Lab Manual of

Electronic Circuit Design

(140311/200311)

Department of Electronics Engineering

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(A Govt. Aided UGC Autonomous & NAAC Accredited Institute Affiliated to RGPV, Bhopal)

Course Outcome

Student will be able to:

- CO1-Design the voltage regulator with specific voltage range.
- CO2- Design the BJT as a switch.
- CO3- Implement the voltage amplifier using BJT.
- CO4- Analyse the RC and LC oscillator using BJT.
- CO5 - Analyse the frequency characteristics of Crystal Oscillator.

Index

EXPERIMENT NO:1

AIM: -

To design and set up a transistor series voltage regulator using BJT and Zener Diode.

1. Load current vs output voltage
2. Input voltage vs output voltage for a constant load current

APPRATUS REQUIRED: -

Breadboard,PCB

CIRCUIT DIAGRAM:-

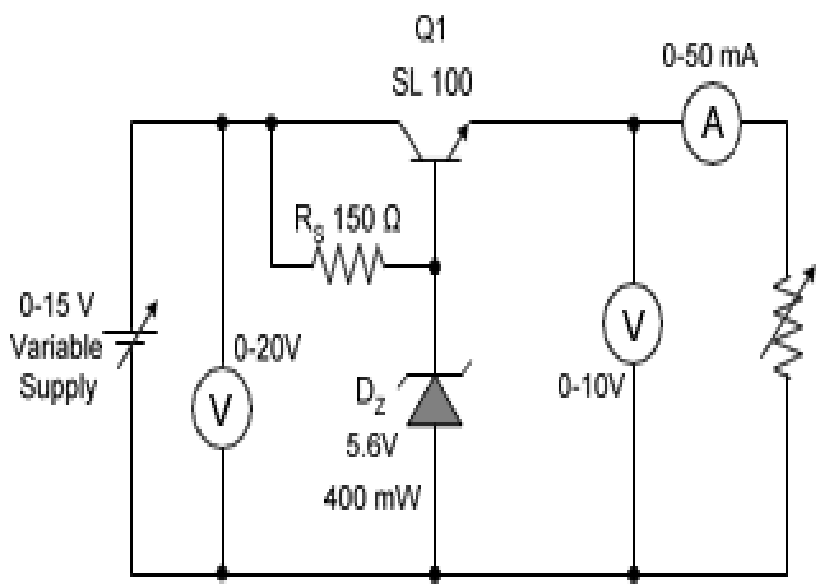


Figure 1.1: voltage regulator using BJT and Zener Diode

THEORY: -

An ideal power supply maintains a constant voltage at its output terminals, no matter what current is drawn from it. The output voltage of a practical power supply changes with load current, generally dropping as load current increases. The power supply specifications include a full load current rating, which is the maximum current that can be drawn from the supply. The terminal voltage when full load current is drawn is called the full load voltage (VFL). The no load voltage (VNL) is the terminal voltage when zero current is drawn from the supply, that is, the open circuit terminal voltage. One measure of power supply performance, in terms of how well the power supply is able to maintain a constant voltage between no load and full load conditions, is called its percentage voltage regulation.
An unregulated power supply has poor regulation, ie. output voltage changes with load variations. If a power supply has poor regulation it possesses high internal impedance. A simple emitter follower regulator is shown in Fig. 1. It is also called a series regulator since the control element (transistor) is in series with the load. It is also called as the pass transistor because it conducts or passes all the load current through the regulator. It is usually a power transistor.

The zener diode provides the voltage reference, and the base to emitter voltage of the transistor is the control voltage. The value of R_S must be sufficiently small, to keep the zener in its reverse breakdown region. Writing Kirchoff's voltage law to the output circuit.

$$V_0+V_{BE}-V_z=0$$
$$V_{BE}=V_z-V_0$$

If V_Z is perfectly constant, the above equation is valid at all times, and any change in *Vo* must cause change in *VBE*, in order to maintain equality.When current demand is increased by decreasing *RL*, *Vo* tends to decrease. From the above equation, it is seen that as VZ is fixed, decrease in *Vo* increases in *VBE*. This will increase the forward bias of the transistor, thereby increasing level of conduction. Thus, the output current is increased to keep *ILRL* a constant. The reverse process occurs when *RL* is increased. Thus, the above circuit keeps the output voltage constant, even if the load varies widely.

PROCEDURE:-

Load regulation

1. The circuit is wired as per the circuit diagram shown in fig. 1.
2. Keep the input voltage constant at Vimin , ie 10 V.
3. Vary the load resistance. Note *IL* and *VO* for each setting of *RL*. Ensure that *Vi* remains same throughout.
4. Draw a plot between *IL* and *VO*.

Line Regulation

Percent line regulation is another measure of the ability of a power supply to maintain a constant output voltage. In this case, it is a measure of how sensitive the output is to the changes in input or line voltage rather than to the changes in load. The specification is usually expressed as the percent change in output voltage that occurs per volt change in input voltage, with the load RL assumed constant.

1. The circuit diagram is wired as per the circuit diagram shown in fig. 1.
2. Keep the load resistance *RL* a constant.
3. Vary the input voltage between the limits for which the regulator is designed (10 to 15V).
4. Note the load voltage *VO* for each setting of *Vin.*
5. Draw a graph between *Vin* (X axis) and *VL* (Y axis).

1. Make rest of the connections as shown in the connection diagram.
2. Observe the final output and verify that the demodulator demodulates that channel data whose corresponding frequency synthesizer output is applied to the demodulator.
3. Follow the same procedure for slow hopping scheme by changing the data rate and PRN sequence rate as shown in the table above for slow hopping scheme.

OBSERVATIONS

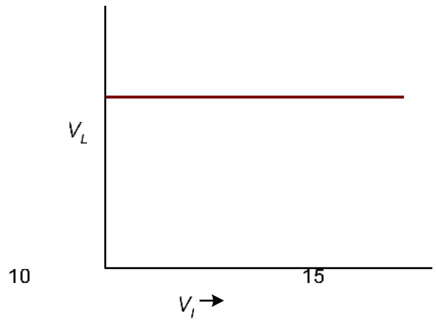
Load Regulation

Load Current I_L mA	Output voltage V_O V

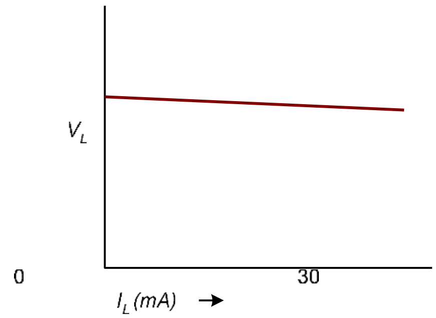
Line Regulation

Input Voltage V_i V	Output voltage VO V

EXPECTED OUTPUT PLOTS



Line Regulation



Load Regulation

RESULT

Line regulation and load regulation curves are plotted.

VIVA QUESTION

Q.-1. Why Zener diode work as voltage regulator?

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Q.-2. What is Line Regulation?

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Q.-3. What is Load Regulation?

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Q.-4. Analyze the working of Zener Diode?

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Q.-5. Explain the term Zener Breakdown?

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EXPERIMENT NO: 2

AIM:-

Study of BJT as a Switch

APPRATUS REQUIRED:-

Breadboard ,Workstation, Function Generator, Trainer Kit, Patch cords, DC Power supply

THEORY:-

Transistor is a three terminal, bipolar, current controlled device. It works in three different regions: Active, Cutoff and Saturation according to applied biasing condition. In this circuit, a square wave input is applied. When input is high, the transistor is turned on and works in saturation region. So maximum current I_C flows through transistor as well as LED. Hence LED emits the light. When input is low (low means not enough to turn on the transistor), the transistor remains in cutoff. So current I_C is zero thus LED does not emit the light. As the input is square wave, the LED will turn on and off alternately. If output is observed on CRO from the collector then it will be also a square wave but out of phase by 180° with input. Thus transistor is working as a switch which can be made on or off by an external input.

CIRCUIT DIAGRAM:-

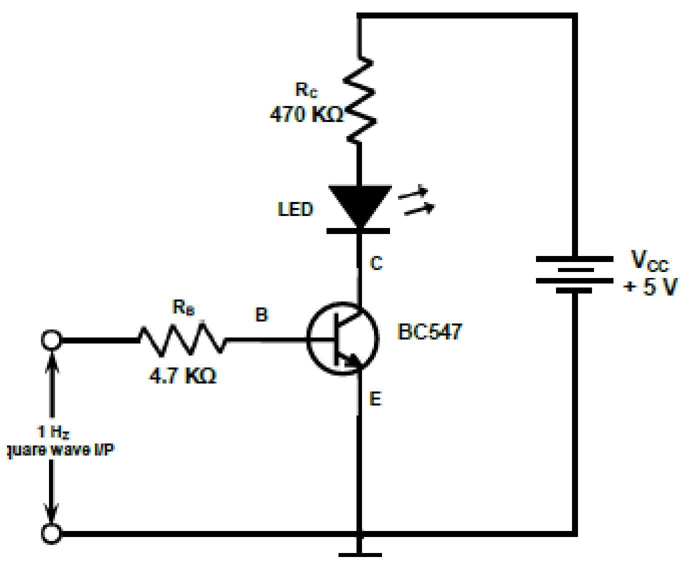

Figure 2.1: BJT as a Switch

PROCEDURE: -

1. Connect the circuit as shown in figure.
2. Apply 1 Hz square wave signal to the base and ground from function generator.
3. Apply 5V V_{CC} to collector and ground.
4. Observe the indication of LED and see the output waveforms on CRO.

RESULT

Result are verified through oscilloscope at the output terminal

VIVA QUESTION

Q.-1. How BJT work as a switch?

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Q.-2. In which region BJT work as a switch ?

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Q.-3. Why BJT called as Bipolar device?

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Q.-4. Explain the Base width modulation?

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Q.-5. Is it possible to make a BJT as a small signal amplifier

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EXPERIMENT NO:3

AIM-

Design a Common Emitter amplifier and determine its voltage gain and output resistance.

APPARATUS REQUIRED-

Breadboard ,Workstation, Function Generator, Trainer Kit, Patch cords, DC Power supply

THEORY-

Amplifiers are classified as small signal amplifiers and large signal amplifiers depending on the shift in operating point, from the quiescent condition caused by the input signal. If the shift is small, amplifiers are referred to as small signal amplifiers and if the shift is large, they are known as large signal amplifiers. In small signal amplifiers, voltage swing and current swing are small. Large signal amplifiers have large voltage swing and current swing and the signal power handled by such amplifiers remain large.
Voltage amplifiers come under small signal amplifiers. Power amplifiers are one in which the output power of the signal is increased. They are called large signal amplifiers. Figure shows the circuit diagram of a common emitter amplifier.

CIRCUIT DIAGRAM:-

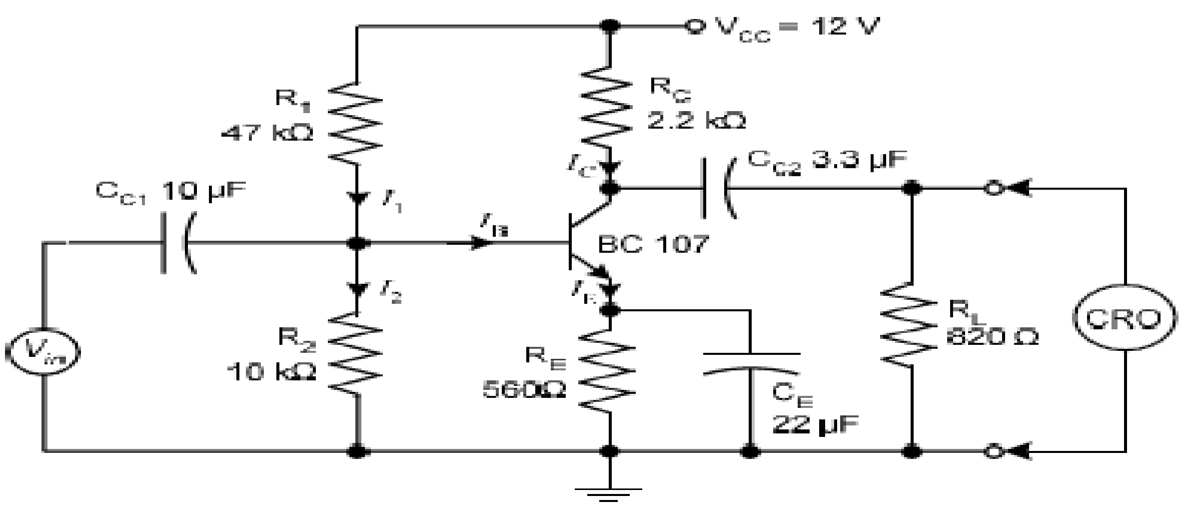

Figure 3.1: CE Amplifier

FREQUENCY RESPONSE

The gain of an ideal amplifier should remain the same for any frequency of the input signal. Therefore, the frequency response curve (gain in db plotted against frequency) becomes a straight line parallel to the frequency axis.

In actual practice, the coupling capacitors and the emitter bypass capacitor reduce the gain at lower frequencies. The capacitance internal to the transistor and stray capacitance due to the wiring reduce the gain at higher frequencies.

Fig 3.2 shows the typical frequency response characteristics of CE amplifier. The curve is flat only for middle range of frequencies. There is one low frequency f_L and one high frequency f_H. beyond which the gains, A_L and A_H are $1/\sqrt{2}$ times the gain A_M (maximum gain) at the middle frequencies. The two frequencies are called lower and higher cut off frequencies. The difference between them is called the bandwidth.

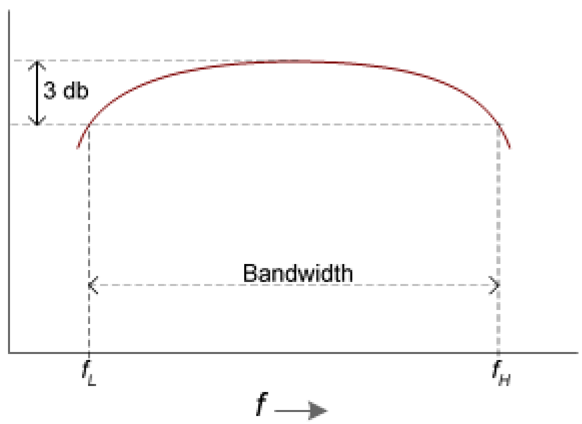

Fig 3.2. Frequency response

PROCEDURE

The circuit is set up as shown in figure 3.1. Input signal V_s is given to the circuit through a signal generator (sinusoidal signal is applied). Measure the magnitude (peak to peak) of the input by using CRO. Connect the CRO to the output side and the amplified output is observed. Increase the frequency in steps and observe the magnitude of V_O. The frequency response is plotted in a semi log sheet.

OBSERVATIONS

Readings are to be taken till Vo decreases appreciably at high frequencies

V_{in} =.........................(p-p)(mV)

Frequency f (Hz)	Vo(p-p) (mV)	$\frac{Vo}{Vin}$	Gain in db 20 log $\frac{Vo}{Vin}$

RESULT

The common emitter amplifier is designed, and its frequency response is plotted.

Voltage gain = V_o/V_{in} =

Lower cutoff frequency =

Upper cutoff frequency =

Bandwidth=

VIVA QUESTION

Q.-1. Explain in detail procedure for measuring β

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Q.-2. Using the values of β, determine the value of α.

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Q3- What is meant by bias stabilization? Why it is used?

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Q4- In the circuit, what should be the effect of reversing the polarity of VBB

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EXPERIMENT NO:4

AIM-

To determine the gain and bandwidth of 2-stage RC coupled amplifier.

APPARATUS REQUIRED-

Breadboard ,Workstation, Function Generator, Trainer Kit, Patch cords, DC Power supply

THEORY-

When two amplifiers are connected in such a way that the output signal of the first serves as the input signal to the second, the amplifier are said to connected in cascade. Amplifier are connected in cascade to extend the gains possible with single stage amplifiers. R.C. Coupling is the most widely used method because it is cheap and provided excellent audio facility over a wide range of frequency. It is usually employed for voltage amplification. Fig. (1) shows two stage R.C. Coupled amplifier. The signal developed across the collector resistor RL of the first stage is coupled to base of second stage through the coupled capacitor C2. This capacitor blocks the DC component of first stage from reaching the base of the second stage. In this way DC biasing of the next stage is not interfered, for this reason capacitor C2 is also called a blocking capacitor.As the coupling from one stage to next is achieved by a coupling capacitor followed by a shunt resistor, therefore the amplifiers are called resistance - capacitance coupled amplifiers resistances **R1,R2, RE1** form the biasing and stabilization network. The emitter bypass capactors offers low reactance path to the signal. Without it, the voltage gain of each stage would be lost. It is worth mentioning that the total gain is less than the product of the gains of individual stages. Its reason is that when the second stage follows the first stage, the effective load resistance of the first stage is reduced due to the shunting effect of the input resistance of the second stage. This reduces the gain of the first and second stage will be reduced due to loading effect of the next stage. However, the gain of the third stage which has no loading effect of subsequent stage remains unchanged. The overall gain will be the product of the gains of three stages.

<u>ADVANTAGES OF R.C COUPLING</u>

1. It requires no expensive or bulky components and no adjustments. Hence, it is small and inexpensive.
2. It has excellent frequency response. The gain is constant over the audio frequency range.
3. Its overall amplification is higher than that of the other couplings.
4. It has minimum possible non-linear distortion because it does not use any coils or transformer which might pick up undesirable signals. Hence, there are no magnetic fields to interfere with the signal.

CIRCUIT DIAGRAM:-

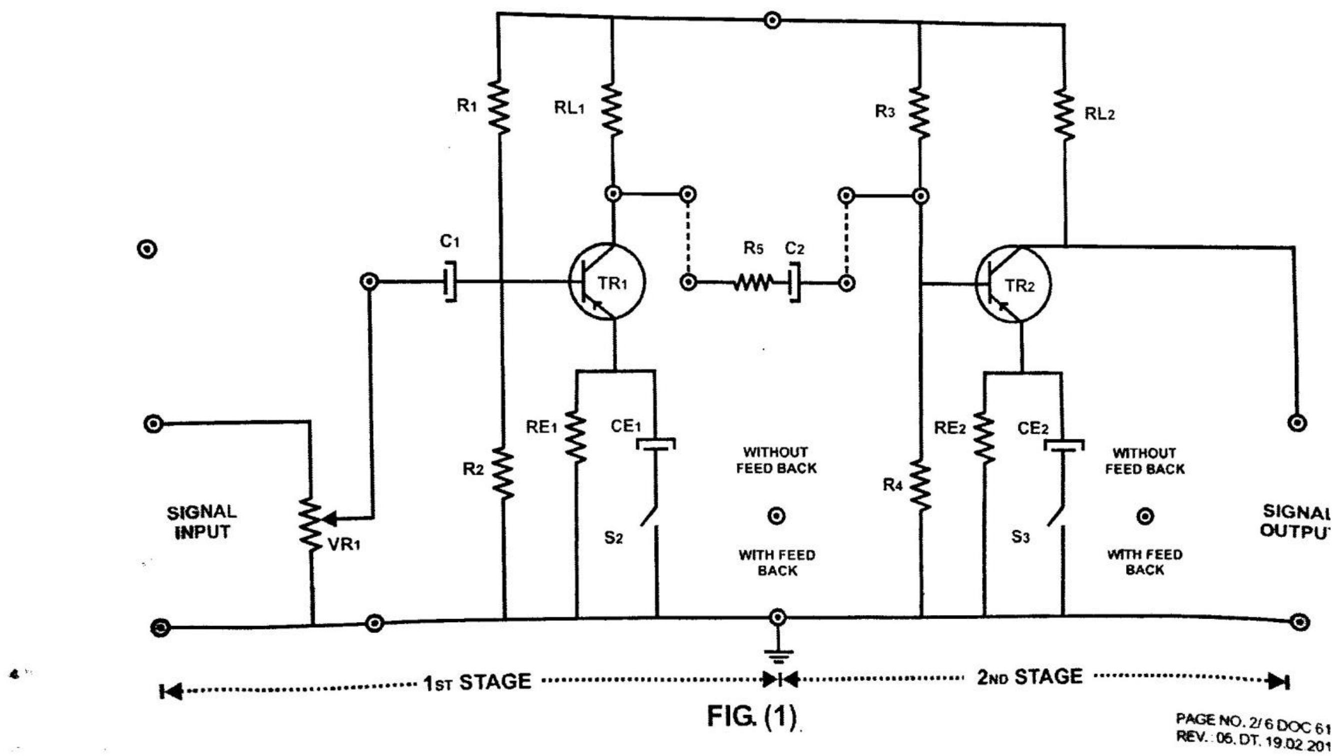

FIG. (1)

PROCEDURE: -

1. Connect Audio frequency signal generator across input terminals. Set it at sine wave signal of 100Hz, 10mV - 20mV peak to peak amplitude.

2. Connect CRO across output of first stage amplifier at red socket above transistor (TR1).

3. Switch ON the instrument as well as CRO.

4. Throw the feed-back SPDT switch (S2) towards, without feed-back position.

5. Observe the output signal on CRO. Adjust the output signal through set amplitude potentiometer provided on the front panel. Calculate voltage gain of first stage by using formula:

   Voltage Gain (Av,) = **Output Voltage** (P-P)/ **Input Voltage** (P-P).

6. Repeat the same procedure for with feed-back position. For this throw the feed-back switch (S2) towards with feed-back position. Note down all the observation as shown in Sample Observation Table (1).

OBSERVATION TABLE (1) FOR 1st STAGE AMPLIFIER

SNO	Frequency	Amplitude with Feedback	Amplitude without Feedback	Gain with Feedback	Gain without Feedback
1	100Hz	**0.2V**	**0.38V**	**20**	**38**
2	1KHz	**0.22V**	**1.8V**	**22**	**180**
3	5KHz	**0.24V**	**2.2V**	**24**	**220**
4	10KHz	**0.2V**	**1.9V**	**20**	**190**
5	50KHz	**0.07V**	**0.54V**	**7**	**54**
6	100KHz	**0.03V**	**0.24V**	**3**	**24**

7. Plot a graph between Frequency vs Output Gain by taking Frequency along X-axis & Output Gain along Y-axis.

B. Voltage Gain & Frequency response of Second Stage Amplifier :

1. Connect input signal from Function Generator to blue sockets just below the resistance (R3).

2. Now connect CRO across output of second stage amplifier.

3. Throw the feed-back switch (S3) towards, without feed-back position.

4. Observe the output signal on CRO. Calculate the Output Voltage Gain by using formula:
Voltage Gain (Av2) = Output Voltage (P-P)/ Input Voltage (P-P)

5. Repeat the same procedure for with feed-back. For this throw the feed-back switch (S3) towards with feed-back position.

6. To check the frequency response of amplifier, increase the frequency from 100Hz-100KHz in small steps and everytime note down the output peak to peak amplitude on CRO. Note down all the observation as shown in Sample Observation Table (2).

OBSERVATION TABLE (2) FOR 2nd STAGE AMPLIFIER

SNO	Frequency	Amplitude with Feedback	Amplitude without Feedback	Gain with Feedback	Gain without Feedback
1	100Hz	**0.08V**	**0.16V**	**8**	**16**
2	1KHz	**0.09V**	**1.2V**	**9**	**120**
3	5KHz	**0.09V**	**2.2V**	**9**	**220**
4	10KHz	**0.07V**	**2.2V**	**7**	**220**
5	50KHz	**0.05V**	**1.0V**	**5**	**100**
6	100KHz	**0.03V**	**0.5V**	**3**	**50**

7. Plot a graph between Frequency vs Output Gain by taking Frequency along X-axis & Output Gain along Y-axis.

Voltage Gain & Frequency response of RC Coupled Amplifier

1. Connect the Red to Red & Blue to Blue dotted sockets through patchcords.

2. Connect Signal Input to Input sockets and CRO probe to output sockets.

3. Keep both switches (S2 & S3) towards without feed-back position and take observation as mentioned in previous cases.

4. Repeat the same procedure for switches (S2 & S3) towards without feed-back position.

5. Observe the output signal on CRO. Adjust output signal with the help of potentiometer (VR1) provided on the front panel. Note down all the observation as shown in Sample Observation Table (3). Calculate the gain as per formula:
   Voltage Gain (Av3) = Output Voltage (P-P)/ Input Voltage (P-P)

6. Plot a graph between Frequency vs Output Gain by taking Frequency along X-axis & Output Gain along Y-axis.

VIVA QUESTION

Q.-1. Explain various types of Coupling Amplifier?

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Q.-2. Discuss Negetive Feedback Amplifier?

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Q.-3. Analyze the concept of Frequency response of an Amplifier?

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EXPERIMENT-5

AIM-

To verify the working operation of Crystal Oscillator.

APPARATUS REQUIRED-

Breadboard ,Workstation, Function Generator, Trainer Kit, Patch cords, DC Power supply

The instrument comprises of the following built in parts:-

1. One Fixed Output DC Regualted power suppIy + 12VDC.
2. Circuit consists of Transistor (SL100), Inductance (50Mh), Resistance & Capacitors combination
3. One Crystal capacitor (10MHz) is provided on the front panel.
4. Circuit diagram for crystal oscillator is printed on the front panel and sockets are provided to connect the CRO across output.

THEORY-

Many electronic devices require a source of energy at a specific frequency which may range from a few Hz to several MHz. This is achieved by an electronics device called oscillator. Oscillators are extensively used in electronics equipment.For eg. In radio and television receivers oscillators are used to generate high frequency wave (called carrier wave) in the tuning stages. Audio frequency & radio frequency signals are required for the repair of radio, television & other electronics equipment. Oscillators are also widely used in radar, electronics computer& other electronics devices. An electronics devices that generates sinusoidal oscillations of desired frequency is known as a sinusoidal oscillator. The basic components of an oscillator are:-

1. Tank Circult
2. Transistor
3. Feedback Circuit

Oscillator is an important device for many electronics circuit applications and its prime function is to generate wave forms at constant amplitude and desired frequency. Basically an oscillator is an electronics circuit which converts DC supply voltage to an output wave form of some frequency. The oscillator circuit must also be capable of producing sustained oscillations. . The oscillators are classified into two basic categories: Sinusoidal& Non-sinusoidal. If the wave form generated looks like sine wave, the circuit is called a sinusoidal oscillator and the circuit producing all other wave forms are called non- sinusoidal oscillator. Sometimes, the oscillators are also classified on basis of frequency of the generated wave form, viz. Audio frequency, Radio frequency and ultra-frequency oscillators.

A Crystal Oscillator is basically a tuned oscillator. It uses a piezoelectric crystal as a resonant circuit.The crystal provides a high degree of frequency stability. Therefore, the crystal oscillators are used whenever great stability is required. Examples are communication transmitters, digital clock etc. Each crystal has a natural frequency f which is given by

$$f = k/t$$

Where k is constant and t is the thickness of the crystal. It is clear that frequency is inversely proportional to crystal thickness. The thinner the crystal, the greater is its natural frequency and vice- versa However, extremely thin crystal may break because of variations. This puts a limit to the frequency obtainable. In practice, frequency between 25kHz-10MHz have been obtained with crystals.

PROCEDURE: -

1. Connect the CRO probes across output sockets of the oscillator.
2. Switch ON the instrument as well as CRO & observe the output .Wave shape on CRO and note down the frequency of oscillation.From CRO or from frequency Counter. The frequency of oscillation will be approximately 10MHz.

STANDARD ACCESSORIES

1. Instruction Manual (DOC668).

OPTIONAL ACCESSORIES

2. Cathode Ray Oscilloscope (CRO) or Frequency Counter.

CIRCUIT DIAGRAM:-

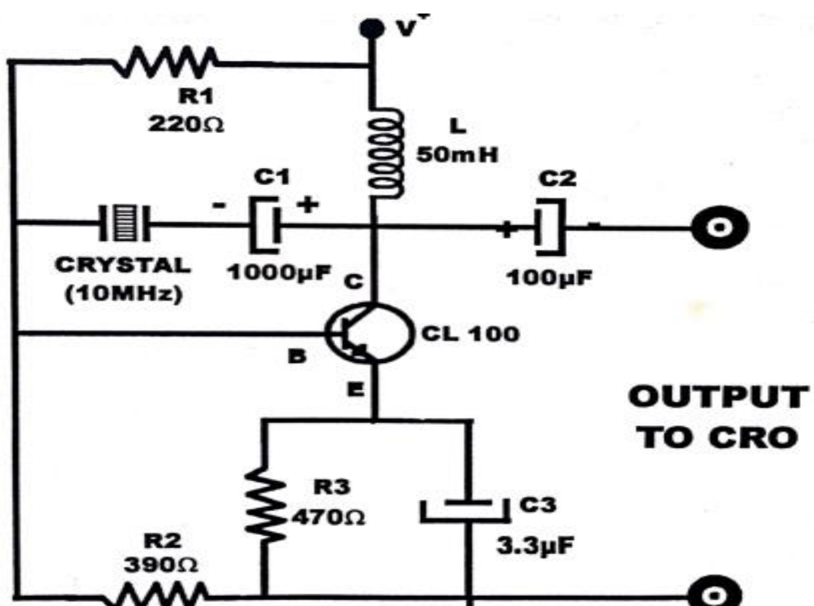

FIG. (1)

RESULT:

Result has been verified by calculating frequency of Oscillator

VIVA QUESTION

Q.-1. Explain High Frequency Oscillator?

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Q.-2. Derive the expression of frquency for Hartley Oscillator?

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Q.-3. Derive the expression of frequency for Colpitt's Oscillator?

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EXPERIMENT-6

AIM-

Analyse the working of RC Phase shift Oscillator using BJT.

APPARATUS REQUIRED-

Breadboard ,Workstation, Function Generator, Trainer Kit, Patch cords, DC Power supply

The instrument comprises of the following built in parts:-

1. Fixed DC Regulated power Supply of +12VDC.
2. A Phase Shift Network consist of three sections R1C1, R2C2,&R3C3. The total Phase Shift produced by The RC network is 180 (60-60-60)
3. One NPN Transistor for further phases shift of 180.

THEORY-

Oscillators using RC network are Phase Shift Oscillators. Lc oscillators are used for generating high frequency. These are not suitable for low frequency ranges. Such as audio Frequency. The alternative is RC network.

The above block diagram shows the essential components of a transistorized Phase Shift Oscillator.

1. **TANK CIRCIUT:-**

The tank circuit consists of three resistance connected in parallel with three capacitors. It is known as frequency determining network. The frequency of oscillations in the circuit depends upon the values of resistance & capacitors.

2. **TRANSISTOR AMPLIFIER:-**

The function of the amplifier is to amplify the oscillations produced by rc circuit. The amplifier receives DC power from battery & converts it into AC power supplying to the tank circuit. The oscillations produced in the tank circuit are applied to the input of the transistor. The transistor increases the output of these oscillations.

3. **FEEDBACK CIRCUIT:-**

The function of feedback circuit is to transfer a part the output energy to R. C. network in proper phase. When the feedback is positive, the overall gain of the amplifier is written as

Af=A/1-AB

Where AB is feedback factor or loop gain.

If AB =1, Af=c . thus the gain becomes infinity i.e., there is output without any input. In other words, the amplifier works as oscillator. The condition AB=1 known as Barkhausen criterion of oscillation.

A transistor Phase Shift Oscillator must introduce in-phase feedback from the output to the input to sustain oscillation. If a common emitter amplifier is used with a resistive collector load, there is a 180 phase shift between the base & collector. hence the phase shift feedback network between collectors & base must introduce an additional 180 phase shift, at some frequency if oscillation is to take plase. A transistor connected as a Phase Shift Oscillator is shown on the collector on the engraved front panel of the instrument. In this common emitter amplifier, feedback is from the collector to the base, i.e. from the output to the input. The 3 section phase shift network consists of C1R1,C2R2,C3R3. So that each section may introduce a 60 phase shift (approx) at the resonant frequency.

The frequency of the oscillations may be expressed as

$$F = 1/[2\pi\ (6RC)^{1/2}]$$

Where C = 0.01μF

R1 = 10kΩ

Calculated frequency = 649.7Hz

CIRCUIT DIAGRAM

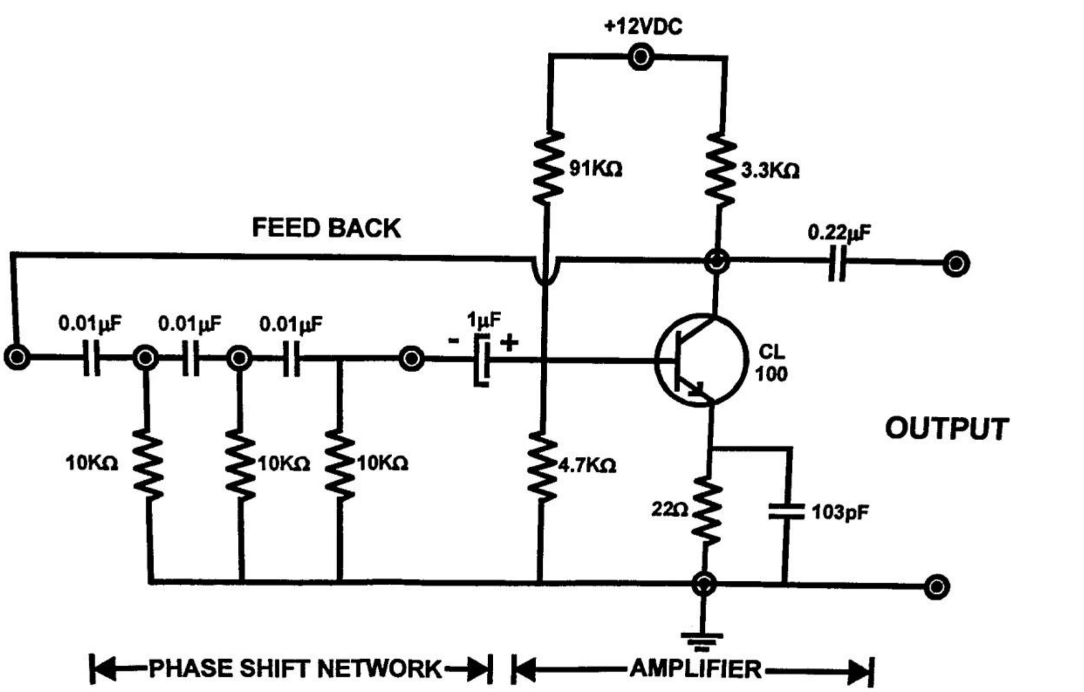

Fig. 1

PROCEDURE:-

1 Connect the CRO probe at output terminals.

2 Switch ON the instrument with an oscilloscope.

3 Observe the output frequency. It will be around 650Hz.

4 Now connect other CRO probe at lst yellow socket and adjust CRO's Time/Division knob at 'XY' mode to observe Phase Shift of 0 as shown below.

5 Compare the other Phase Shifts by connecting the other yellow sockets one by one.

6 Lissajous pattern for different phase shift are shown below.

Note: Adjust the Volt/division knobs of CRO if required to the desired phase shift pattern

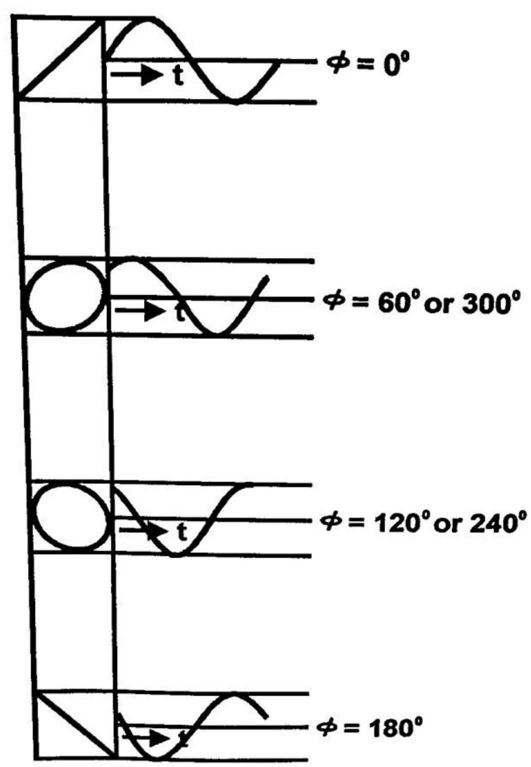

FIG. (2) LISSAJOUS PATTERNS WITH DIFFERENT PHASE SHIFT

RESULT:

Result has been verified by observing Lissajous Patterns with Different Phase Shift

VIVA QUESTION

Q.-1. Explain Low Frequency Oscillator

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Q.-2. Derive the expression of frequency for RC Phase Shift Oscillator

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Q.-3. How RC Phse Shift Oscillator different from Weinbridge Oscillator

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EXPERIMENT-7

AIM-

Analyse the working of Clapp Oscillator.

APPARATUS REQUIRED-

Breadboard ,Workstation, Function Generator, Trainer Kit, Patch cords, DC Power supply

The instrument comprises of the following built in parts:-

1. Fixed Output DC Regulated Power Supply of +12 VDC.
2. Circuit consists of transistor (CL100) & biasing resistances Combination.
3. Inductor(L =2. 5 MH) is placed the front panel.

Tank circuit consists of three capacitors & one inductor

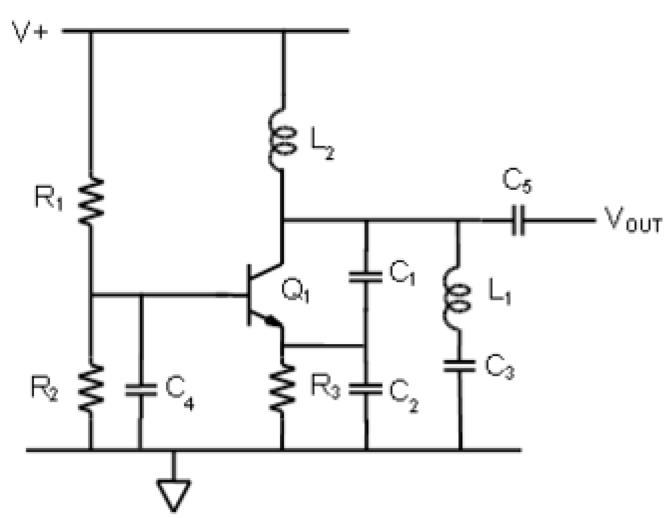
THEORY-

Clap oscillator is a slight modification of colpitts Oscillator as shown in Figure (1). In this oscillator a capacitor is placed in series with the tank inductor L. Addition of this capcitor improves frequency stability and eliminates the effect of transistor parameters on the operation of the circuit. The operation of the circuit is the same as that of the colpitts oscillator.

Fo = 1/2 (LC)$^{1/2}$

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

CIRCUIT DIAGRAM



PROCEDURE:-

CRO

1. Connect external +12V DC supply & Ground to the + 12VDC & Ground (GND) Sockets of the module with the help of patchcords.
2. Connect the CRO probes across output sockets of the module.
3. Switch ON the instrument as well as CRO & observe the output wave shape on CRO and note down the frequency of oscillation from CRO or from Frequency Counter.

$f_o = 1/2 \quad (LC)^{1/2}$

$1/C = 1/C_1 + 1/C_2 + 1/C_3$

CALCULATION:-

C1 = 1 µF
C2 = 0.01µF
C3 = 0.033µF

Then

C = 7.6 nf
L = 2.5 mH

Calculated frequency = 36.51 kHz

RESULT:

Result has been verified by observing waveform at different Phase Shift

VIVA QUESTION

Q.-1. How Clapp Oscillator if different from Colpitt's Oscillator?

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Q.-2. Why it is called as Clapp Oscillator?

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Q.-3. How Barkhausen Criterion satisfies in Clapp Oscillator?

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