FCEC003 LAB FILE

MANAN SURI

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2020UCO1696
COE 3

Contents

EXPERIMENT 5

Date: 28 Decemeber,2020

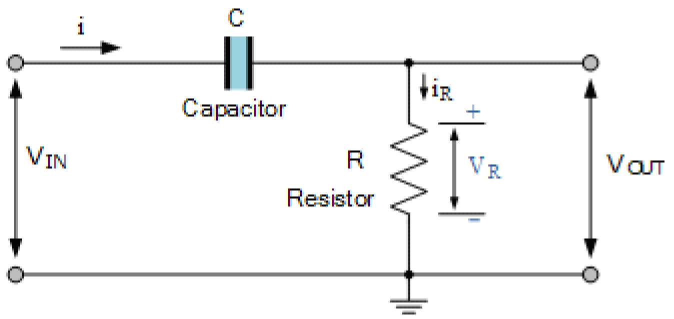
Aim: *To design and construct RC differentiator and RC integrator circuit and study its frequency response of RC differentiator as high pass filter and RC integrator circuit as low pass filter.*

Software Required: LT Spice XVII

Theory:

RC Differentiator:

An RC differentiator circuit is a wave shaping circuit. It constitutes a capacitor in series and a resistor in parallel at the output. The time constant (R x C) of the circuit is very small in comparison with the period of the input signal. As the name shows the circuit does the mathematical operation 'differentiation' on the input signal. At the time of differentiation the voltage drop across R will be very small in comparison with the drop across C.



$$V_{OUT} = RC\frac{dV_{IN}}{dt}$$

The output voltage, V_{OUT} is the derivative of the input voltage, V_{IN} which is weighted by the constant of RC, where RC represents the time constant.

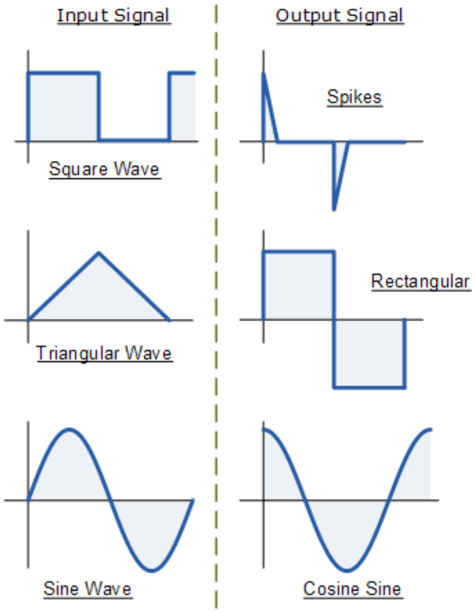


Fig.1

Differentiator as High Pass Filter:

In circuit the reactance of the capacitor is very high at low frequencies so the capacitor acts like an open circuit and blocks any input signals at V_{IN} until the cut-off frequency point (f_C) is reached. Above this cut-off frequency point the reactance of the capacitor has reduced sufficiently as to now act more like a short circuit allowing all of the input signal to pass directly to the output as shown below in the filters response curve. At low frequencies, the output of a differentiator is zero whereas at high frequencies, its output is of some finite value.

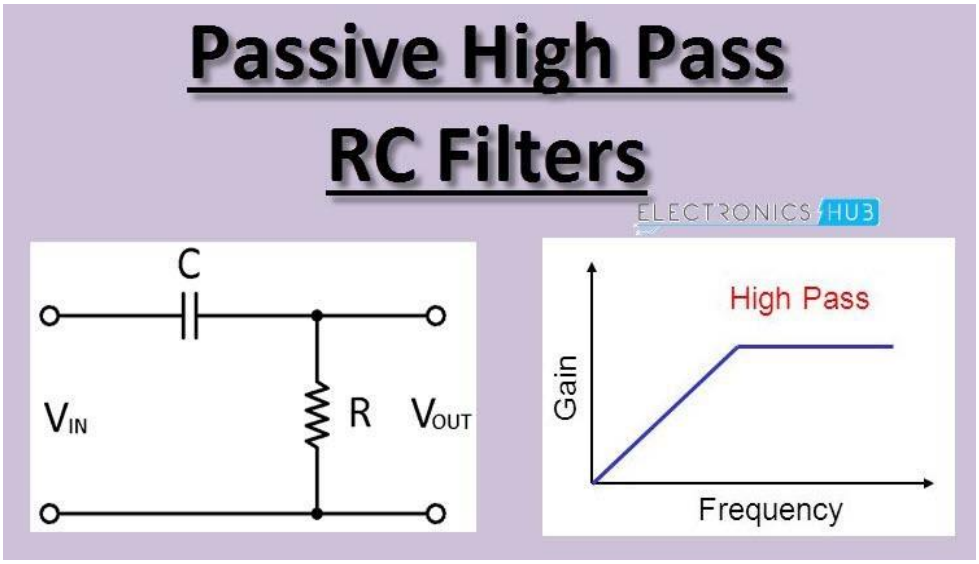


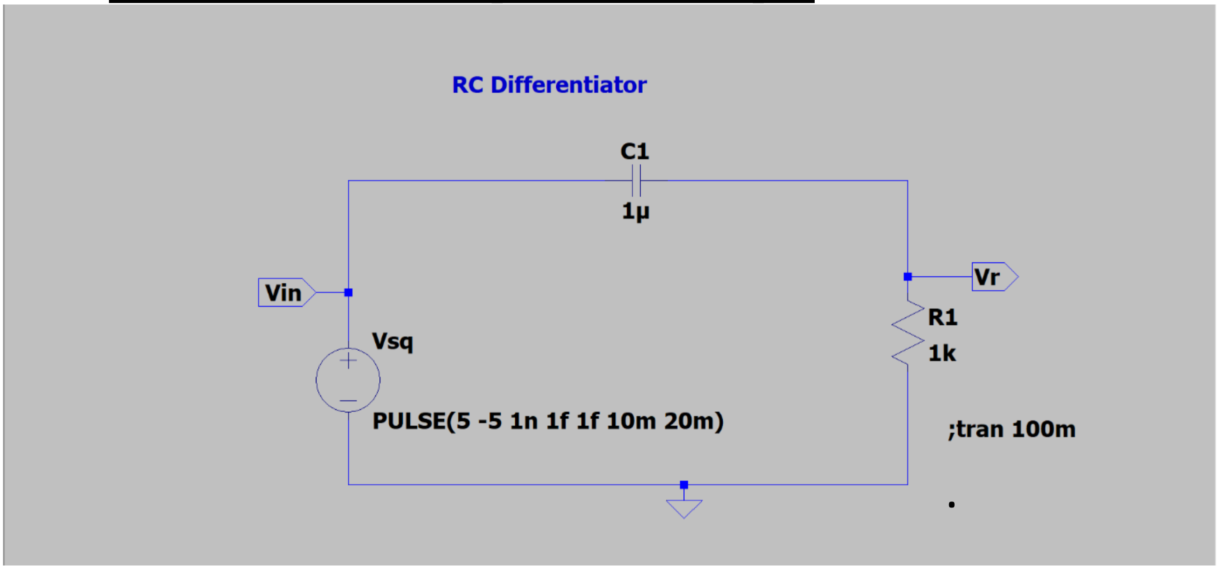
Fig.2

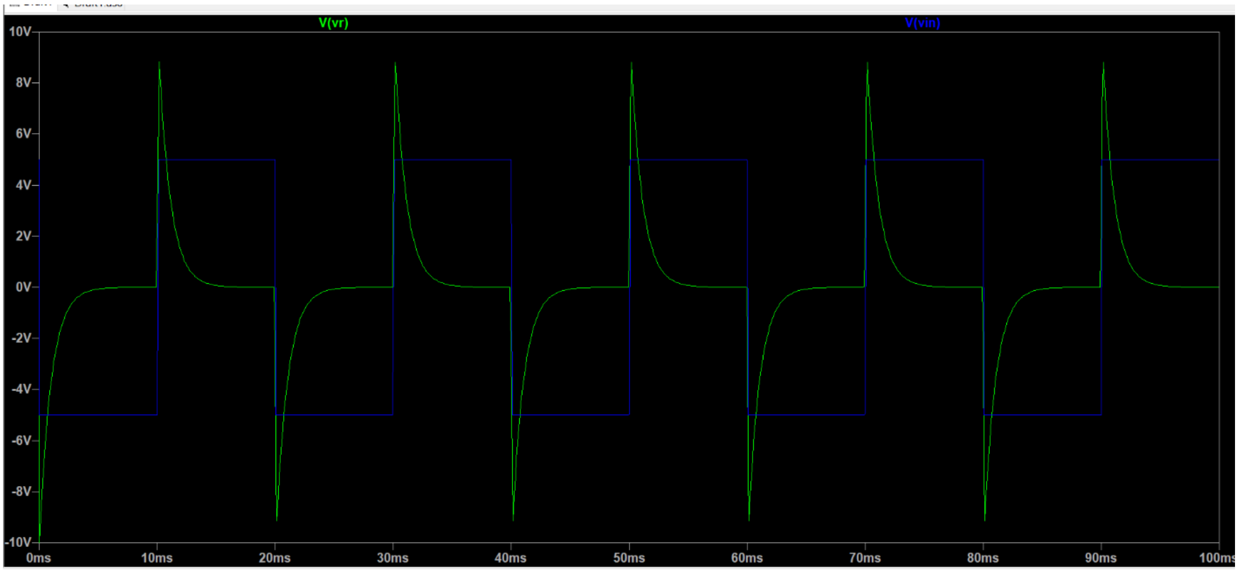
OBSERVATIONS:

1. Assemble the circuit on software.
2. Choose C=1uF, R=1kohm.
3. Apply square input waveform of Time period=20ms and observe spike output waveform as given in Fig.1.

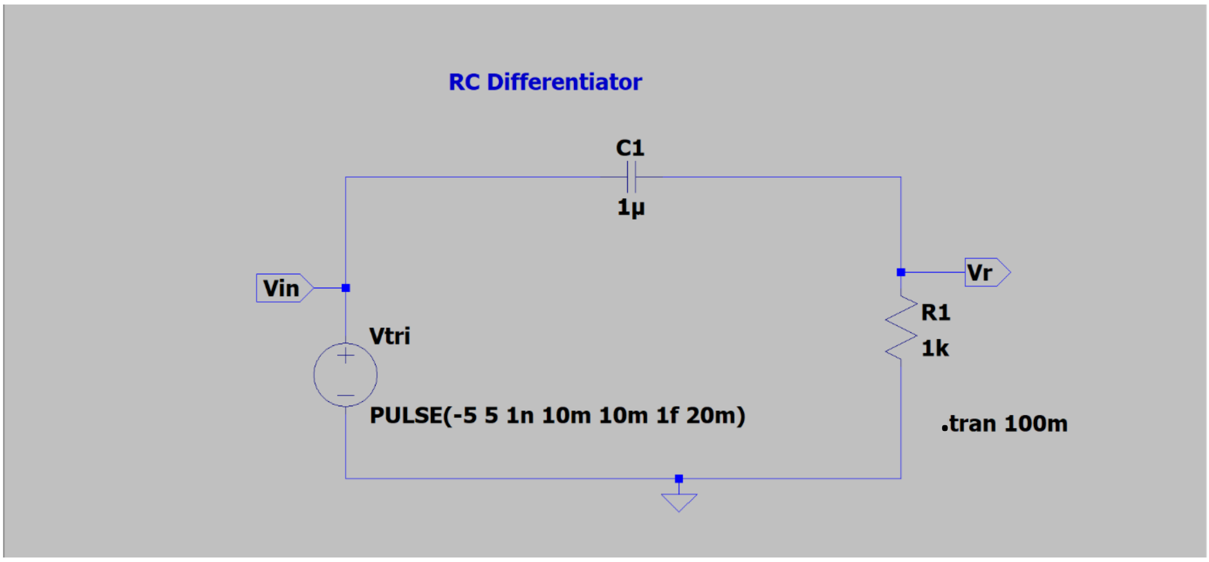
4. Apply triangular input waveform of Time period=20ms and observe the square output waveform as given in Fig.1.
5. Plot the ac response for circuit by applying sin input of 1V and sweep the input signal frequency.

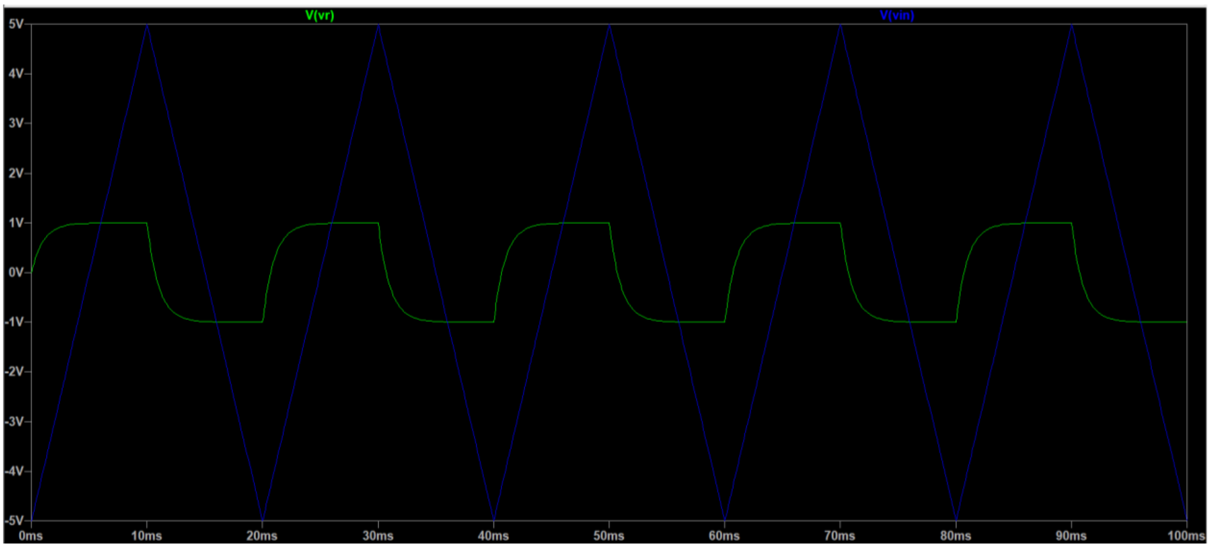
1. RC Differentiator, Square Wave Input



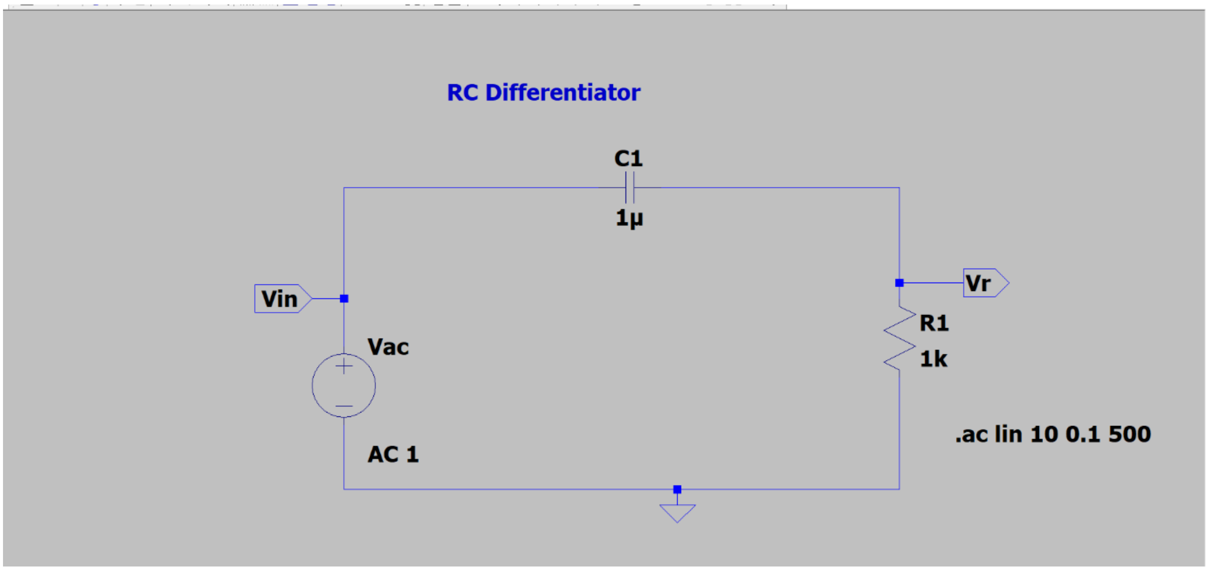


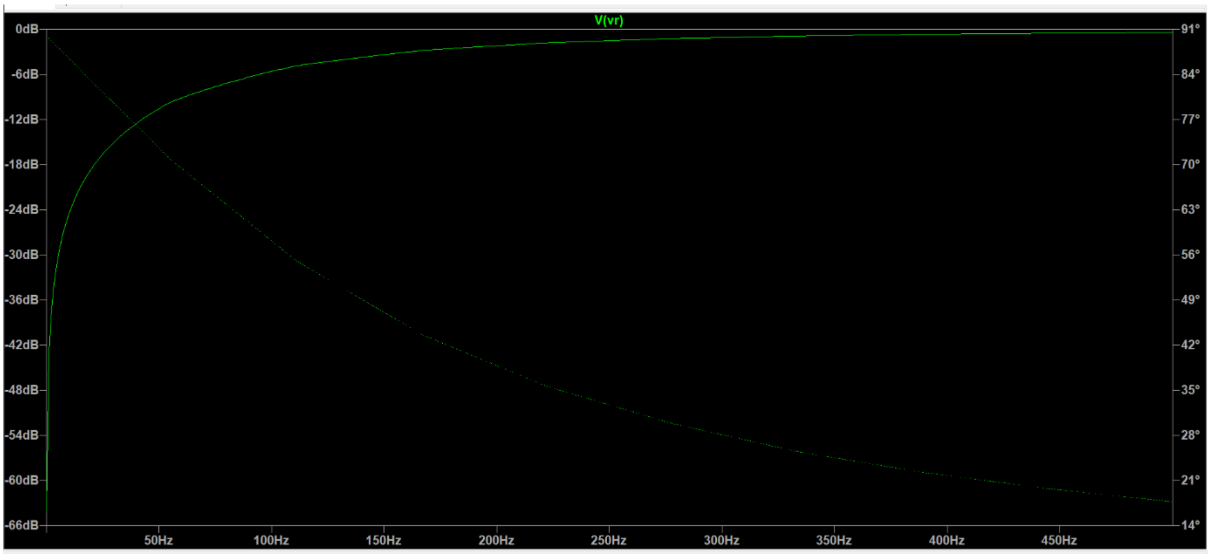
2. RC Differentiator, Triangle Wave Input





3. RC Differentiator, AC Analysis (High Pass filter)





RC Integrator

An RC integrator circuit is a wave shaping circuit. It constitutes a resistor in series and a capacitor in parallel to the output. As the name suggests it does the mathematical operation 'integration' on the input signal. The time constant RC of the circuit is very large in comparison with the time period of the input signal. Under this condition the voltage drop across C will be very small in comparison with the voltage drop across R. For satisfactory integration it is necessary that RC ≥ 5T, where T is time period of the input.

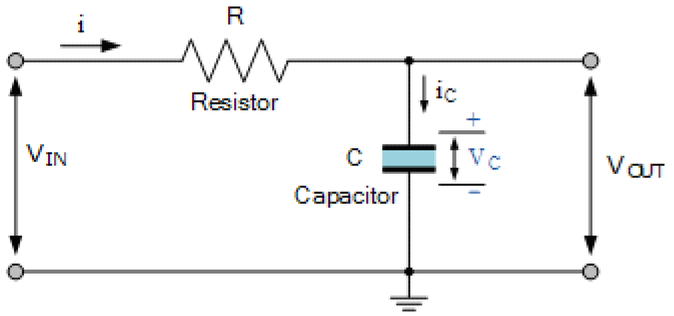


Fig.3

An RC integrator circuit is one in which the output voltage, V_{OUT} is proportional to the integral of the input voltage,

$$V_{OUT} = \frac{1}{RC}\int_0^t V_{IN(t)}\,dt$$

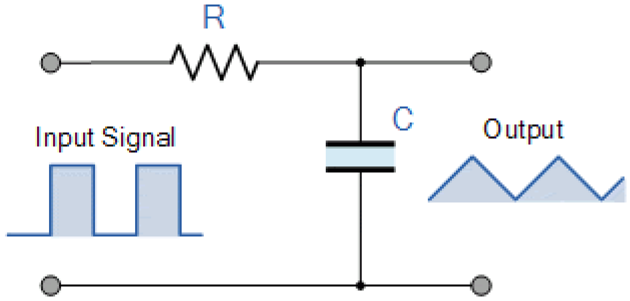


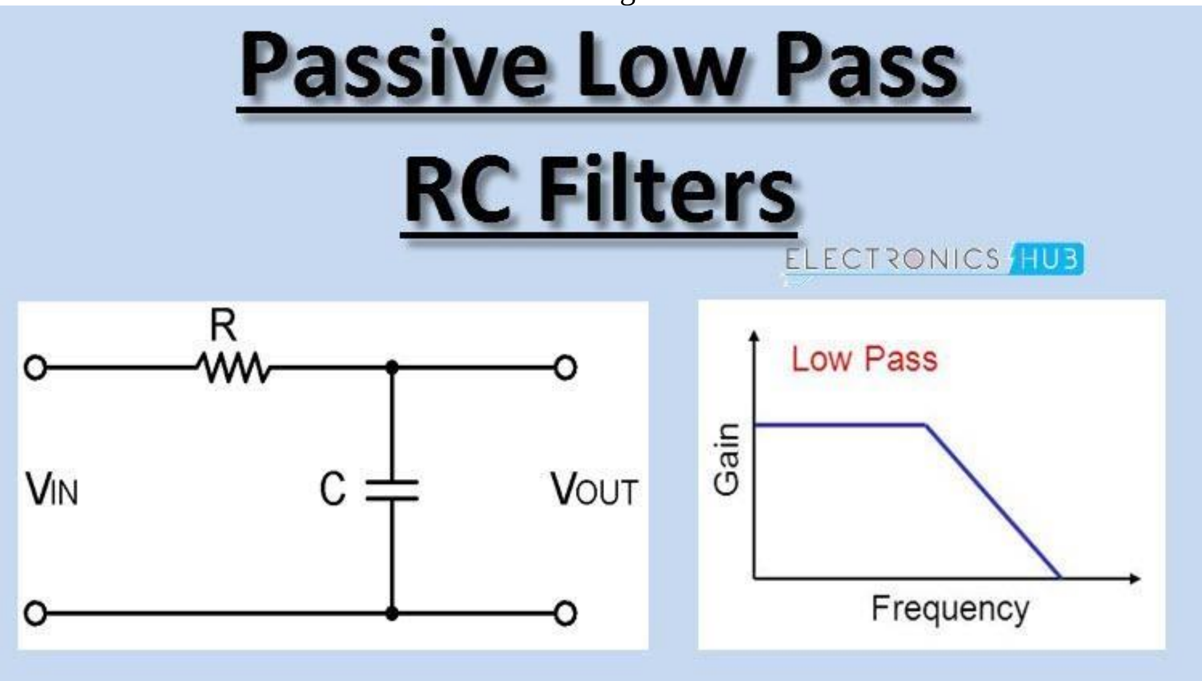
Fig.4

When pulse waveform is given at the input, capacitor charges through R and output voltage builds up slowly. Capacitor continues to charge as long as input voltage is present. When input falls to zero, capacitor discharges and output falls to zero slowly. As the value of RC >> T, the charging current is almost constant and the output become linear. Hence a square pulse input provides a triangular output.

RC INTEGRATOR AS Low Pass Filter:

As reactance of a capacitor varies inversely with frequency, while the value of the resistor remains constant as the frequency changes. At low frequencies the capacitive reactance, (X_C) of the capacitor will be very large compared to the resistive value of the resistor, R. This means that the voltage potential, V_C across the capacitor will be much larger than the voltage drop,

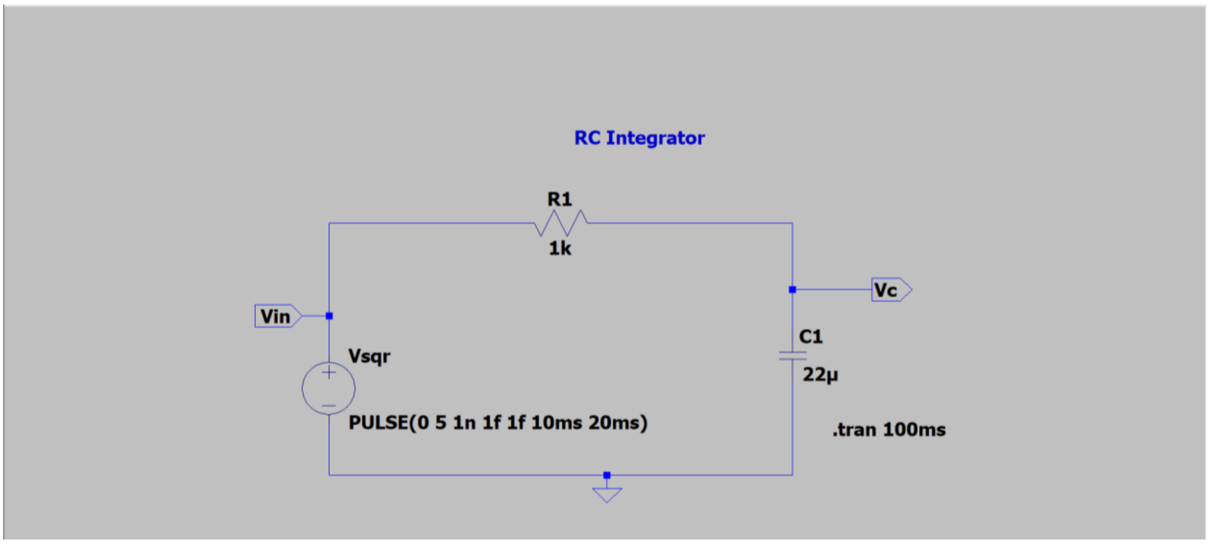
V_R developed across the resistor. At high frequencies the reverse is true with V_C being small and V_R being large due to the change in the capacitive reactance value. The circuit above is that of an RC Low Pass Filter circuit. The Frequency response of a practical low pass filter, when it works as an Integrator is as shown below.

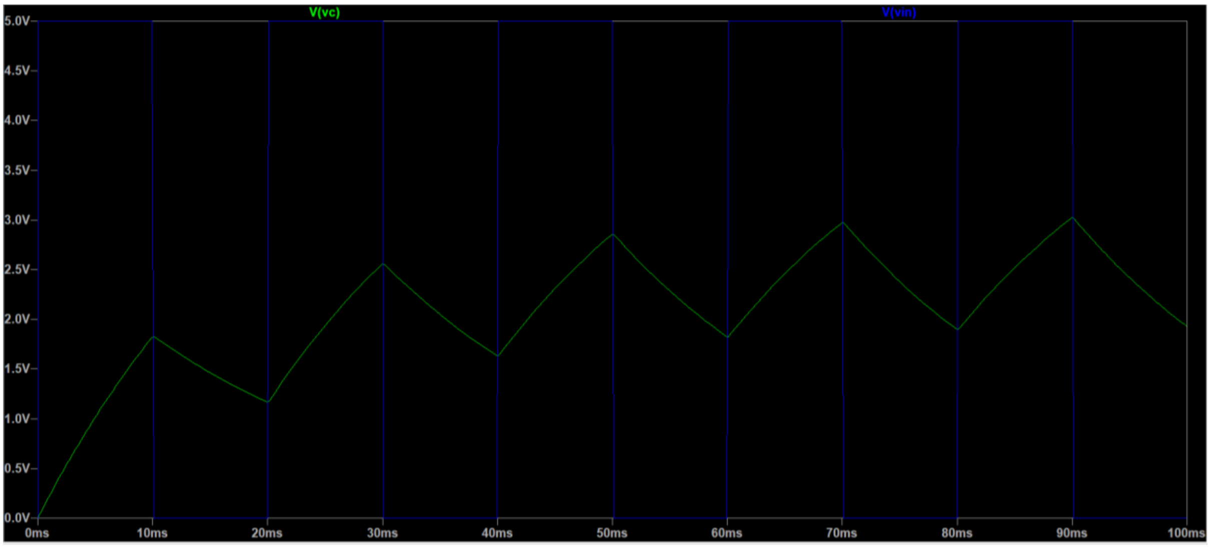


Observations:

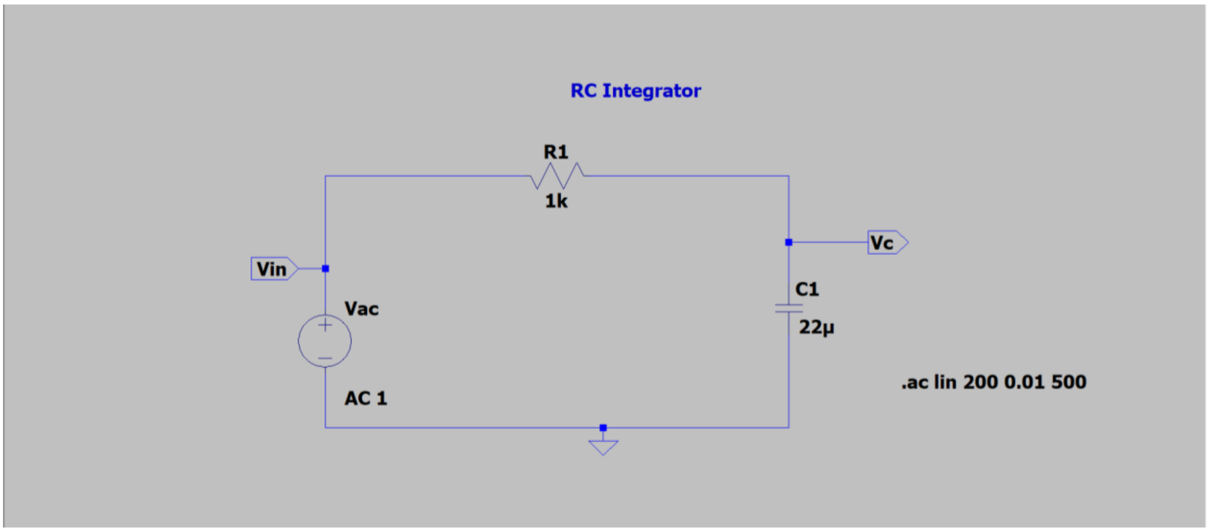
1. Assemble the circuit on software.
2. Choose R=1kohm and C=22uF.
3. Apply square input waveform of Time period=10ms and observe triangular output waveform as given in Fig.4.
4. Plot the ac response for circuit by applying sin input of 1V and sweep the input signal frequency.

1. RC Integrator, Square Wave Input





2. RC Integrator, AC Analysis



EXPERIMENT 6

Date: 5 January,2021

Aim: *Implementation of Clipping and Clamping Circuits.*
Software Required: LT Spice XVII

Theory:

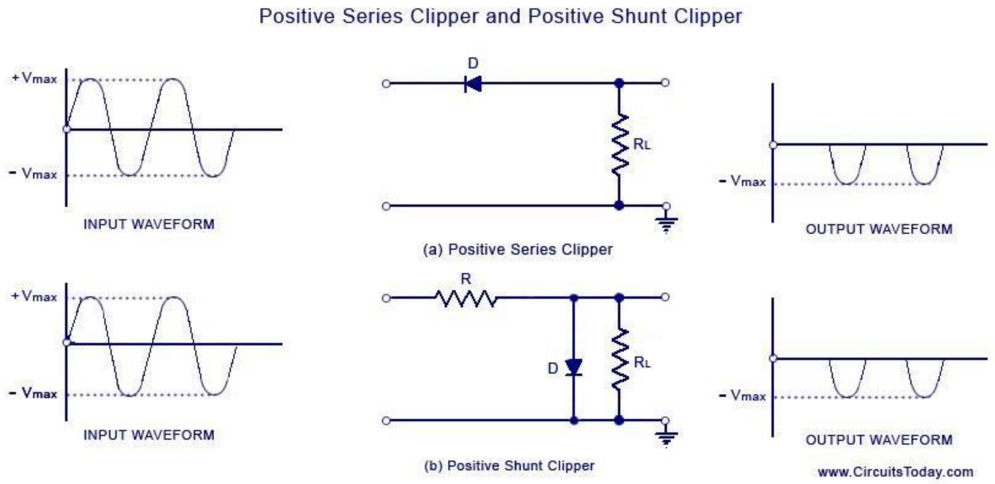
DIODE CLIPPERS

Depending on the features of the diode, the positive or negative region of the input signal is "clipped" off and accordingly the diode clippers may be positive or negative clippers.

There are two general categories of clippers: series and parallel (or shunt). The series configuration is defined as one where diode is in series with the load, while the shunt clipper has the diode in a branch parallel to the load.

Positive Diode Clipper

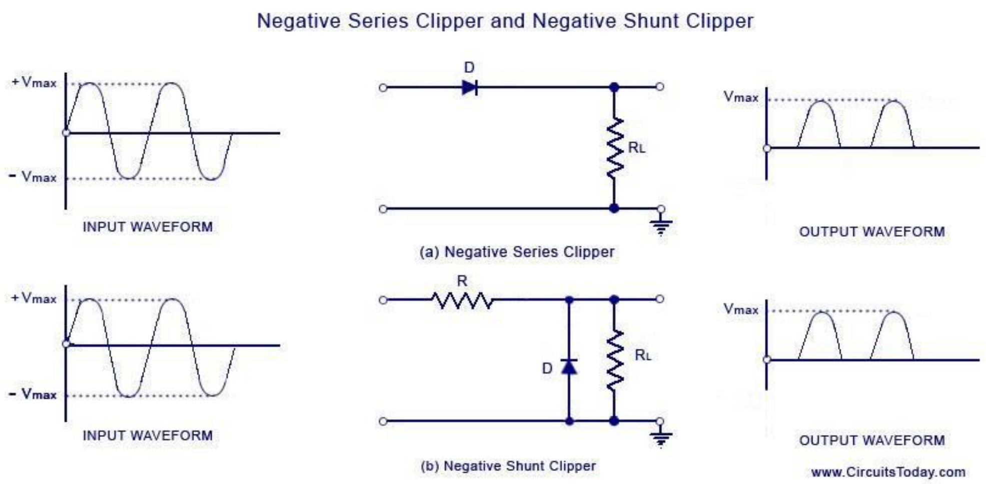
In a positive clipper, the positive half cycles of the input voltage will be removed.



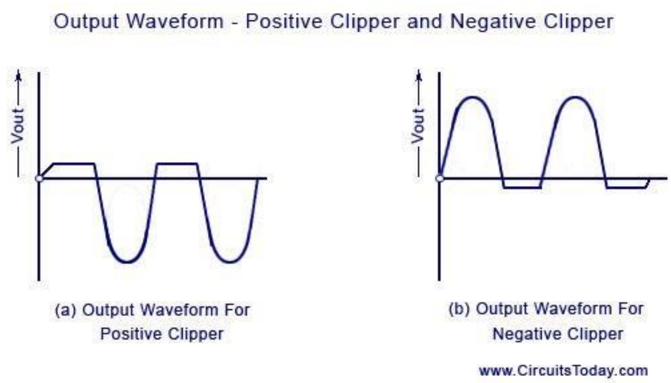
As shown in the figure, the diode is kept in series with the load. During the positive half cycle of the input waveform, the diode 'D' is reverse biased, which maintains the output voltage at 0 Volts. Thus causes the positive half cycle to be clipped off. During the negative half cycle of the input, the diode is forward biased and so the negative half cycle appears across the output.

Negative Diode Clipper

The negative clipping circuit is almost same as the positive clipping circuit, with only one difference. If the diode in figures (a) and (b) is reconnected with reversed polarity, the circuits will become for a negative series clipper and negative shunt clipper respectively. The negative series and negative shunt clippers are shown in figures (a) and (b) as given below.



In all the above discussions, the diode is considered to be ideal one. In a practical diode, the breakdown voltage will exist (0.7 V for silicon and 0.3 V for Germanium). When this is taken into account, the output waveforms for positive and negative clippers will be of the shape shown in the figure below.



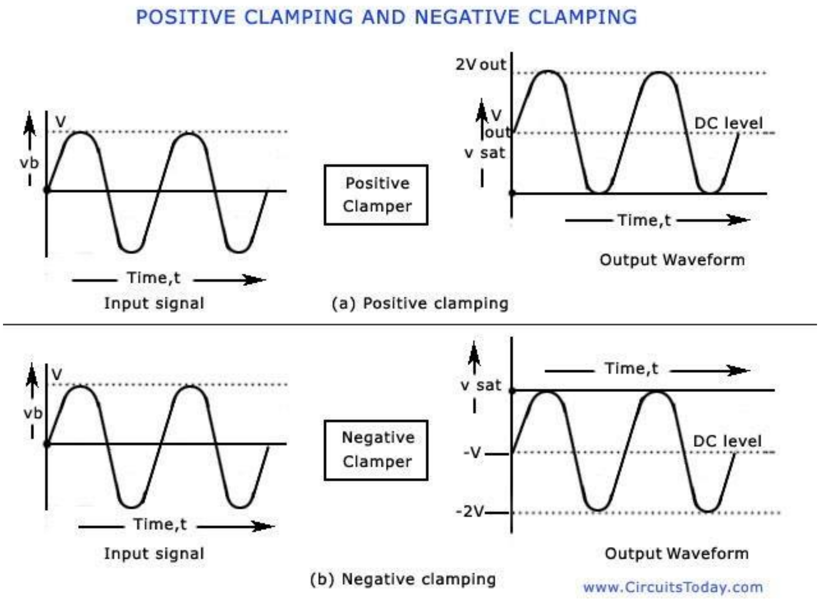
DIODE CLAMPERS

A clamping circuit is used to place either the positive or negative peak of a signal at a desired level. The dc component is simply added or subtracted to/from the input signal. The clamper is also referred to as an IC restorer and ac signal level shifter.

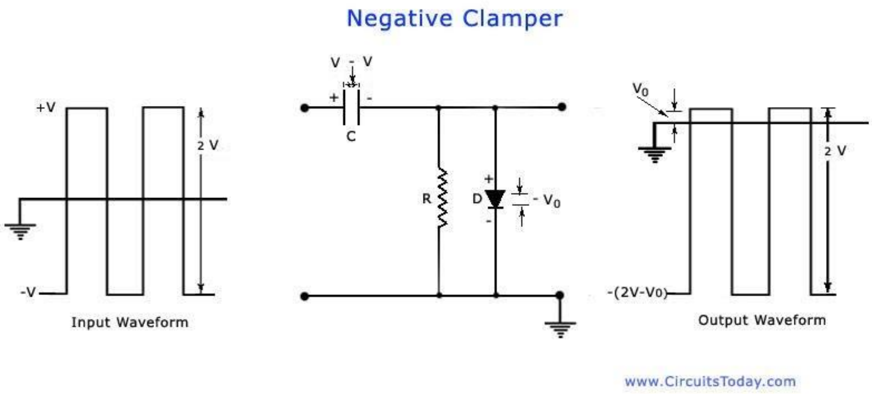
A clamp circuit adds the positive or negative dc component to the input signal so as to push it either on the positive side, as illustrated in figure (a) or on the negative side, as illustrated in figure (b).

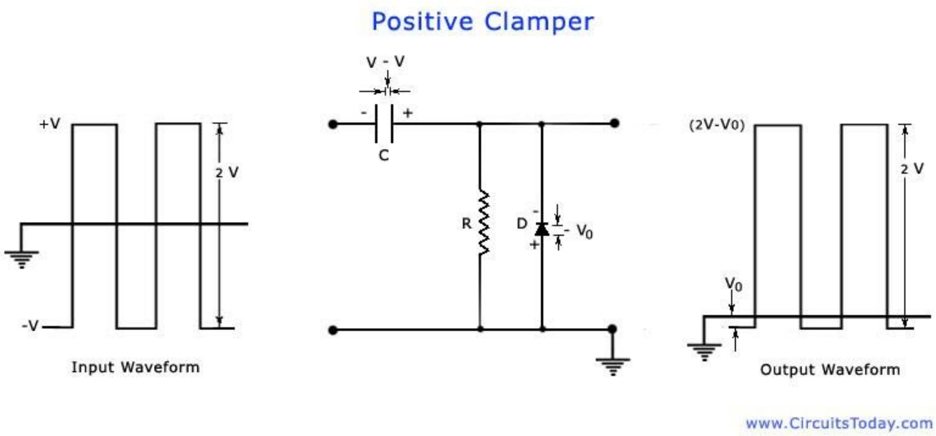
The circuit will be called a positive clamper, when the signal is pushed upward by the circuit. When the signal moves upward, as shown in figure (a), the negative peak of the signal coincides with the zero level.

The circuit will be called a negative clamper, when the signal is pushed downward by the circuit. When the signal is pushed on the negative side, as shown in figure (b), the positive peak of the input signal coincides with the zero level.



Consider a negative clamping circuit, a circuit that shifts the original signal in a vertical downward direction, as shown in the figure below. The diode D will be forward biased and the capacitor C is charged with the polarity shown, when an input signal is applied. During the positive half cycle of input, the output voltage will be equal to the barrier potential of the diode, V0 and the capacitor is charged to (V – VQ). During the negative half cycle, the diode becomes reverse-biased and acts as an open-circuit. Thus, there will be no effect on the capacitor voltage. The resistance R, being of very high value, cannot discharge C a lot during the negative portion of the input waveform. Thus during negative input, the output voltage will be the sum of the input voltage and the capacitor voltage and is equal to – V – (V — V0) or – (2 V – V0). The value of the peak-to-peak output will be the difference of the negative and positive peak voltage levels is equal to V0-[-(2V-V0)] or 2 V.

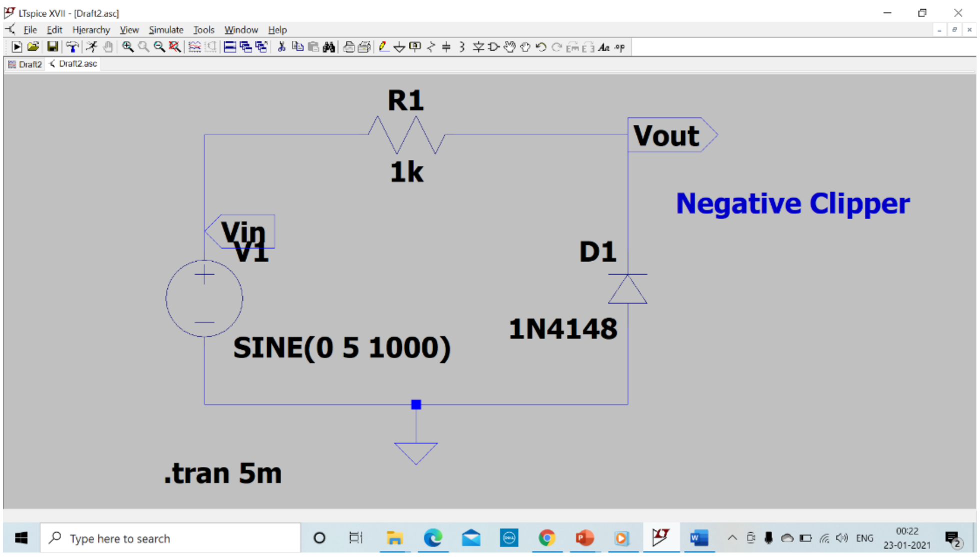


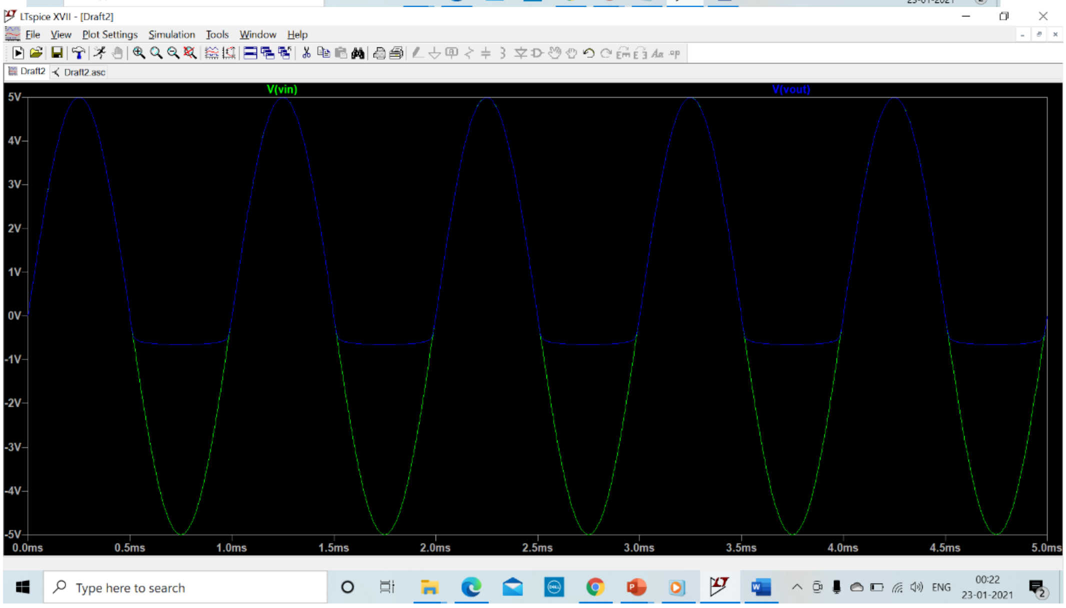


Implementation & Output

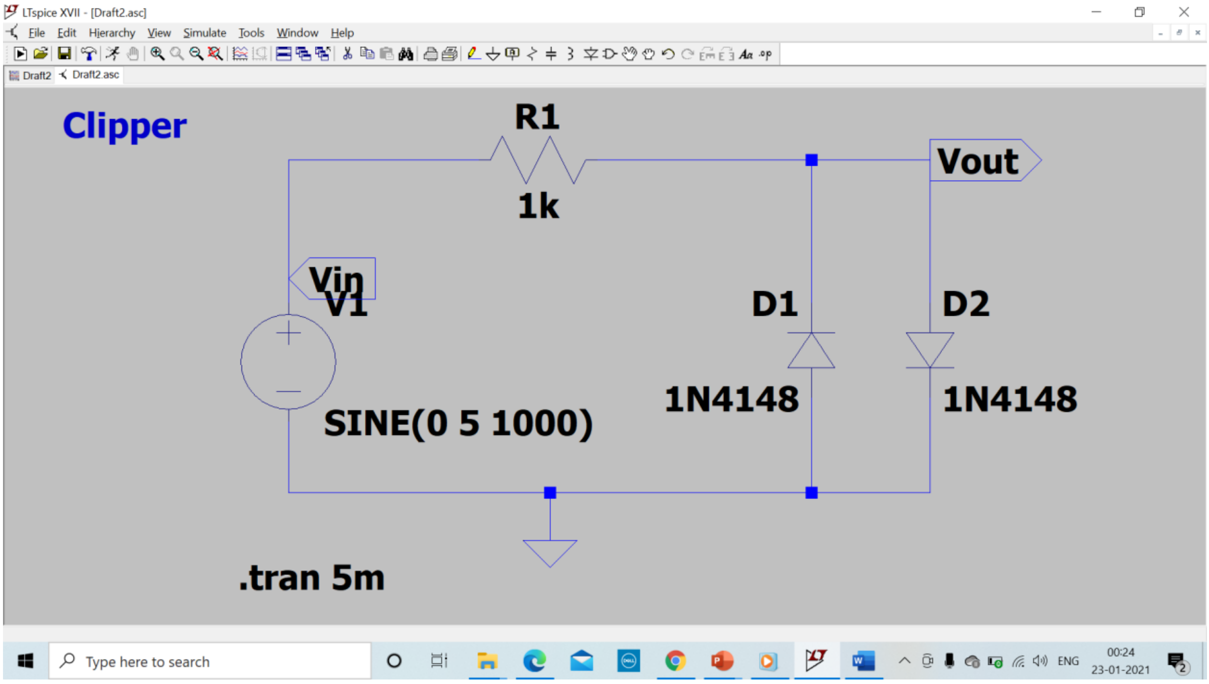
Clipper

A)

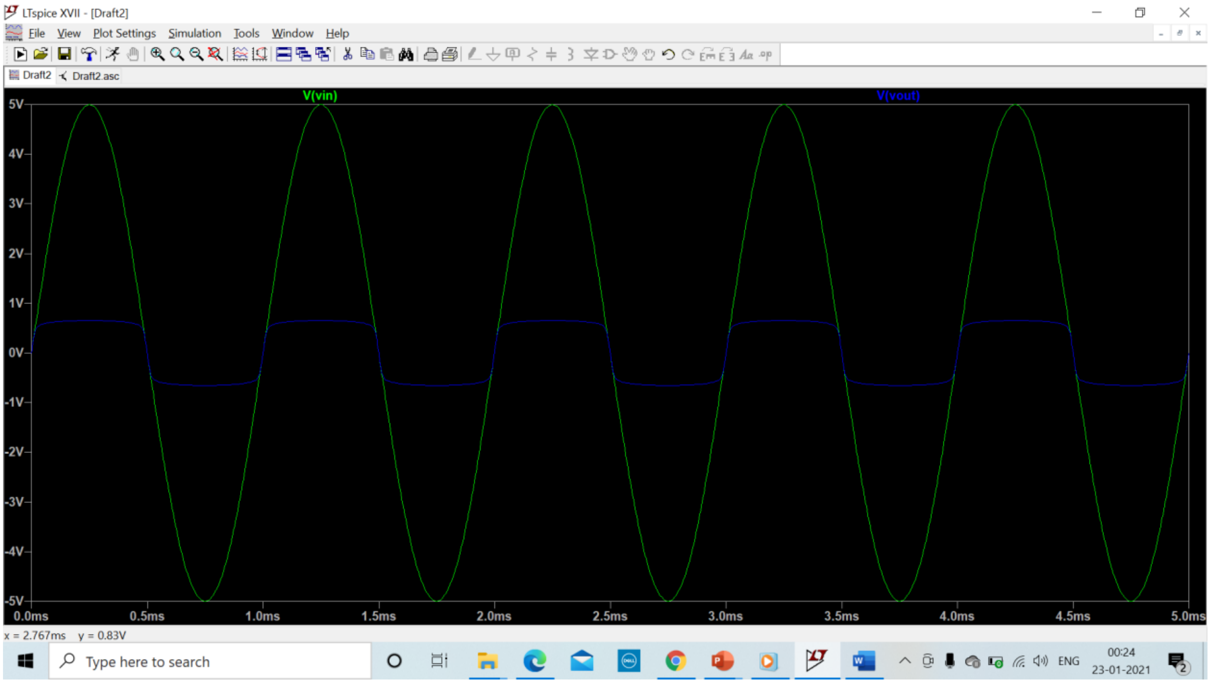




B)

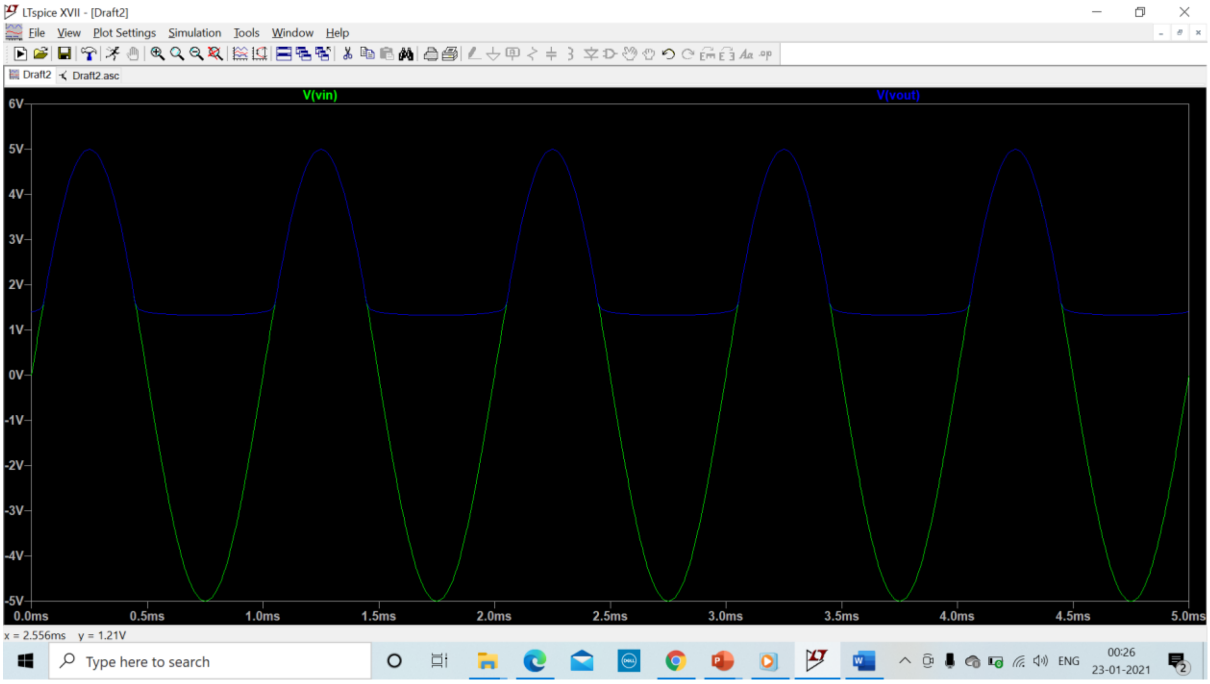


LTspice XVII - [Draft2.asc]
Clipper
R1
1k
Vout
Vin
V1
D1
D2
1N4148
1N4148
SINE(0 5 1000)
.tran 5m



LTspice XVII - [Draft2]
V(vin)
V(vout)
5V
4V
3V
2V
1V
0V
-1V
-2V
-3V
-4V
-5V
0.0ms
0.5ms
1.0ms
1.5ms
2.0ms
2.5ms
3.0ms
3.5ms
4.0ms
4.5ms
5.0ms
x = 2.767ms y = 0.83V

C)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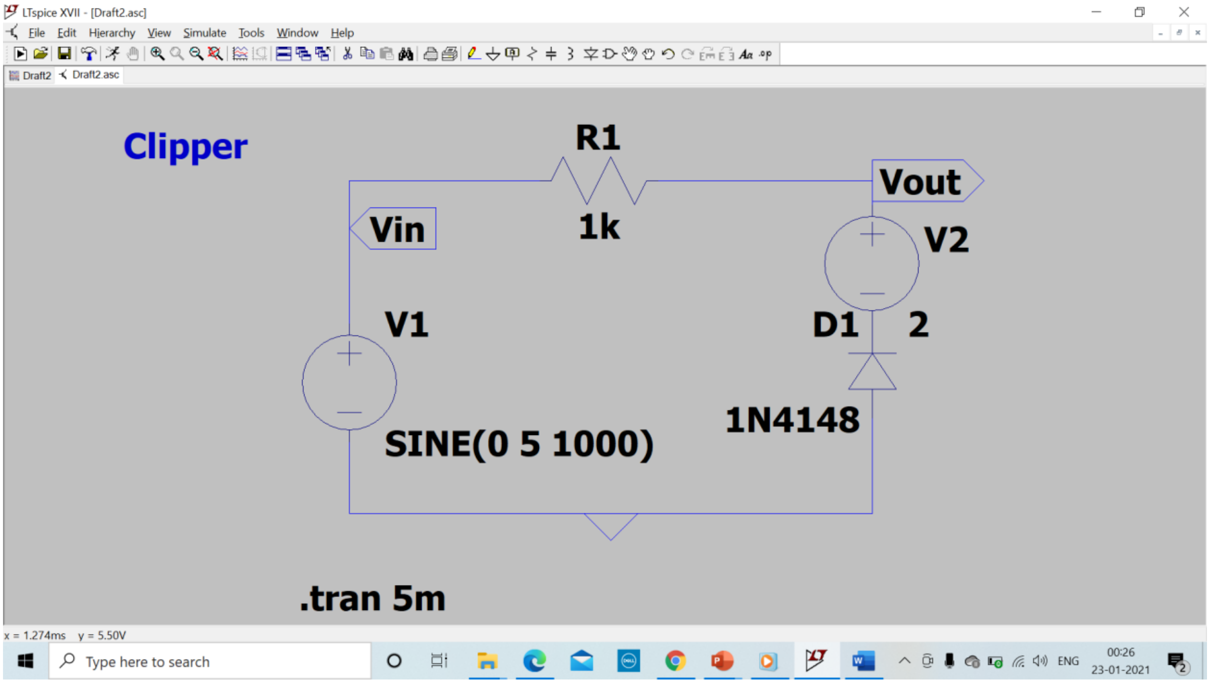
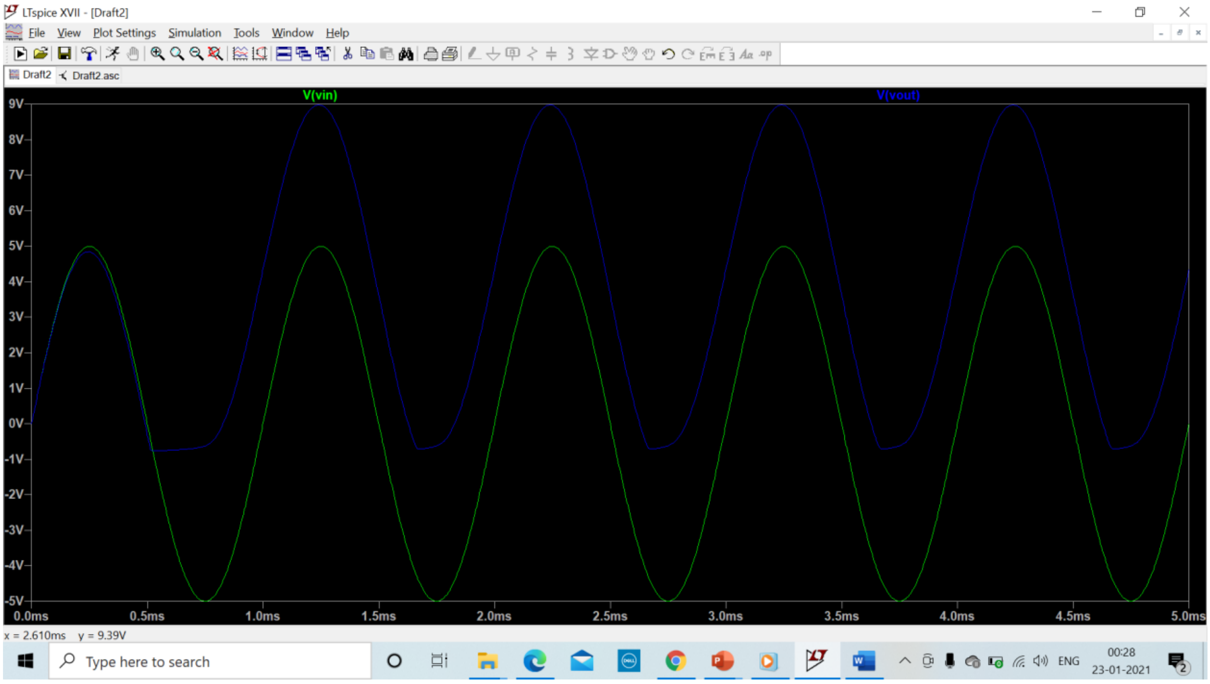
File View Plot Settings Simulation Tools Window Help
Draft2 Draft2.asc
V(vin)
V(vout)
6V
5V
4V
3V
2V
1V
0V
-1V
-2V
-3V
-4V
-5V
0.0ms
0.5ms
1.0ms
1.5ms
2.0ms
2.5ms
3.0ms
3.5ms
4.0ms
4.5ms
5.0ms
x = 2.556ms y = 1.21V
Type here to search
ENG
00:26
23-01-2021

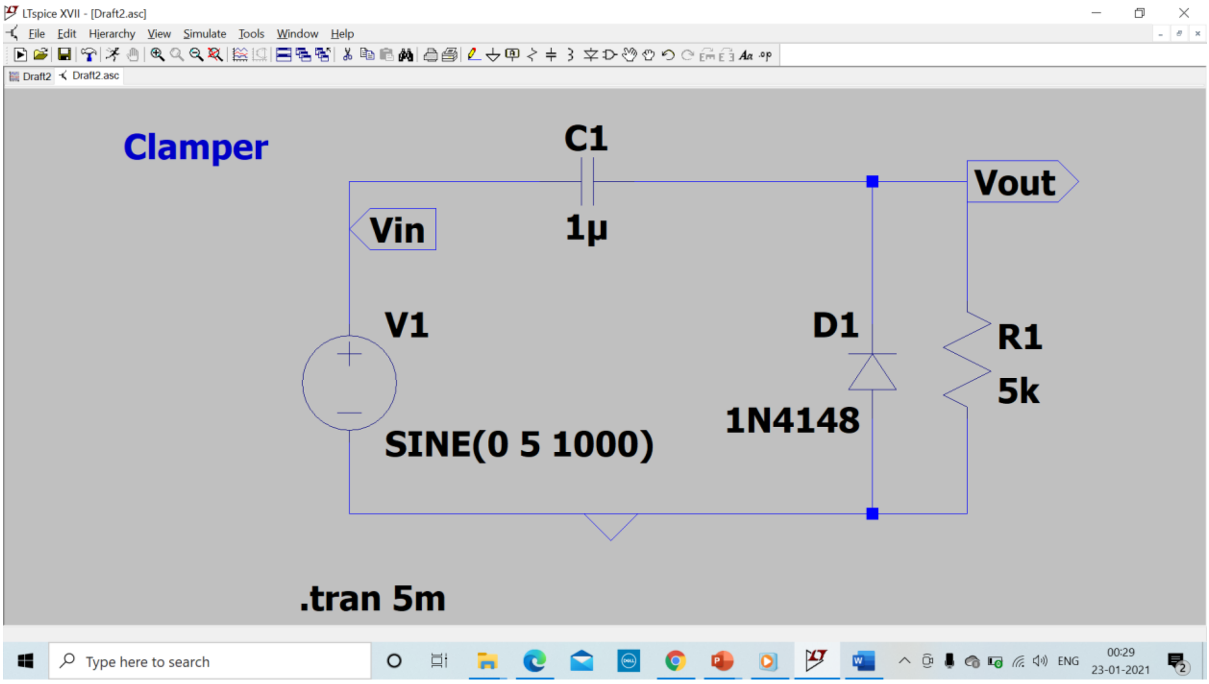

LTspice XVII - [Draft2.asc]
File Edit Hierarchy View Simulate Tools Window Help
Draft2 Draft2.asc
Clipper
R1
Vout
Vin
1k
V2
V1
D1
2
1N4148
SINE(0 5 1000)
.tran 5m
x = 1.274ms y = 5.50V
Type here to search
ENG
00:26
23-01-2021

Clamper

A)



LTspice XVII - [Draft2]
File View Plot Settings Simulation Tools Window Help
Draft2
Draft2.asc
V(vin)
V(vout)
9V
8V
7V
6V
5V
4V
3V
2V
1V
0V
-1V
-2V
-3V
-4V
-5V
0.0ms
0.5ms
1.0ms
1.5ms
2.0ms
2.5ms
3.0ms
3.5ms
4.0ms
4.5ms
5.0ms
x = 2.610ms y = 9.39V
Type here to search
ENG
00:28
23-01-2021



LTspice XVII - [Draft2.asc]
File Edit Hierarchy View Simulate Tools Window Help
Draft2
Draft2.asc
Clamper
C1
1µ
Vin
Vout
V1
SINE(0 5 1000)
D1
1N4148
R1
5k
.tran 5m
Type here to search
ENG
00:29
23-01-2021

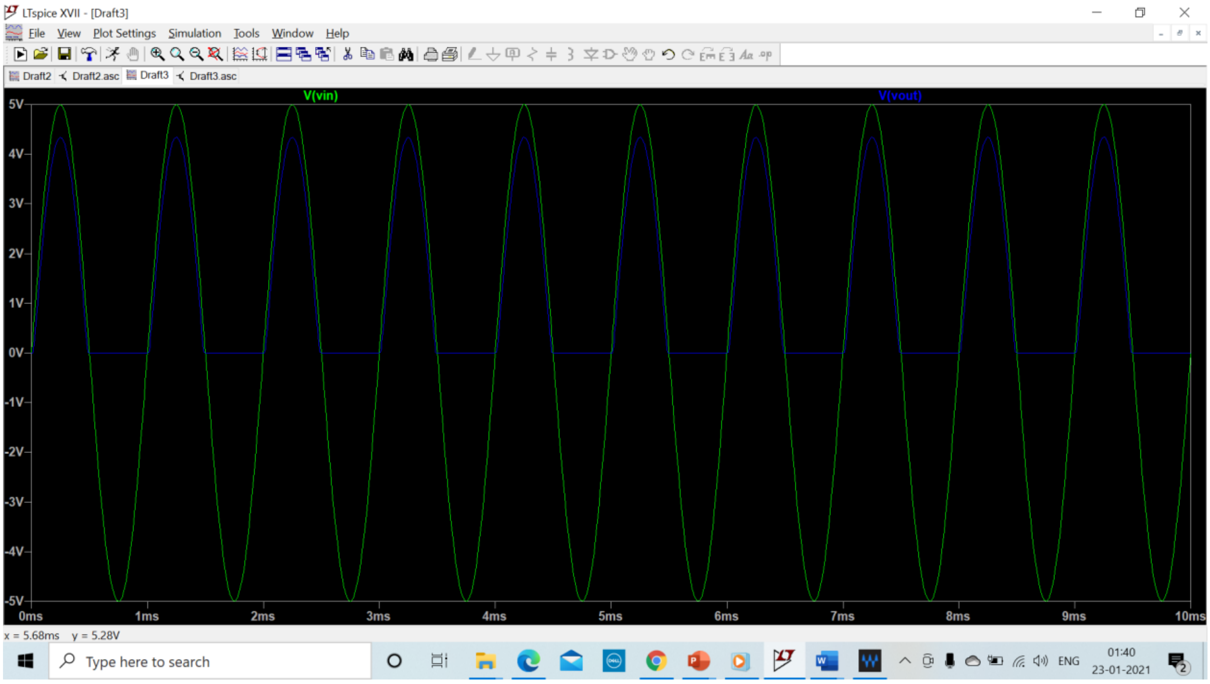
EXPERIMENT 7

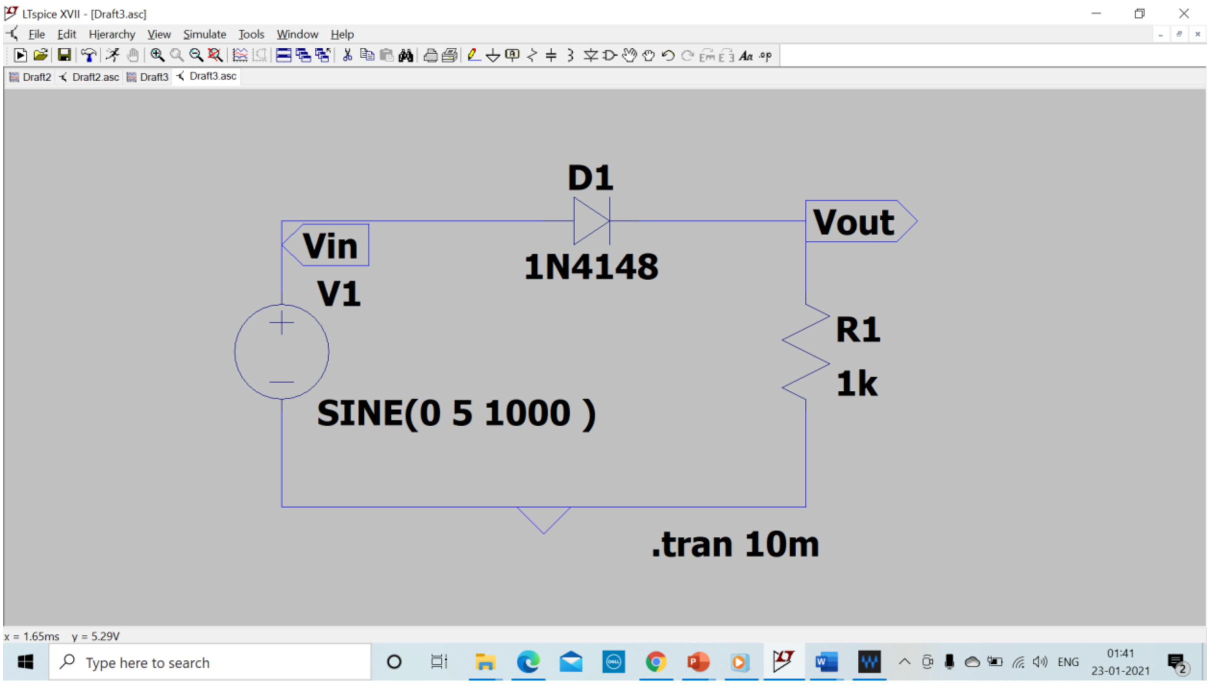
Date: 6 January,2021

Aim: *Implementation of Half Wave and Full wave Rectifier*

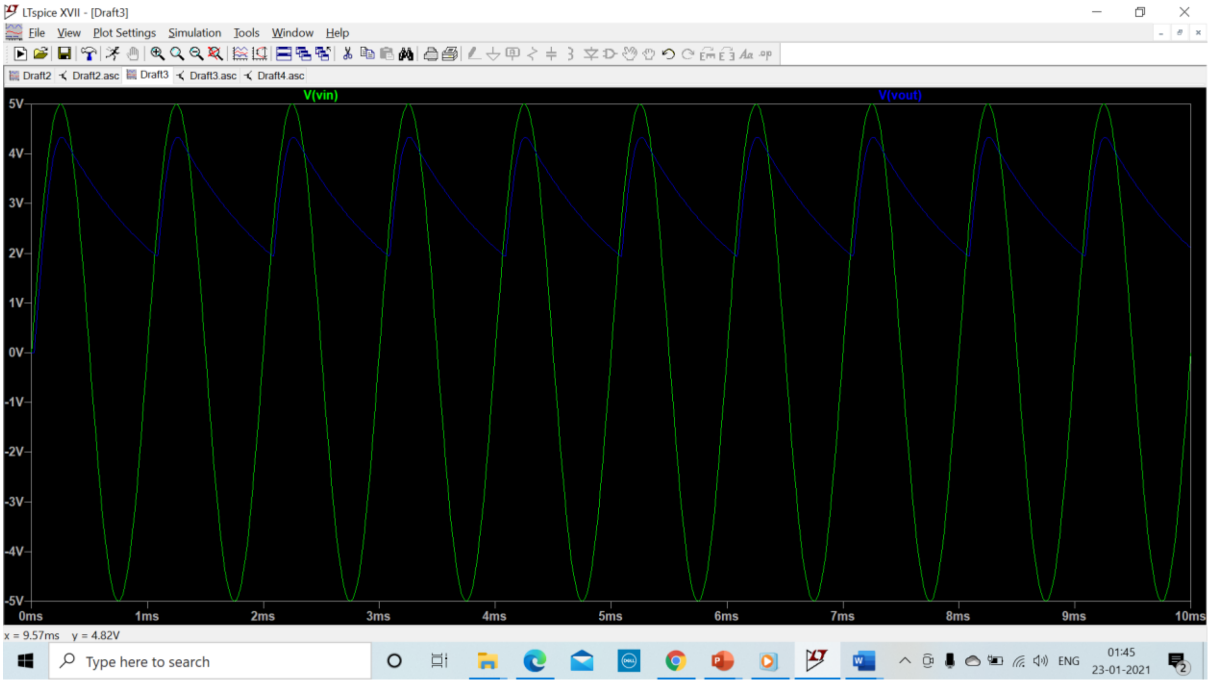
Software Required: LT Spice XVII

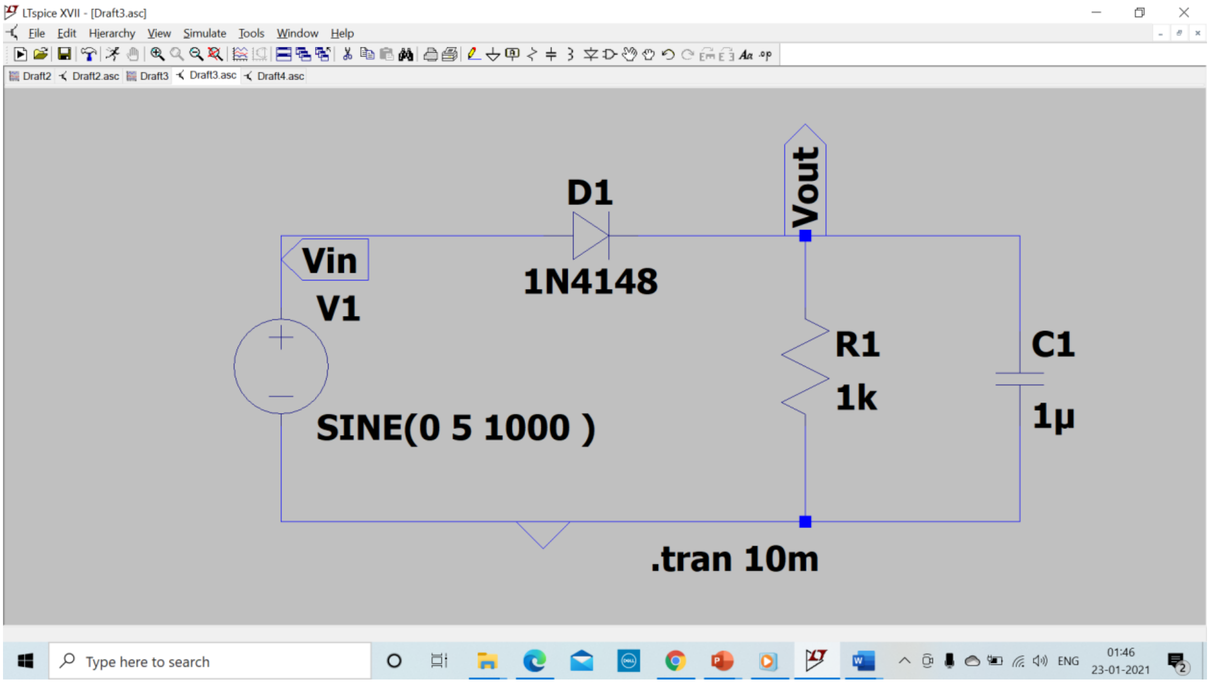
Half Wave Rectifier



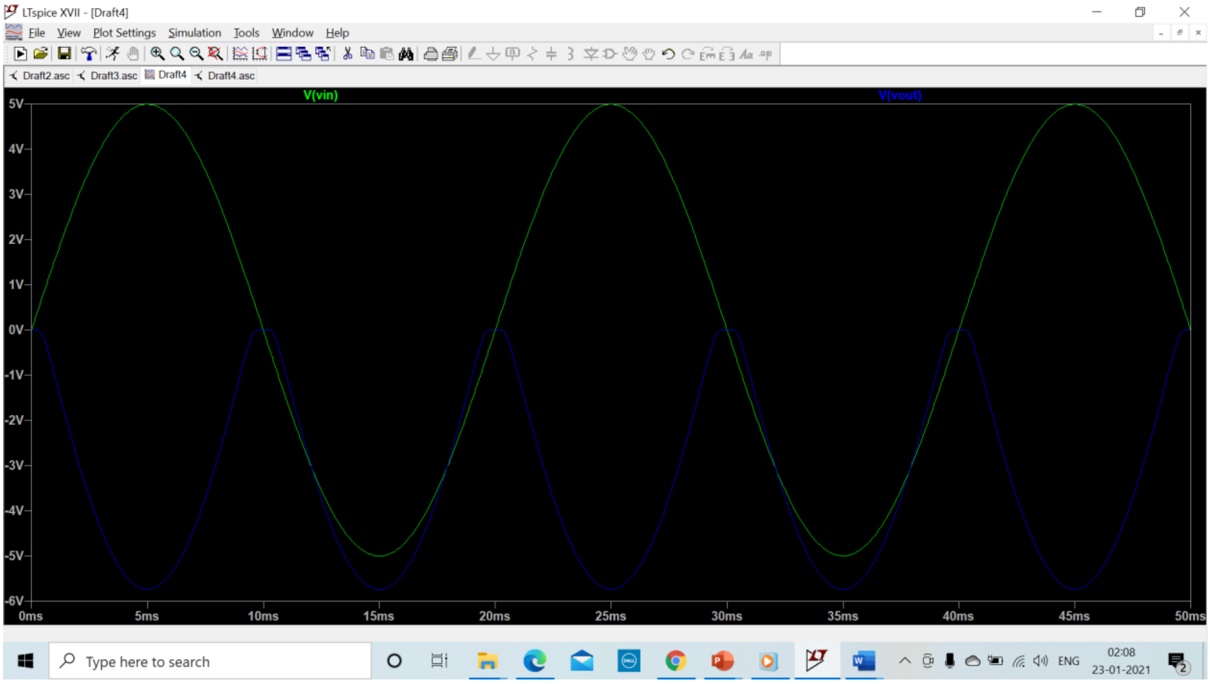


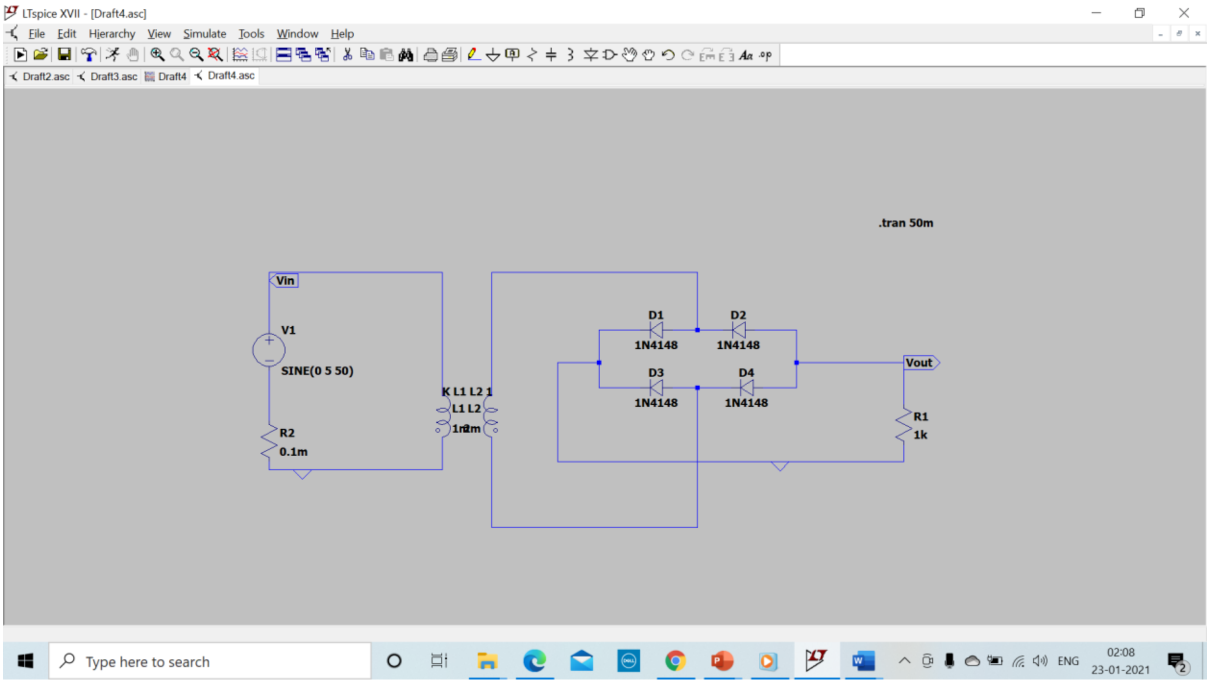
With RC Load:


LTspice XVII - [Draft3]
File View Plot Settings Simulation Tools Window Help
V(vin)
V(vout)
5V
4V
3V
2V
1V
0V
-1V
-2V
-3V
-4V
-5V
0ms
1ms
2ms
3ms
4ms
5ms
6ms
7ms
8ms
9ms
10ms
x = 9.57ms y = 4.82V
Type here to search
01:45
23-01-2021

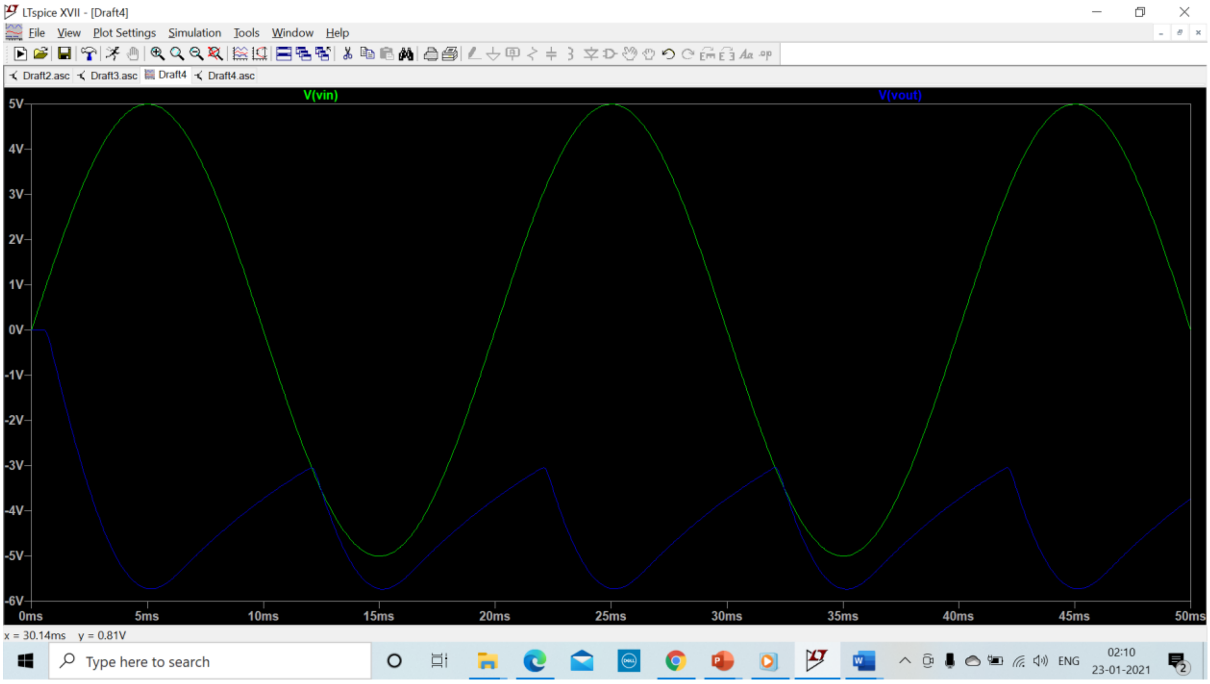

LTspice XVII - [Draft3.asc]
File Edit Hierarchy View Simulate Tools Window Help
D1
1N4148
Vout
Vin
V1
R1
1k
C1
1µ
SINE(0 5 1000)
.tran 10m
Type here to search
01:46
23-01-2021

Full Wave Bridge Rectifier





With RC load: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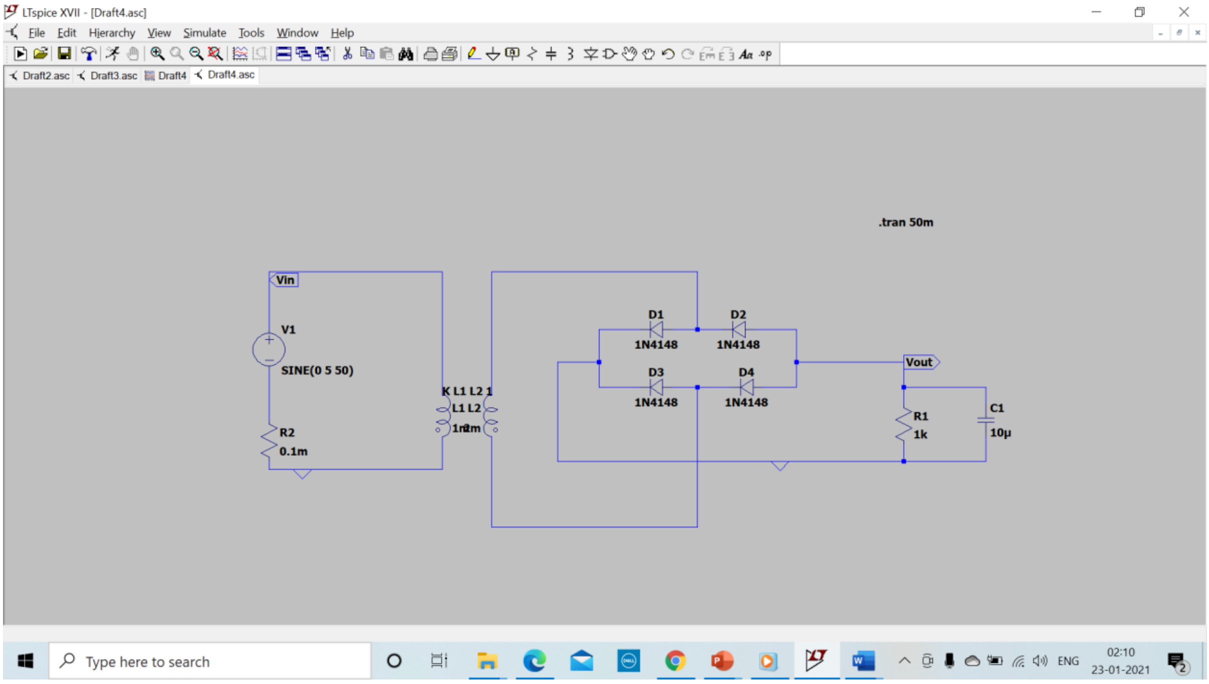
V(vin)
V(vout)
5V
4V
3V
2V
1V
0V
-1V
-2V
-3V
-4V
-5V
-6V
0ms
5ms
10ms
15ms
20ms
25ms
30ms
35ms
40ms
45ms
50ms
x = 30.14ms y = 0.81V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.tran 50m
Vin
V1
SINE(0 5 50)
R2
0.1m
K L1 L2 1
L1 L2
1m
D1
1N4148
D2
1N4148
D3
1N4148
D4
1N4148
Vout
R1
1k
C1
10µ

EXPERIMENT 8

Date: 6 January,2021

Aim: To construct a Transformer.

Software Required: LT Spice XVII

Theory:

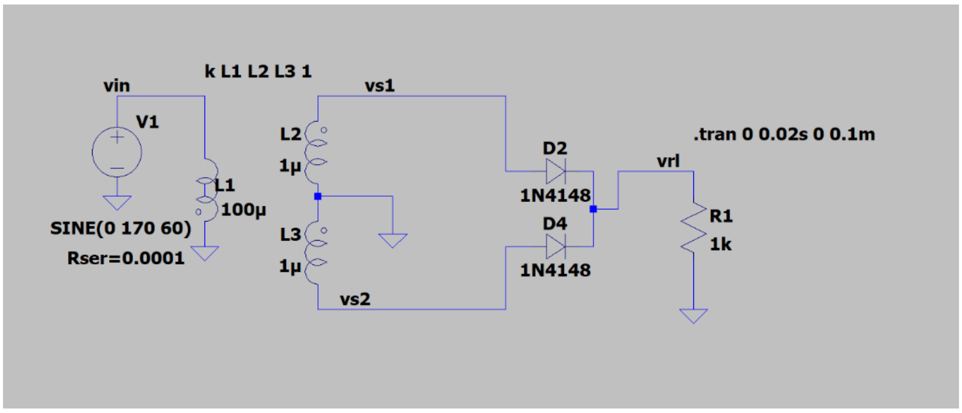
Step down Voltage Transformer

- Number of primary turns > Number of secondary turns
- Primary voltage > Secondary voltage

Step up Voltage Transformer

- Number of primary turns < Number of secondary turns
- Primary voltage < Secondary voltage

Circuit:



Output: