3}{Rin}\right]$$

$$\text{Inverting Equation: } Vout = -\frac{Rf}{Rin} \times Vin$$

$$\text{then, } -Vout = \left[\frac{R_F}{Rin}V1 + \frac{R_F}{Rin}V2 + \frac{R_F}{Rin}V3\right]$$



$$-Vout = \frac{R_F}{R_{IN}}\left(V1 + V2 + V3 \ldots .etc\right)$$

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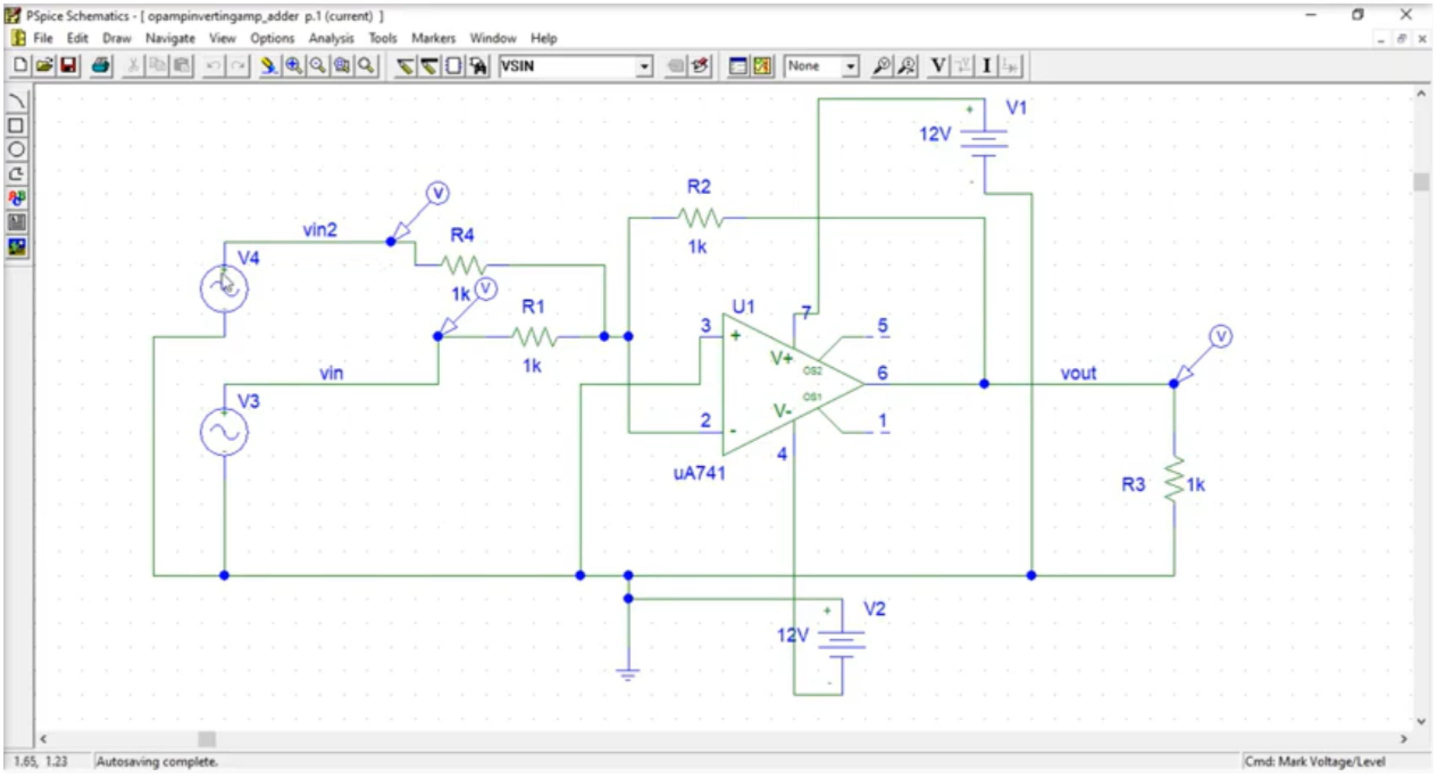

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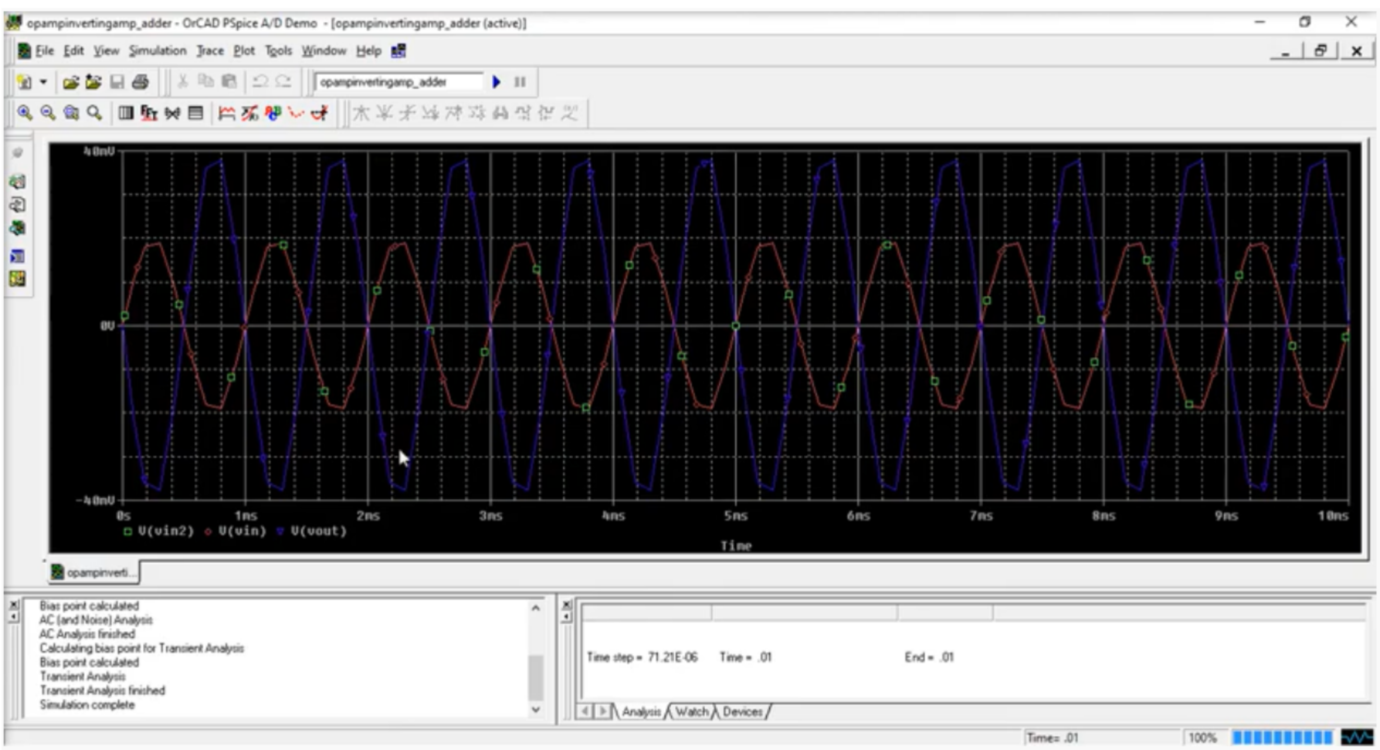

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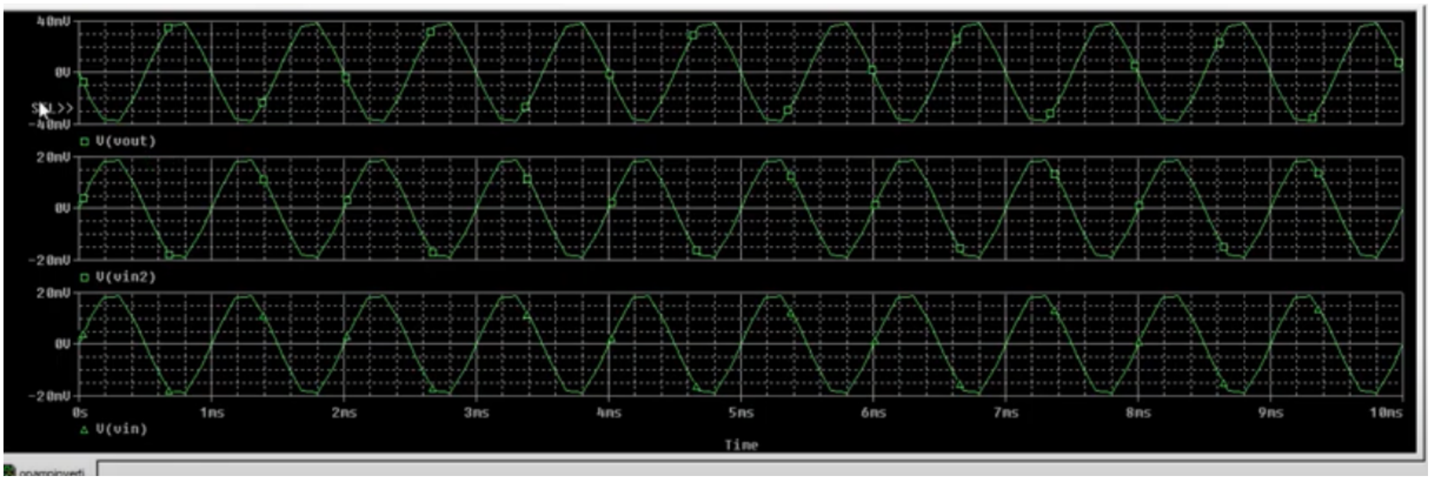

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