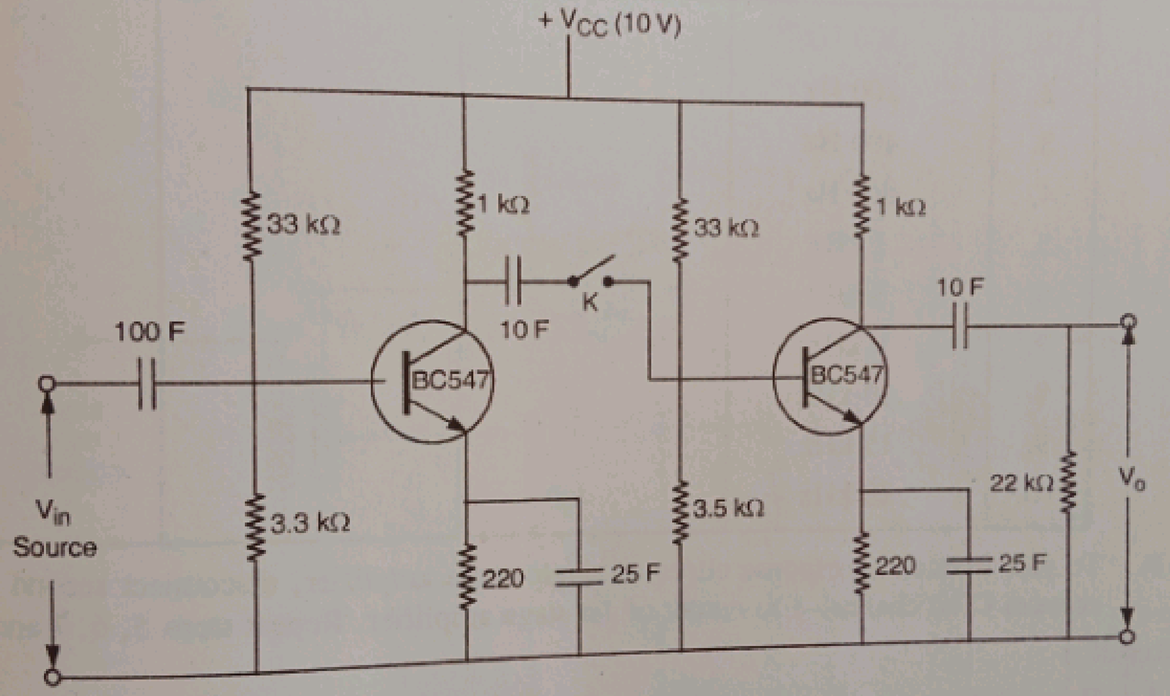
PRACTICAL – 1

Aim : Plot the frequency response of two stage RC coupled amplifier and calculate band width and compare it with single stage amplifier.

Apparatus required :

1. Two stage RC coupled amplifier
2. Signal generator
3. C.R.O.
4. Multimeter
5. Power supply.

Circuit diagram :



Theory : Multistage amplifier is widely used in applications where high gain is required. If gain of each stage is A_1 and A_2, then overall gain is given as ;

$$A = A_1A_2$$

In actual practice, gain is less than A. This is due to loading effect of second stage. The frequency response of amplifier is plot of gain versus frequencies. The bandwidth is measured from frequency response curve. It is range of frequency for which gain is more than 70·7% of maximum value.

Procedure :

1. Connect circuit components as shown in figure.
2. Connect signal generator to input terminal of amplifier.
3. Connect output terminal of multistage amplifier to CRO channel 1 through CRO probe.
4. Turn on power supply of signal generator, CRO, multistage amplifier.

5. Select 100 Hz frequency of signal generator, measure amplitude using multimeter. Measure output voltage from CRO by adjusting voltage per division switch.
6. Note frequency of input signal, amplitude of input and output into observation table and calculate gain.
7. Repeat steps 5 and 6 for frequency range 100 Hz to 20 kHz.
8. Plot the gain versus frequency curve and measure.

Observation Table :

S.No.	Frequency f	Input amplitude V_{in}	Output amplitude V_o	Gain $\frac{V_o}{V_{in}}$
1.	100 Hz			
2.	200 Hz			
3.	400 Hz			
4.	800 Hz			
5.	1 kHz			
6.	5 kHz			
7.	6 kHz			
8.	10 kHz			
9.	15 kHz			
10.	20 kHz			

9. To plot frequency response curve of single stage amplifier, disconnect second stage and connect CRO channel–1 to output of 1st stage amplifier. Repeat steps 5, 6, 7 and 8.

Result :

1. Bandwidth for two stage amplifier.
   Lower cut off frequency, f_1 = ...
   Upper cut off frequency, f_2 = ...
   Bandwidth = $f_2 - f_1$ = ...
2. Bandwidth for single stage amplifier
   Lower cut off frequency, f_1 = ...
   Upper cut off frequency, f_2 = ...
   Bandwidth = $f_2 - f_1$ = ...

Precautions :

1. Before switching power supply ON, ensure that circuit components are connected as per diagram.
2. The supply voltage to circuit and input voltage to amplifier should not exceed the maximum rated voltage, otherwise components may get damaged due to high current.

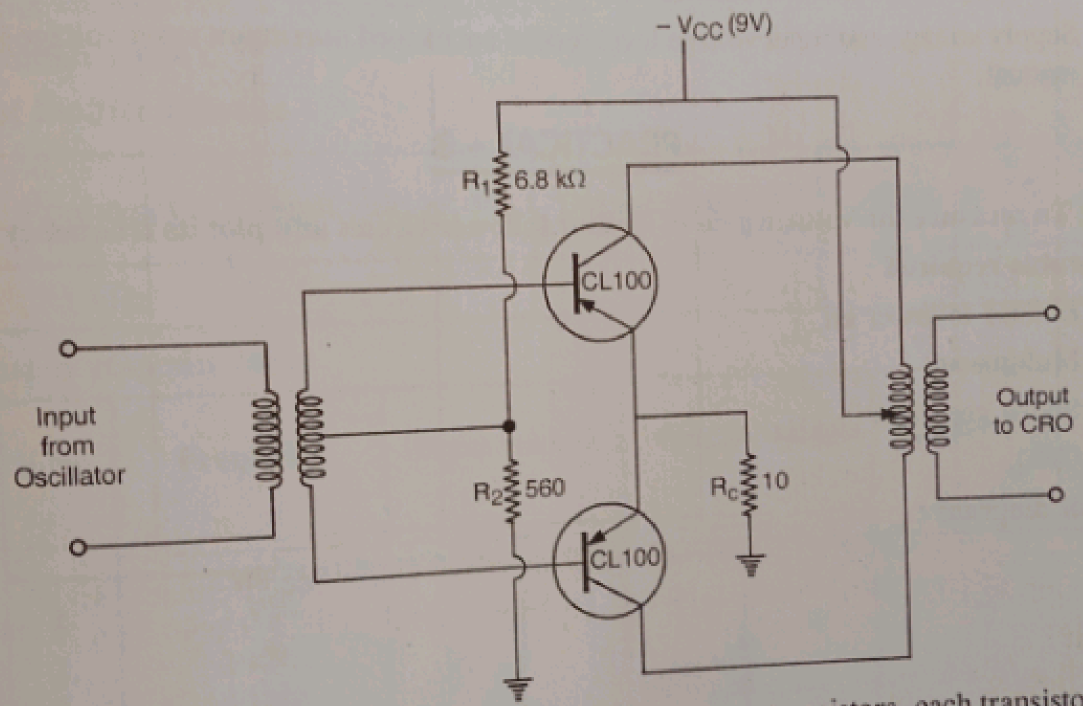
PRACTICAL – 2

Aim : To measure the gain of push-pull amplifier at 1 kHz.

Apparatus required :

1. Push-pull amplifier kit.
2. DC power supply
3. Audio oscillator
4. CRO
5. Multimeter (*digital*).

Circuit diagram :



Theory : Push-pull amplifier is a power amplifier. It uses two transistors, each transistor is biased to operate in class B mode. When input is positive, then transistor T_1 is ON and T_2 is OFF. Similarly, when input is negative, T_1 is OFF and T_2 is ON. The output is taken across secondary winding of output transformer.

Procedure :

1. Connect the components as shown in circuit diagram.
2. Connect output of audio oscillator to input terminal of push-pull amplifier.
3. Select frequency of oscillator equal to 1 kHz.
4. Connect output terminal of push pull amplifier to channel no. 1 of CRO.
5. Turn on power supply of oscillator, amplifier and CRO.
6. Adjust voltage per division and time per division switch of CRO to set waveform on front panel screen.

7. Measure voltage of output of oscillator and also measure output amplitude from CRO screen.
8. Note the output and input amplitude in observation table and calculate gain.

Observation Table :

Frequency	Input V_{in}	Output V_o	Gain $= \frac{V_o}{V_{in}}$
1 kHz	 V	 V	....

Result :

Gain of amplifier = ...

Precautions :

1. Connections in circuit should be strictly as per circuit diagram.
2. Supply voltage and input voltage level should not exceed maximum rated voltage in amplifier manual.

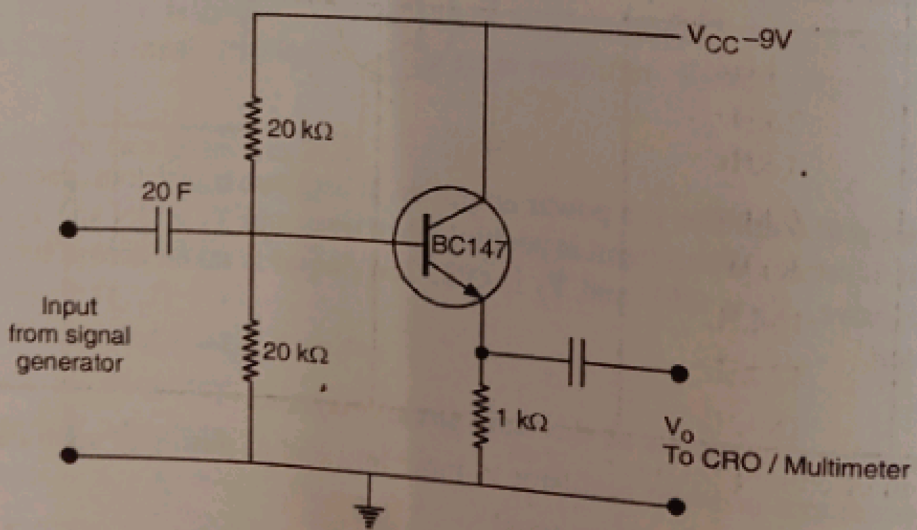
PRACTICAL – 3

Aim : To measure the voltage gain of emitter follower circuit and plot its frequency response.

Apparatus required :

1. Emitter follower kit
2. Multimeter
3. Signal generator
4. CRO.

Circuit diagram :



Theory : Emitter follower is negative feedback amplifier. In this circuit, entire output voltage is feedbacked to input. Therefore, feedback factor, B = 1. Hence, overall gain of amplifier is :

$$A_f = \frac{A}{1+AB} = \frac{A}{1+A} \simeq 1$$

As gain is unity, the output follows the input. The output is taken at emitter terminal and is equal to input. Therefore, circuit is called emitter follower. The input impedance is high and output impedance is low. It is widely used as a buffer amplifier.

Procedure :

1. Connect the circuit components as shown in figure.
2. Apply audio signal from signal generator to input terminals of emitter follower circuit.
3. Connect output terminals of emitter follower to CRO channel–1 through probe.
4. Select frequency of signal generator equal to 1 kHz. Measure input voltage and output voltage.
5. Note the value of input and output amplitude in observation table and calculate gain.
6. Vary the frequency of signal generator from 1 kHz to 20 kHz. Measure voltage gain at each frequency.
7. Plot the gain versus frequency curve.

Observation Table :

Gain of Emitter follower

Frequency	Input voltage, V_{in}	Output voltage V_o	Gain $= \frac{V_o}{V_{in}}$
1 kHz	 V	 V	....

Frequency response curve

S.No.	Frequency	Input voltage V_{in}	Output voltage V_o	Gain $= \frac{V_o}{V_{in}}$
1.	1 kHz	...	...	...
2.	2 kHz	...	...	...
3.	4 kHz	...	...	...
4.	6 kHz	...	...	...
5.	8 kHz	...	...	...
6.	10 kHz	...	...	...
7.	12 kHz	...	...	...
8.	15 kHz	...	...	...

Result : Gain of emitter follower circuit

$A = ...$

Actual gain $= 1$

Error $= 1 - A = ...$

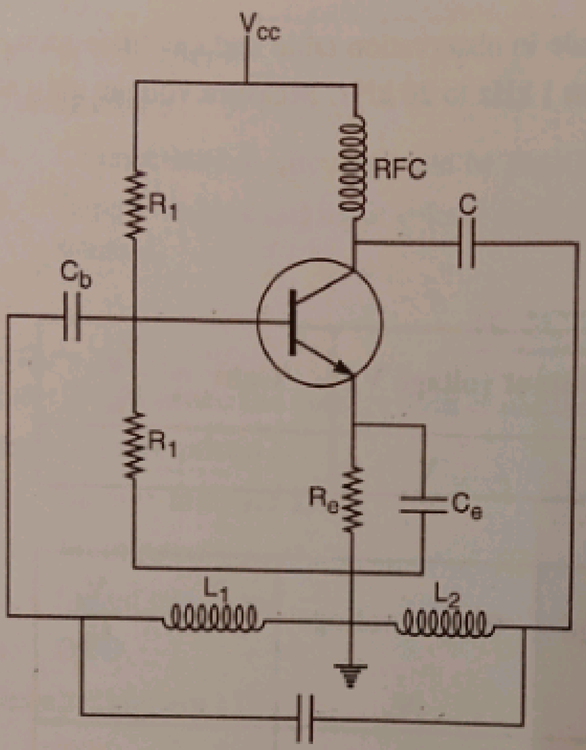
PRACTICAL – 4

Aim : To plot waveshape and measure frequency of output of Hartley and Colpits oscillators.

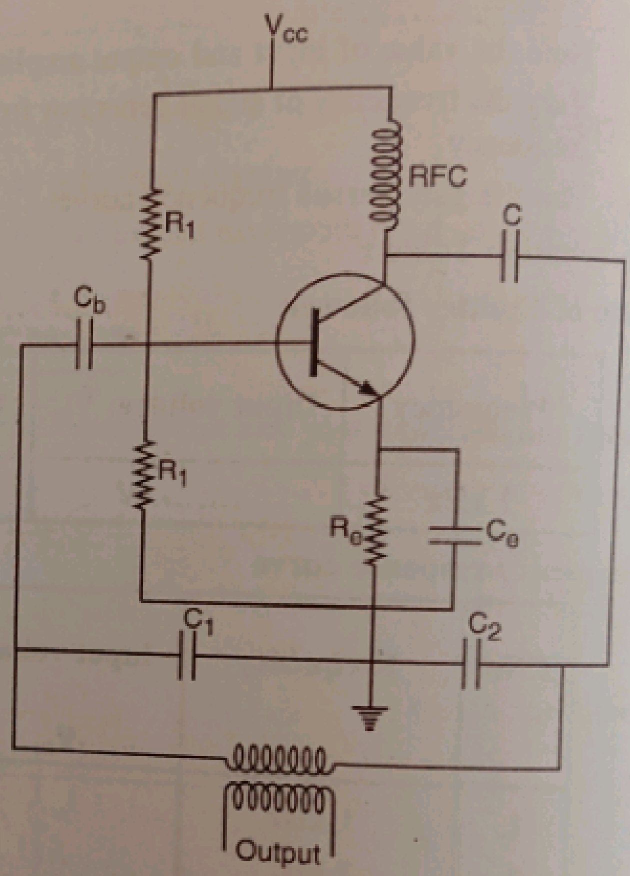
Apparatus required :

1. Hartley oscillator and Colpits oscillator kit.
2. CRO and probe.
3. DC supply.

Circuit diagram :



Hartley oscillator kit



Colpits oscillator kit

Theory : The oscillator generates sinusoidal waveform. It uses positive feedback. It consists of amplifier and resonant circuit. In Hartley oscillator, inductor is splitted whereas in Colpitts oscillator, capacitor is splitted. The part of output voltage is fedback to input. The resonant circuit generates undamped oscillations at frequency for which loop gain is unity and total phase shift in close loop is 2π or integer multiple of 2π.

Procedure :

1. Connect the components on kit as per circuit diagram.
2. Turn on power supply of kit.
3. Connect the output terminal of oscillator to CRO channel no.1 through CRO probes.
4. Adjust voltage per division and time per division switch of CRO to observe waveform on front panel screen.
5. To measure frequency of wave form, note the number of divisions covered by one cycle of wave.

6. Note the position of time per division switch. Multiply the number of divisions with position of time per division switch. It gives time period of wave. Let it be 'T'.
7. The frequency of waveform will be, $f = 1/T$.

Observation :

STUDENTS ACTIVITY

Plot waveform as observed on CRO

Result :

Time period, 'T' = Number of divisions covered by one cycle × Position of time/division

$$f = \frac{1}{T} = ...\text{Hz}$$

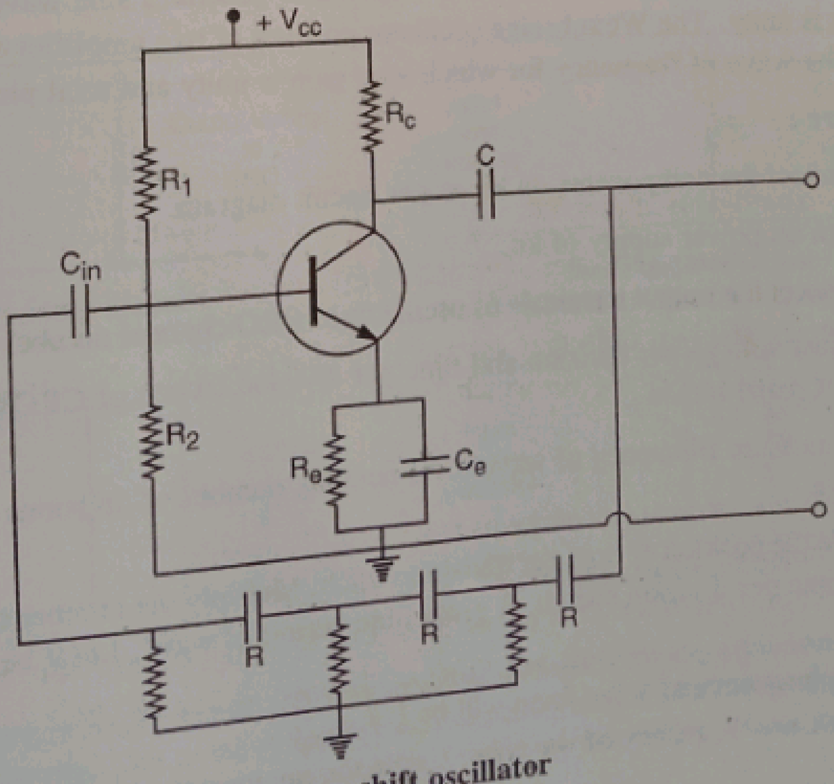
PRACTICAL - 5

Aim : To plot waveshape and measure frequency of output waveform of RC phase shift and Wein bridge oscillator.

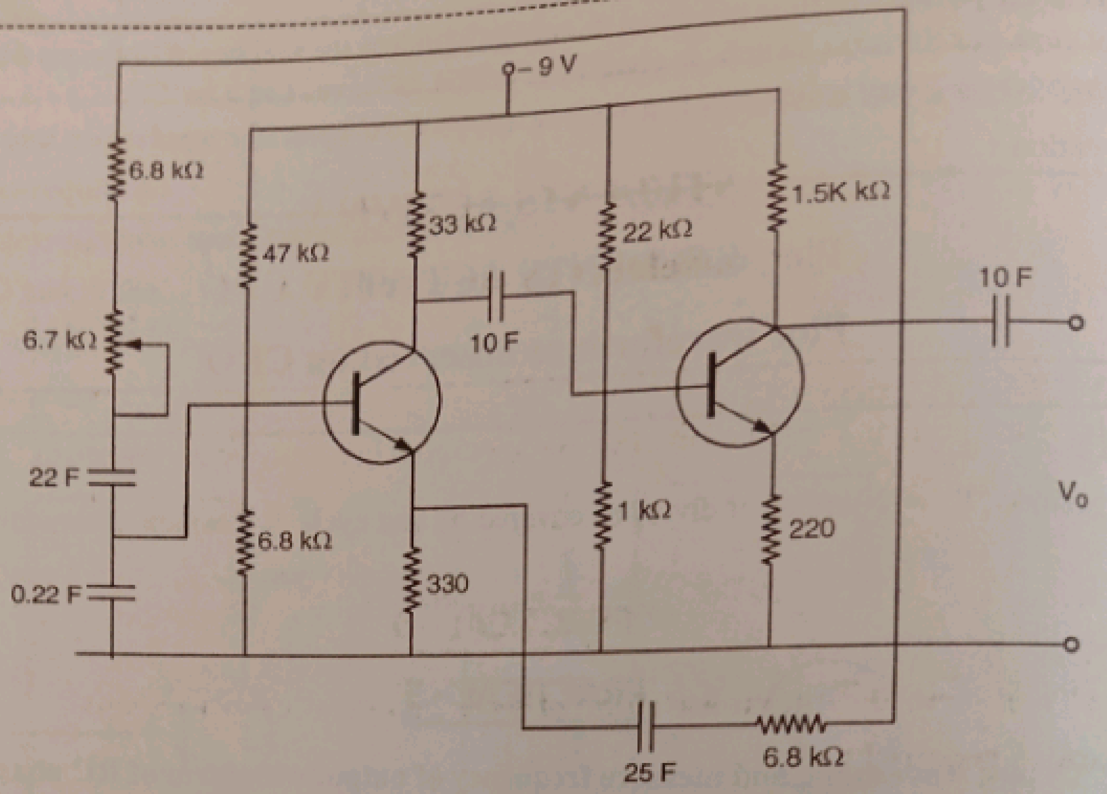
Apparatus required :

1. RC phase shift and Wein bridge oscillator kit.
2. CRO and probes.
3. DC supply.

Circuit diagram :



(*i*) RC phase shift oscillator



***(ii)* Wein bridge oscillator**

Theory : Phase shift and Wein bridge oscillators use RC circuit as resonant circuit. These oscillators generate fixed frequency sine waveform. In RC phase shift oscillator, three RC circuits cause 180° phase shift and additional 180° phase shift is caused by amplifier. Therefore to generate undamped oscillations, total phase shift become 2π. The oscillator generates sine wave of frequency for which the loop gain is unity. The Wein bridge oscillator consists of two amplifier stages and bridge circuit. It generates the wave of frequency for which loop gain is unity and total phase shift is 2π.

Procedure :

1. Connect the components on kit as per circuit diagram.
2. Turn on power supply of kit.
3. Connect the output terminals of oscillator to CRO channel number-1 through CRO probes.
4. Adjust voltage per division and time per division switch of CRO to observe waveform on front panel screen.
5. To measure frequency of waveform, note the number of divisions covered by one cycle of wave.
6. Note the position of time per division switch. Multiply the number of divisions with position of time per division switch. It gives time period of wave. Let it be 'T'.
7. The frequency of wave form will be ; $f = \frac{1}{T}$.

Observation :

STUDENTS ACTIVITY

Plot waveform as observed on CRO

Result : Time period, T = Number of divisions covered by one cycle × position of time/division.

$$f = \frac{1}{T} = \ldots\ldots \text{ Hz}$$

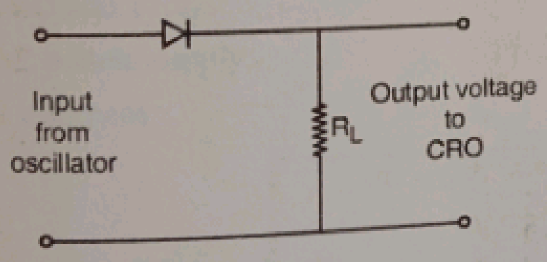
PRACTICAL – 6

Aim : To observe the output waveform of series and shunt clipper circuits.

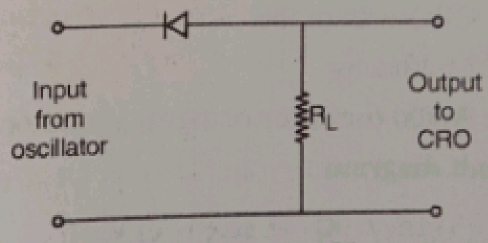
Apparatus required :

1. Series and shunt clipper kit
2. Multimeter
3. CRO
4. Oscillator.

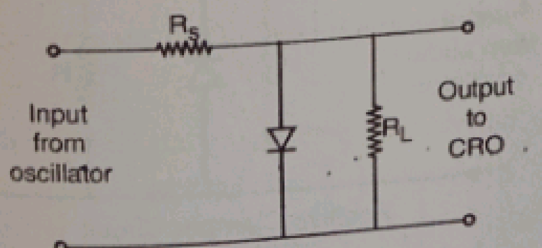
Circuit diagram :



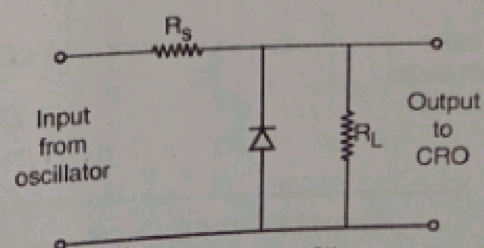
Series Positive Clipper



Series Negative Clipper



Shunt Positive Clipper



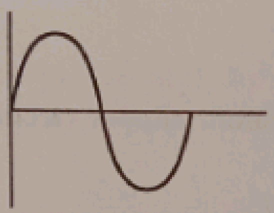
Shunt Negative Clipper

Theory : Clipper circuit removes part of either positive or negative cycle of waveform. There are two types of clipper circuits. The positive clipper circuit removes positive half cycle of waveform whereas negative clipper circuit removes negative half cycle of waveform. These circuits are also called series and shunt clipper. If diode is connected in series with load, the clipper is called series clipper circuit. If diode is connected in parallel with load, then it is called shunt clipper.

Procedure :

1. Connect the components as shown in figure.
2. Apply low frequency signal from signal generator or audio oscillator to input terminal of clipper circuit.
3. Connect output terminal to CRO channel-1 through probe. Adjust voltage per division switch or time per division switch to observe waveform on screen of CRO.

Observation :

Input waveform	Output waveform
	Student activity

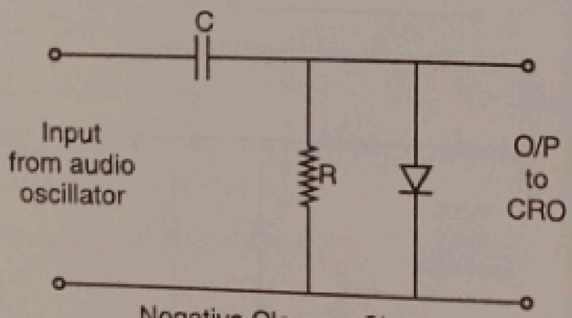
PRACTICAL – 7

Aim : To observe the output of clamping circuits.

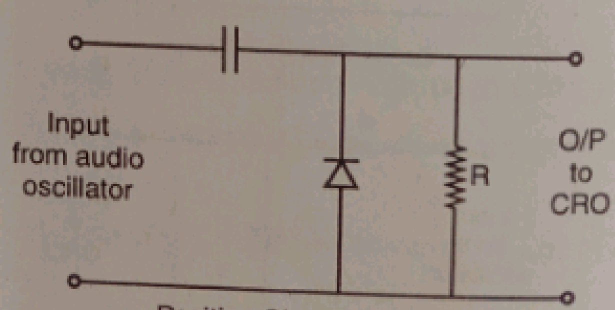
Apparatus required :

1. Clamper circuit kit
2. CRO with probe
3. Multimeter
4. Audio oscillator or signal generator.

Circuit diagram :



Negative Clamper Circuit



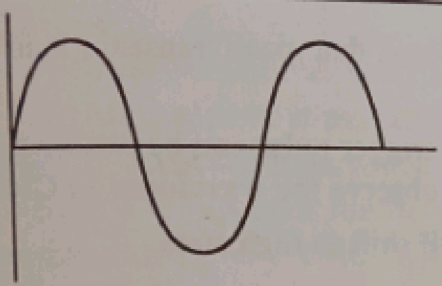
Positive Clamper Circuit

Theory : Clamper circuits are also called *dc* resistor circuits. It adds *dc* level into *ac* signal. The positive clamper adds *dc* level such that wave is shifted into positive side. Similarly negative clamper circuit shifts waveform into negative side.

Procedure :

1. Connect the components as per circuit diagram.
2. Connect input of circuit to standard signal generator or audio oscillator.
3. Connect output terminal to CRO channel–1 through probe. Then switch on the power supply of CRO and frequency generator.
4. Adjust voltage per division and time per division switch of CRO to observe waveform on front panel screen.

Observations :

Input waveform	Output waveform
	Student activity

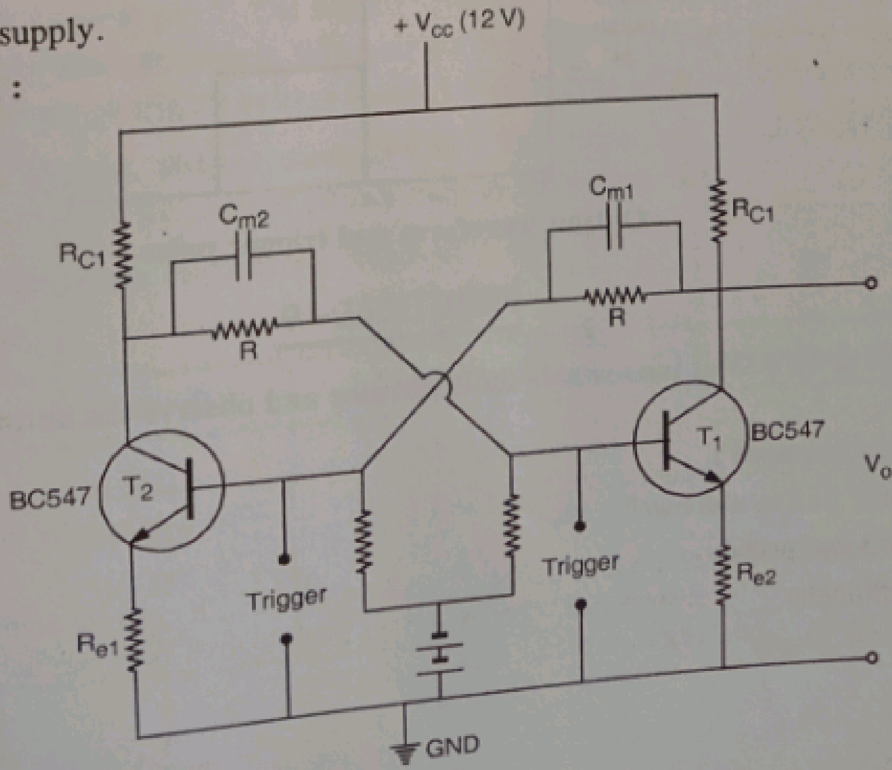
PRACTICAL – 8

Aim : To observe the output waveform of a bistable multivibrator.

Apparatus required :

1. Bistable multivibrator kit
2. CRO and probe
3. DC power supply.

Circuit diagram :



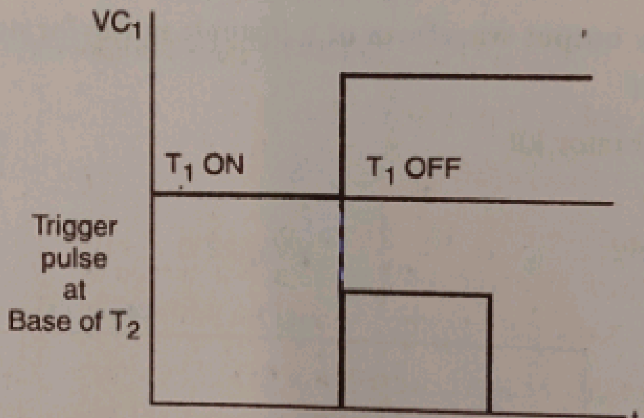
Theory : Bistable multivibrator has two stable states. If one transistor T_1 is ON, then T_2 will be OFF. It consists of two stage amplifier. The output of one is coupled to input of other. It is called bistable because when power to circuit is turn ON, then one transistor will conduct more current than other. Thereby one will be ON and other will be OFF. This is stable state of circuit. In order to change stage of transistor, trigger pulse is applied at base of either transistor. If trigger pulse is to be applied to ON transistor, it should be negative. If it is applied to OFF transistor, it should be positive. The capacitor C_{m1} and C_{m2} speed up the transition of state from one transistor to other.

Procedure :

1. Connect the components on kit as shown in figure.
2. Connect output terminal that can be collector terminal of any of these two transistors to CRO channel–1 through CRO probe.
3. The CRO will show *dc* level at output. If it is low, that mean transistor is in ON state and if output is high, then transistor is OFF.
4. Apply trigger pulse to base of transistor. The trigger pulse can be obtained from *dc* supply $-V_{cc}$ or $-V_{bb}$. When trigger pulse is applied, observe the waveform on CRO.
5. If the output is low before trigger pulse, it will shift to high state.

Observations :

Output waveform :



Output waveform and trigger pulse

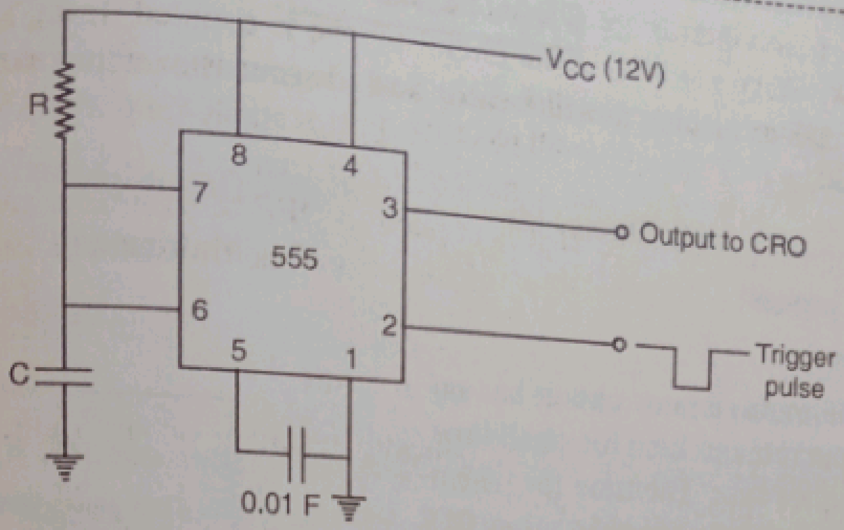
PRACTICAL – 9

Aim : Use of IC 555 as monostable multivibrator and observe the output of different values of RC.

Apparatus required :

1. Timer 555 as monostable kit.
2. CRO and probe
3. Multimeter
4. Power supply

Circuit diagram :



Theory : In a monostable multivibrator, the circuit has only one stable output. The output remains low. When trigger pulse is applied at pin number 2, the output shifts from low state to high state. The output remains high for time duration which depends on RC circuit. The capacitor charges through R to V_{CC}. When voltage at capacitor reaches 2/3 V_{CC}, the output shifts back to low state. The width of output pulse is equal to $T_w = 1 \cdot 1$ RC.

Procedure :

1. Connect the component as shown in circuit diagram.
2. Connect output terminal number 3 to CRO channel number 1 through CRO probes.
3. Turn on power supply of timer and CRO.
4. Adjust voltage per division switch to see output waveform. The output will be low.
5. Apply trigger pulse at pin 2. The trigger pulse can be obtained by connecting pin no. 2 to negative supply through switch. When switch is turned on, trigger will be available on pin 2. The magnitude of trigger voltage should be more than 1/3 V_{CC}. It should be negative.
6. As trigger is applied, observe wave on CRO. The output will be high. After small time duration *i.e.* $t = 1 \cdot 1$ RC, output returns back to stable state (low).
7. Repeat the experiment for different values of R and C.

Observations Table :

S.No.	Resistor R	Capacitor C	Output waveform
1.	1 MΩ	10 μF	—
2.	500 kΩ	1 μF	—
3.	100 kΩ	1 μF	—
4.	10 kΩ	0·1 μF	—

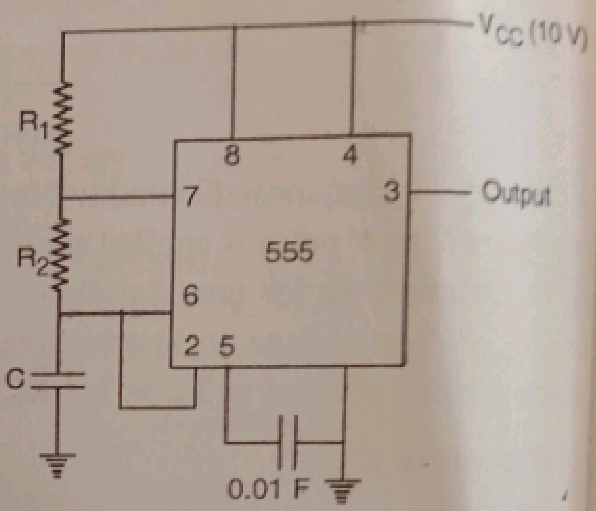
PRACTICAL – 10

Aim : Use of IC 555 as astable multivibrator and observe the output at different duty cycles.

Apparatus required :

1. Timer 555 astable multivibrator kit
2. DC supply
3. CRO with probes
4. Multimeter

Circuit diagram :



Theory : Astable multivibrator circuit has no stable state. The output remains high for small time duration and then it goes low. The time for which output remains high and low depends upon RC circuit connected to 555 timer. When output is high, capacitor C charge through R_1 and R_2 to V_{CC}. When voltage reach 2/3 V_{CC}, the output fall to low state. Now capacitor discharges through resistor R_2 into pin 7 (*discharge pin*). When voltage reach 1/3 V_{CC}, the output shifts to high state. Astable multivibrator circuit generates square wave at its output.

The time period of wave is given as ;

$$T = 0{\cdot}69\,(R_1 + 2R_2)\,C.$$

$$f = \frac{1}{0{\cdot}69\,(R_1+2R_2)\,C}$$

The duty cycle of wave is ratio of ON time to time period of wave

$$D = \frac{T_{ON}}{T}\times 100 = \frac{R_1+R_2}{R_1+2R_2}\times 100$$

Procedure :

1. Connect the components as shown in circuit diagram.
2. Connect output terminal of timer *i.e.* pin 3 to CRO channel number 1 through CRO probe
3. Turn on power supply of CRO and 555 timer.
4. Adjust voltage per division and time per division switch of CRO to observe waveform on CRO front panel display.
5. Change values of R_1 and R_2 to observe waveform.

Observations :

S.No.	Resistor R_1	Resistor R_2	Capacitor C	Duty cycle (D)	Output Waveform
1.					
2.					