Department of Electronics & Communication Engineering

LAB MANUAL

SUBJECT: ELECTRONICS LAB - II [04BEC202]

B.Tech II Year – IV Semester

(Branch: ECE)

BHAGWANT UNIVERSITY

SIKAR ROAD, AJMER

DEPARTMENT OF ECE

II YEAR IV SEMESTER ECE

LIST OF EXPERIMENTS

Course/Paper: 04BEC-202

BEC Semester-IV

1. Plot gain-frequency characteristics of BJT amplifier with and without negative feedback in the emitter circuit and determine bandwidths, gain bandwidth products and gains at 1kHz with and without negative feedback.

2. Study of series and shunt voltage regulators and measurement of line and load regulation and ripple factor.

3. Plot and study the characteristics of small signal amplifier using FET.

4. Study Wein bridge oscillator and observe the effect of variation in R & C on oscillator frequency

5. Study transistor phase shift oscillator and observe the effect of variation in R & C on oscillator frequency and compare with theoretical value.

6. Study the following oscillators and observe the effect of variation of C on oscillator frequency: (a) Hartley (b) Colpitts

7. Design Fabrication and Testing of k-derived filters (LP/HP).

8. Study of a Digital Storage CRO and store a transient on it.

9. To plot the characteristics of UJT and UJT as relaxation.

10. To plot the characteristics of MOSFET and CMOS.

EXPERIMENT 1: PLOT GAIN-FREQUENCY CHARACTERISTICS OF BJT AMPLIFIER.

Objectives:

- To graph the collector characteristics of a transistor using experimental methods.
- To measure AC and DC voltages in a common-emitter amplifier.

Equipment:

Instruments
1 DC Power Supply
3 Digital Multimeter
(DMM) 1 Function
Generator
1 Oscilloscope

Components
Capacitors: 15 µF, 10 µF
Resistors: 1 kΩ, 3 kΩ, 10 kΩ, 33 kΩ, 330 kΩ, 10 kΩ potentiometer, 1MΩ potentiometer
Transistors: 2N3904

Procedure:

Part A : The Collector Characteristics (BJT)***Using two potentiometers***

1. Construct the circuit of *Fig. 4.1*. Vary the 1MΩ potentiometer to set I_B = 10 µA as in Table 4.1.

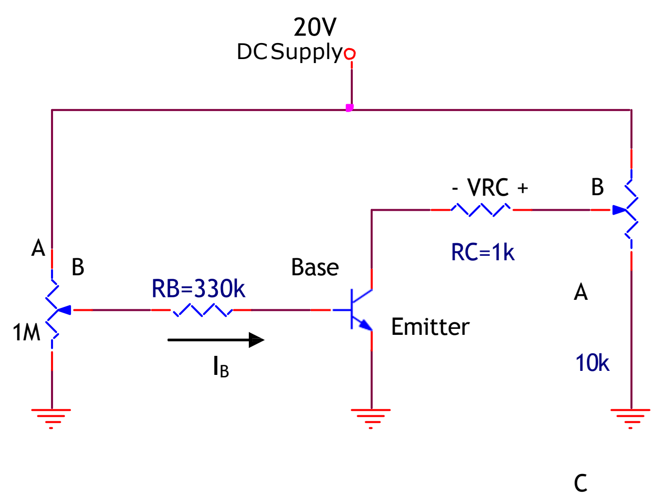


Fig. 4.1

2. Set the V_{CE} to 2V by varying the 10kΩ potentiometer as required by the first line of Table 4.1.
3. Record the V_{RC} and V_{BE} values in Table 4.1.

4. Vary the 10 kΩ potentiometer to increase V_{CE} from 2V to the values appearing in Table 4.1. (Note: I_B should be maintained at 10 μA for the range of V_{CE} levels.) Record V_{RC} and V_{BE} values for each of the measured V_{CE} values. Use the mV range for V_{BE}.
5. Repeat step 2 through 5 for all values of I_B indicated in Table 4.1.
6. Compute the values of I_C (from $I_C = V_{RC}/R_C$) and I_E (from $I_E = I_B+I_C$). Use measured resistor value for R_C.
7. Using the data of Table 4.1, plot the collector characteristics of the transistor on a graph paper. (Plot I_C versus V_{CE} for the various values of I_B. Choose an appropriate scale for I_C and label each I_B curve).

Part B : Common-Emitter DC Bias

1. Measure all resistor values (R_1, R_2, R_C and R_E) from circuit in *Fig. 4.2* using DMM.
2. Calculate DC Bias values (V_B, V_E, V_C and I_E) and record them.
3. Calculate AC dynamic resistance, r_e.
4. Construct circuit as of *Fig. 4.2* and set V_{CC} = 10 V.
5. Measure the DC bias values (V_B, V_E, V_C and I_E) and record them.
6. Calculate I_E using values obtained in Step 5.
7. Calculate r_e using the value of I_E from Step 6.
8. Compare value of r_e obtained both from Step 3 & 7.

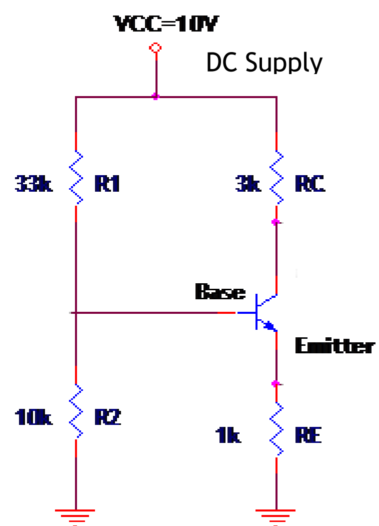


Fig. 4.2

PSPICE Instructions:

Using PSPICE Simulation, find the DC Bias values (V_B, V_E, V_C and I_E) for the circuit in *Fig.*

Compare the values obtained from PSPICE with the experimental ones.Results and Calculations:

Part A – Step 3

I_B (μA)	V_{CE} (V) meas	V_{RC} (V) meas	I_C (mA) (calc)	V_{BE} (V) meas	I_E (mA) (calc)
	2				
	4				
10	6				
	8				
	2				
	4				
30	6				
	8				
	2				
50	4				
	6				
	8				

Table
4.1

Part B

R_1 (measured) =__________, R_2 (measured) =____________, R_C (measured)=____________________R_E(measured) = ________________

V_B (calculated) =_________________-___, V_E (calculated) = __________
V_C (calculated) =_______________, I_E (calculated) = _______________

r_e (calculated) = ____________________

$$r_e = \frac{26(mV)}{I_E \quad (mA)}$$

V_B (measured) =____________, V_E (measured) = ______________V_C (measured) =_______________________,I_E (calculated) using measured values of V_E and R_E = ______

$$I_E = V_E / R_E$$

r_e (measured) =___________________, using measured I_E from Step 6.

Graph I_C versus V_{CE} for each value of I_B (use graph paper)

RESULT : Thus we have observed gain-frequency characteristics of BJT amplifier.

EXPERIMENT 2: STUDY OF SERIES AND SHUNT VOLTAGE REGULATORS.

AIM: TO STUDY ABOUT SERIES AND SHUNT VOLTAGE REGULATORS.

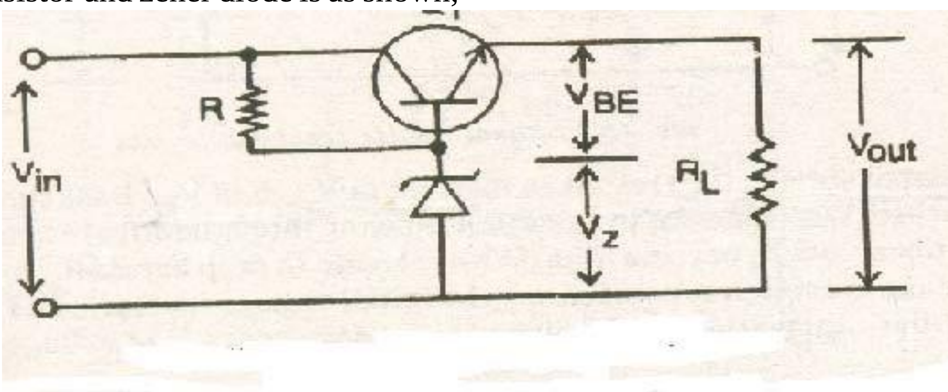
THEORY: The regulated power supply is a combination of three circuits, the bridge rectifier, the capacitor filter and zener diode voltage Regulator. Basically there are two types of voltage regulators

(i) Series Voltage Regulator (ii) Shunt Voltage Regulator

The series Regulator is placed in series with load and Shunt Regulator is placed in parallel with Load.

TRANSISTOR SERIES VOLTAGE REGULATOR

A voltage Regulator generally employs some active devices such as zener, or a transistor or both to achieve its objective. A series voltage regular using a transistor and zener diode is as shown,



The circuit is called a series voltage regulator because the load current passes through the series transistor Q1.The main drawback of series regulator is that the pass transistor can be destroyed by excessive load current.

TRANSISTOR SHUNT VOLTAGE REGULATOR

An increase in input voltage results in increase in output voltage and base – Emitter voltage.

RESULT : Thus we have studied about series and shunt voltage regulators..

EXPERIMENT 3: CHARACTERISTICS OF FIELD EFFECT TRANSISTOR

AIM:

To obtain the Drain and Transfer (V-I) characteristics of FET and to plot the characteristics.

APPARATUS REQUIRED:

S.NO.	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY (NO.S)
1	*FET*	BFW10/11		1
2	*Resistor*		1 kΩ	2
3	*Voltmeter*	D.C	(0 – 5V) (0 – 100V)	*One from each*
4	*Ammeter*	D.C	(0 – 50mA)	1
5	*Regulated Power Supply*	D.C	(0 – 30V)	2
6	*Bread Board*			1
7	*Connecting wires*			*Required*

THEORY:

A FET is a three terminal device, having the characteristics of high input impedance and less noise, the Gate to Source junction of the FET s always reverse biased. In response to small applied voltage from drain to source, the n-type bar acts as sample resistor, and the drain current increases linearly with V_{DS} .With increase in I_D the ohmic voltage drop between the source and the channel region reverse biases the junction and the conducting position of the

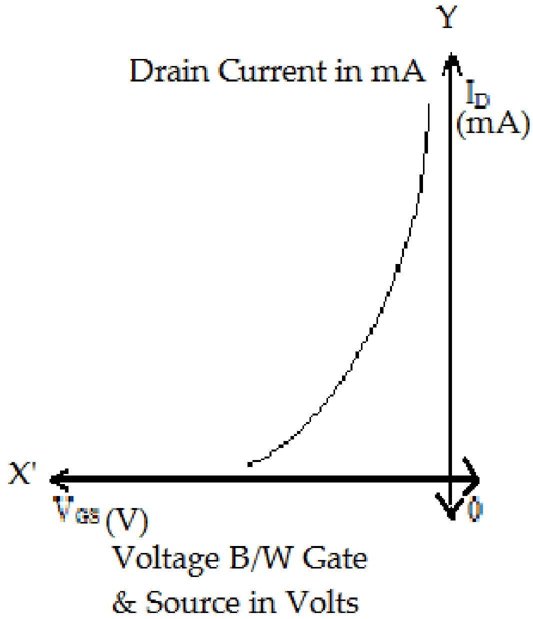
MODEL GRAPH:

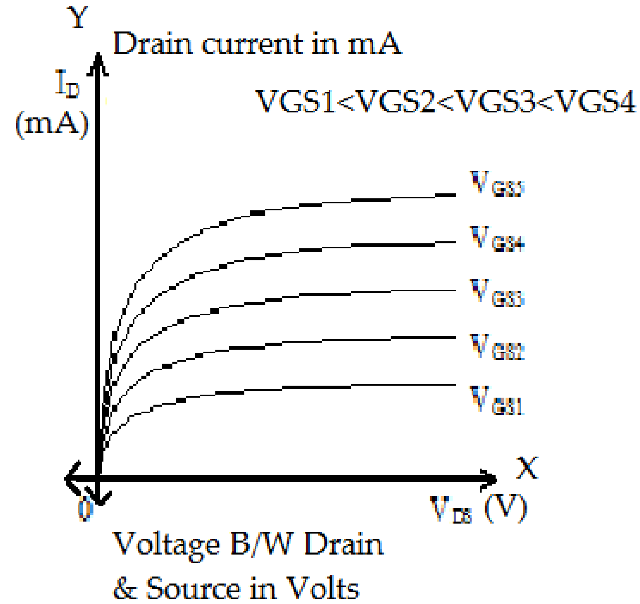
Transfer Characteristics

V_{GS}(V) Vs I_D(mA)

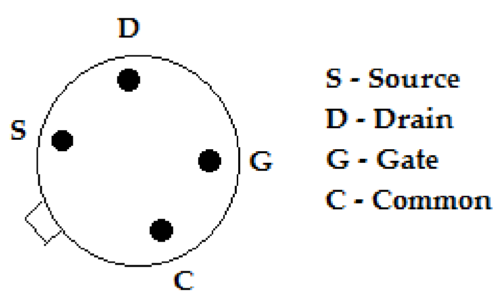
Drain Characteristics

V_{DS}(V) Vs I_D(mA)





JFET PIN DIAGRAM



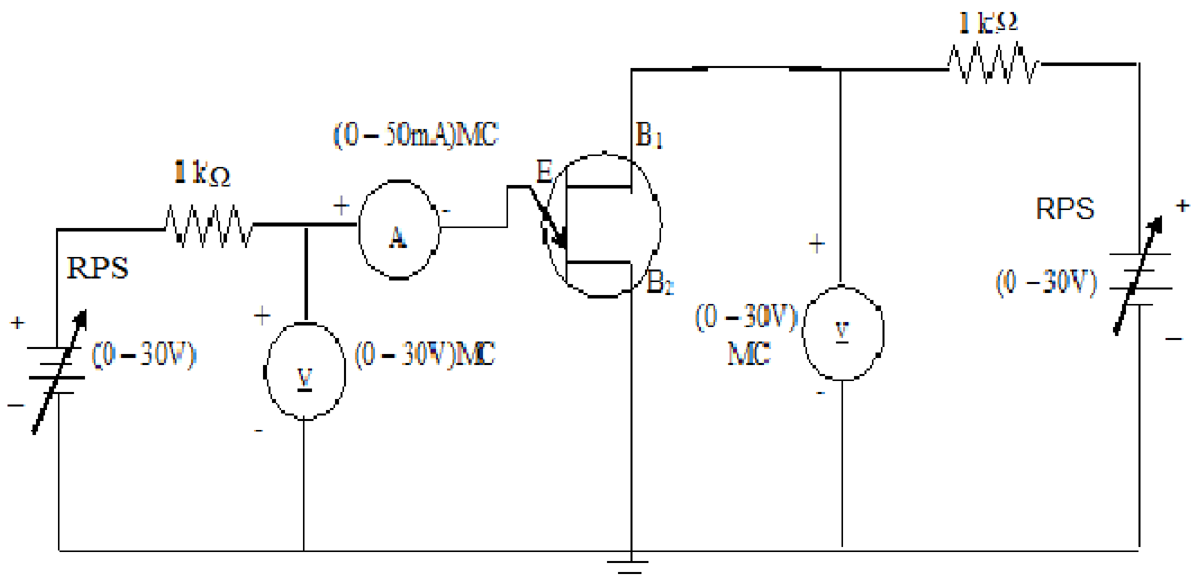
channel begins to remain constant. The V_{DS} at this instant is called "pinch of voltage". If the gate to source voltage (VGS) is applied in the direction to provide additional reverse bias, the pinch off voltage ill is decreased.

PROCEDURE:

1. Identify the terminals of the FET given and set up the circuit on breadboard as shown in figure.
2. Wire the circuit as shown in figure. By keeping the Gate Source voltage constant and varying the Drain Source voltage, I_D eadings are noted down.
3. Wire the circuit as shown in figure. By keeping the Drain Source voltage constant and varying the Gate Source voltage, I

   readings are noted down.
4. The above procedure was repeated and ammeter and voltmeter readings were noted.
5. VI characteristics curves were drawn.

CIRCUIT DIAGRAM:



TABULATION:

Sl.No	V_{BB1} =		V_{BB2} =	
	V_E (V)	I_E (mA)	V_E (V)	I_E (mA)
1.				
2.				
3.				
4.				
5.				
6.				
7.				

RESULT:

Thus the Drain and Transfer (V-I) characteristics of the FET were obtained and the characteristics curves were plotted.

EXPERIMENT 4: STUDY OF RC PHASE SHIFT OSCILLATOR.

AIM:

To design and set up an RC phase shift oscillator using BJT and to observe the sinusoidal output waveform.

APPARATUS REQUIRED:

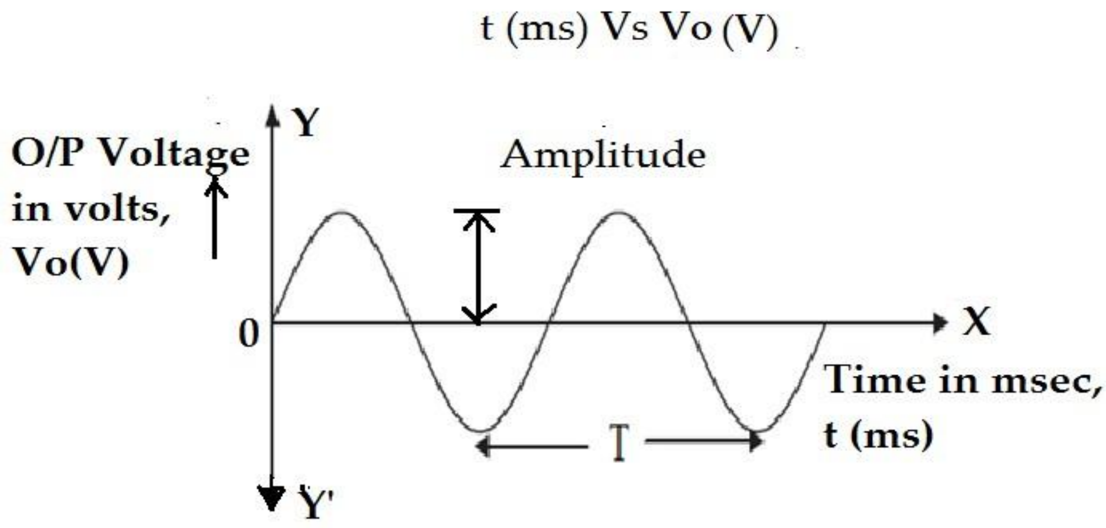
S.NO.	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY (NO.S)
1	*Transistor*	BC547		1
2	*Resistors*		47kΩ, 10kΩ,2.2kΩ,680Ω	*one from each*
3	*Resistor*		4.7kΩ	*3*
3	*Capacitors*		1µF,22µF	*one from each*
4	*Capacitor*		0.01 µF	3
5	*CRO*			
6	*RPS*		(0 – 30V)	1
7	*Bread Board*			1
8	*Connecting wires*			Required

THEORY:

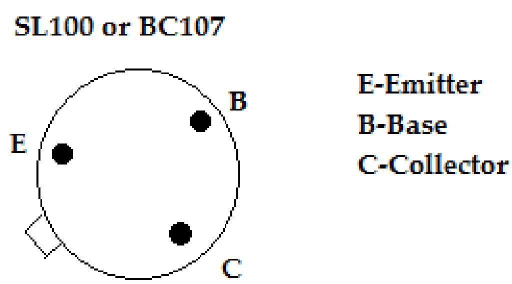
An oscillator is an electronic circuit for generating an AC signal voltage with a DC supply as the only input requirement. The frequency of the generated signal is decided by the circuit elements used. An oscillator requires an amplifier, a frequency selective network and a positive feedback from the output to the input.

The Barkhausen criterion for sustained oscillation is $A\beta = 1$ where A is the gain of the amplifier and β is the feedback factor (gain).The unity gain means signal is in phase. (If the signal is 180^0 out of phase and gain will be -1). RC-Phase shift Oscillator has a CE amplifier followed by three sections of RC phase shift feed-back Networks. The output of the last stage is return to the input of the amplifier. The values of R and C are chosen such that the phase shift of each RC section is 60°.Thus The RC ladder network produces a total phase shift of 180° between its input and output voltage for the given frequency. Since CE Amplifier produces 180 ° phases shift. The total phase shift from the base of the transistor around the circuit and back to the base will be exactly 360° or 0°. This satisfies the Barkhausen condition for sustaining oscillations and total loop gain of this circuit is greater than or equal to 1, this condition used to generate the sinusoidal oscillations.

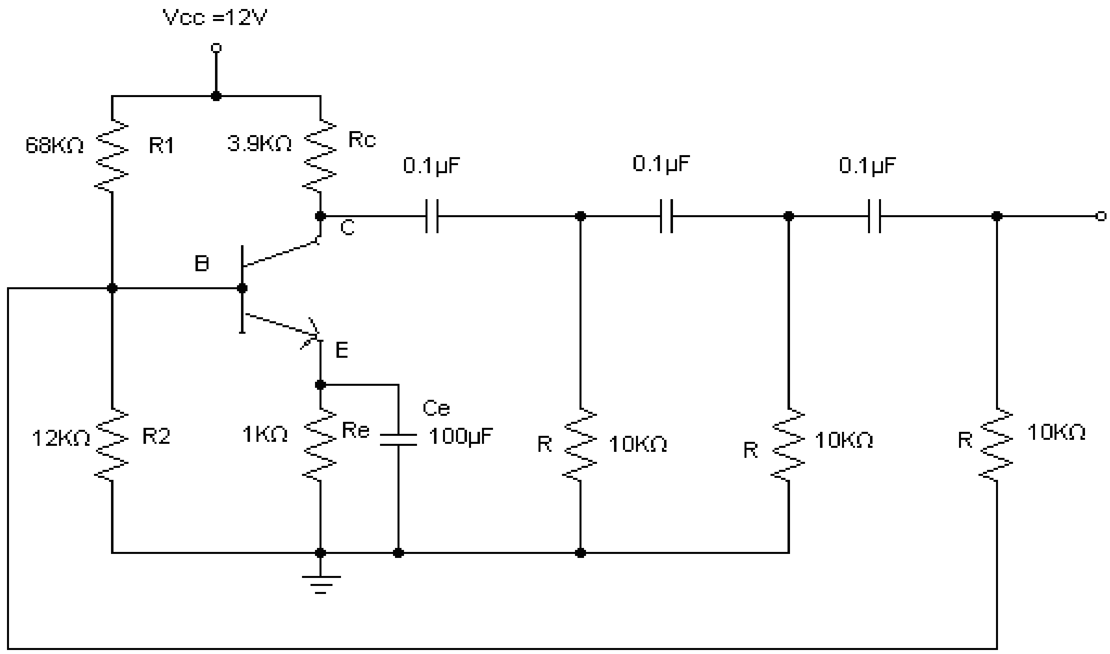
MODEL GRAPH:



BJT PIN DIAGRAM



CIRCUIT DIAGRAM:



PROCEDURE:

1. Identify the pin details of BC107 Transistor (or equivalent silicon Transistor such as BC108/547) and test it using a millimeter. Set up the circuit on breadboard as shown in figure.
2. A 12V Supply Voltage is given by using Regulated power supply and output is taken from collector of the Transistor.
3. By using CRO the output time period and voltage are noted.
4. Plot all the readings curves on a single graph sheet.

RESULT:

Thus the RC phase shift oscillator using BJT was obtained and the output waveform was plotted.

EXPERIMENT 5: STUDY OF WEIN BRIDGE OSCILLATOR.

AIM:

To design and set up a Wein Bridge oscillator using BJT and to observe the sinusoidal output waveform.

APPARATUS REQUIRED:

S.NO.	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY (NO.S)
1	*Transistor*	BC547		2
2	*Resistors*		47kΩ, 10kΩ,2.2kΩ,680Ω	*one from each*
3	*Resistor*		4.7kΩ	*3*
3	*Capacitors*		1μF,22μF	*one from each*
4	*Capacitor*		0.01 μF	3
5	*CRO*			
6	*RPS*		(0 – 30V)	1
7	*Bread Board*			1
8	*Connecting wires*			Required

THEORY:

An oscillator is an electronic circuit for generating an AC signal voltage with a DC supply as the only input requirement. The frequency of the generated signal is decided by the circuit elements used. An oscillator requires an amplifier, a frequency selective network and a positive feedback from the output to the input.
The Barkhausen criterion for sustained oscillation is $A\beta = 1$ where A is the gain of the amplifier and β is the feedback factor (gain).The unity gain means signal is in phase. (If the signal is 180^0 out of phase and gain will be -1).

A Wien bridge oscillator is a type of electronic oscillator that generates sine waves. It can generate a large range of frequencies. The oscillator is based on a bridge circuit originally developed by Max Wien in 1891 for the measurement of impedances. The bridge comprises four resistors and two capacitors. The oscillator can also be viewed as a positive gain amplifier combined with a bandpass filter that provides positive feedback. Automatic gain control, intentional non-linearity and incidental non-linearity limit the output amplitude in various implementations of the oscillator.

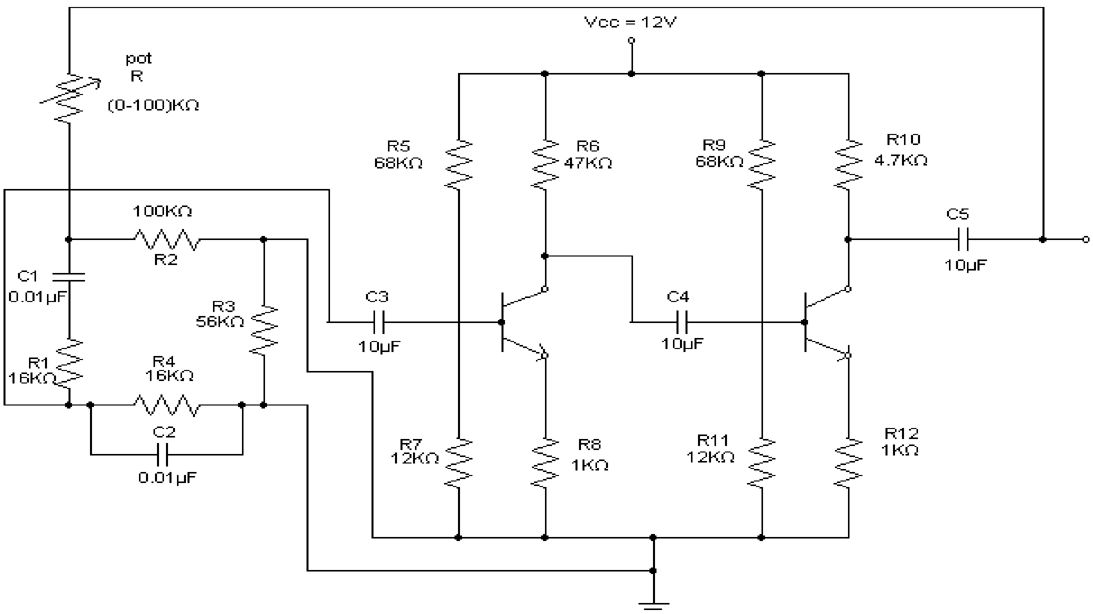
The circuit shown to the right depicts a common implementation of the oscillator, with automatic gain control, using modern components. Under the condition that $R_1=R_2=R$ and $C_1=C_2=C$, the frequency of oscillation is given by:

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

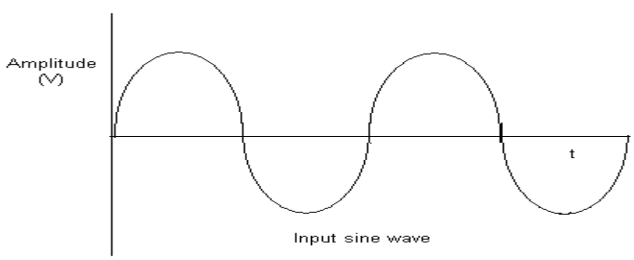
and the condition of stable oscillation is given by

$$R_b = \frac{R_f}{2}$$

CIRCUIT DIAGRAM:



MODEL GRAPH:



PROCEDURE:

1. Identify the pin details of BC107 Transistor (or equivalent silicon Transistor such as BC108/547) and test it using a millimeter. Set up the circuit on breadboard as shown in figure.
2. A 12V Supply Voltage is given by using Regulated power supply and output is taken from collector of the Transistor.

3. By using CRO the output time period and voltage are noted.
4. Plot all the readings curves on a single graph sheet.

RESULT:

Thus the Wein Bridge oscillator using BJT was obtained and the output waveform was plotted.

EXPERIMENT 6: STUDY OF COLPITTS OSCILLATOR.

AIM:

To design and set up a Colpitts oscillator using BJT and to observe the sinusoidal output waveform.

APPARATUS REQUIRED:

S.NO	APPARATUS	SPECIFICATION	QUANTITY
1.	Transistor	BC 107	1
2.	Resistors	11.64 KΩ, 552.2Ω,10.02KΩ1.67kΩ	Each 1
3.	Capacitors	53.5nF,80µF, 100mF	2,1,1
4.	Inductor	0.78mH	1
5.	RPS	±12V	1
6.	CRO	1MHz	1
7.	Connecting wires	-	Req.

THEORY:

A Colpitts oscillator is the electrical dual of a Hartley oscillator, where the feedback signal is taken from an "inductive" voltage divider consisting of two coils in series (or a tapped coil). Fig. 1 shows the common-base Colpitts circuit. L and the series combination of C_1 and C_2 form the parallel resonant tank circuit which determines the frequency of the oscillator. The voltage across C_2 is applied to the base-emitter junction of the transistor, as feedback to create oscillations. Fig. 2 shows the common-collector version. Here the voltage across C_1 provides feedback. The frequency of oscillation is approximately the resonant frequency of the LC circuit, which is the series combination of the two capacitors in parallel with the inductor

$$f_0 = \frac{1}{2\pi\sqrt{L\left(\frac{C_1C_2}{C_1+C_2}\right)}}$$

DESIGN PROCEDURE:

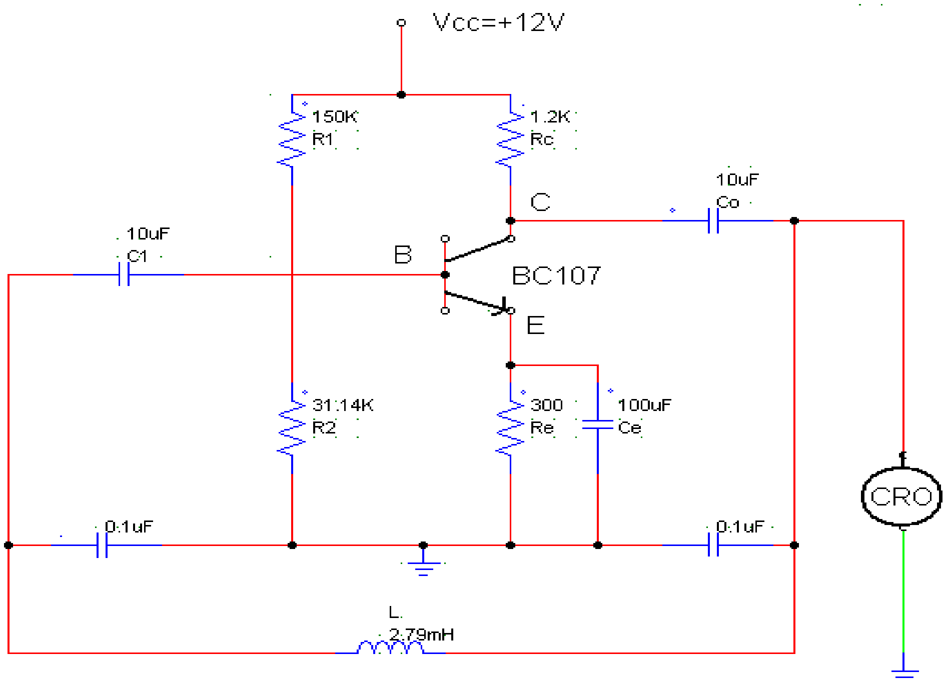
Select a appropriate transistor and note down its specification such as V_{CE},$I_{C(MAX)}$, $h_{fe(min)}$ and $V_{be(sat)}$.

- $V_{CC}= V_{CEQ}$
- $R_2=S* R_E$
- $V_{CC}[R_2/(R_1+ R_2)= V_{BE}+V_{BE(SAT)}$
- $V_{R1}+V_{R2}=V_{CC}$
- $h_{fe} \geq C_1* C_2/(C_1+ C_1)$
- $X_{CE} \leq R_E/10$

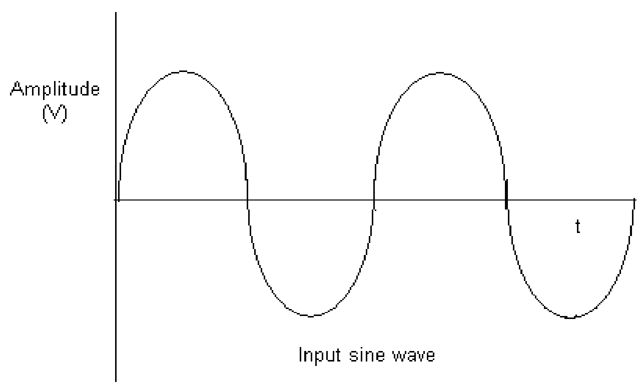
PROCEDURE:

- Hook up the circuit as shown in the circuit diagram.
- Switch on the power supply.
- Slight modification in value of C_1 and C_2 can be made to get perfect sine wave output.
- Observe the output waveform in CRO.

CIRCUIT DIAGRAM:



MODEL GRAPH:



TABULATION:

Amplitude(Volts)	Time(ms)	Frequency (KHz)

RESULT:

Thus the Colpitts oscillator was designed and its output waveform was verified.

EXPERIMENT 7: STUDY OF HARTLEY OSCILLATOR.

AIM:

To design and set up a Hartley oscillator using BJT and to observe the sinusoidal output waveform.

APPARATUS REQUIRED:

S.NO	APPARATUS	SPECIFICATION	QUANTITY
1.	Transistor	BC 107	1
2.	Resistors	2.74 KΩ, 1.76KΩ,10.58KΩ	1,2,1
3.	Capacitors	0.1µF, 0.1µF	Each 2
4.	Inductor	0.1mH,0.33mH	Each 1
5.	RPS	±12V	1
6.	CRO	1MHz	1
7.	Connecting wires	-	Req.

THEORY:

The **Hartley oscillator** is an electronic oscillator circuit in which the oscillation frequency is determined by a tuned circuit consisting of capacitors and inductors, that is, an LC oscillator. The Hartley oscillator is distinguished by a tank circuit consisting of two series-connected coils (or, often, a tapped coil) in parallel with a capacitor, with an amplifier between the relatively high impedance across the entire LC tank and the relatively low voltage/high current point between the coils. The Hartley oscillator is the dual of the Colpitts oscillator which uses a voltage divider made of two capacitors rather than two inductors. Although there is no requirement for there to be mutual coupling between the two coil segments, the circuit is usually implemented using a tapped coil, with the feedback taken from the tap, as shown here. The optimal tapping point (or ratio of coil inductances) depends on the amplifying device used, which may be a bipolar junction transistor.

DESIGN PROCEDURE:

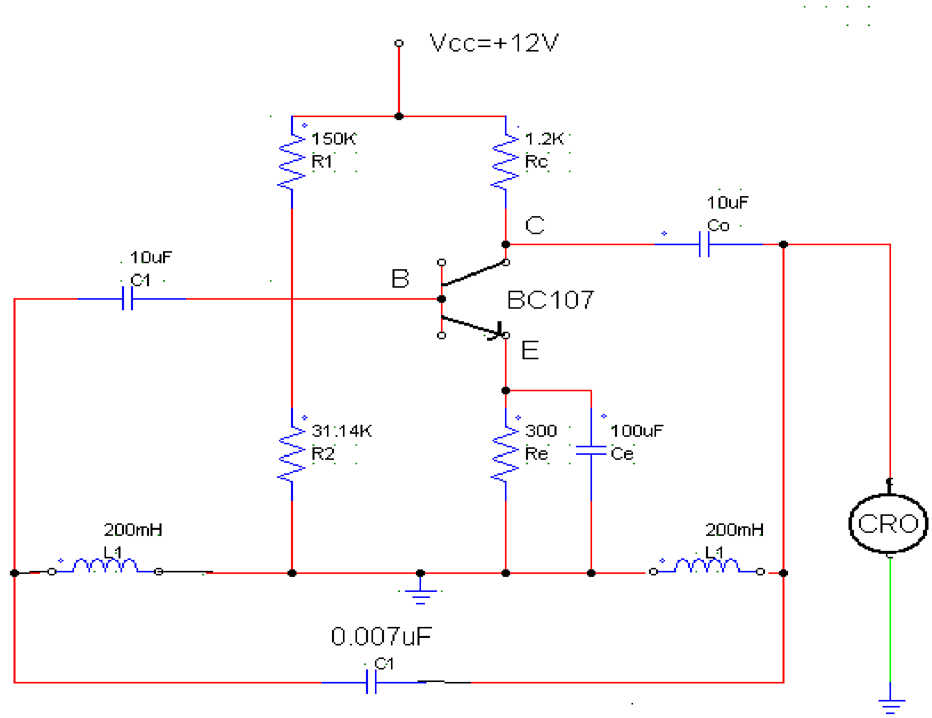
Select a appropriate transistor and note down its specification such as V_{CE},$I_{C(MAX)}$, $h_{fe(max)}$ and $V_{be(sat)}$.

- $V_{CC}= V_{CEQ}+ I_{CQ}(R_C+R_E)$
- $R_2=S^* R_E$
- $V_{CC}[R_2/(R_1+ R_2)= V_{BE}+V_{BE(SAT)}$
- $V_{R1}+V_{R2}=V_{CC}$

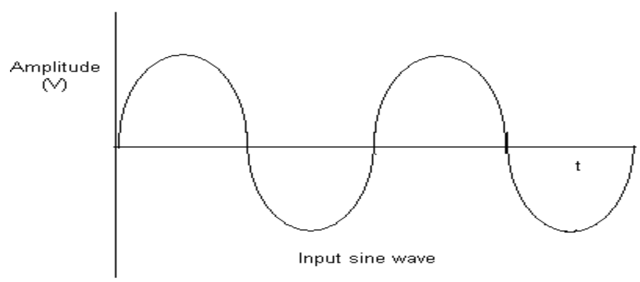
PROCEDURE:

- Hook up the circuit as shown in the circuit diagram.
- Switch on the power supply.
- Slight modification in value of L_1 and L_2 can be made to get perfect sinewave output.
- Observe the output waveform in CRO.

CIRCUIT DIAGRAM:



MODEL GRAPH:



TABULATION:

Amplitude(Volts)	Time(ms)	Frequency (KHz)

RESULT:

Thus the Hartley oscillator was designed and its output waveform was verified.

EXPERIMENT 8: Characteristics of UJT and UJT as relaxation.

AIM:

To study and observe the characteristics of UJT.

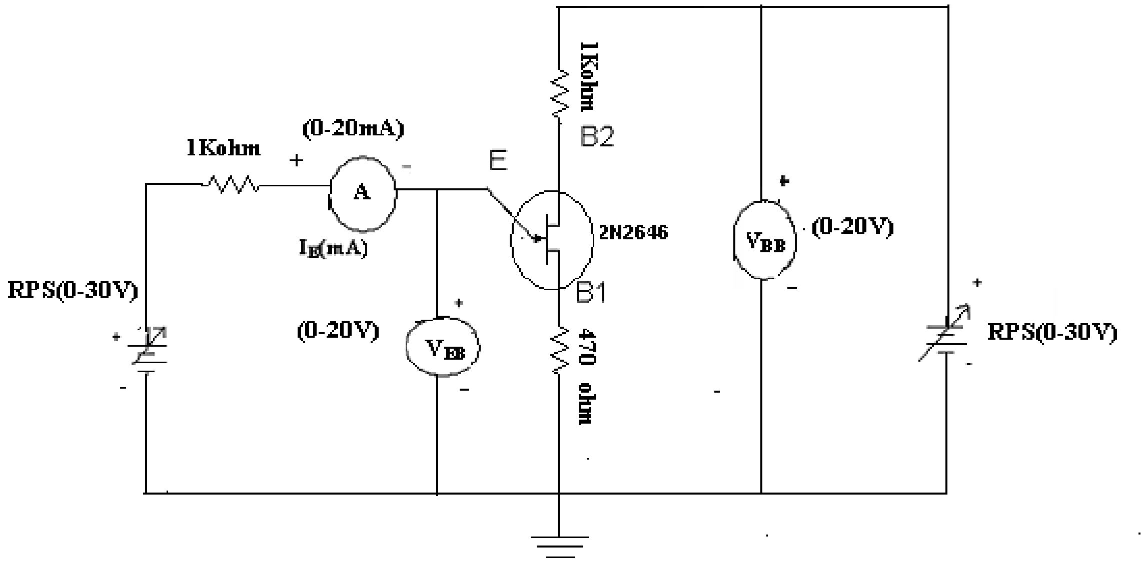
APPARATUS:

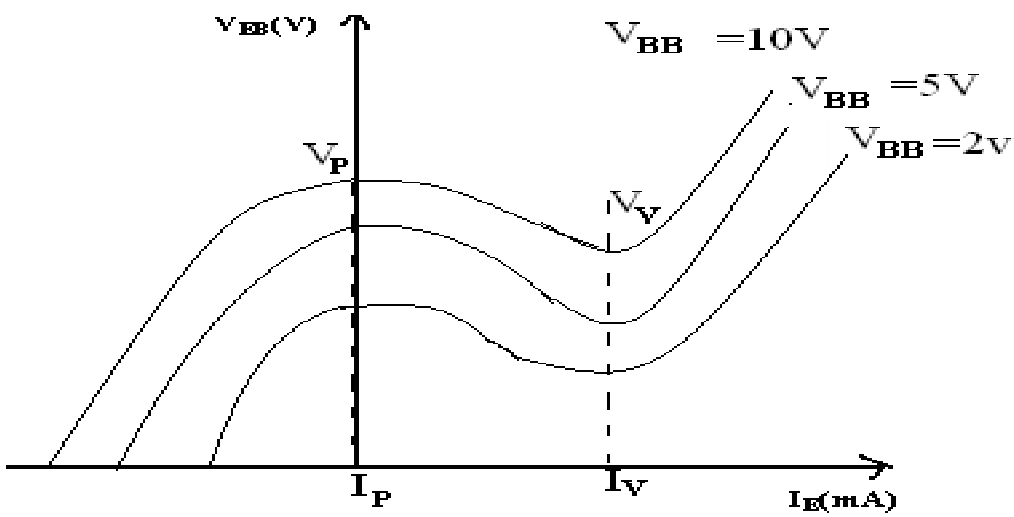
Regulated power supply (0-30V)	-2Nos
0-20V (DMM)	-2Nos
mA (DMM)	-1No.
Resistors 1Kohm	-2Nos
Resistor 470 ohm	-1No.
Breadboard Connecting wires	

THEORY: A Unijunction Transistor (UJT) is an electronic semiconductor device that has only one junction. The UJT Unijunction Transistor (UJT) has three terminals an emitter (E) and two bases (B1 and B2). The base is formed by lightly doped n-type bar of silicon. Two ohmic contacts B1 and B2 are attached at its ends. The emitter is of p- type and it is heavily doped. The resistance between B1 and B2, when the emitter is open-circuit is called interbase resistance. The original Unijunction transistor, or UJT, is a simple device that is essentially a bar of N type semiconductor material into which P type material has been diffused somewhere along its length. The 2N2646 is the most commonly used version of the UJT.

The UJT is biased with a positive voltage between the two bases. This causes a potential drop along the length of the device. When the emitter voltage is driven approximately one diode voltage above the voltage at the point where the P diffusion (emitter) is, current will begin to flow from the emitter into the base region. Because the base region is very lightly doped, the additional current (actually charges in the base region) causes (conductivity modulation) which reduces the resistance of the portion of the base between the emitter junction and the B2 terminal. This reduction in resistance means that the emitter junction is more forward biased, and so even more current is injected. Overall, the effect is a negative resistance at the emitter terminal. This is what makes the UJT useful, especially in simple oscillator circuits. hen the emitter voltage reaches V_p, the current starts o increase and the emitter voltage starts to decrease. This is represented by negative slope of the characteristics which is referred to as the negative resistance region, beyond the valley point, RB1 reaches minimum value and this region, V_{EB} proportional to $I_{E.}$

CIRCUIT DIAGRAM:





PROCEDURE:

1. Connection is made as per circuit diagram.
2. Output voltage is fixed at a constant level and by varying input voltage corresponding emitter current values are noted down.
3. This procedure is repeated for different values of output voltages.
4. All the readings are tabulated and Intrinsic Stand-Off ratio is calculated using $\eta = (V_P - V_D) / V_{BB}$
5. A graph is plotted between V_{EE} and I_E for different values of $V_{BE.}$

OBSEVATIONS:

V_{BB}=10		V_{BB}=5		V_{BB}=2	
V_{EB}(V)	I_E(mA)	V_{EB}(V)	I_E(mA)	V_{EB}(V)	I_E(mA)

RESULT: Thus we have studied and observed the characteristics of UJT.

EXPERIMENT 9: TO STUDY ABOUT CATHODE RAY OSCILLOSCOPE.

AIM:

To study about cathode ray oscilloscope (CRO).

APPARATUS:

CRO, CONNECTING LEADS, POWER SUPPLY.

THEORY:

An oscilloscope is a test instrument which allows us to look at the 'shape' of electrical signals by displaying a graph of voltage against time on its screen. It is like a voltmeter with the valuable extra function of showing how the voltage varies with time. A graticule with a 1cm grid enables us to take measurements of voltage and time from the screen.

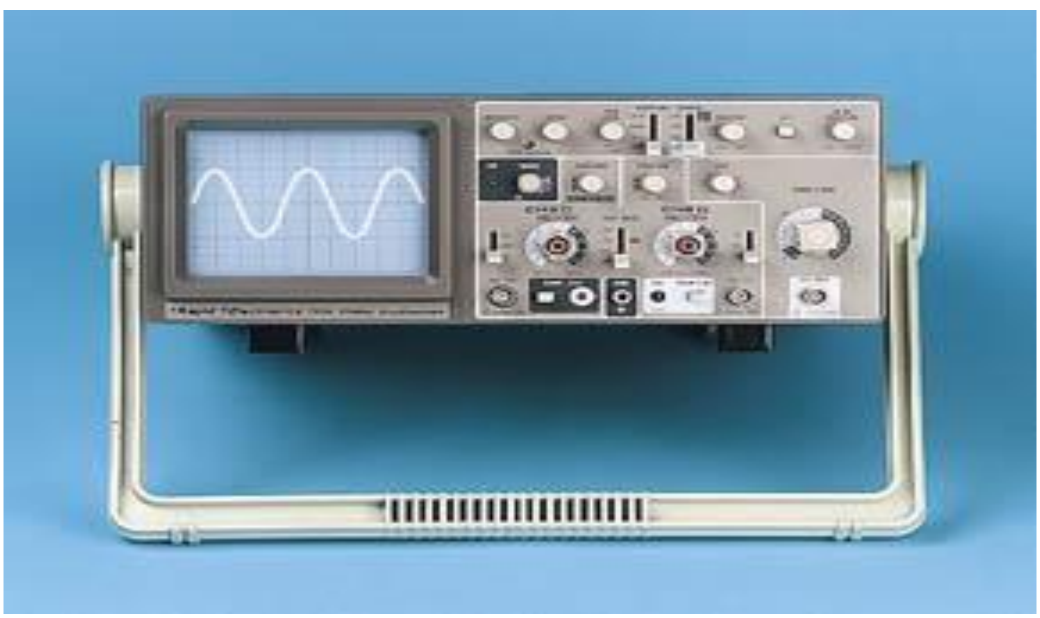
The cathode-ray oscilloscope (CRO) is a common laboratory instrument that provides accurate time and amplitude measurements of voltage signals over a wide range of frequencies. Its reliability, stability, and ease of operation make it suitable as a general purpose laboratory instrument. The heart of the CRO is a cathode-ray tube.

The graph, usually called the trace, is drawn by a beam of electrons striking the phosphor coating of the screen making it emit light, usually green or blue. This is similar to the way a television picture is produced.

Oscilloscopes contain a vacuum tube with a cathode (negative electrode) at one end to emit electrons and an anode (positive electrode) to accelerate them so they move rapidly down the tube to the screen. This arrangement is called an electron gun. The tube also contains electrodes to deflect the electron beam up/down and left/right.

The electrons are called cathode rays because they are emitted by the cathode and this gives the oscilloscope its full name of cathode ray oscilloscope or CRO.

A dual trace oscilloscope can display two traces on the screen, allowing us to easily compare the input and output of an amplifier for example. It is well worth paying the modest extra cost to have this facility.



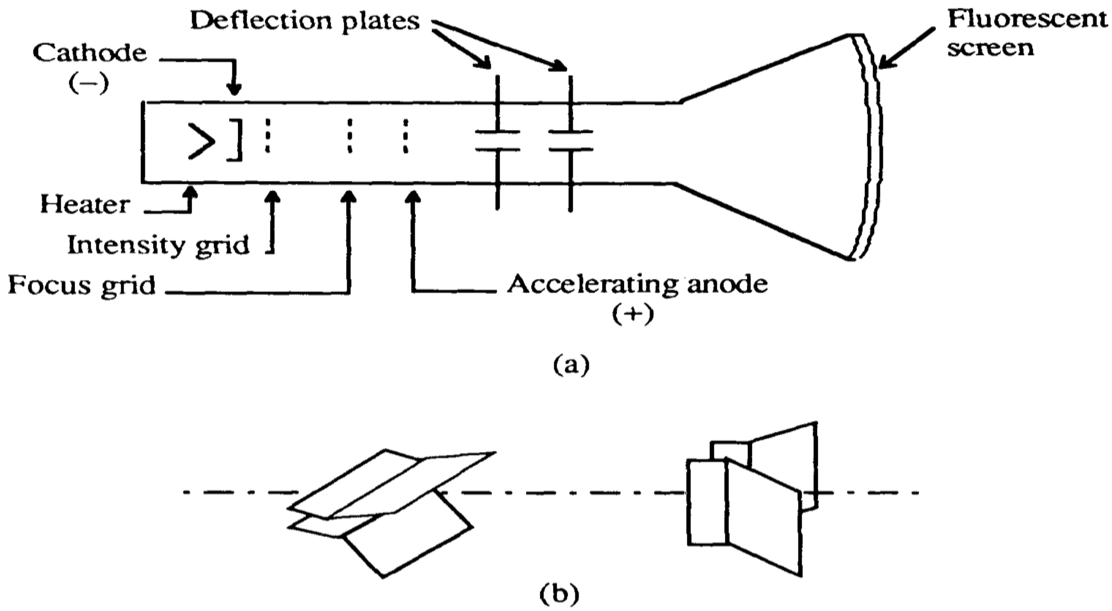


Figure 1. Cathode-ray tube: (a) schematic, (b) detail of the deflection plates.

Setting up an oscilloscope:

Oscilloscopes are complex instruments with many controls and they require some care to set up and use successfully. It is quite easy to 'lose' the trace off the screen if controls are set wrongly.

There is some variation in the arrangement and labeling of the many controls. So, the following instructions may be adapted for this instrument.

1. Switch on the oscilloscope to warm up (it takes a minute or two).
2. Do not connect the input lead at this stage.
3. Set the AC/GND/DC switch (by the Y INPUT) to DC.
4. Set the SWP/X-Y switch to SWP (sweep).
5. Set Trigger Level to AUTO.
6. Set Trigger Source to INT (internal, the y input).
7. Set the Y AMPLIFIER to 5V/cm (a moderate value).
8. Set the TIMEBASE to 10ms/cm (a moderate speed).
9. Turn the time base VARIABLE control to 1 or CAL.
10. Adjust Y SHIFT (up/down) and X SHIFT (left/right) to give a trace across the middle of the screen, like the picture.
11. Adjust INTENSITY (brightness) and FOCUS to give a bright, sharp trace.

The following type of trace is observed on CRO after setting up, when there is no input signal connected.

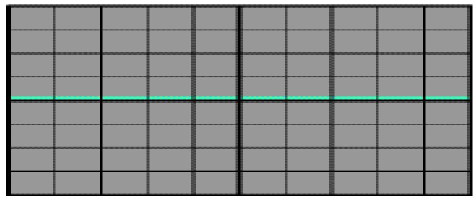
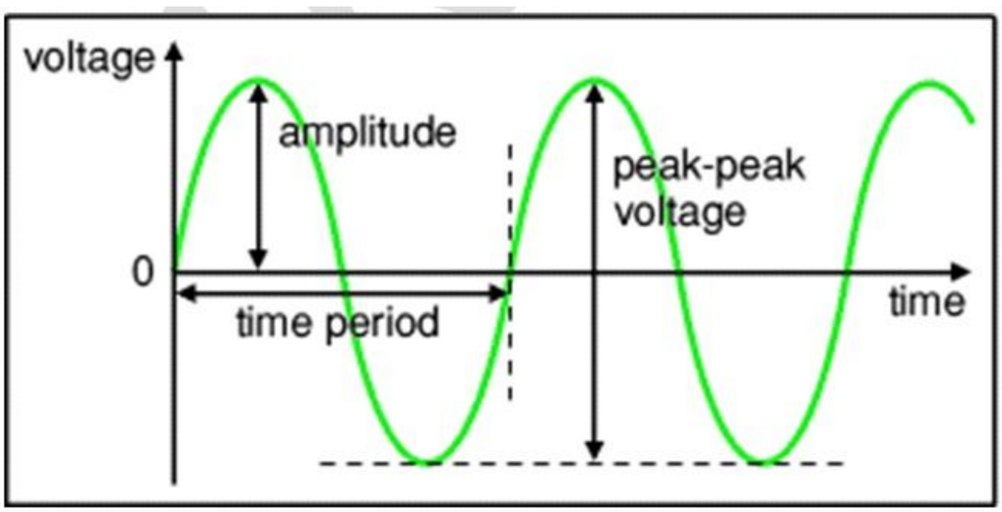


FIG. OSCILLOSCOPR PROBES AND LEADS

Measuring voltage and time period

The trace on an oscilloscope screen is a graph of voltage against time. The shape of this graph is determined by the nature of the input signal. In addition to the properties labeled on the graph, there is frequency which is the number of cycles per second. The diagram shows a sine wave but these properties apply to any signal with a constant shape



- **Amplitude** is the maximum voltage reached by the signal. It is measured in volts.
- **Peak voltage** is another name for amplitude.
- **Peak-peak voltage** is twice the peak voltage (amplitude). When reading an oscilloscope trace it is usual to measure peak-peak voltage.
- **Time period** is the time taken for the signal to complete one cycle.

It is measured in seconds (s), but time periods tend to be short so milliseconds (ms) and microseconds (μs) are often used. 1ms = 0.001s and 1μs = 0.000001s.

- **Frequency** is the number of cycles per second. It is measured in hertz (Hz), but frequencies tend to be high so kilohertz (kHz) and megahertz (MHz) are often used. 1kHz = 1000Hz and 1MHz = 1000000Hz.

$$\text{Frequency} = \frac{1}{\text{Time period}}$$

$$\text{Time period} = \frac{1}{\text{Frequency}}$$

A) Voltage: Voltage is shown on the vertical y-axis and the scale is determined by the Y AMPLIFIER (VOLTS/CM) control. Usually peak-peak voltage is measured because it can be read correctly even if the position of 0V is not known. The amplitude is half the peak-peak voltage.

Voltage = distance in cm × volts/cm

B) Time period: Time is shown on the horizontal x-axis and the scale is determined by the TIMEBASE (TIME/CM) control. The time period (often just called period) is the time for one cycle of the signal. The frequency is the number of cycles per second, frequency = 1/time period.

Time = distance in cm × time/cm

RESULT: Thus we have studied about CRO.