DELHI TECHNOLOGICAL UNIVERSITY

EE 313

LIC LAB REPORT

Submitted to:

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2K19/EE/005

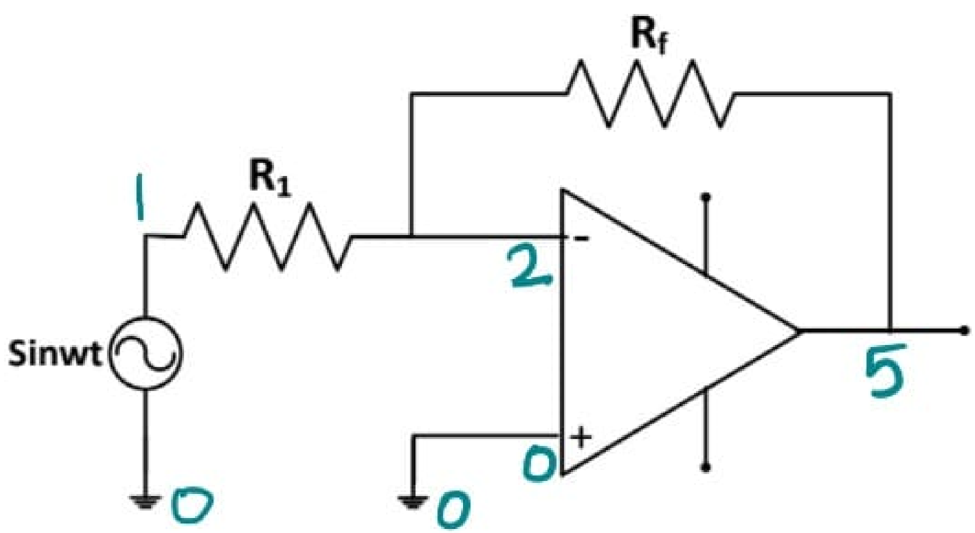
CONTENTS

EXPERIMENT 1

Aim : To design and implement the following types of amplifiers using IC 741
a. Inverting
b. Non-inverting
c. Voltage follower

1. Inverting Amplifier

a. Circuit Diagram:

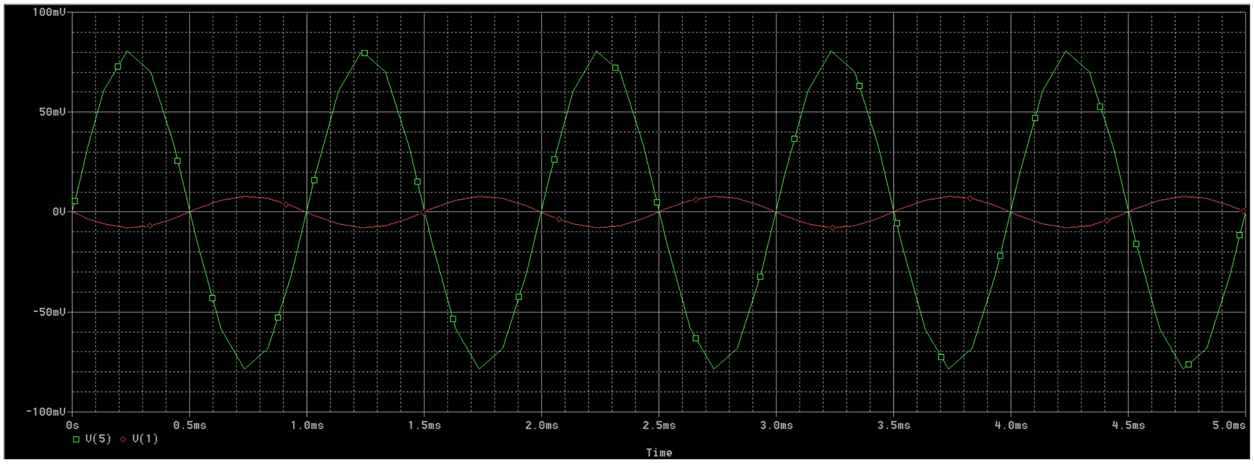


b. Netlist code

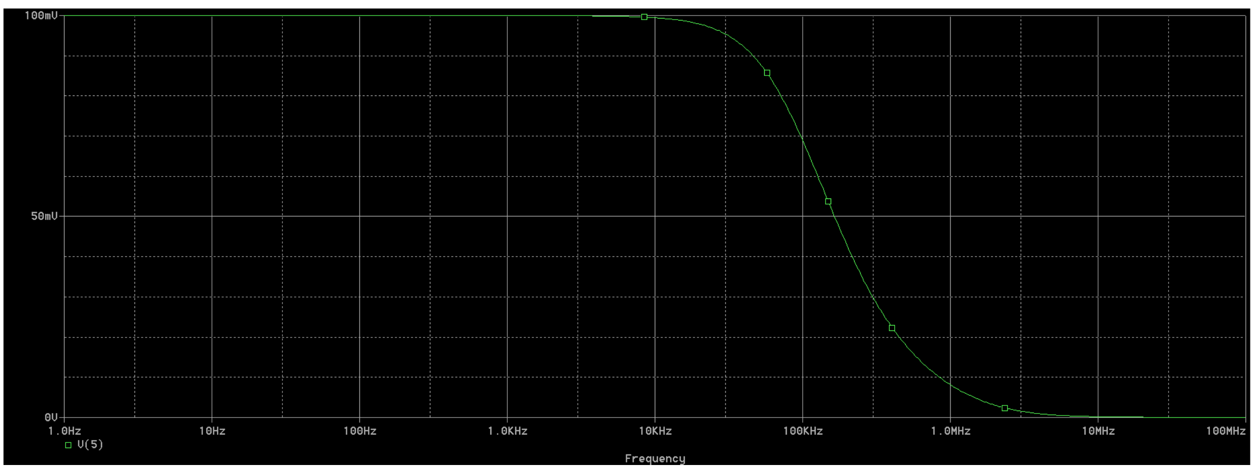
```
*Exp-1.1 a Inverting Amplifier
X1 0 2 3 4 5 ua741
V1 0 1 AC 10m sin(0 8m 1k)
R2 5 2 10K
R1 2 1 1K
Vp 3 0 DC 12
Vn 0 4 DC 12

* Analysis setup *
.tran 0 5m
.probe

.ac dec 100 1 100Mega
.probe
```

c. **Simulation**

Transient Analysis

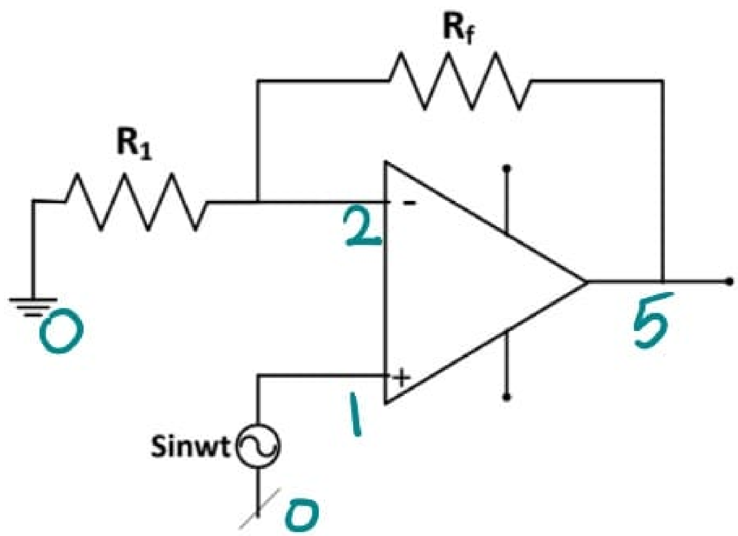


AC Analysis



2. Non-Inverting Amplifier

a. Circuit diagram

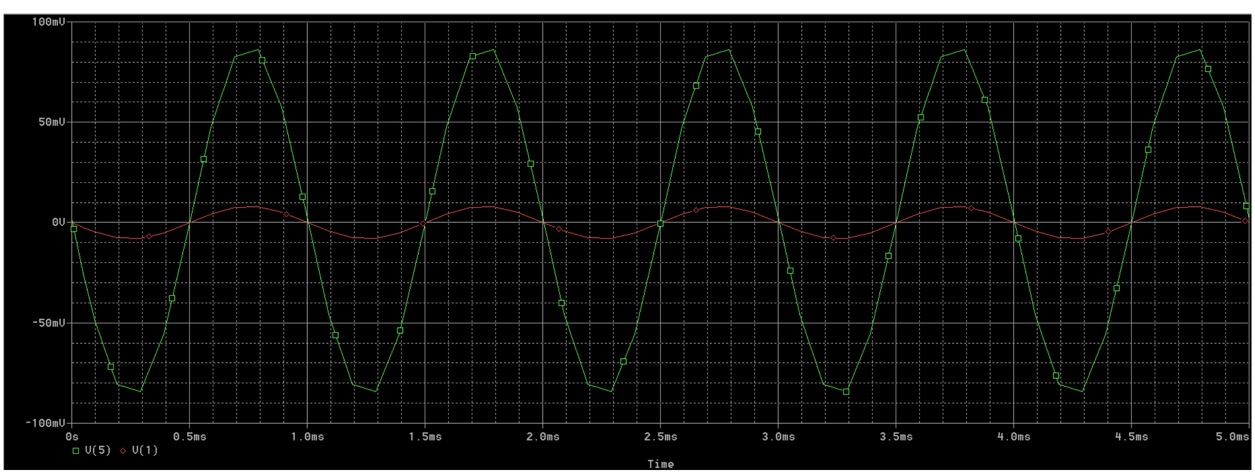


b. Netlist Code

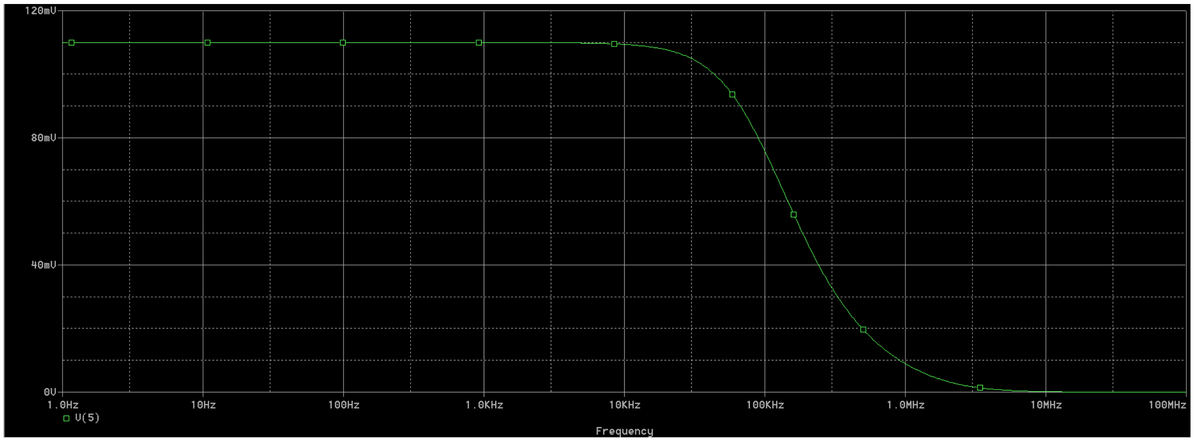
```
*Exp-1.1 b Non-Inverting Amplifier
X1 1 2 3 4 5 ua741
V1 0 1 AC 10m sin(0 8m 1k)
R2 5 2 10K
R1 2 0 1K
Vp 3 0 DC 12
Vn 0 4 DC 12
* Analysis setup *
.tran 0 5m
.probe
.ac dec 100 1 100Mega
.probe
```

c. Simulation

Transient Analysis

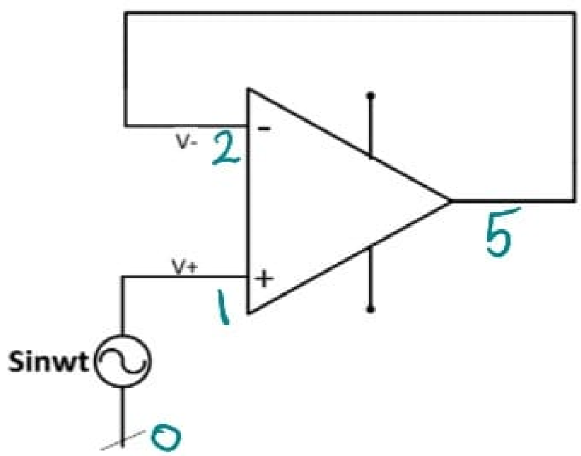


AC Analysis



3. <u>Voltage follower</u>

a. Circuit diagram

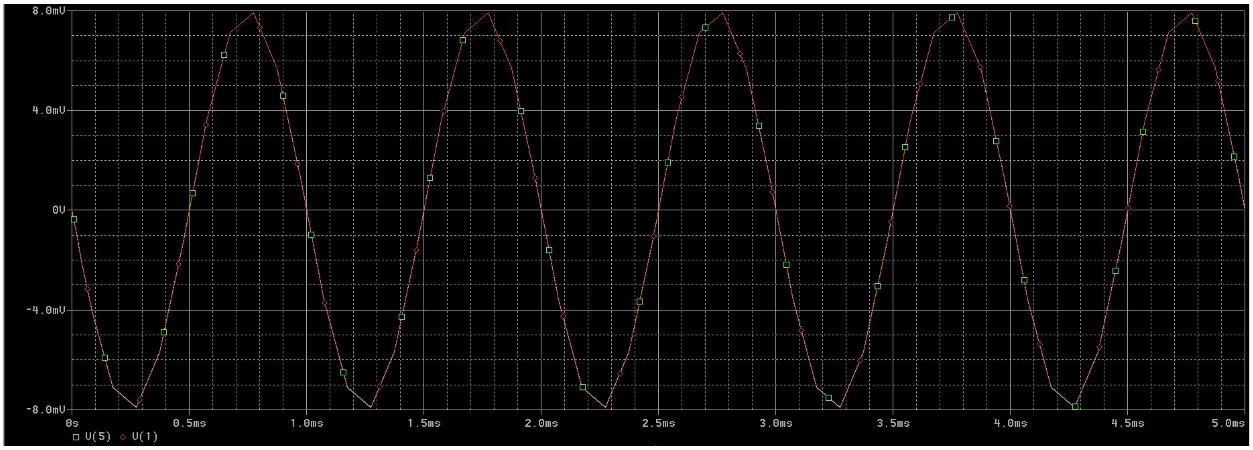


b. Netlist Code

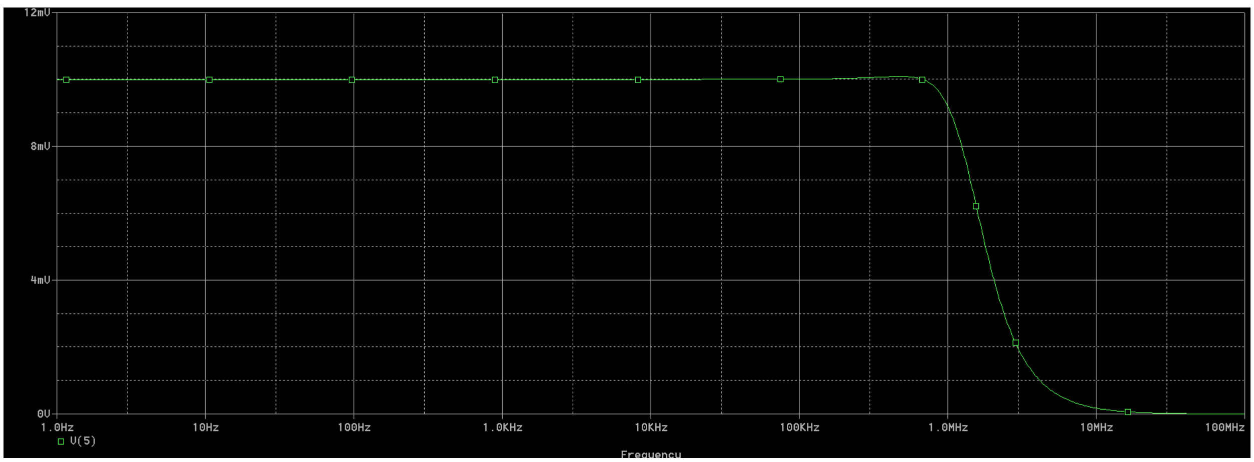
```
*Exp-1.1 c Voltage Follower
X1 1 2 3 4 5 ua741
V1 0 1 AC 10m sin(0 8m 1k)
Vo 2 5 DC 0
Vp 3 0 DC 12
Vn 0 4 DC 12
* Analysis setup *
.tran 0 5m
.probe
.ac dec 100 1 100Mega
.probe
```

c. Simulation

Transient Analysis



AC Analysis



EXPERIMENT 2

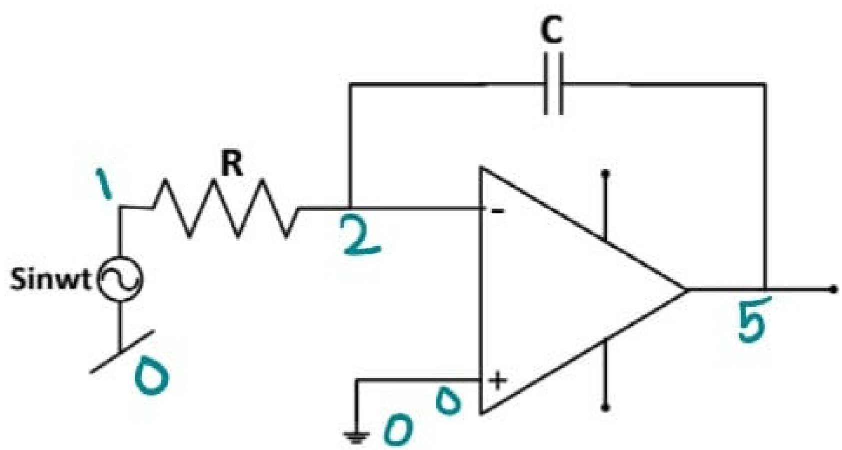
<u>Aim :</u> To design and implement using IC 741

1) Integrator
2) Differentiator

1. Integrator

A. Ideal Integrator

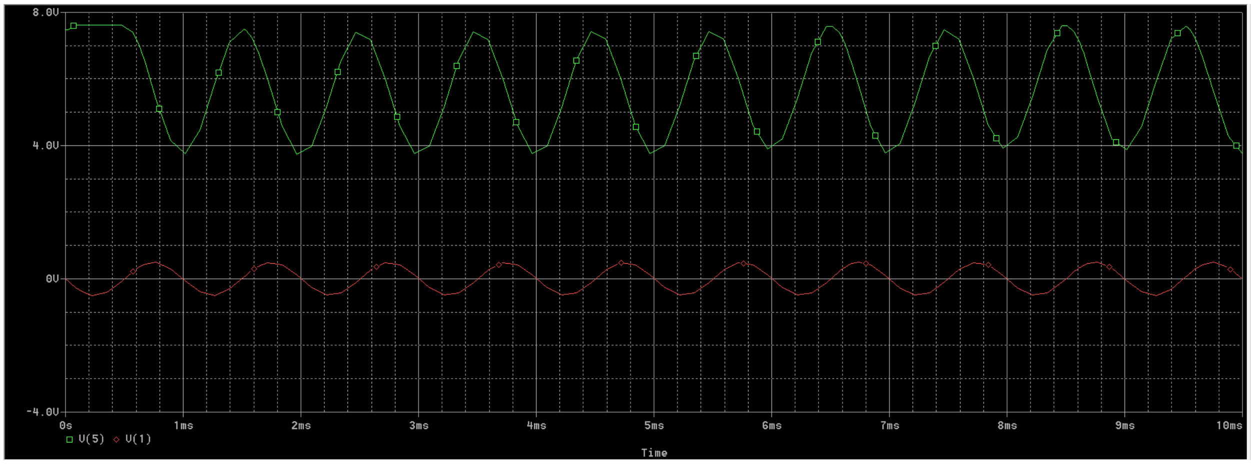
a. Circuit Diagram

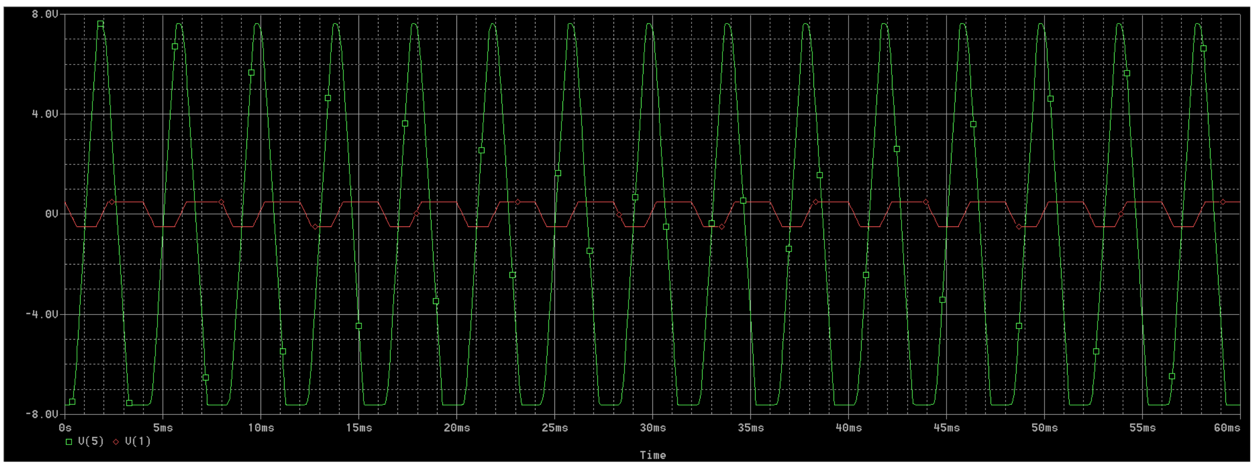


b. Netlist Code

```
*Exp-2 a Ideal Integrator
X1 0 2 3 4 5 ua741
*graph 1
V1 0 1 AC 10m sin(0 500m 1k)
*graph 2
V1 0 1 pulse(-500mv 500mv 0 0 0 1ms 4ms)
C 5 2 10n
R1 2 1 4k
Vp 3 0 DC 8
Vn 0 4 DC 8
* Analysis setup *
.tran 0 60m
.probe
.ac dec 100 1 100Mega
.probe
```

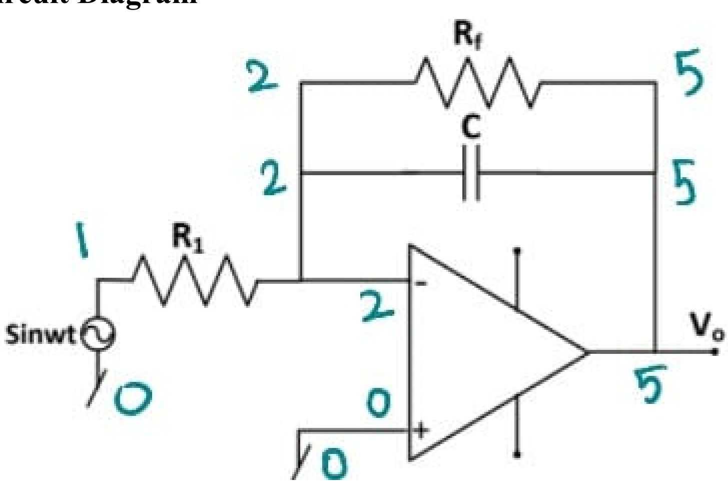
c. Simulation





B. <u>Lossy Integrator</u>

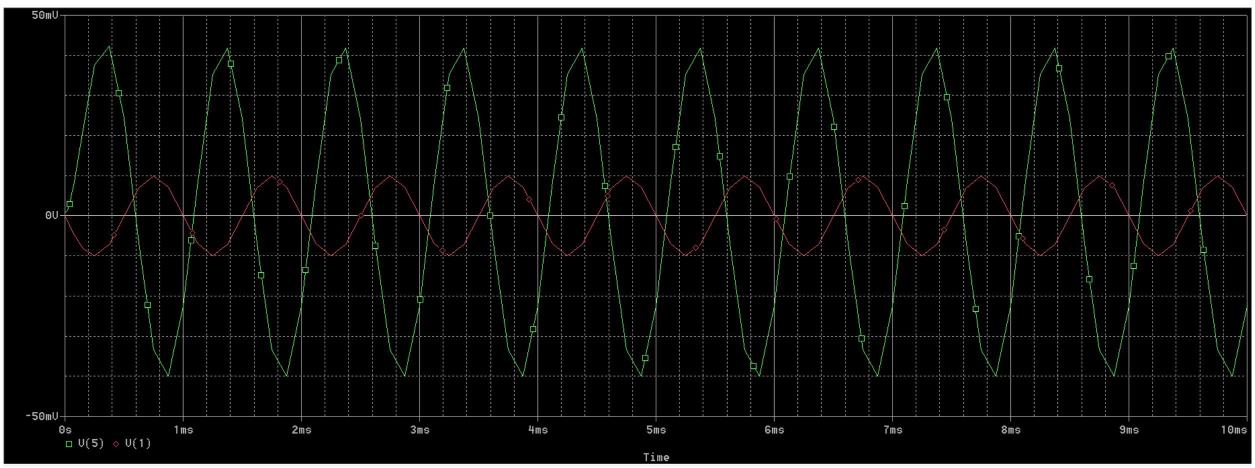
a. Circuit Diagram

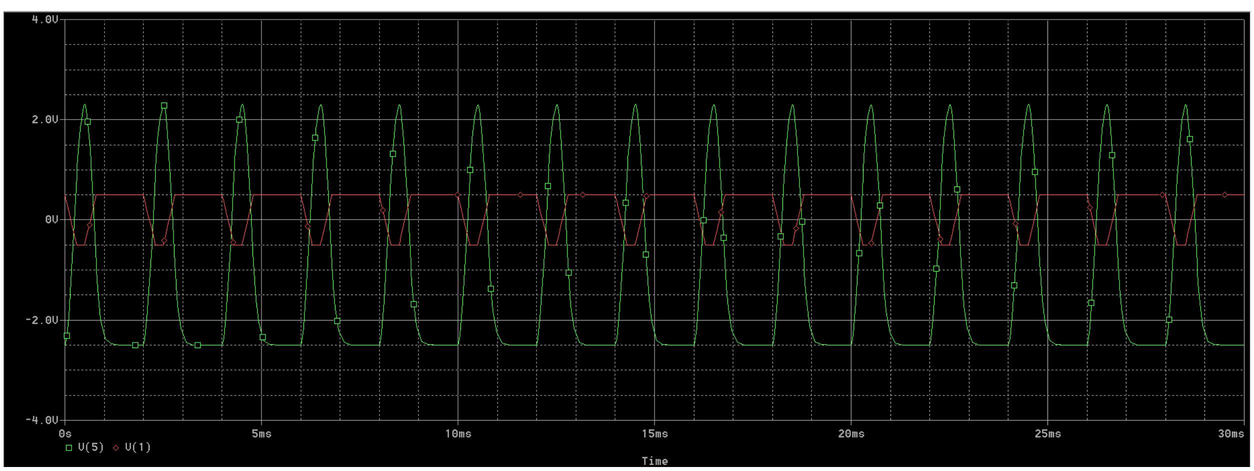


b. Netlist Code

```
*Exp-2 aii Lossy Integrator
X1 0 2 3 4 5 ua741
*graph 1
V1 0 1 AC 100m sin(0 10m 1k)
*graph 2
V1 0 1 pulse(-500mv 500mv 0 0 0 0.2ms 2ms)
C 5 2 10n
R1 2 1 2k
R2 2 5 10k
Vp 3 0 DC 8
Vn 0 4 DC 8
* Analysis setup *
.tran 0 30m
.probe
.ac dec 100 1 100Mega
.probe
```

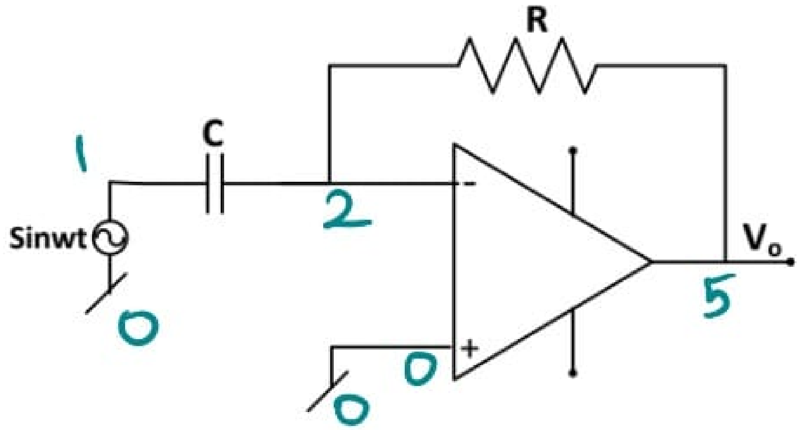
c. Simulation





2. Differentiator

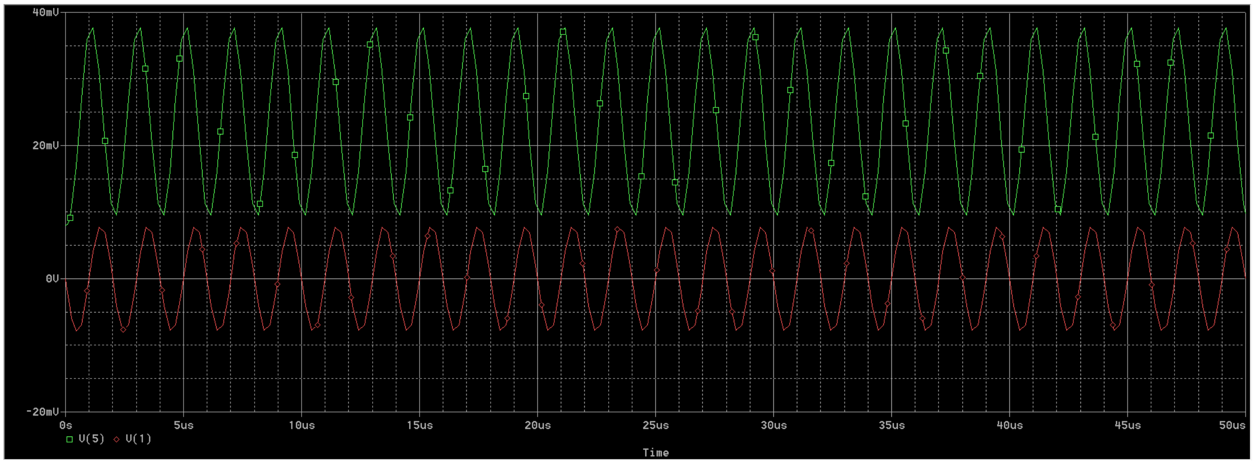
a. Circuit Diagram

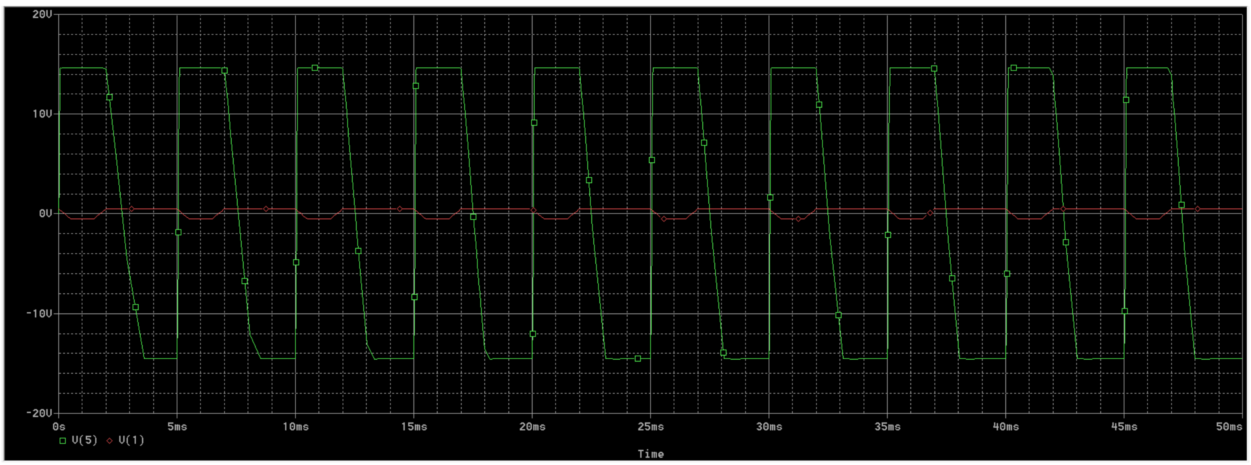


b. Netlist Code

```
*Exp-2 b Differentiator
X1 0 2 3 4 5 ua741
*graph 1
V1 0 1 AC 500m sin(0 8m 500k)
*graph 2
V1 0 1 pulse(-500mv 500mv 0 0 0 1ms 5ms)
C 1 2 100u
R 2 5 100k
Vp 3 0 DC 15
Vn 0 4 DC 15

* Analysis setup *
*graph 1
.tran 0 50u
*graph 2
.tran 0 50m
.probe

.ac dec 100 1 100Mega
.probe
```

c. Simulation





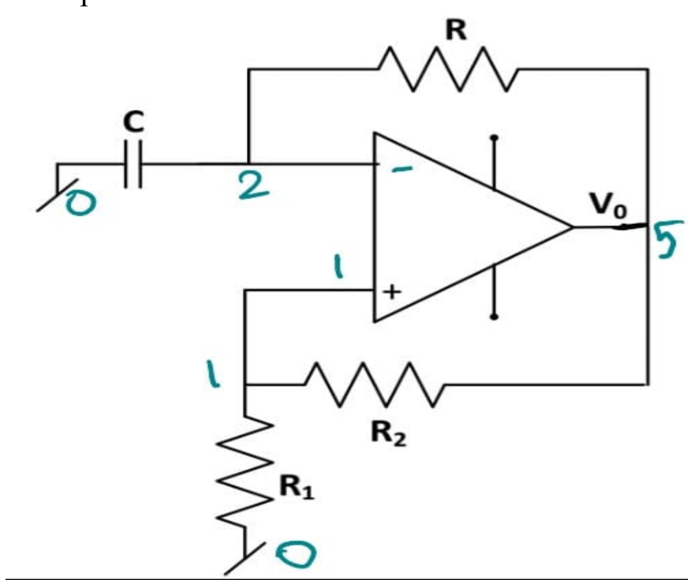
EXPERIMENT 3

Aim : To design and implement a square wave generator using IC-741 (astable multivibrator).

Design Procedure :

Given frequency = 100Hz
Therefore to design the square wave generator:
T = 2RC ln(1+2R1/R2)
Where T = 1/f = 1/100 = 10ms
Let R = 5kOhms
C = 1uF
hence , 2RC = 2*5000*0.000001 = .01
now , ln(1+2R1/R2) = 1 // to make T = .01s
On solving the above eqn : R2 = 1.164R1
Take R1= 10kOhms therefore, R2 = 11.64kOhms

Therefore, the value of components are :

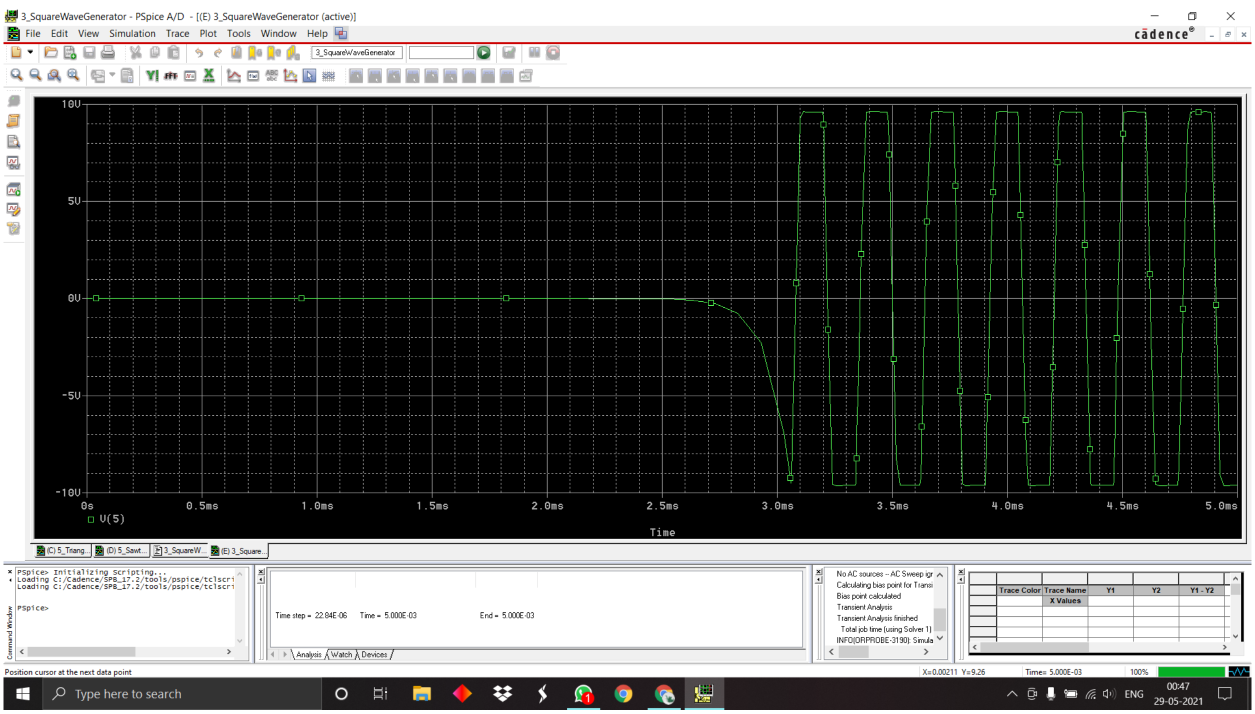


R = 5kOhms
C = 1uF
R1 = 10kOhms
R2 = 11.64kOhms
(T = 10ms and frequency = 100Hz)

Netlist Code

```
*Exp-3 Square Wave Generator Astable Multivibrator
X1 1 2 3 4 5 ua741

C 0 2 10n

R 2 5 10k
R1 1 0 10k
R2 1 5 10k

Vp 3 0 DC 10
Vn 0 4 DC 10

* Analysis setup *
.tran 0 5m
.probe

.ac dec 100 1 100Mega
.probe
```

Simulation

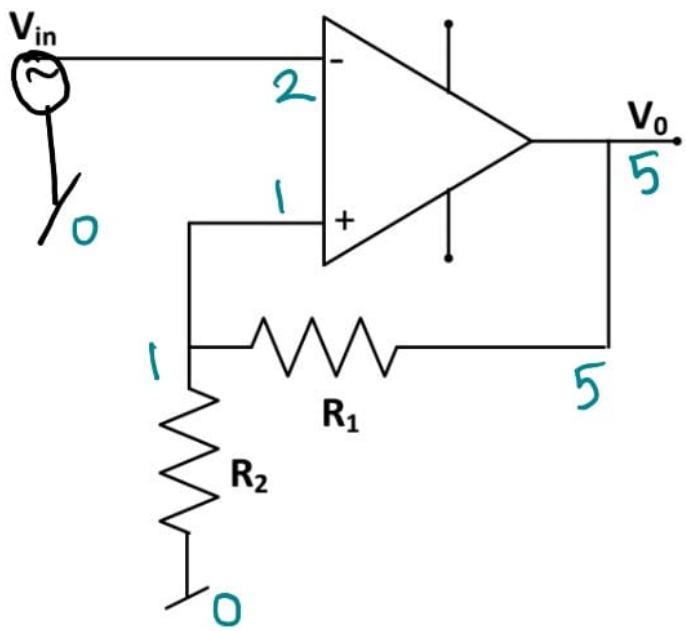


EXPERIMENT 4

Aim : To design and implement a Schmitt trigger with inverting and non-inverting transfer characteristics using IC-741.

1. **Inverting Mode**

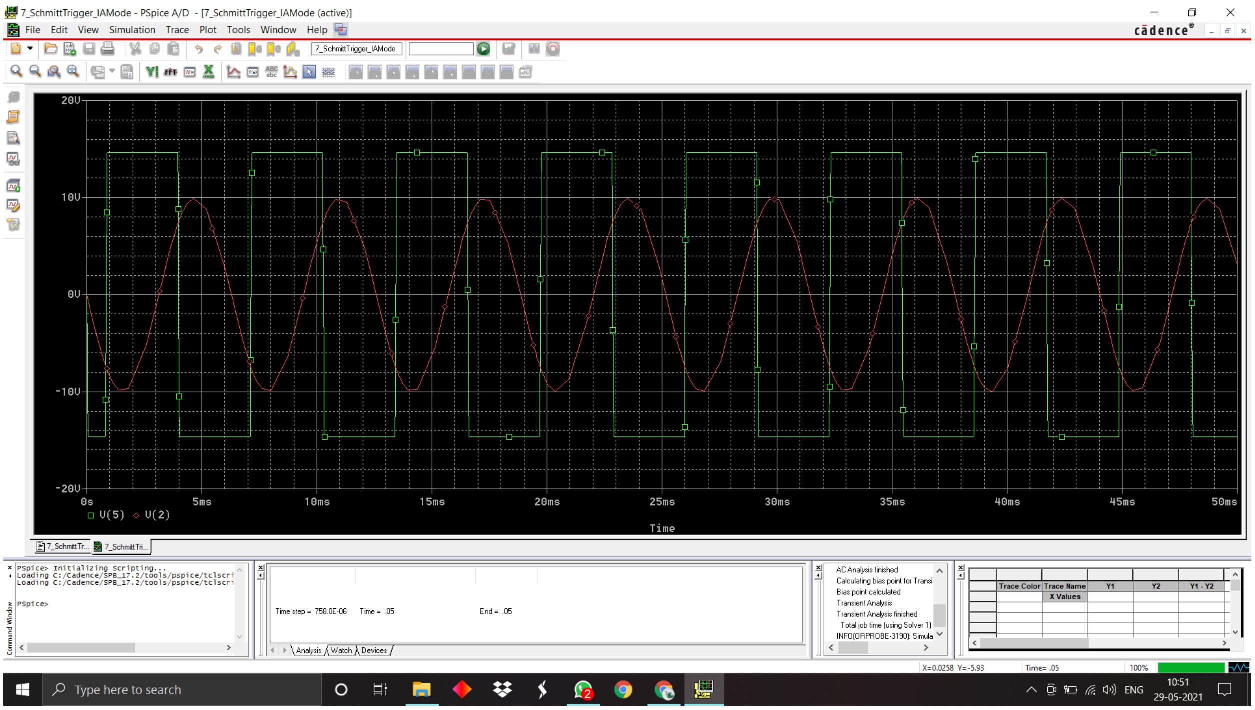
a. **Circuit Diagram**



b. **Netlist Code**

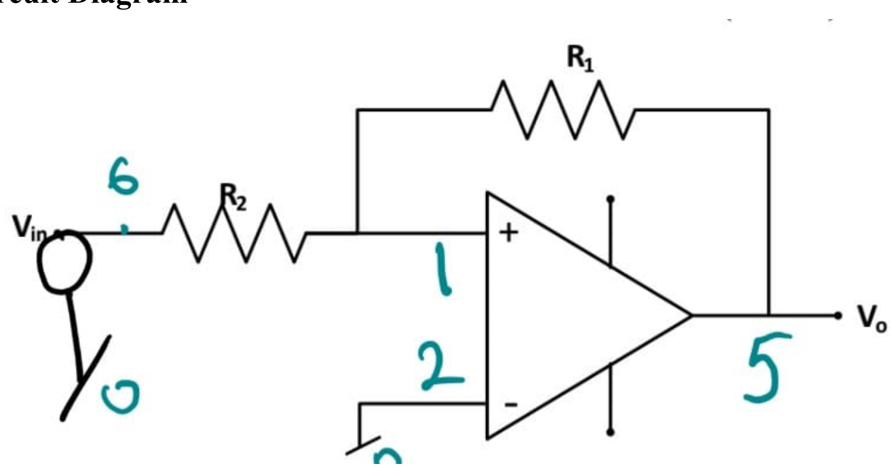
```
*Exp-7 Schmitt Trigger IA Mode
X1 1 2 3 4 5 ua741

V1 0 2 AC 500m sin(0 10 159)

R1 1 5 10k
R2 1 0 10k

Vp 3 0 DC 10
Vn 0 4 DC 10

* Analysis setup *
.tran 0 100ms
.probe
```

c. Simulation



2. Non-Inverting Mode

a. Circuit Diagram

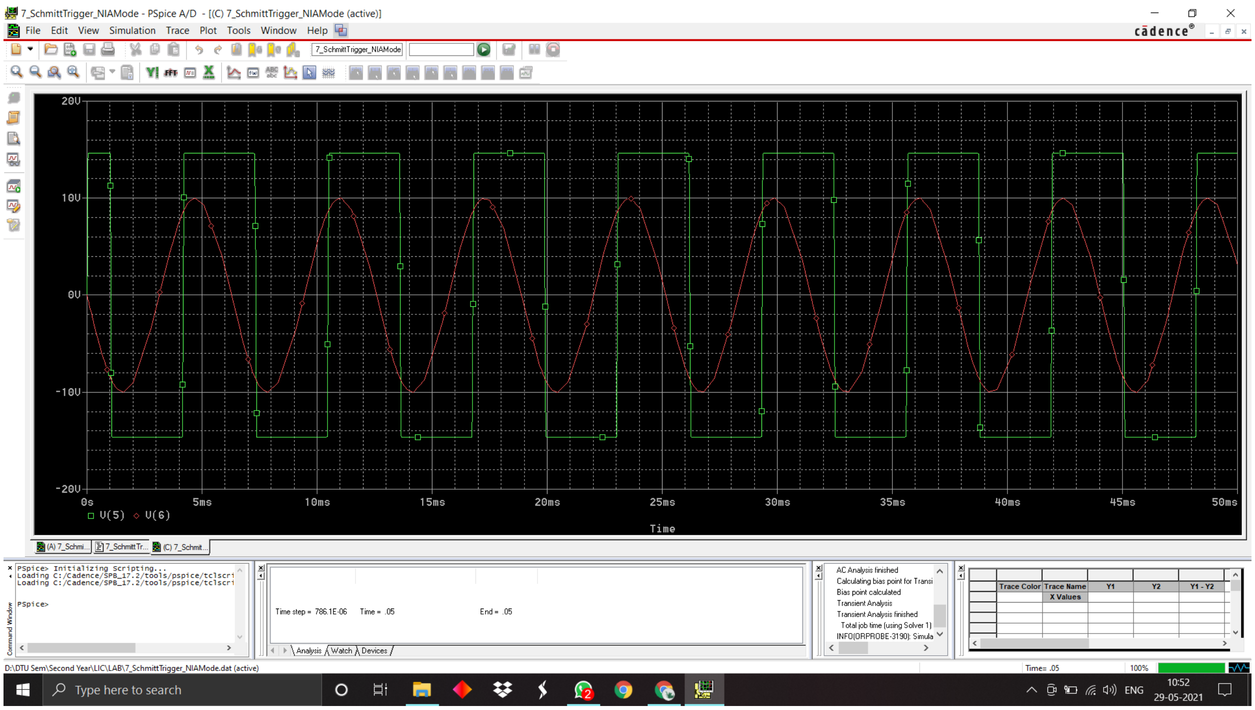


b. Netlist Code

```
*Exp-7 Schmitt Trigger NIA Mode
X1 1 0 3 4 5 ua741

V1 0 6 AC 500m sin(0 10 159)

R1 1 5 10k
R2 1 6 5.8k

Vp 3 0 DC 15
```

```
Vn 0 4 DC 15

* Analysis setup *
.tran 0 50ms
.probe
```

c. Simulation

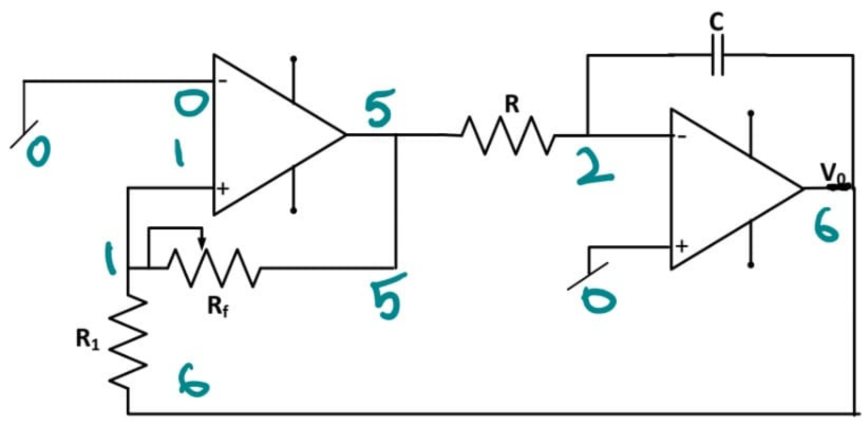


EXPERIMENT 5

Aim : To design and implement the following types of relaxation oscillators
1) Triangular
2) Rectangular

__**Triangular-wave and square-wave**__

a. **Circuit Diagram**



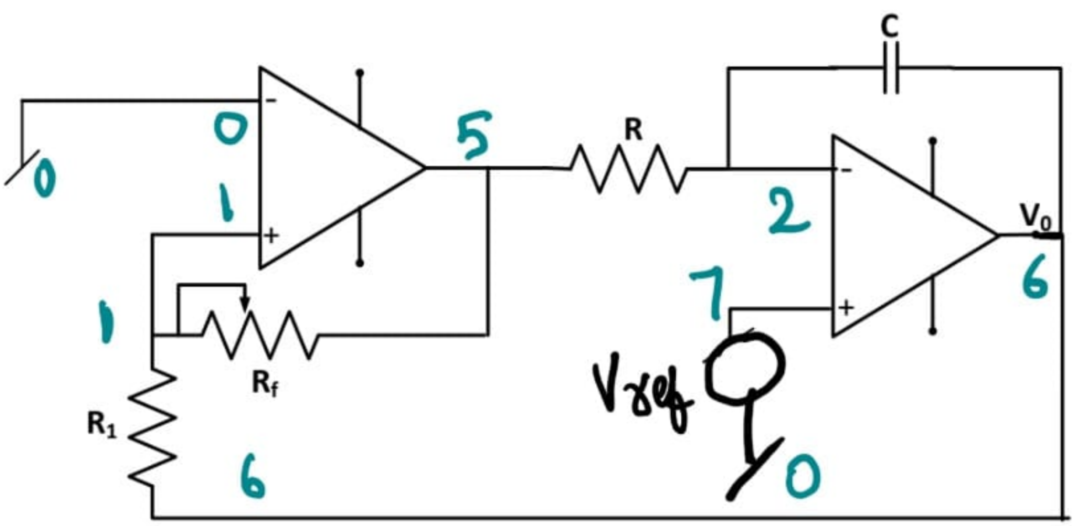
b. **Netlist Code**

```
*Exp-5 Triangular Wave Generator
X1 1 0 3 4 5 ua741
X2 0 2 3 4 6 ua741

C 6 2 0.05u

R2 2 5 10k
R1 1 6 10k
R3 1 5 40k

Vp 3 0 DC 15
Vn 0 4 DC 15

* Analysis setup *
.tran 0 10m
.probe

.ac dec 100 1 100Mega
.probe
```

c. Simulation

2. <u>Sawtooth wave and Square wave</u>

Only add a 7V DC source at the non-inverting terminal of the second opamp.

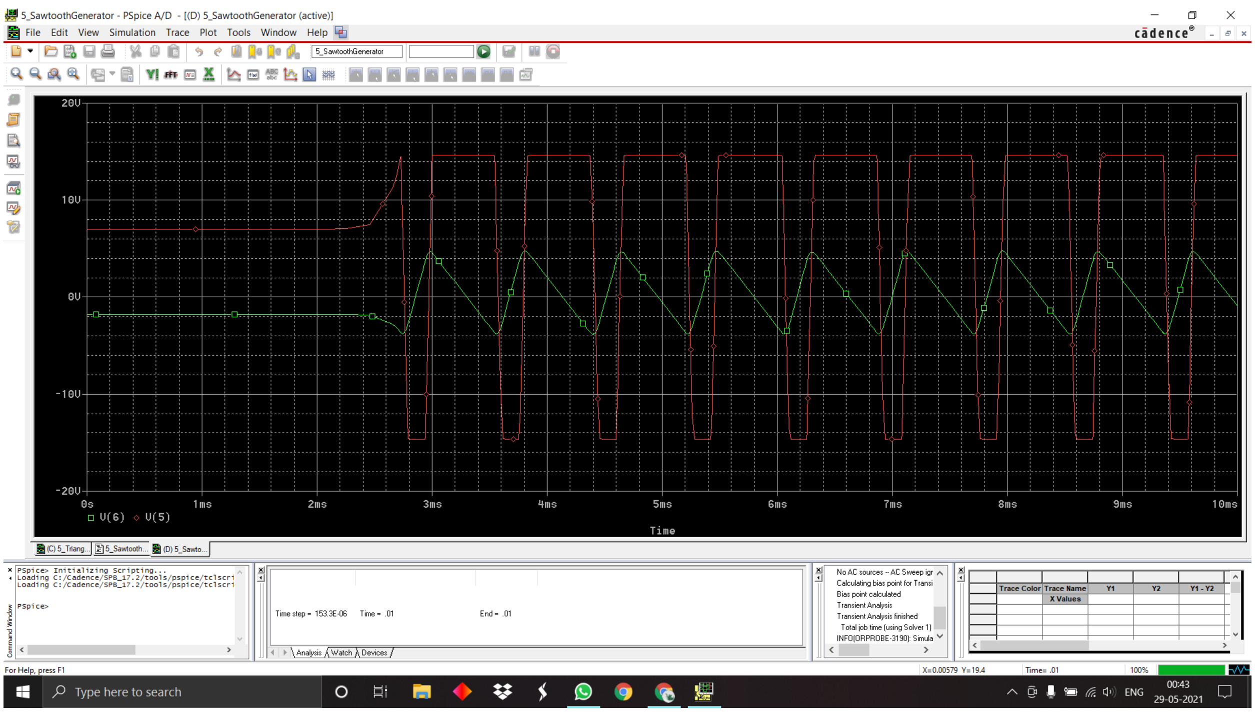


a. Netlist Code

```
*Exp-5 Sawtooth Generator
X1 1 0 3 4 5 ua741
X2 0 2 3 4 6 ua741

C 6 7 0.05u
```

```
R2 7 5 10k
R1 1 6 10k
R3 1 5 40k

Vref 7 2 DC 7

Vp 3 0 DC 15
Vn 0 4 DC 15

* Analysis setup *
.tran 0 10m
.probe

.ac dec 100 1 100Mega
.probe
```

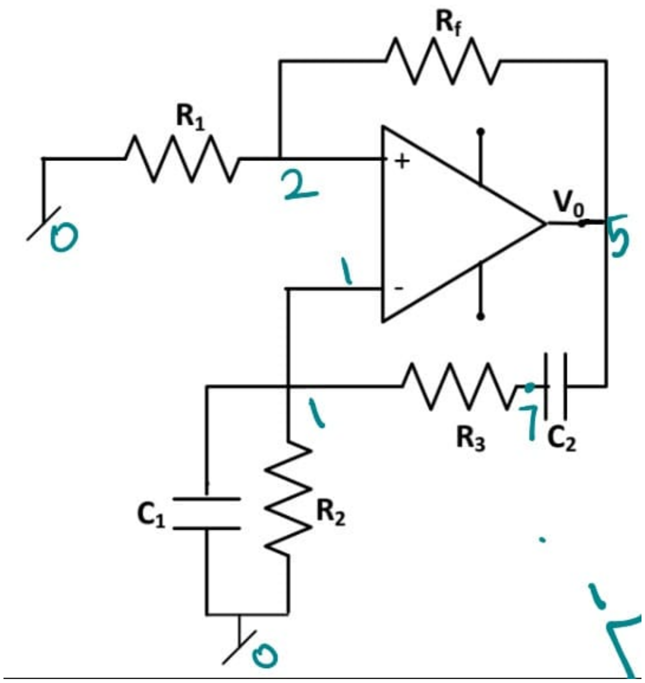
b. Simulation



EXPERIMENT 6

Aim : To design and implement a Wein Bridge Oscillator (WBO).

a. Circuit Diagram



Design Procedure:

We know,

$$f_o = \frac{1}{2\pi\sqrt{R_2 R_3 C_1 C_2}}$$

Therefore, R2 = R3 = 10k

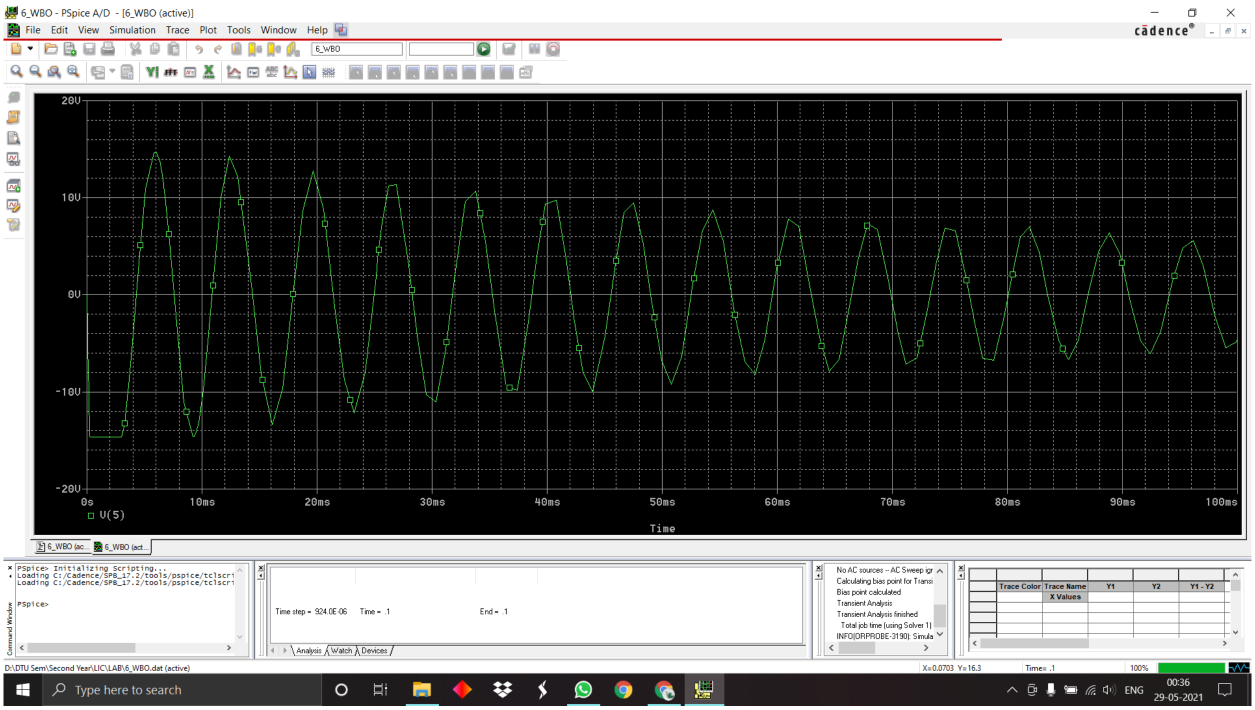
And C1 = C2 = 0.1u

b. Netlist Code

```
*Exp-6 Wein Bridge Oscillator (WBO)
X1 1 2 3 4 5 ua741
C1 1 6 0.1u
C2 1 0 0.1u

R1 2 0 10k
R2 1 0 10k
R3 6 5 10k
R4 2 5 20k

Vp 3 0 DC 15
Vn 0 4 DC 15
```

```
.ic V(1)=0 V(6)=20V
.tran 1u 0.1
```

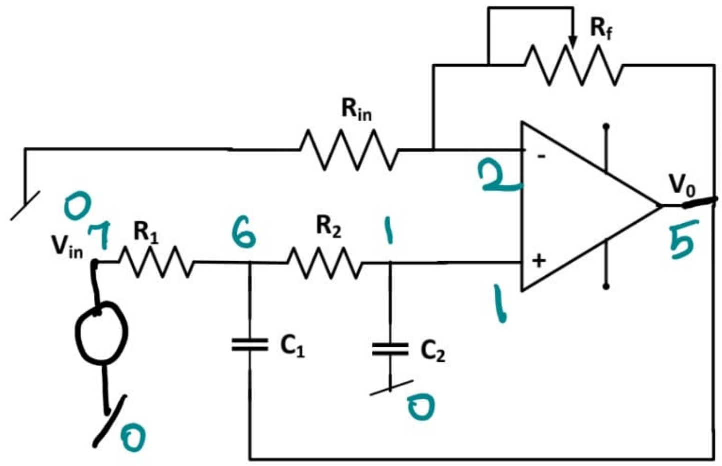
c. Simulation



EXPERIMENT 7

Aim : Implementation of a 2nd order low pass filter.

a. **Circuit Diagram**



Design Procedure:

The transfer function of the circuit is given by $\frac{V_o}{V_{in}} = \frac{K\omega_o^2}{s^2 + s\frac{\omega_o}{Q} + \omega_o^2}$

Where $K = 1 + \frac{R_f}{R_1}$; $\omega_o^2 = \frac{1}{R_1 R_2 C_1 C_2}$; $Q = \frac{\sqrt{G_1 G_2}}{G_1 + G_2(2-K)}$

For a Butterworth type of response the value of Q should be 0.707 which yields a value of K= 1.586, this gives the following relation between Rf and R1 :
Rf = 0.586R1

If R1 = R2 = 10k, therefore Rf=5860 & let Rin = 10k
And C1 = C2 = 0.1u

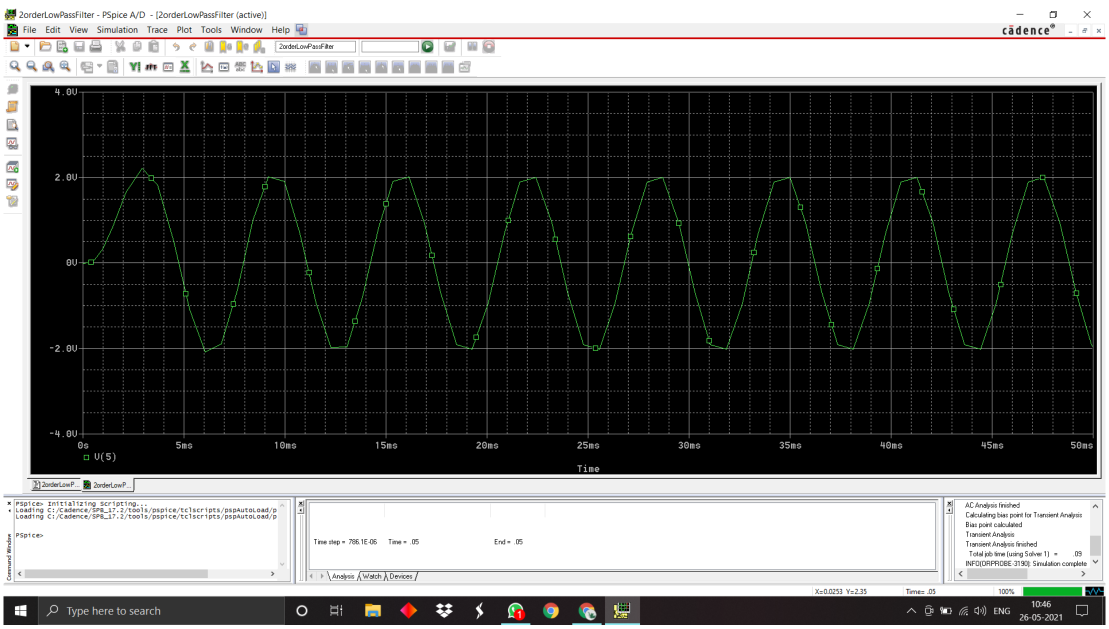
b. **Netlist Code**

```
Second Order Low Pass Filter
X1 1 2 3 4 5 ua741
V1 7 0 AC 10 sin(0 2 159)
R1 7 6 10K
R2 1 6 10K
*Rin
R3 2 0 10K
*Rf
R4 2 5 5860
```

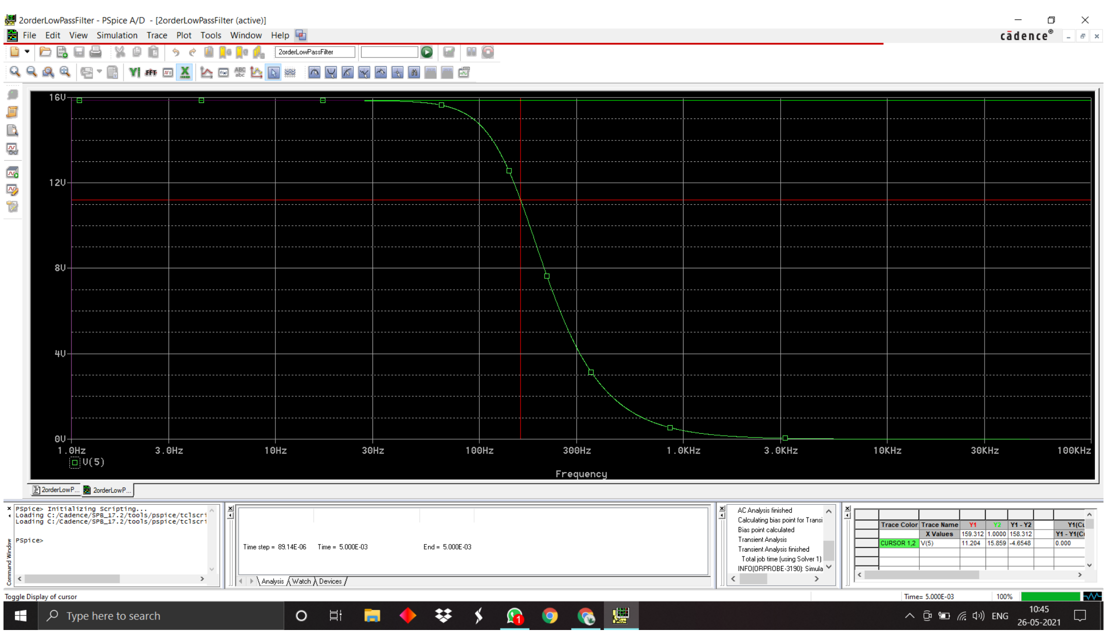
```
C1 6 5 0.1uF
C2 1 0 0.1uF
Vp 3 0 DC 15
Vn 0 4 DC 15

.tran 0 50m
.ac DEC 1001 1 50k
.probe
```

c. Simulation

1) Transient Analysis



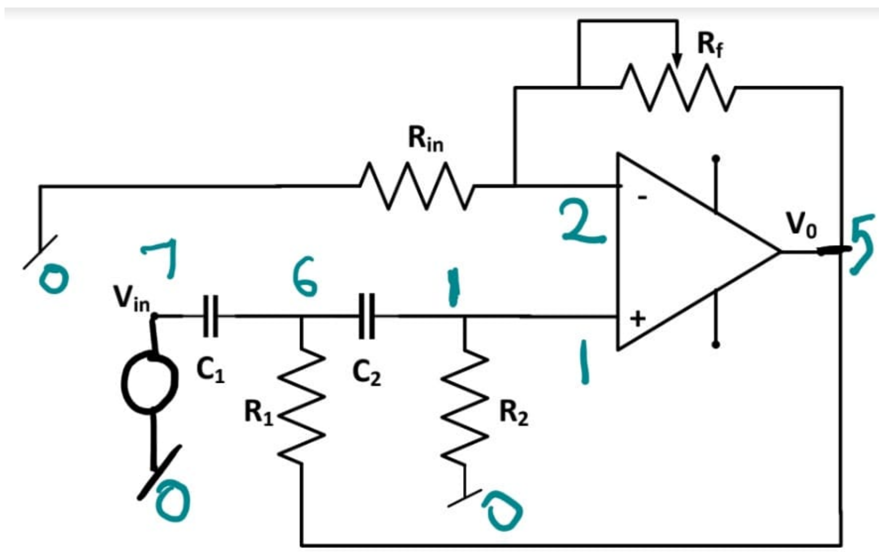
2) AC Analysis



EXPERIMENT 8

Aim : Implementation of a 2nd order high pass filter.

a. **Circuit Diagram**



Design Procedure;

The transfer function of the circuit is given by $\dfrac{V_o}{V_{in}} = \dfrac{KS^2}{s^2 + s\dfrac{\omega_o}{Q} + \omega_o^2}$

$$\text{Where K=} K = 1 + \frac{R_f}{R_1} \; ; \omega_o^2 = \frac{1}{R_1 R_2 C_1 C_2}$$

$$Q = \frac{1}{R_1 C_1 + R_1 C_2 + R_2 C_2 (1 - K)}$$

For a Butterworth type of response the value of Q should be 0.707 which yields a value of K= 1.586, this gives the following relation between Rf and R1
Rf = 0.586 * R1
If R1 = R2 = 10k, therefore Rf=5860 & let Rin = 10k
And C1 = C2 = 0.1u

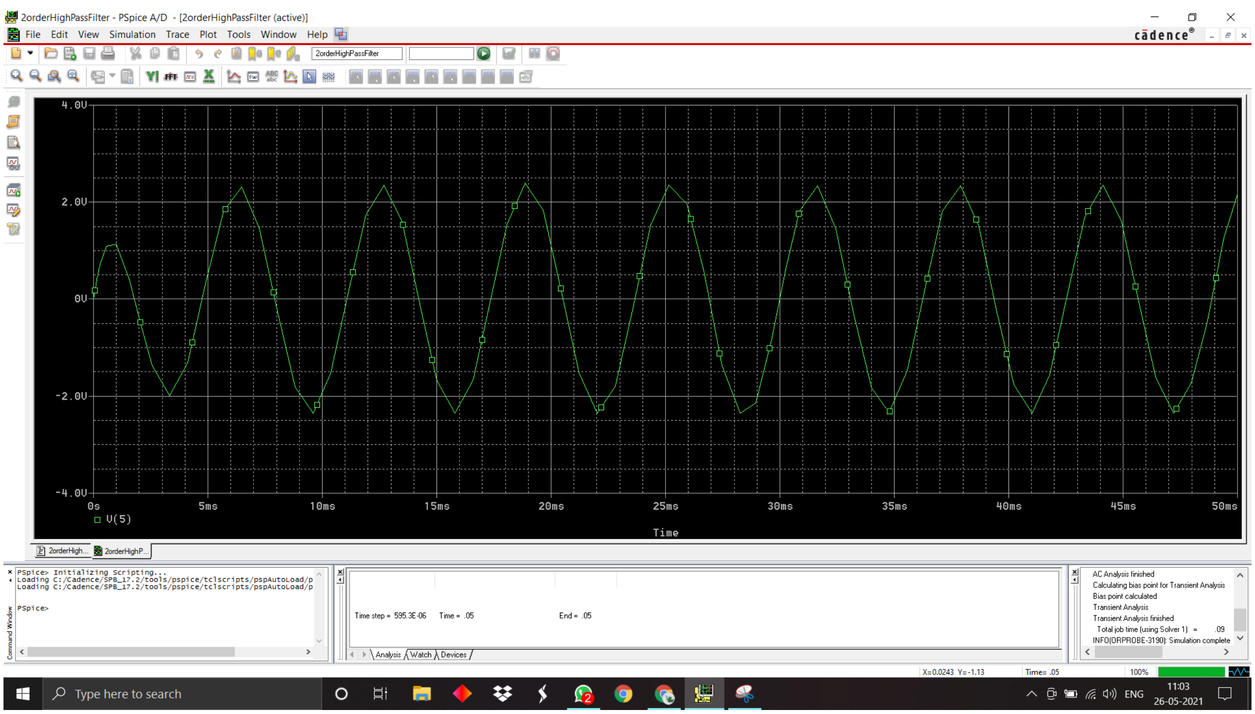
b. **Netlist Code**

```
Second Order High Pass Filter
X1 1 2 3 4 5 ua741
V1 7 0 AC 10 sin(0 2 159)
R1 5 6 10K
R2 1 0 10K
```

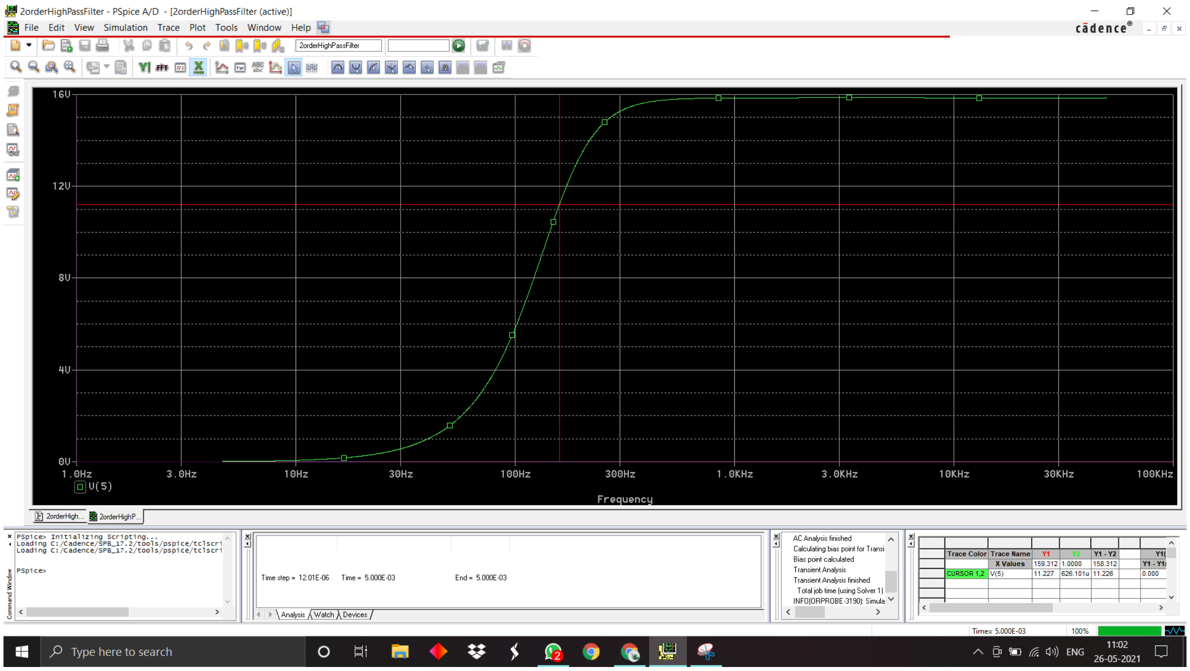
```
*Rin
R3 2 0 10K
*Rf
R4 2 5 5860
C1 6 7 0.1uF
C2 1 6 0.1uF

Vp 3 0 DC 15
Vn 0 4 DC 15
.tran 0 50m
.ac DEC 1001 1 50k
.probe
```

c. Simulation

1) Transient Analysis



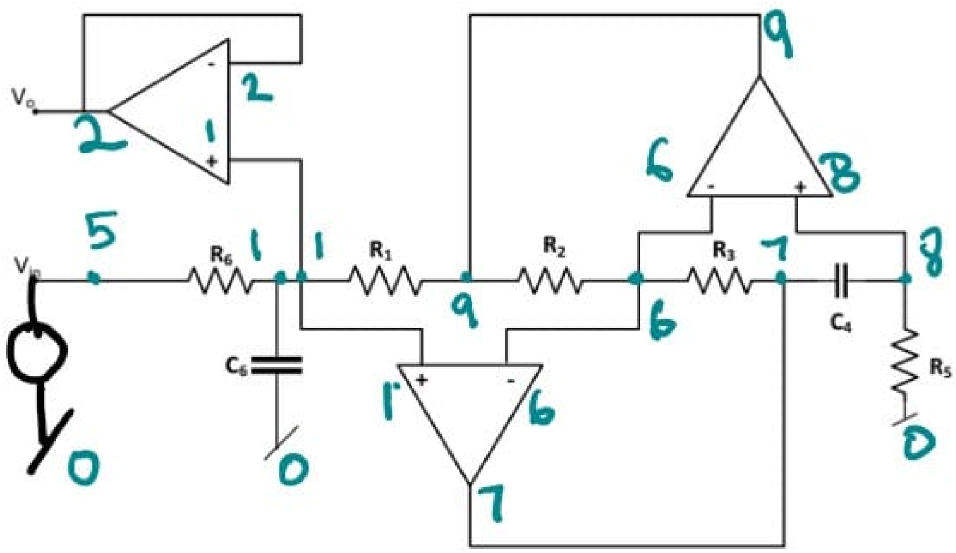
2) AC Analysis



EXPERIMENT 9

Aim : To design and implement a GIC (Generalized impedance converter) based 2nd order band pass filter using µA 741.

a. Circuit Diagram



Design Procedure;

Transfer function of band pass filter can be given as:

$$T..F. = \frac{s\left(\frac{1}{CR}\right)}{s^2 + s\left(\frac{1}{CR}\right) + \frac{1}{LC}}$$

Therefore, $w^2 = 1/LeqC$

$f = 1/\sqrt{2\boldsymbol{\pi}LeqC}$

$Leq = Ra^2Ca$

$wo/Q = 1/RC$

Given: $f = 159$Hz and Q = 1

$\sqrt{LeqC} = .001$

Let, $C = 1$uF

Therefore, $Leq = 1 \rightarrow Ra^2 Ca = 1$

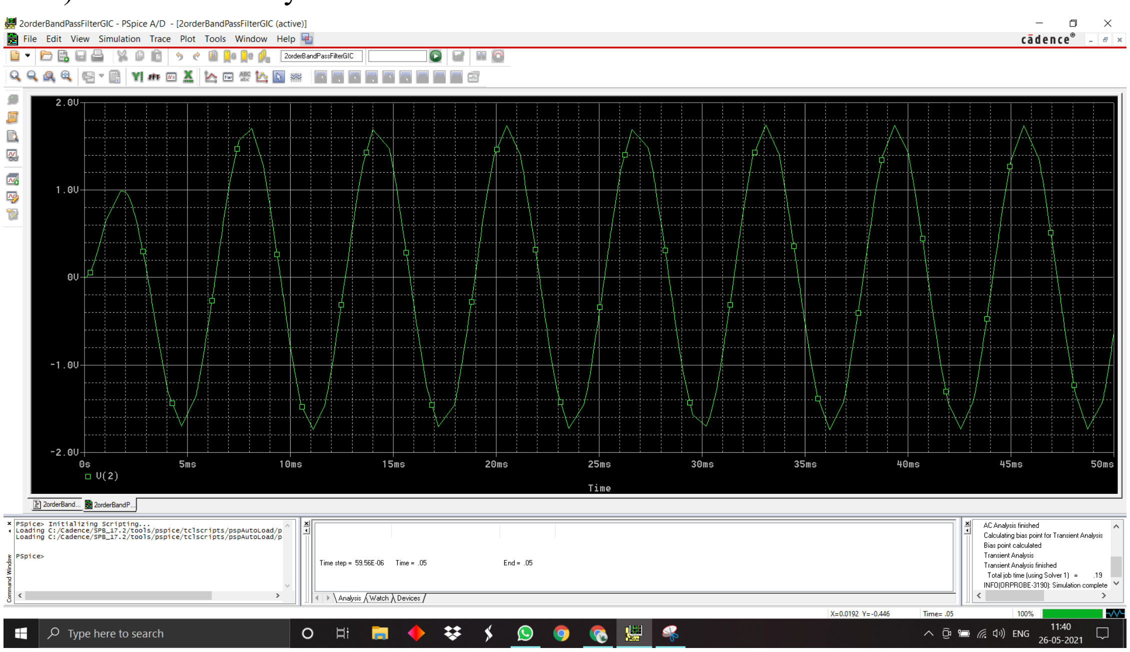
Let, $Ra = 10k$ therefore, $Ca = 10\text{nF}$
For $Q = 1, wo = 1/RC$
Therefore, $RC = .001$
Hence, $R = 1k\Omega$

b. Netlist Code

```
Second Order Band Pass Filter GIC
X1 1 2 3 4 2 ua741
X2 1 6 3 4 7 ua741
X3 8 6 3 4 9 ua741
V1 5 0 AC 1 sin(0 2 159)
R 5 1 1K
C 1 0 1uF
R2 1 9 10K
R3 9 6 10K
R4 6 7 10K
R5 8 0 10k
C2 7 8 10nF
Vp 3 0 DC 15
Vn 0 4 DC 15

.tran 0 65ms 45ms 65ms

.ac DEC 100 1 100mega
.probe
```

c. Simulation

1) Transient Analysis



2) AC Analysis