

||Jai Sri Gurudev||



**ADICHUNCHANAGIRI UNIVERSITY**

**BGS INSTITUTE OF TECHNOLOGY**



**BG Nagara – 571448 (Bellur Cross)  
Nagamangala Taluk, Mandya District.**

# **LINEAR IC's AND COMMUNICATION LABORATORY MANUAL 18ECL48**

For  
IV Semester B.E.  
2019-2020

**DEPARTMENT OF  
ELECTRONICS AND COMMUNICATION ENGINEERING**

Prepared by:

Approved by:

1. Mrs. KAVITHA B C, Asst. Prof
2. Mrs. NANDINI S , Asst. Prof
3. Mrs. PRAFULLA P S, Asst. Prof

Head of Department

## **DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING**

### **VISION:**

To develop high quality engineers with technical knowledge, skills and ethics in the area of Electronics and Communication Engineering to meet industrial and societal needs.

### **MISSION:**

1. To provide high quality technical education with up-to-date infrastructure and trained human resources to deliver the curriculum effectively in order to impart technical knowledge and skills.
2. To train the students with entrepreneurship qualities, multidisciplinary knowledge and latest skill sets as required for industry, competitive examinations, higher studies and research activities.
3. To mould the students into professionally-ethical and socially-responsible engineers of high character, team spirit and leadership qualities.

### **PROGRAM EDUCATIONAL OBJECTIVES (PEO's):**

After 3 to 5 years of graduation, the graduates of Electronics and Communication Engineering will;

1. Engage in industrial, teaching or any technical profession and pursue higher studies and research.
2. Apply the knowledge of Mathematics, Science as well as Electronics and Communication Engineering to solve social engineering problems.
3. Understand, Analyze, Design and Create novel products and solutions.
4. Display professional and leadership qualities, communication skills, Team spirit, multidisciplinary traits and lifelong learning aptitude.

## **LINEAR IC'S AND COMMUNICATION LAB SYLLABUS**

### **Course Learning Objectives:**

This laboratory course enables students to

- ◆ Design, Demonstrate and Analyze instrumentation amplifier, filters, DAC, adder, differentiator and integrator circuits, using op-amp.
- ◆ Design, Demonstrate and Analyze multivibrator and oscillator circuits using Op-amp
- ◆ Design, Demonstrate and Analyze analog systems for AM, FM and Mixer operations.
- ◆ Design, Demonstrate and Analyze balance modulation and frequency synthesis.
- ◆ Demonstrate and Analyze pulse sampling and flat top sampling.

### **Laboratory Experiments**

1. Design an instrumentation amplifier of a differential mode gain of  $\_A$  using three amplifiers.
2. Design of RC Phase shift and Wien's bridge oscillators using Op-amp.
3. Design active second order Butterworth low pass and high pass filters.
4. Design 4 bit R – 2R Op-Amp Digital to Analog Converter (i) using 4 bit binary input from toggle switches and (ii) by generating digital inputs using mod-16 counter.
5. Design Adder, Integrator and Differentiator using Op-Amp.
6. Design of Monostable and Astable Multivibrator using 555 Timer.
7. Demonstrate Pulse sampling, flat top sampling and reconstruction.
8. Amplitude modulation using transistor/FET (Generation and detection).
9. Frequency modulation using IC 8038/2206 and demodulation.
10. Design BJT/FET Mixer.

11.DSBSC generation using Balance Modulator IC 1496/1596.

12.Frequency synthesis using PLL.

**Beyond Syllabus:**

1. **Half wave precision rectifier**

**Course Outcomes:**

On the completion of this laboratory course, the students will be able to:

- Analyze the working of differential amplifier, filters and calculate cut off frequency and roll off of filters and design oscillators for any frequency.
- Generate R-2R DAC and also staircase wave using mod-16 counter, use adder and integrator and differentiator for suitable applications.
- Demonstrate the working of 555 timer and its applications and also can be able to generate amplitude modulation, frequency modulation and pulse amplitude modulation.
- Gain hands on experience in DSBSC generation, Mixer and PLL working.

## 1. Design an instrumentation amplifier of a differential mode gain of $\_A$ using three amplifiers

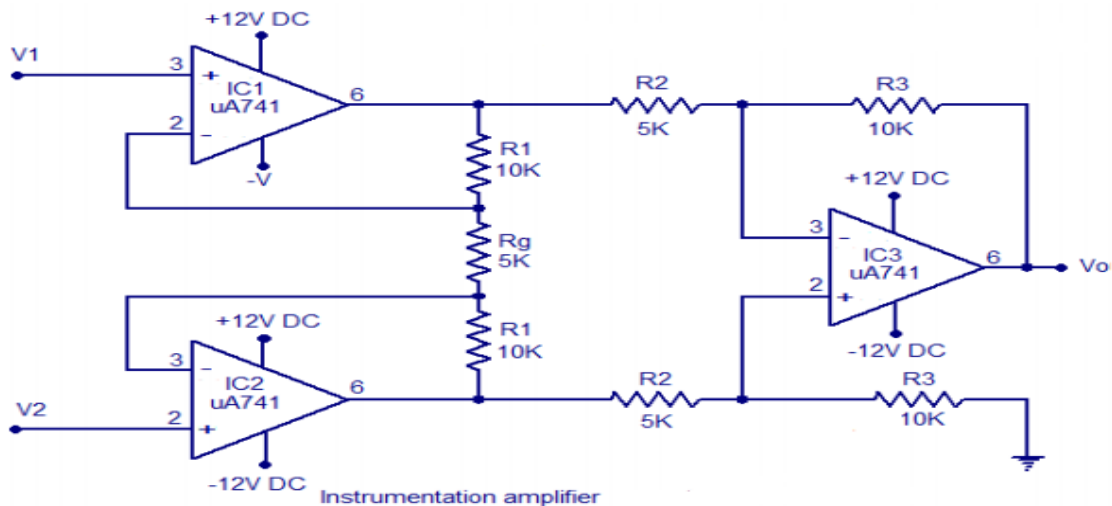
### AIM:

To design an instrumentation amplifier of a differential mode gain of 'A' using three amplifiers

### COMPONENTS REQUIRED:

Op-amp IC 741, Resistors, Capacitor, Connecting wires, Connecting board, CRO-probes

### CIRCUIT DIAGRAM:



### DESIGN:

$$\text{Gain } (A_v) = V_o / (V_2 - V_1) = (1 + (2R_1/R_g)) \times (R_3/R_2)$$

Circuit is designed for gain 10

If gain variable, then replace  $R_g$  with a 5K POT

### PROCEDURE:

1. Make the circuit connections as shown in the diagram
2. Circuit is designed for gain 10
3. Apply DC inputs to  $V_1$  and  $V_2$
4. Note down the corresponding output at pin no.6

### RESULT:

Thus the Instrumentational amplifier is designed and tested using Op-amp 741IC.

## 2. Design of RC Phase shift and Wien's bridge oscillators using Op-amp

### A) RC Phase shift oscillator

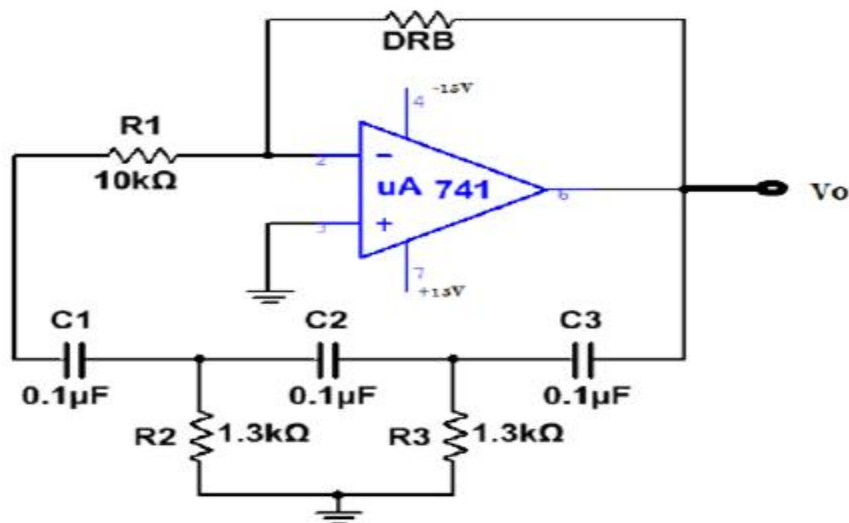
#### AIM:

To design RC phase shift oscillator for the given frequency of oscillations

#### COMPONENTS REQUIRED:

Sl. No.	Particulars	Range	Quantity
1.	Op-amp	$\mu A741$	01
2.	Resistors	as per design	-
3.	Capacitors	$0.1\mu F$	03
4.	Spring board & connecting wires		01 Set
5.	CRO		01

#### CIRCUIT DIAGRAM:



#### DESIGN:

Given  $f=500\text{Hz}$ , and  $A_v=29$

Assume  $C_1=C_2=C_3=C=0.1\mu F$

$$f = \frac{1}{2\pi RC\sqrt{6}}$$

$$R = \frac{1}{2\pi \cdot 0.1\mu \cdot 500 \cdot \sqrt{6}}$$

$$R = 1.3\text{K}\Omega$$

$$A_v = -(DRB)/R_1$$

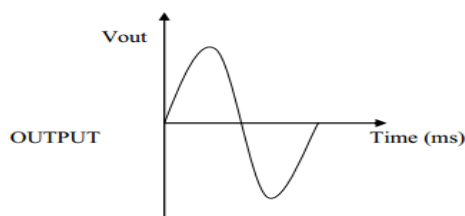
Assume  $R_1 = 10k\Omega$

$$\text{So, } DRB \geq 29 \times R_1$$

### **PROCEDURE:**

1. Connect the circuit as per the circuit diagram
2. Switch ON the Dual power supply & connect the CRO probe at pin no-6 of an op-amp.
3. Adjust the feedback resistor to get the oscillations. Provided that amplifier gain should meet 29
4. Observe the sine wave as output using CRO & measure the frequency.
5. Verify the frequency with the designed value

### **WAVEFORM:**



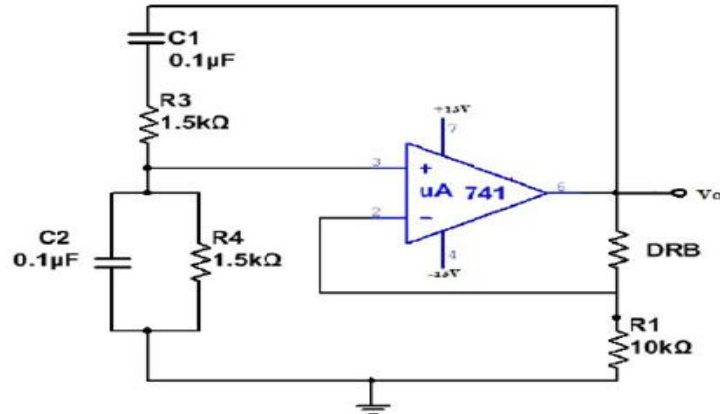
### **B) Wien's bridge oscillator**

#### **AIM:**

To design Wien's bridge oscillator for the given frequency of oscillations

#### **COMPONENTS REQUIRED:**

Sl. No.	Particulars	Range	Quantity
1.	Op-amp	$\mu A741$	01
2.	Resistors	as per design	-
3.	Capacitor	$0.1\mu F$	03
4.	Spring board & connecting wires		01 Set
5.	CRO		01



**DESIGN:**

Given  $f=1\text{KHz}$

Assume  $C1=C2=C=0.1\mu\text{F}$

$$f = \frac{1}{2\pi RC}$$

$$f = \frac{1}{2\pi RC}$$

$$R = \frac{1}{2\pi \cdot 0.1\mu \cdot 1K}$$

$$R = 1.59K\Omega$$

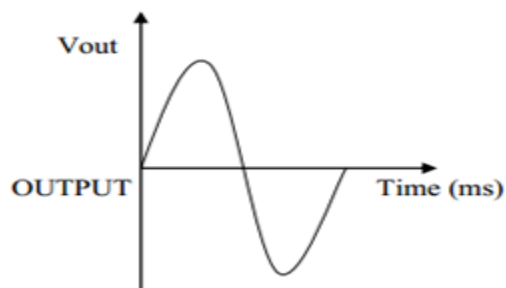
$$1 + \frac{R_f}{R_1} \geq 3$$

Assume  $R_1 = 10K\Omega$  then  $R_f > 2 \cdot R_1$

$$R_f = 20K\Omega$$

**PROCEDURE:**

1. Connect the circuit as per the circuit diagram
2. Switch ON the Dual power supply & connect the CRO probe at pin no-6 of an op-amp.
3. Adjust the feedback resistor to get the oscillations. Provided that amplifier gain should meet 3
4. Observe the sine wave as output using CRO & measure the frequency.
5. Verify the frequency with the designed value

**WAVEFORM:****RESULT:**

Thus RC Phase Shift and Wien Bridge Oscillator were designed and tested using op-amp IC 741.

### 3. Design active second order Butterworth low pass and high pass filters.

#### A) Second Order Low pass filter

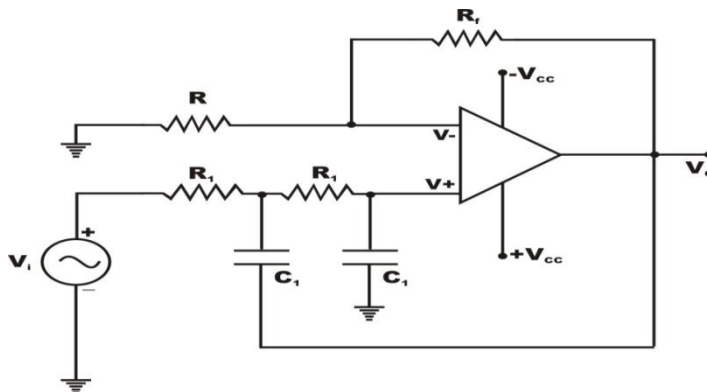
##### AIM:

To design an active second order low pass filter for cut-off frequency 1 KHz.

##### COMPONENTS REQUIRED:

Sl.no	Components	Specification	Quantity
1	Op-amp	$\mu A741$	1
2	CRO	-	1
3	Signal generator	-	1
4	Resistors	15k $\Omega$ , 10k $\Omega$ , 5.6k $\Omega$	2, 1, 1
5	Capacitors	0.01 $\mu f$	2

##### CIRCUIT DIAGRAM:



##### DESIGN:

Let  $A_f = 1.568$  &  $f_c = 1\text{KHz}$

Cut off frequency:  $f_c = 1/2\pi RC$

Assume  $C = C_1 = 0.01\mu f$

$R = 1/2\pi f_c C$

$R = 1/2 \times \pi \times 1k \times 0.01\mu f$

$R = 15.92\text{K}\Omega$

Use  $R = R_1 = 15\text{k}\Omega$

$A_f = 1 + (R_f / R)$

$$1.568-1 = R_f / R$$

$$R_f = 5.6 \text{ K}\Omega \text{ when } R = 10 \text{ K}\Omega$$

### PROCEDURE:

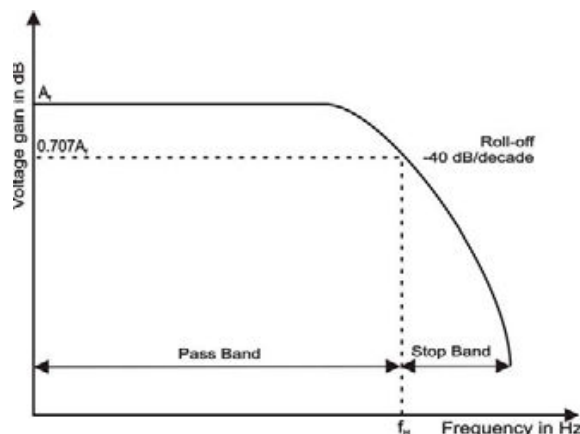
1. Circuit connections are made as shown in the fig.
2. Input voltage is kept constant at 2V
3. The input frequency is varied from 100Hz to 50KHz.
4. At each step corresponding output is measured.
5. The gain in dB is calculated by using the formula  $A_f = 20 \log v_o/v_i$
6. The graph of gain v/s frequency is plotted on the graph sheet.
7. The higher cut-off frequency, roll-off rate are calculated and compared with theoretical values.

### TABULAR COLUMN:

Input voltage,  $v_{in} = \underline{\hspace{2cm}}$

F in Hz	O/p voltage	Gain = $20 \log v_o/v_i$

### WAVEFORM:



**RESULT:**

Cut-off frequency Theoretical= \_\_\_\_\_

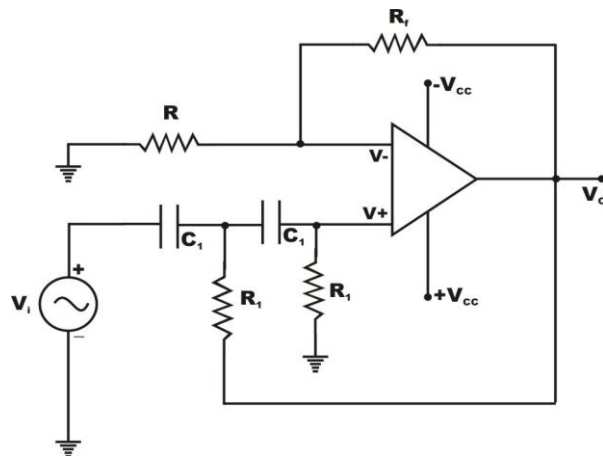
Cut-off frequency Practical= \_\_\_\_\_

**B) Second Order High pass filter****AIM:**

To design an active second order high pass filter for cutoff frequency 2KHz

**COMPONENTS REQUIRED:**

Sl.no	Components	Specification	Quantity
1	Op-amp	$\mu A741$	1
2	CRO	-	1
3	Signal generator	-	1
4	Resistors	15k $\Omega$ , 10k $\Omega$ , 5.6k $\Omega$	2, 1, 1
5	Capacitors	0.01 $\mu f$	2

**CIRCUIT DIAGRAM:****DESIGN:**Let  $A_f = 1.568$  &  $f_c = 1\text{KHz}$ Cut off frequency :  $f_c = 1/2\pi RC$ Assume  $C = C_1 = 0.01\mu f$  $R = 1/2\pi f_c C$  $R = 1/2 \times \pi \times 1k \times 0.01\mu f$

$R = 15.92\text{K}\Omega$

Use  $R = R_1 = 15\text{k}\Omega$

$$A_f = 1 + (R_f / R)$$

$$1.568 - 1 = R_f / R$$

$R_f = 5.6\text{K}\Omega$  when  $R = 10\text{K}\Omega$

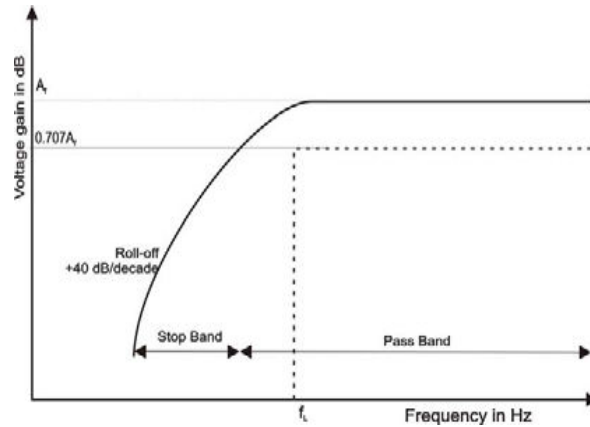
**PROCEDURE:**

1. Circuit connections are made as shown in the fig.
2. Input voltage is kept constant at 2V
3. The input frequency is varied from 100Hz to 50KHz
4. At each step corresponding output is measured.
5. The gain in dB is calculated by using the formula  $A_f = 20 \log v_o/v_i$
6. The graph of gain v/s frequency is plotted on the graph sheet.
7. The higher cut-off frequency, roll-off rate are calculated and compared with theoretical values.

**TABULAR COLUMN:**

Input voltage,  $v_{in} = \underline{\hspace{2cm}}$

F in Hz	O/p voltage	Gain = $20 \log v_o/v_{in}$



**RESULT:**

Cut-off frequency Theoretical= \_\_\_\_\_

Cut-off frequency Practical= \_\_\_\_\_

**4. Design 4 bit R – 2R Op-Amp Digital to Analog Converter (i) using 4 bit binary input from toggle switches and (ii) by generating digital inputs using mod-16 counter.**

**A) 4 bit binary input from toggle switches**

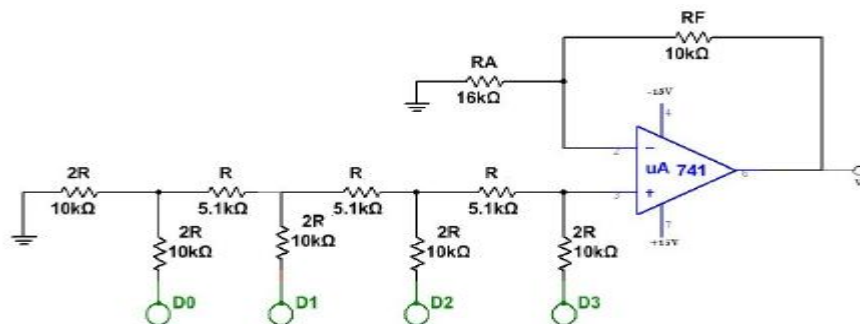
**AIM:**

To design the 4-bit DAC using op-amp from toggle switch to get the output voltage for various values of binary data

**COMPONENTS REQUIRED:**

Sl. No.	Particulars	Specification	Quantity
1.	IC	$\mu A741$	01
2.	Resistors	As per design	-
3.	Multimeter	-	01
4.	Base board + connecting wires	-	01 Set

**CIRCUIT DIAGRAM:**



**DESIGN:**

Design 4 bit R-2R DAC for an output voltage,  $V_o = 5V$ ,

when the input is  $(10)_d$  [i.e.,  $(1010)_b$ ].

$D_3 \ D_2 \ D_1 \ D_0$

$(10)_{10} = (1 \ 0 \ 1 \ 0)_2$

Therefore  $D_3 = 1$  (MSB),  $D_2 = 0$ ,  $D_1 = 1$ ,  $D_0 = 0$  (LSB)

$$A_v = \frac{V_o}{V_i} \Rightarrow V_o = A_v \cdot V_i$$

$$V_o = \left(1 + \frac{R_F}{R_A}\right) \frac{V_{ref}}{16} (D_0 + 2D_1 + 4D_2 + 8D_3)$$

Assume  $R_F = 10k\Omega$ ,  $V_{ref} = 5V$

$$5 = \left(1 + \frac{10k}{R_A}\right) \frac{5}{16} (2 \times 1 + 8 \times 1)$$

$$R_A = 16k\Omega$$

**PROCEDURE:**

1. Make the connection as shown in the circuit diagram
2. Digital input data is given at D<sub>3</sub>, D<sub>2</sub>, D<sub>1</sub>, D<sub>0</sub> & corresponding analog output voltage V<sub>0</sub> is measured using voltmeter
3. Tabulate the readings & plot the graph of V<sub>in</sub> V/S V<sub>0</sub>

**TABULAR COLUMN:**

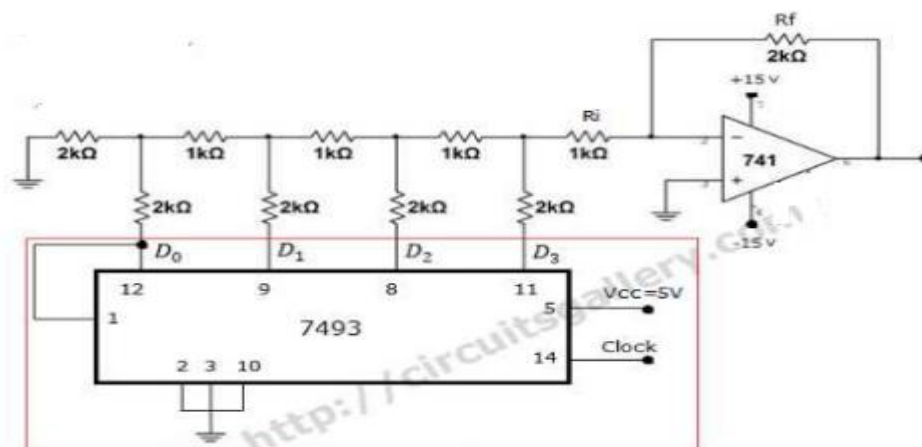
Decimal Value	Binary Inputs				Analog O/P Vo(volts) Theoretical values	Analog O/P Vo(volts) Practical values
	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>		
0	0	0	0	0		
1	0	0	0	1		
2	0	0	1	0		
3	0	0	1	1		
4	0	1	0	0		
5	0	1	0	1		
6	0	1	1	0		
7	0	1	1	1		
8	1	0	0	0		
9	1	0	0	1		
10	1	0	1	0		
11	1	0	1	1		
12	1	1	0	0		
13	1	1	0	1		
14	1	1	1	0		
15	1	1	1	1		

**RESULT:****B) Generating digital inputs using mod-16 counter****AIM:**

To design the 4-bit DAC using op-amp from toggle switch to get the output voltage for various values of binary data

**COMPONENTS REQUIRED:**

Sl. No.	Particulars	Specification	Quantity
1.	IC	μA741	01
2.	Resistors	As per design	-
3.	Multimeter	-	01
4.	Base board + connecting wires	-	01 Set



**PROCEDURE:**

1. Make the connection as shown in the circuit diagram
2. Construct a modulo-16 counter using a suitable digital IC like 7493.
3. Digital input data is given at D3, D2, D1, D0 & corresponding analog output voltage  $V_0$  is measured using voltmeter
4. Tabulate the readings & plot the graph of  $V_{in}$  V/S  $V_0$

**TABULAR COLUMN:**

Observation:

Decimal Value	Binary Inputs				Analog O/P $V_o$ (volts) Theoretical values	Analog O/P $V_o$ (volts) Practical values
	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>		
0	0	0	0	0		
1	0	0	0	1		
2	0	0	1	0		
3	0	0	1	1		
4	0	1	0	0		
5	0	1	0	1		
6	0	1	1	0		
7	0	1	1	1		
8	1	0	0	0		
9	1	0	0	1		
10	1	0	1	0		
11	1	0	1	1		
12	1	1	0	0		
13	1	1	0	1		
14	1	1	1	0		
15	1	1	1	1		

**RESULT:**

The analog signals are converted to digital and the analog data is recovered

## 5. Design Adder, Integrator and Differentiator using Op-Amp.

### A) Adder

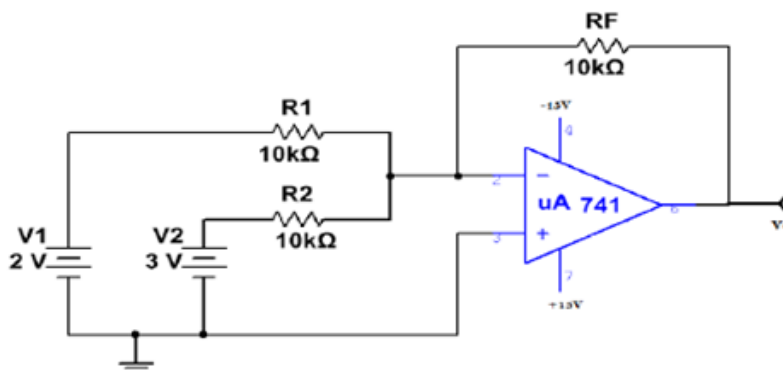
#### AIM:

To Study the output & design of inverting adder using op-amp

#### COMPONENTS REQUIRED:

Sl. No.	Particulars	Specification	Quantity
1.	Op-amp	$\mu A$ 741	01
2.	Resistors	As per design	-
3.	Multimeter		01
4.	Spring board + Connecting wires		01 Set

#### CIRCUIT DIAGRAM:



#### DESIGN:

Given  $A_v = 1$

Let  $R_1 = R_2 = R = 10k\Omega$

$$A_v = -\frac{R_F}{R}; R_F = A_v \times R$$

$$R_F = 10k\Omega$$

#### PROCEDURE:

1. Make the connections as per the circuit diagram
2. Apply input from signal generator  $V_1 = 2v$  &  $V_2 = 3v$
3. Observe the output at pin no-6

Sl. No.	Theoretical values of Vo	Practical values of Vo
1		
2		

**RESULT:**

Thus an Adder using op-amp are designed and their performance was successfully tested using op-amp IC 741.

**B) Integrator**

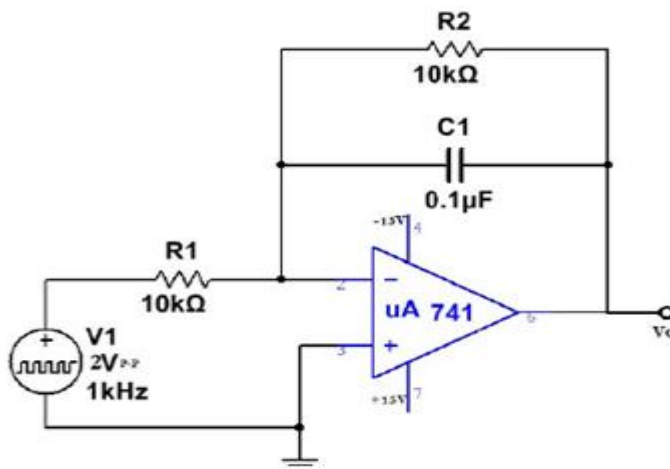
**AIM:**

To Study the output & design of Integrator using op-amp

**COMPONENTS REQUIRED:**

Sl. No.	Particulars	Specification	Quantity
1.	Op-amp	$\mu A$ 741	01
2.	Resistors and Capacitors	As per design	-
3.	CRO and Signal Generator		01 Set
4.	Spring board + Connecting wires		01 Set

**CIRCUIT DIAGRAM:**



**DESIGN:**Given  $A_v = 1$ Let  $R_1 = 10k\Omega$ 

$$v_o = -\frac{1}{R_1 C_F} \int_0^t v_{in} dt$$

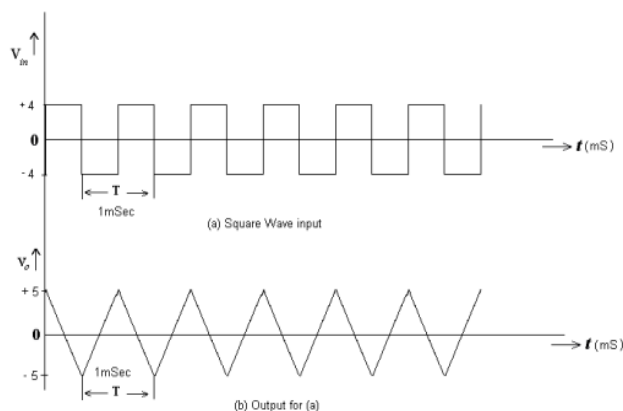
$$A_v = -R_2/R_1$$

$$R_2 = A_v * R_1$$

$$R_2 = 10k\Omega$$

**PROCEDURE:**

1. Connect the circuit as per shown in the circuit diagram.
2. Apply the square wave/sine input of  $2V_{p-p}$  at 1KHz
3. Observe the output at pin 6
4. Draw input and output waveforms

**WAVEFORM:****RESULT:**

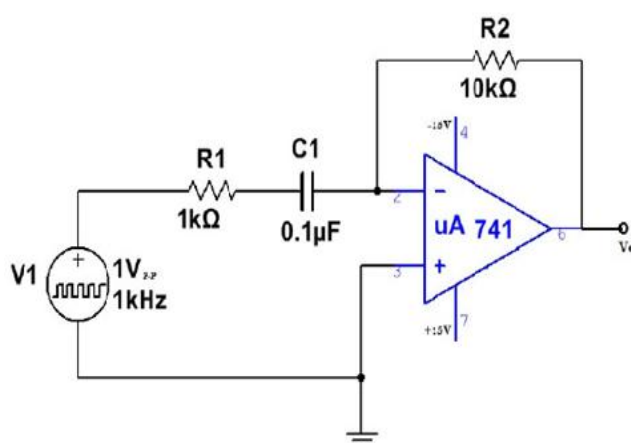
Thus an Integrator using op-amp are designed and their performance was successfully tested using op-amp IC 741.

**C) Differentiator****AIM:**

To Study the output & design of Differentiator using op-amp

**COMPONENTS REQUIRED:**

Sl. No.	Particulars	Specification	Quantity
1.	Op-amp	$\mu A$ 741	01
2.	Resistors and Capacitors	As per design	-
3.	CRO and Signal Generator		01 Set
4.	Spring board + Connecting wires		01 Set

**CIRCUIT DIAGRAM:****DESIGN:**

Given  $A_v = 1$

Let  $R_1 = 10k\Omega$

$$A_v = -R_2/R_1$$

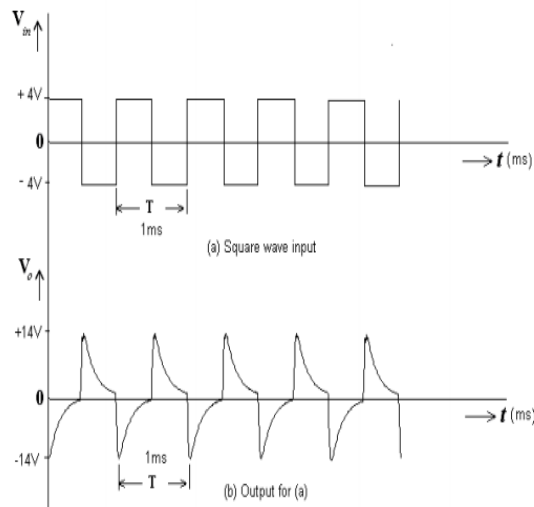
$$R_2 = A_v \cdot R_1$$

$$R_2 = 10k\Omega$$

$$V_{out} = -RC \frac{dV_{in}}{dt}$$

**PROCEDURE:**

1. Connect the circuit as per shown in the circuit diagram.
2. Apply the square wave of  $2V_{p-p}$  at 1KHz
3. Observe the output at pin 6
4. Draw input and output waveforms



**RESULT:**

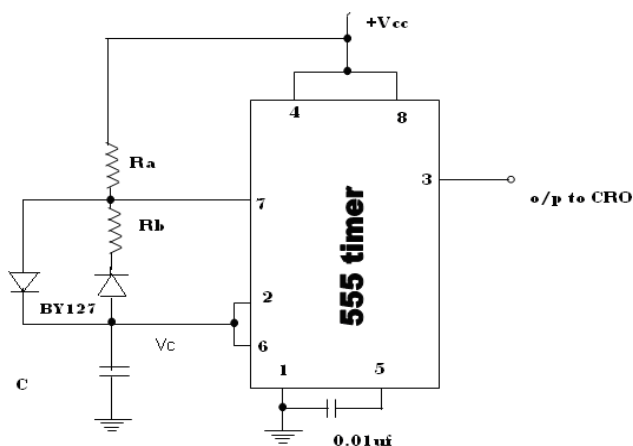
Thus an Differentiator using op-amp are designed and their performance was successfully tested using op-amp IC 741

**6. Design of Monostable and Astable Multivibrator using 555 Timer.****A) Astable Multivibrator****AIM:**

To rig up a Astable Multivibrator using IC 555 timer to generate a square wave of desired frequency and duty cycle.

**COMPONENTS REQUIRED:**

Sl.no	Components	Specification	Quantity
1	Op-amp	IC 555	1
2	CRO		1
3	Capacitor	0.1 $\mu$ f, 0.01 $\mu$ f	1, 1
4	Resistors	10k $\Omega$ , 3.3k $\Omega$	1, 1
5	Diode	BY 127	2

**CIRCUIT DIAGRAM:****DESIGN:**

Astable multivibrator circuit using 555 timer for  $f = 1 \text{ KHz}$ , duty cycle = 70 % and  $V_{out} = 5 \text{ Volts}$

$$\text{WKT } T_{on} = 0.69 (R_a + R_b) \dots\dots\dots (1)$$

$$T_{off} = 0.69 (R_b) C \dots\dots\dots (2)$$

$$T = 1/f = 1 / 1\text{kHz} = 1\text{ms}$$

$$T_{on} = 0.75\text{ms}$$

$$T_{off} = 0.25\text{ms}$$

$$\text{Choose } C = 0.1\mu\text{f}$$

From equation (2)

$$0.25\text{ms} = 0.69(R_b)0.1\mu$$

$$R_b = 3.62\text{k}\Omega \quad \text{use } \mathbf{R_b = 3.3\text{k}\Omega}$$

From equation (1)

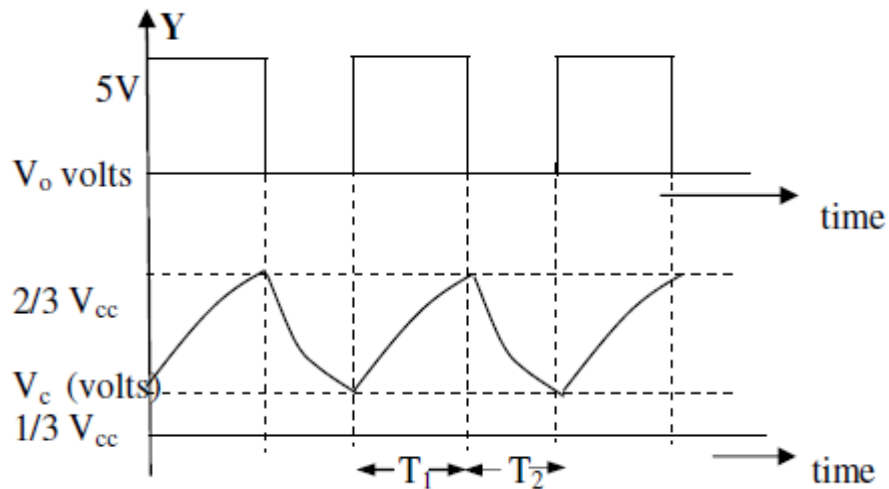
$$0.75 = 0.69(R_a + 3.3\text{k})$$

$$R_a = 7.66\text{k}\Omega \quad \text{use } R_a = 10\text{k}\Omega$$

### **PROCEDURE:**

1. Connections are made as shown in the circuit diagram.
2. The  $T_{on}$ ,  $T_{off}$  and  $T$  of the output wave forms at pin 3 is measured and is verified with the designed value.
3. Capacitor voltage wave forms is observed at pin 2 or 6.

### **WAVEFORM:**



### **RESULT:**

$$T_{on} = \text{-----} \quad T_{off} = \text{-----} \quad F = \text{-----}$$

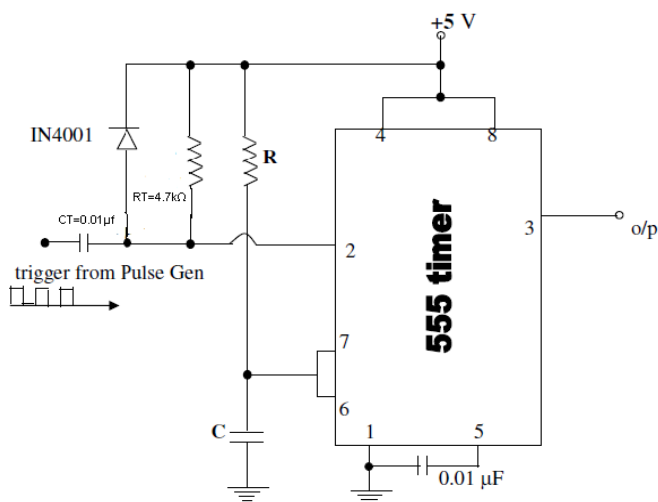
### **B) Monostable Multivibrator**

#### **AIM:**

To rig up a Monostable Multivibrator using IC 555 timer to generate a pulse of Given width

Sl.no	Components	Specification	Quantity
1	Op-amp	IC 555	1
2	CRO	-	1
3	Capacitor	0.1 $\mu$ f, 0.01 $\mu$ f	1, 2
4	Resistors	4.7k $\Omega$ , 10k $\Omega$	1, 1
5	Diode	BY 127	1
6	Signal Generator	-	1

**CIRCUIT DIAGRAM:**



**DESIGN:**

O/p pulse width = delay time  $T_d = 0.5\text{msec}$

O/p delay time  $T_d = 1.1RC$

Assume  $C = 0.1\mu\text{f}$

$R = 9.09\text{k}\Omega$  Use  **$R = 10\text{k}\Omega$**

Choose:  $R_T C_T < T_d / 10$

Assume  $C_T = 0.01\mu\text{f}$

$R_T < 0.5\text{m} / 10 \times 0.01\mu\text{f}$

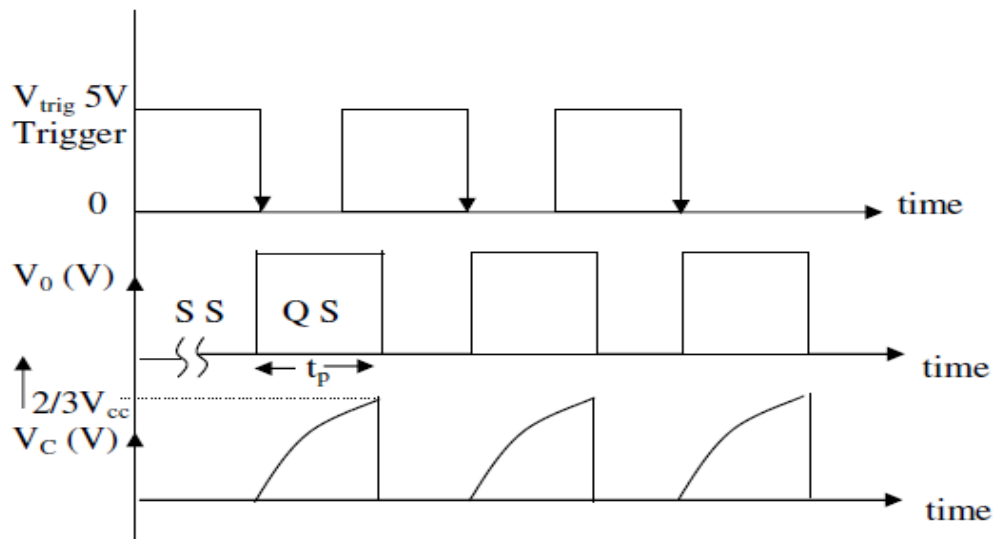
$R_T = 5\text{k}\Omega$  use  **$R_T = 4.7\text{k}\Omega$**

$f = 1/T$  trigger pulse freq

$F = 1\text{ KHz}$ ,  $T = 1\text{ms}$  o/p delay time

**PROCEDURE:**

1. Connections are made as shown in the circuit diagram.
2. Trigger pulses are applied at pin 2 (the duty cycle of trigger pulses is adjusted so that its Off time is less than pulse width  $W$  )
3. The pulse width of the waveforms at pin 3 is measured and verified with the designed Value.
4. Capacitor voltage waveforms is observed at pin No.6 or 7.

**WAVEFORM:****RESULT:**

Pulse width ( $W$ ) given = \_\_\_\_\_

Pulse width ( $W$ ) observed = \_\_\_\_\_

## 7. Demonstrate Pulse sampling, flat top sampling and reconstruction.

### AIM:

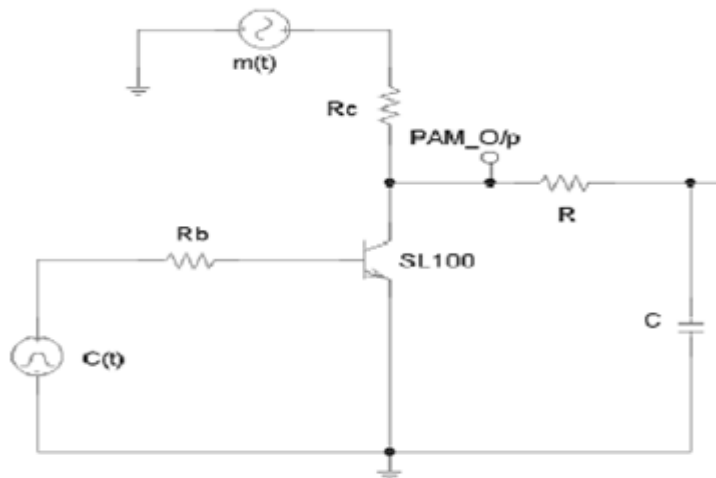
To demonstrate pulse sampling & design a circuit to demodulate the obtain the pulse sampling signal & verify sampling theorem

### COMPONENTS REQUIRED:

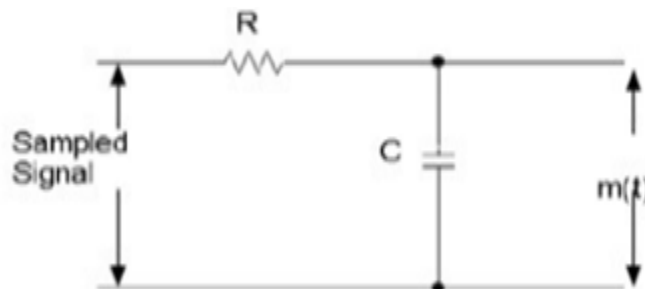
Sl.no	Components	Specification	Quantity
1	Transistor	SL100	1
2	Resistor	4.7K, 10K, 1K, 180ohm	1 each
3	Signal generator	-	2
4	Power supply	-	1
5	CRO with probes	-	1
6	Bread board	-	1

### CIRCUIT DIAGRAM:

#### (a) MODULATION CIRCUIT



#### (b) DEMODULATION CIRCUIT



**DESIGN:**

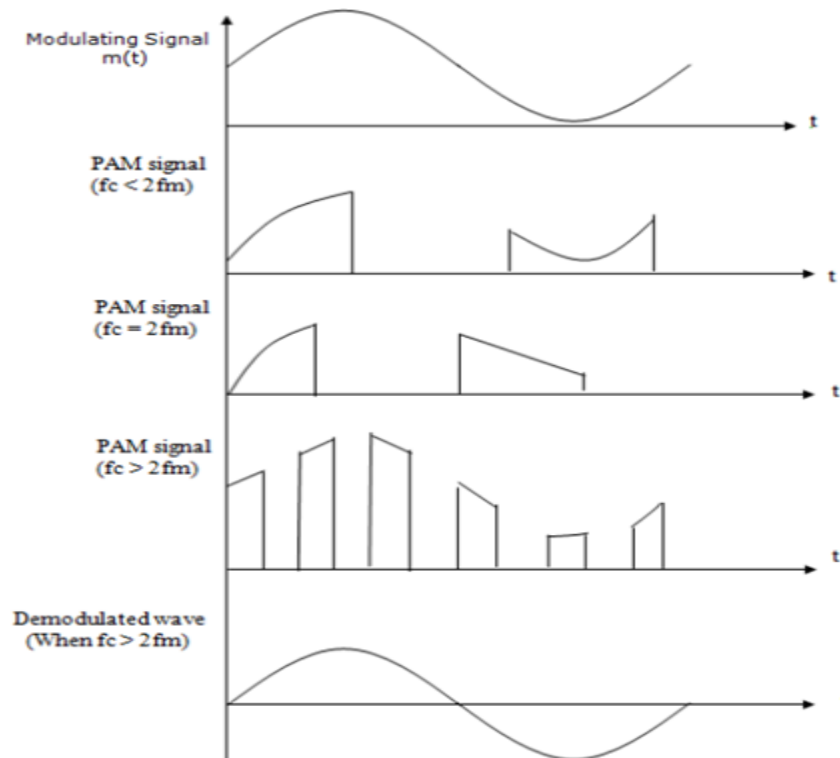
$$f_m = 1/(2\pi RC)$$

Assume  $C = 0.1\mu\text{F}$ ,  $f_m = 495\text{Hz}$

$R = 3.3\text{K ohm}$

**PROCEDURE:**

1. Check the Components for their working condition
2. Connections are made as shown in the circuit
3. Apply the square wave carrier signal of  $2V_{P-P}$  amplitude, frequency of  $1\text{kHz}$
4. Apply the sine wave modulating signal of frequency of  $f_m$  &  $3\text{V}$  dc shift
5. Observe the PAM waveform
6. Observe the demodulated signal at the output of the LPF & note  $f_0$  &  $V_0$
7. Repeat the above steps for  $f_c = 2f_m$  &  $f_c < 2f_m$

**WAVEFORM:**

PAM (v)	$E_{\max}(v)$	$E_{\min}(v)$	$\% \mu = (E_{\max} - E_{\min}) / (E_{\max} + E_{\min}) \times 100$
2			
3			
4			
5			

**RESULT:**

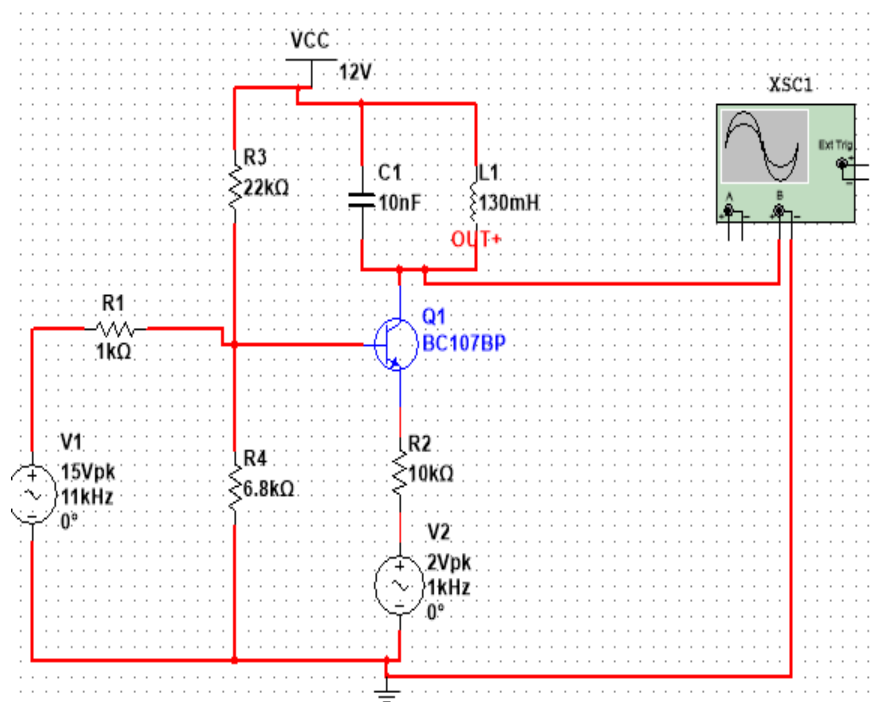
The output of pulse sampling & the demodulation circuit are verified using the waveform

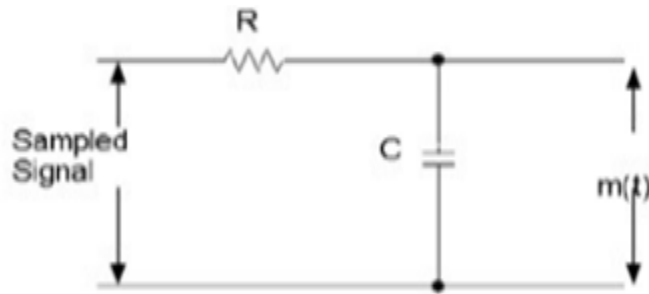
**8. Amplitude modulation using transistor/FET (Generation and detection).****AIM:**

To design an amplitude Modulation & Demodulation and find the percentage of modulation

**COMPONENTS REQUIRED:**

Sl.no	Components	Specification	Quantity
1	Transistor	CL100/BC107	1
2	DIB	30mH	1
3	Capacitor	0.01 $\mu$ F, 4.7 $\mu$ F	1
4	Resistors	100K, 560ohm	2,1
5	Signal generators		1
6	CRO with probes		1
7	Bread board		1
8	Connecting wires		1 bunch

**CIRCUIT DIAGRAM:****(a) MODULATION CIRCUIT**



**DESIGN:**

$$f_m = 1/(2\pi RC)$$

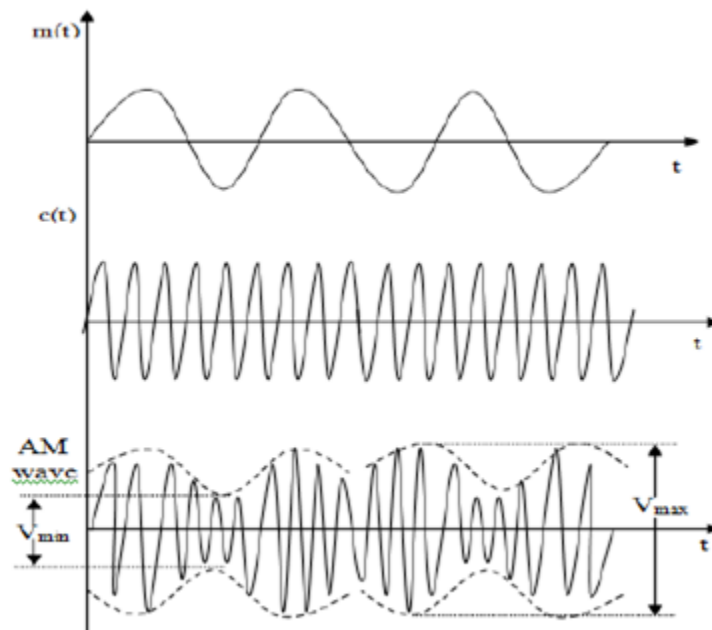
Assume  $C = 0.1\mu\text{F}$ ,  $f_m = 495\text{Hz}$

$R = 3.3\text{K ohm}$

**PROCEDURE:**

1. Make connections as shown in figure.
2. Set the carrier frequency.
3. Set the modulating signal.
4. Keep carrier amplitude constant and vary the modulating voltage in steps and measure
5. Measure  $V_{\max}$  and  $V_{\min}$ , and calculate modulation index.

**WAVEFORM:**



M(t)(v)	E <sub>max</sub> (v)	E <sub>min</sub> (v)	$\% \mu = (E_{\max} - E_{\min}) / (E_{\max} + E_{\min}) \times 100$
2			
3			
4			
5			

**RESULT:**

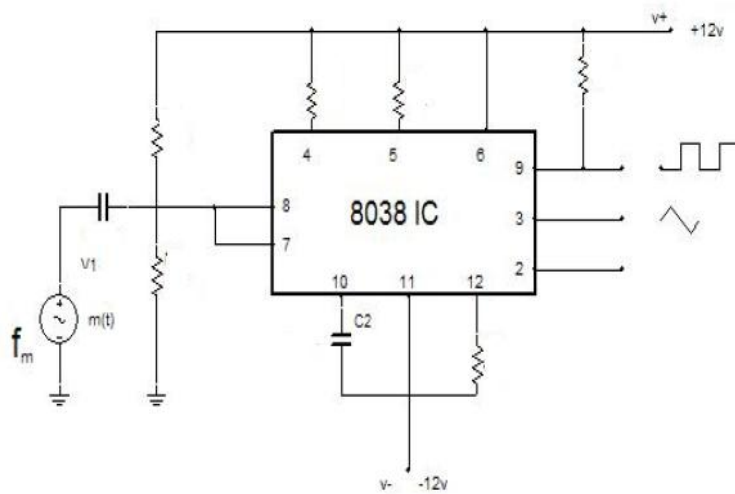
The amplitude modulation & demodulation circuit are verified. The modulation index is also verified

**9. Frequency modulation using IC 8038/2206 and demodulation.****AIM:**

To generate FM wave using IC 8038, find the modulation index & bandwidth of operation.

**COMPONENTS REQUIRED:**

Sl.no	Components	Specification	Quantity
1	IC 8038		
2	Resistors	12K, 10K, 82K	3,1
3	Capacitors	10 $\mu$ F, 0.001 $\mu$ F	1
4	Signal generator		1
5	Power supply		1
6	CRO with probes		1
7	Bread board		1
8	Connecting wires		1 bunch

**CIRCUIT DIAGRAM:****DESIGN:**

$$R_A = R_B, \quad f = 25 \text{ KHz}, \quad C = 0.001 \mu\text{F}$$

$$f = 0.3 / RC$$

$$R = 0.3 / (f * C)$$

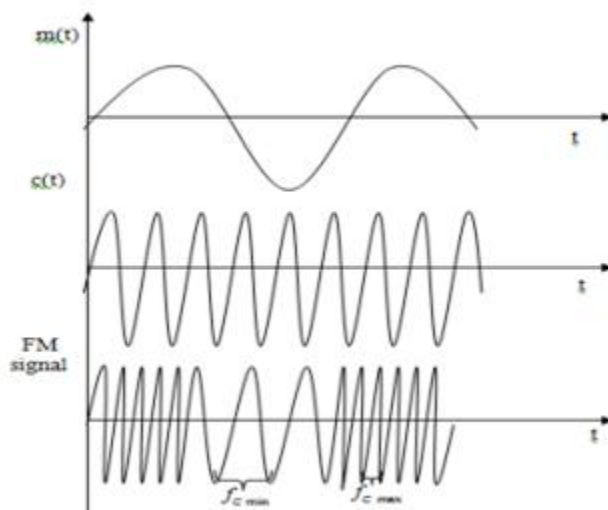
$$R = 12 \text{ K}\Omega$$

$$R_A = R_B = R$$

Choose  $R_1 = 82 \text{ K}\Omega$

**PROCEDURE:**

1. Check the components/ Equipments for their working condition.
2. Connections are made as shown in the circuit diagram.
3. By switching off the modulating signal  $m(t)$  note the frequency of the carrier wave at PinNo.2 of IC-8038.
4. Apply the modulating signal with suitable amplitude to get the FM signal.
5. Note the maximum ( $f_{\max}$ ) and minimum ( $f_{\min}$ ) frequency of the carrier wave in FM signal
6. Calculate the frequency deviation, modulation index and bandwidth.

**WAVEFORM:****TABULAR COLUMN:**

Amp	$T_{\min}$	$f_{\max}$	$T_{\max}$	$f_{\min}$	$\Delta f$	$\beta = \Delta f / f_m$	$B.W = 2f_m(1 + \beta)$

**RESULT:**

The modulation & bandwidth of frequency is obtained.

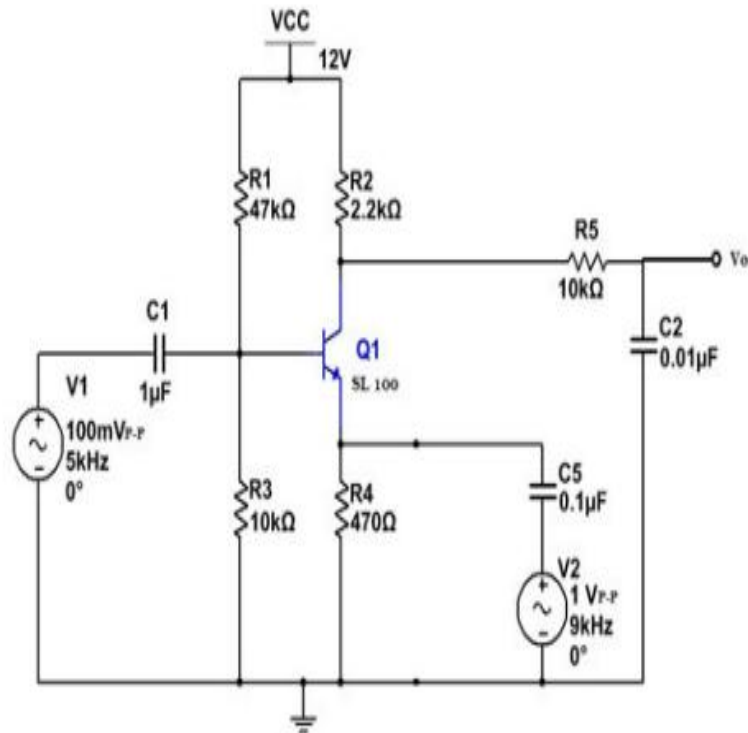
**AIM:**

Design a BJT Mixer circuit and verify the result

**COMPONENTS REQUIRED:**

Sl.no	Components	Specification	Quantity
1	Transistor	BC1707	1
2	Resistors	47K, 22K, 10K, 560 ohm	1,1,3,1
3	Capacitors	0.01 $\mu$ F, 0.1 $\mu$ F	3,1
4	Power supply	-	1
5	Function generator	-	2
6	CRO with Probes	-	1
7	Connecting wires	-	1 bunch

**CIRCUIT DIAGRAM:**



**Design:**

Given,  $V_{CE} = 5 \text{ V}$  and  $I_C = 2 \text{ mA}$  Assume  $\beta = 100$

$$V_{CC} = 2V_{CE} = 2 \times 5 = 10 \text{ V}$$

Let  $V_{RE} = 10\% V_{CC} = 1 \text{ V}$

$$R_E = V_{RE} / (I_C + I_B)$$

$$I_B = I_C / \beta = 2 \text{ mA} / 100 = 20 \mu\text{A}$$

$$R_E = 1 / (2 \text{ mA} + 20 \mu\text{A}) = 495 \Omega$$

Choose  $R_E = 470 \Omega$

Apply KVL to collector loop

$$V_{CC} - I_C R_C - V_{CE} - V_E = 0$$

$$R_C = (V_{CC} - V_{CE} - V_E) / I_C = (10 - 5 - 1) / 2 \text{ mA}$$

$$R_C = 2 \text{ k}\Omega \quad \text{Choose } R_C = 2.2 \text{ k}\Omega$$

Let  $I_{R1} = 10 I_B = 10 \times 20 \mu\text{A} = 200 \mu\text{A}$

$$V_{R2} = V_{BE} + V_E$$

$$= 0.6 + 1 = 1.6 \text{ V (Since transistor is silicon make } V_{BE} = 0.6 \text{ V)}$$

$$R_2 = V_{R2} / (I_{R1} - I_B) = 1.6 / (200 \mu\text{A} - 20 \mu\text{A})$$

$$R_2 = 8.8 \text{ k}\Omega \quad \text{Choose } R_2 = 10 \text{ k}\Omega$$

$$R_1 = (V_{CC} - V_{R2}) / I_{R1} = (10 - 1.6) / 200 \mu\text{A}$$

$$R_1 = 42 \text{ k}\Omega \quad \text{Choose } R_1 = 47 \text{ k}\Omega$$

$$X_{CE} \ll R_E$$

$$X_{CE} = R_E / 10$$

$$1 / (2 \pi f C_E) = 470 / 10$$

$$\text{Let } f = 100 \text{ Hz}$$

$$C_E = 33 \mu\text{F} \quad \text{Choose } C_E = 47 \mu\text{F}$$

**PROCEDURE:**

1. Check the components for the working condition
2. Connections are made as shown in the circuit diagram
3. Apply the input signals as mentioned in the circuit diagram
4. Observe the output waveform
5. Measure the output frequency it as to be equal to  $f_0 = f_1 - f_2 \text{ Hz}$

**RESULT:**

Thus the BJT mixer circuit is designed and result is verified

## 11. DSBSC generation using Balance Modulator IC 1496/1596.

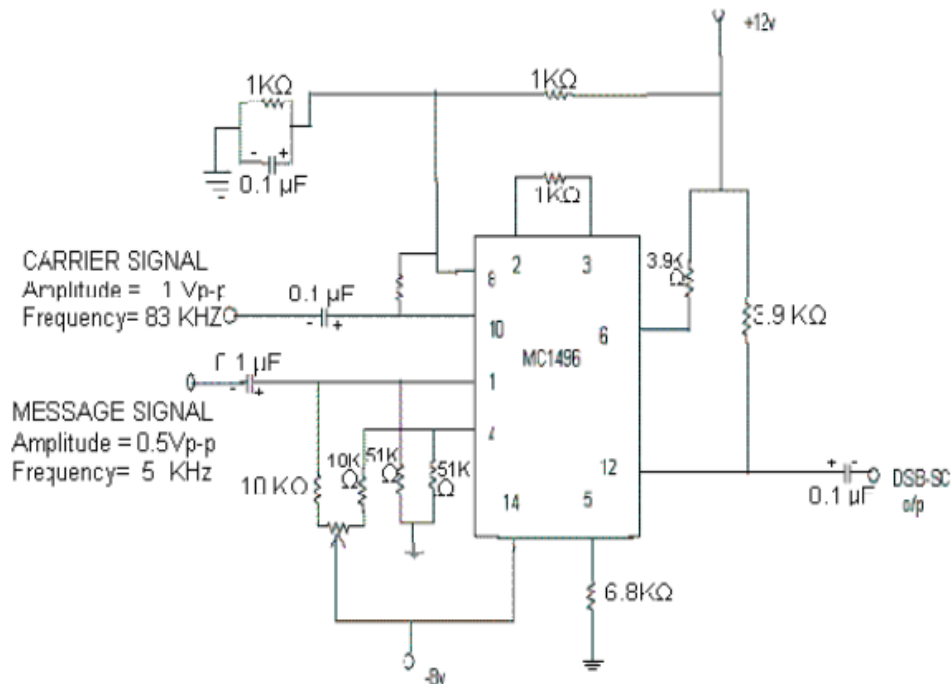
### AIM:

Design an DSB-SC (Double Side Band Suppressed Carrier) Modulation circuit and Verify the result

### COMPONENTS REQUIRED:

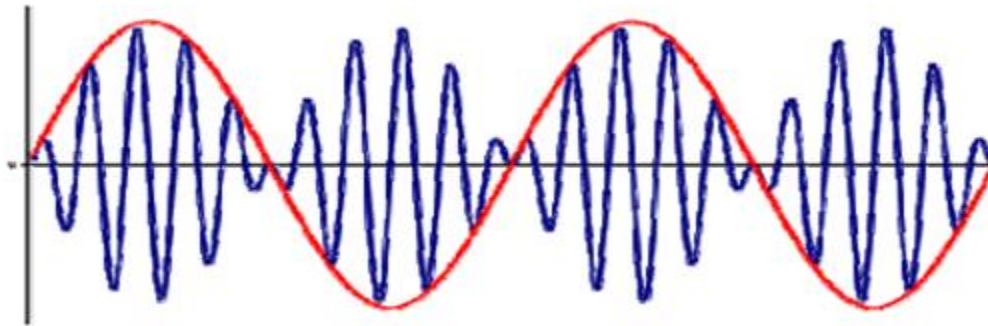
Sl.no	Components	Specification	Quantity
1	IC1496		
2	Resistors	1K,3.9K,10K,51K,6.8K $\Omega$	3,2,2,2,1
3	Capacitor	0.1 $\mu$ F	4
4	Power supply	-	1
5	Connecting board	-	1
6	CRO-probes	-	1
7	Connecting wires	-	1

### CIRCUIT DIAGRAM:



**PROCEDURE:**

1. Check the components for their working condition
2. Connections are made as shown in the circuit diagram
3. Apply the carrier signal of  $1V_{p-p}$  amplitude & frequency of 83KHz is applied as carrier to pin no-10
4. Apply the message signal of  $0.5V_{p-p}$  amplitude & frequency of 5KHz is given as message signal to pin no-1
5. Observe the DS-BSC output waveform

**WAVEFORM:****RESULT:**

Thus the DSB-SC circuit is designed and result is verified

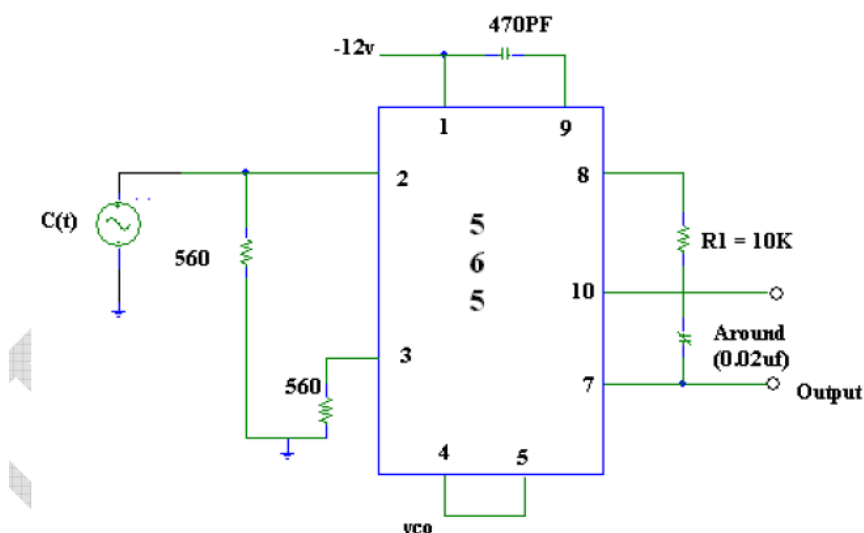
**AIM:**

To conduct an experiment to study FM demodulation using 565 IC PLL

**COMPONENTS REQUIRED:**

Sl.no	Components	Quality	Quantity
1	PLL IC	565 IC	1
2	CRO		1
3	Capacitor	470PF, 0.01 $\mu$ F, 0.1 $\mu$ F	1,1,1
4	Resistors	560 $\Omega$ , 10K $\Omega$	1,1
5	Decade capacitance box		1

**CIRCUIT DIAGRAM:**



**DESIGN:**

$f_c = 63.8\text{KHz}$ (fm generator)

$f_c = 0.3 / R_1 C_1$

Let  $C_1 = 470\text{PF}$  then  $R_1 = 10\text{K}\Omega$

Design of LPF:  $f_c = 1 / 2\pi R C_2$

$f_c \gg f_m$  , signal say 500Hz

$C = 0.08\mu\text{F}$ (DCB)

$R = 560\Omega$

**PROCEDURE:**

1. With Pin no.4 & 5 disconnected & without FM at pin no.
2. Measure the VCO frequency at pin no.4 and make it to be 63.8 KHz by adjusting
3. Inter connect pin no.4 & 5 and apply un modulated carrier to pin no.2
4. Slightly vary the carrier frequency, VCO frequency also changes, the PLL is locked. If VCO frequency does not change if PLL is not locked, changes input frequency or VCO frequency to lock the PLL
5. In the same rate modulate the carrier at pin no.2 and observe demodulate signal at pinno.7 and compare if  $m(t)$  modulation signal.

**RESULT:**

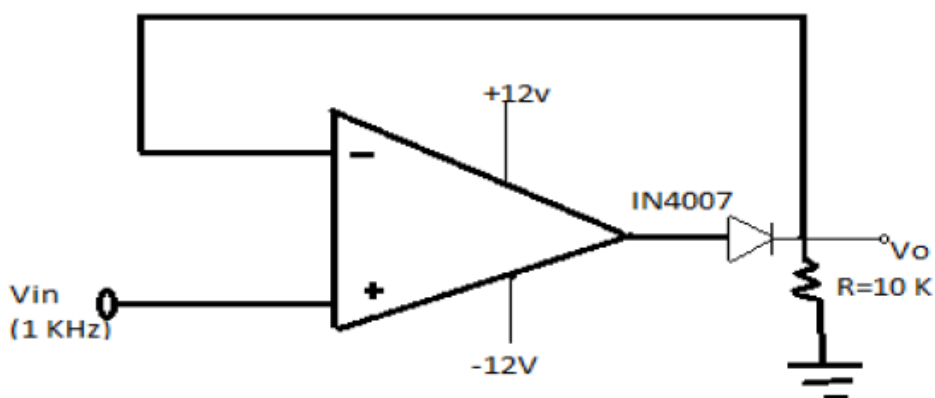
Frequency synthesis using PLL circuit is verified

**BEYOND SYLLABUS****1. Half wave precision rectifier****AIM:**

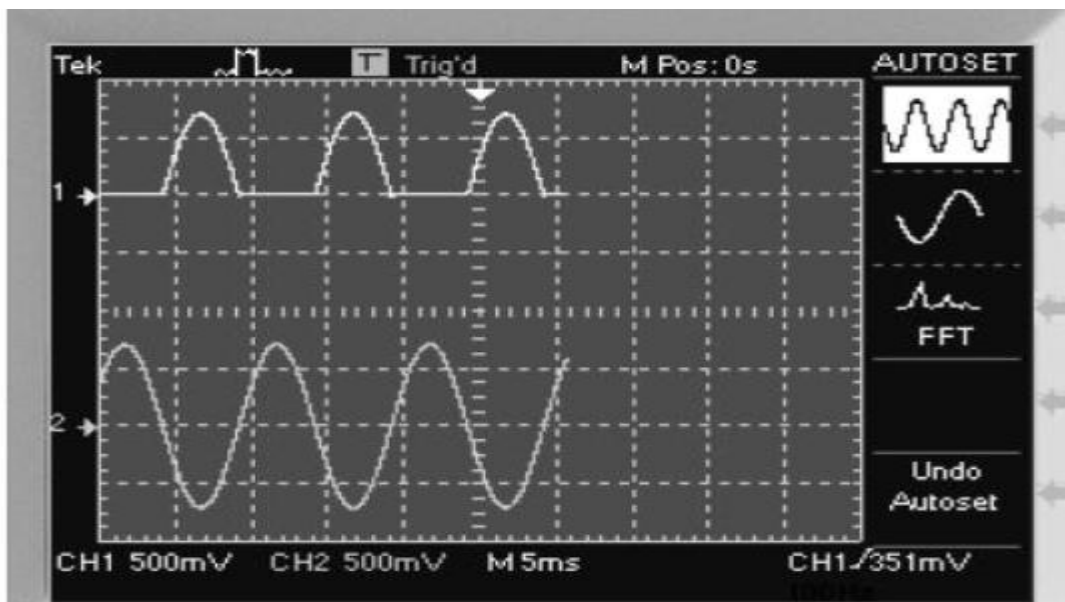
To design and obtain half wave precision rectification using OP-Amp and to observe the transfer characteristics.

**COMPONENTS REQUIRED:**

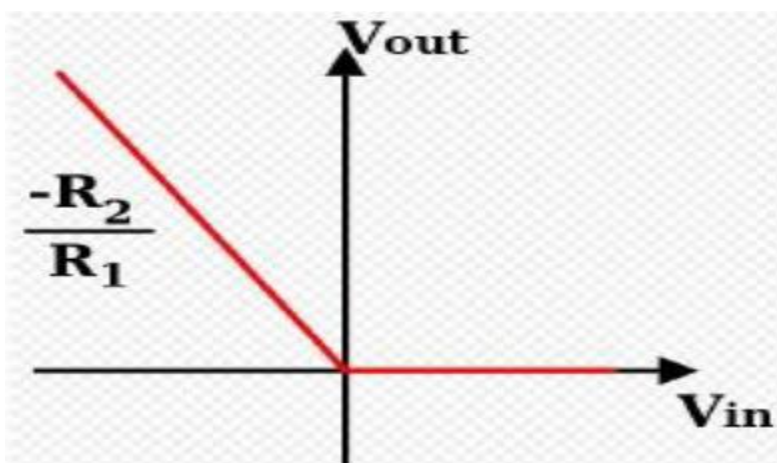
Sl. no	Components	Specification	Quantity
1	Op-amp	$\mu A741$	1
2	Resistors	10K ohm	1
3	Diode	IN4007	1
4	Signal generator	-	1
5	Connecting board	-	1
6	CRO-probes	-	1
7	CRO	-	1
8	Connecting wires	-	1 bunch

**CIRCUIT DIAGRAM:****PROCEDURE:**

1. Check all the components & make connections as shown in the figure.
2. Set the signal generator amplitude 1vp-p sine wave.
3. Observe the input and rectified output signal waveform on the CRO.
4. Plot the graph.



**TRANSFER CHARACTERISTICS:**



**RESULT:**

Half wave precision rectifier is designed using an op-amp and the transfer characteristics are plotted.

**VIVA VOCE Questions**

1. What is an Op-Amp?
2. What are the other applications of Op-Amp?
3. What are the ideal characteristics of an Op-Amp?
4. Why two power supplies +15 V and -15 V are required in an Op-Amp?
5. What are the internal blocks of an Op-Amp?
6. What is the origin for slew rate?
7. What is meant by virtual around?
8. Define CMRR?
9. Define offset voltage and offset currents for an OP-Amp?
10. What are the limitations of an ordinary OP-Amp Differentiator?
11. Explain why integrators are preferred over differentiator in analog computers?
12. What is the function of High pass RC ckt?
13. What is the function of Low pass RC ckt?
14. What is meant by Tilt?
15. What is meant by Rise time?
16. How a high pass circuit acts as a Differentiator?
17. How a Low pass circuit acts as a Integrator?
18. What is the other application op amp?
19. List the different types of comparator
20. How would recognize that positive feedback is being used in an op amp circuit
21. How two power supply +15v and -15v are required in an op amp circuit ?
22. What are the internal blocks of an op amp ?
23. What is the difference between symmetrical triggering and asymmetrical triggering?
24. What are the other names of Monostable Multivibrator?
25. Explain the working of Monostable Multivibrator?
26. Monostable Multivibrator has how many stable states?
27. What is a quasi-stable state?

28. What are the applications of Monostable Multivibrator?
29. What are the initial states of a Monostable Multivibrator?
30. Which type of Triggering is used in Monostable Multivibrator?
31. What is the effect of temperature on Monostable Multivibrator?
32. Which type of feedback is present in Monostable Multivibrator?
33. Derive the expression for pulse width?
34. What is the other name of Astable Multivibrator?
35. Explain the working of Astable Multivibrator?
36. What is a quasi-stable state?
37. What are the applications of Astable Multivibrator?
38. Explain How Astable Multivibrator can be used as a voltage to frequency converter?
39. Which type of biasing present in Astable Multivibrator?
40. How Astable acts as a free running oscillator?
41. Define time constant?
42. Define UTP & LTP?
43. What is the other name of a Schmitt Trigger ckt?
44. Explain the working of Schmitt Trigger ckt?
45. What are the applications of Schmitt Trigger?
46. What is a Voltage Regulator?
47. What are the advantages of adjustable voltage regulators over the fixed voltage regulators?
48. What is voltage reference? Why it is needed?
49. What is the function of a series pass transistor?
50. What voltage options are variables in 78XX and 79XX voltage regulators?
51. Show the standard representation of IC voltage regulator?
52. List and explain the characteristics of three terminal IC voltage regulators?
53. Explain the important parameters of 78XX regulator?

54. Explain the protections used in 78XX?
55. What are the Limitations of three terminal voltage regulators?
56. Define Duty Cycle?
57. What are the other applications of 555 timer?
58. Draw the internal circuit diagram of 555 timer?
59. Explain the operation of 555 timer?
60. Explain the function of reset?
61. Derive the expression for time delay of monostable multivibrator?
62. Discuss the applications of timer in monostable multivibrator?
63. Give methods for obtaining symmetrical square wave?
64. what are the modes of operation of a 555 timer?
65. Discuss the operation of a FSK generator using timer?

