AURORA'S ENGINEERING COLLEGE

BHONGIR, NALGONDA DIST. – 508116.

lab manual of

ELECTRONICS ENGINEERING LAB

2nd Year MECH, 1st Semester, 2013-14.

Department Of
Electronics and Communication Engineering

LAB CODE

1. Students should report to the concerned labs as per the time table schedule.

2. Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.

3. After completion of the experiment, certification of the concerned staff in-charge in the observation book is necessary.

4. Students should bring a note book of about 100 pages and should enter the readings/observations into the note book while performing the experiment.

5. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate last session should be submitted and certified by the staff member in-charge.

6. Not more than three students in a group are permitted to perform the experiment on a setup.

7. The group-wise division made in the beginning should be adhered to, and no mix up of student among different groups will be permitted later.

8. The components required pertaining to the experiment should be collected from stores in-charge after duly filling in the requisition form.

9. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.

10. Any damage of the equipment or burn-out of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.

11. Students should be present in the labs for the total scheduled duration.

12. Students are required to prepare thoroughly to perform the experiment before coming to Laboratory.

13. Procedure sheets/data sheets provided to the students' groups should be maintained neatly and to be returned after the experiment.

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1. Transistor CE Characteristics (Input and Output)

1) AIM:
1) To study and plot the input and output characteristics of BJT in CE configuration.
2) Find the current amplification factor β.
3) Find the dynamic input & output Resistance.

2) i. APPARATUS:
Dual Regulated power supply (0 – 30)V
Moving coil ammeter (0 – 10 mA), (0 -1mA)
Moving coil voltmeter (0 – 1 V), (0 – 10 V)
Bread board - 1
Connecting wires (single strand) - 20

ii.) COMPONENTS: –
Transistor BC107
Resistor – (10 kΩ)

3) THEORY:
In this CE arrangement, input is applied between base & emitter terminals and output is taken from collector and emitter terminals. Here emitter of the transistor is common to both input and output circuits. Hence the name Common Emitter (CE) configuration.

For CE configuration, we define the important parameters as follows:

1. The base current amplification factor (β) is the ratio of change in collector current ΔI_C to the change in base current ΔI_B is known as Base current amplification factor.

$$\beta = \frac{\Delta I_C}{\Delta I_B} | V_{CB} = const$$

In almost any transistor, less than 5% of emitter current flows as the base current. The value of β is generally greater than 20.Usually its value ranges from 20 to 500. This type of arrangement or configuration is frequently used as it gives appreciable current gain as well as voltage gain.

2. Input resistance is the ratio of change in base-emitter voltage to the change in base-current at constant V_{CE}

i.e.,

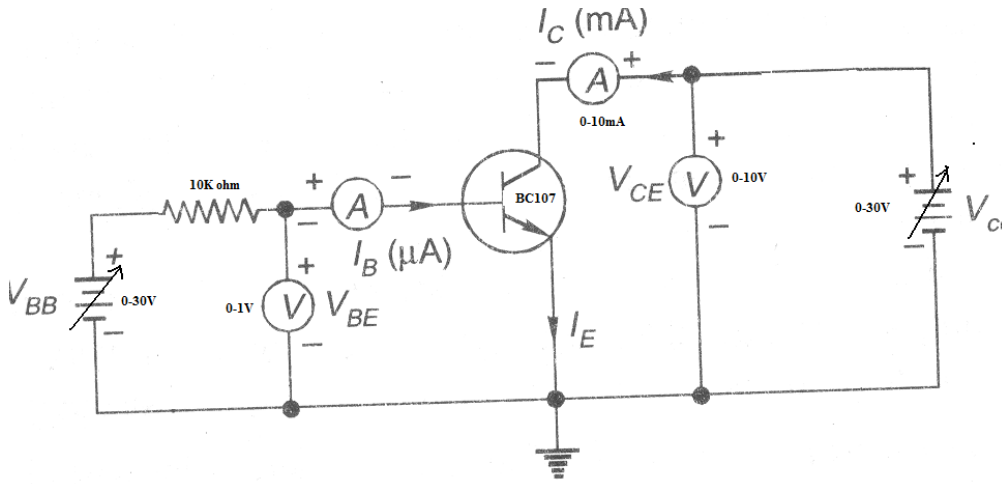
$$r_i = \frac{\Delta V_{BE}}{\Delta I_B} | .V_{CE} = const$$

The value of input resistance for the CE circuit is of the order of a few hundred Ω's.

3. Output resistance is the ratio of change in collector-emitter voltage to change in collector current at constant I_B.

$$r_O = \frac{\Delta V_{Ce}}{\Delta I_C} | I_E = const$$ .It is in the order of 50 kΩ

4. CIRCUIT DIAGRAM:



5. PROCEDURE

Input characteristics

1. Connect the circuit as per the given circuit diagram on bread board
2. Set V_{CE} = 5V, vary V_{BE} in steps of 0.1V & note down the corresponding I_B. Repeat the above procedure for 10V, 15V & 20V
3. Plot the graph V_{BE} Vs I_B for a constant V_{CE} taking V_{BE} is taken on x axis & I_B on y axis
4. Calculate input resistance $\frac{\Delta V_{BE}}{\Delta I_B} |_{V_{CE} = const}$

Output Characteristics

1. Connect the circuit as per the given circuit diagram on the bread board
2. Open the inpit circuit, vary the collector voltage V_{CE} in steps of 1V and note down the corresponding collector current Ic.
3. Set I_B= 20μA, vary V_{CE} in steps of 1V and note down the corresponding I_C. Repeat the above procedure for 40μA, 80μA, 100μA.
4. Plot the graph taking V_{CE} on X-axis & I_C on y-axis at corresponding constant I_B
5. Calculate the output resistance $\frac{\Delta V_{CE}}{\Delta I_C} |_{I_B = const}$
6. Calculate the current amplification factor $\beta = \frac{\Delta I_C}{\Delta I_B} |_{V_{CB} = const}$

6. TABULAR FORM

I/p Characteristics

V_{CE} = 5V	
V_{BE}(V)	I_B(mA)

V_{CE} = 10V	
V_{BE}(V)	I_B(mA)

V_{CE} = 15V	
V_{BE}(V)	I_B(mA)

O/p Characteristics

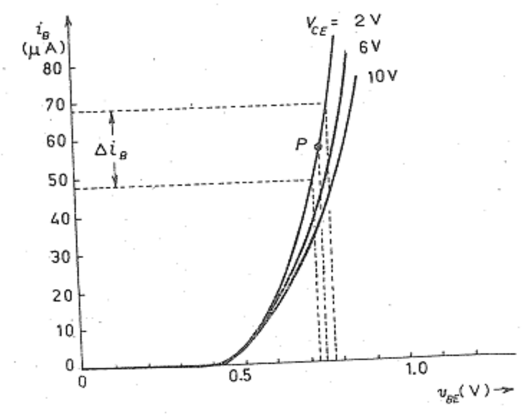
I_B = 20μA	
V_{CE}	I_C(mA)

I_B = 40μA	
V_{CE}	I_C(mA)

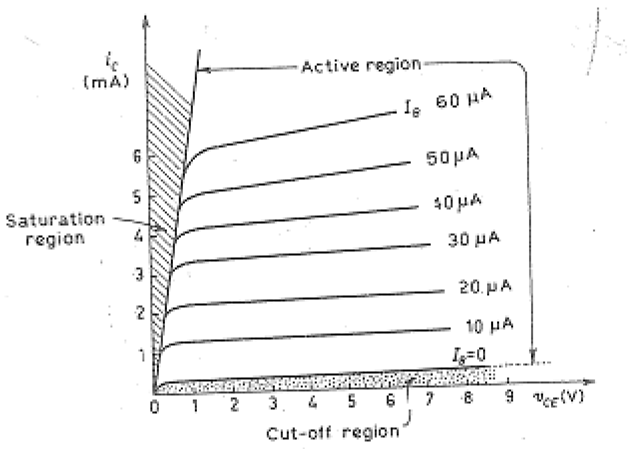
I_B = 60μA	
V_{CE}	I_C(mA)

7. **GRAPH**: -

Input Characteristics: -



Output Characteristics: -



8) CALCULATIONS: -

I/p Resistance = $\frac{\Delta V_{BE}}{\Delta I_B} |_{V_{CE} = const}$

O/p Resistance = $\frac{\Delta V_{CE}}{\Delta I_C} |_{I_B = const}$

Current amplification factor $\beta = \frac{\Delta I_C}{\Delta I_B} |_{V_{CB} = const}$

9) RESULTS: -

1. Input and output characteristics are plotted on the graph.
2. The transistor parameters are given below

Dynamic I/p Resistance = _______

Dynamic O/p Resistance = _______

Current amplification factor β=_____

10) INFERENCE: -

I/p characteristics: -

1.As compared to CB arrangement I_B increases less rapidly with V_{BE}. Input resistance of CE circuit is higher than that of CB circuit.

2. Input characteristics resembles that of a forward biased pn junction diode curve. This is expected since the base emitter section of a transistor is a pn junction.

O/p characteristics

1.For any value of V_{CE} above knee voltage, the collector current I_C is approximately equal to βI_B.

2. The collector current is not zero when I_B is zero. It has a value of I_{CEO}, the reverse leakage current.

<u>11. APPLICATIONS</u>:

1) Used as amplifier
2) Used in communication circuits
3) Used as a switch
4) Used in audio frequency applications

<u>12. QUESTIONS</u>:

1) What is Transistor?
2) Draw the npn & pnp transistor symbols.
3) Why is base region made thin?
4) Why is transistor not equivalent to two pn junction diodes connected back to back?
5) Why is collector current slightly less than emitter current?
6) What is the significance of arrow in the transistor symbol?
7) What is β?
8) What is the range of input resistance?
9) What is the range of output resistance?
10) Why small change in α leads to large change in β.

2. FULLWAVE RECTIFIER WITH & WITHOUT FILTERS

1. AIM:
1. To examine the input and output waveform of full wave rectifier
2. To find ripple factor and average voltage

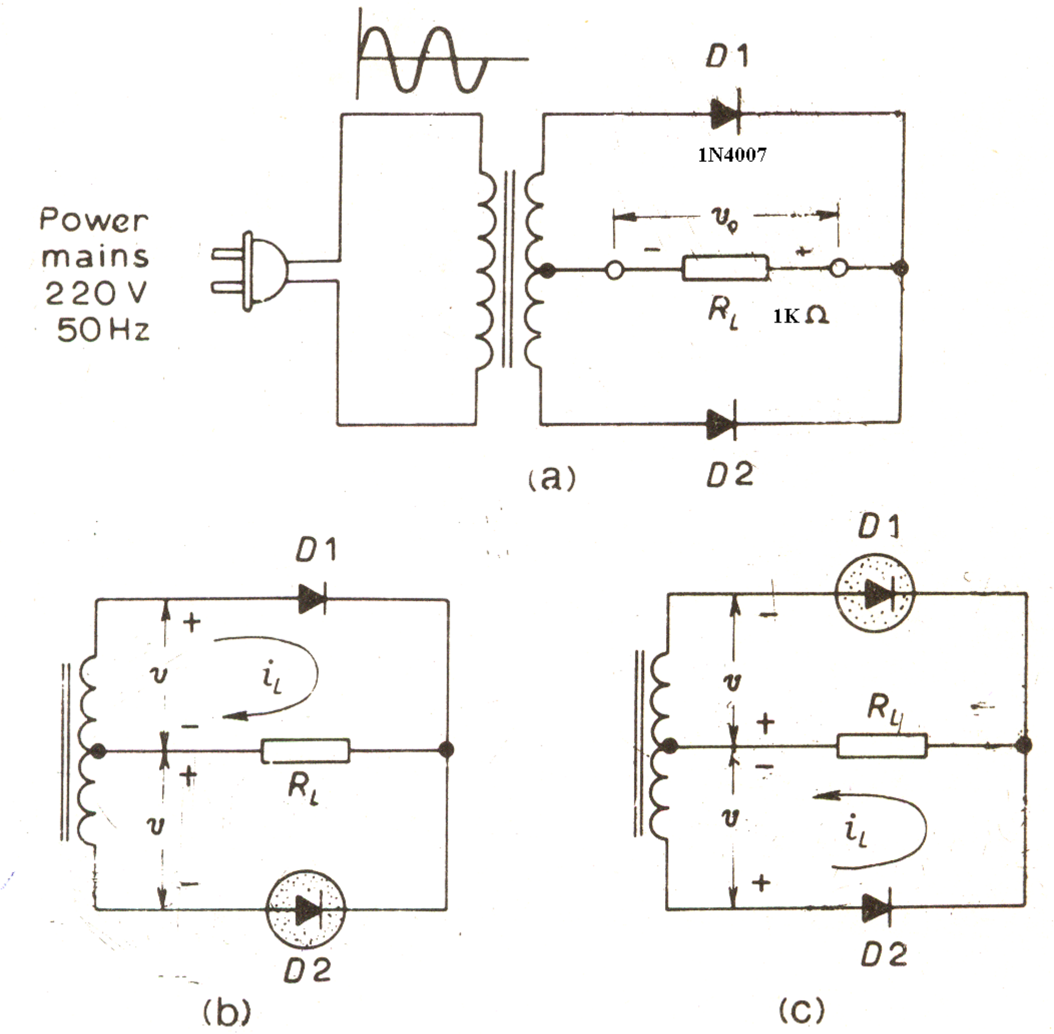
2. EQUIPMENTS REQUIRED:

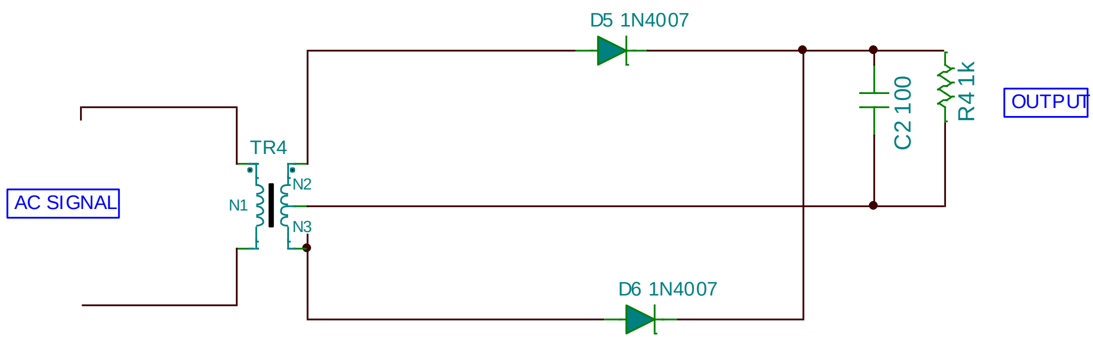
i. Apparatus:
1. Bread Board
2. CRO
3. Connecting wires
4. Digital Multimeter
5. TransformerPrimary voltage (0-230v)
6. BNC probes

ii. COMPONENTS REQUIRED:
1. Capacitor (100μF)
2. Diode (1N4007)
3. Resistor (1kΩ)

3. THEORY:
During positive half cycle Diode D1 is forward biased and diode D2 is reversed biased so current conducts through D1 due to which voltage is developed across the load resistance. and During negative half cycle Diode D2 is forward biased and diode D1 is reversed biased so current conducts through D2 due to which voltage is developed across the load resistance.

4. CIRCUIT DIAGRAM:





5. PROCEDURE:

Without filter:

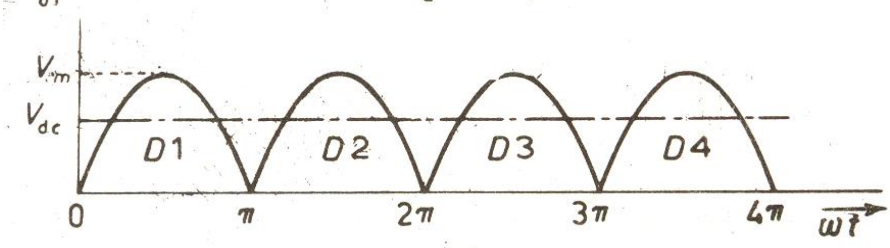
1. Connect the circuit as per the circuit diagram
2. Measure the voltages at the Load resistors
   (a) Keep the DMM in DC mode to measure dc voltage
   (b) Keep the DMM in AC mode to measure RMS voltage
3. Compare the theoretical and practical values.
4. Tabulate the observations

5. Observe the voltage wave form across the secondary of the transformer and also across the output in CRO.

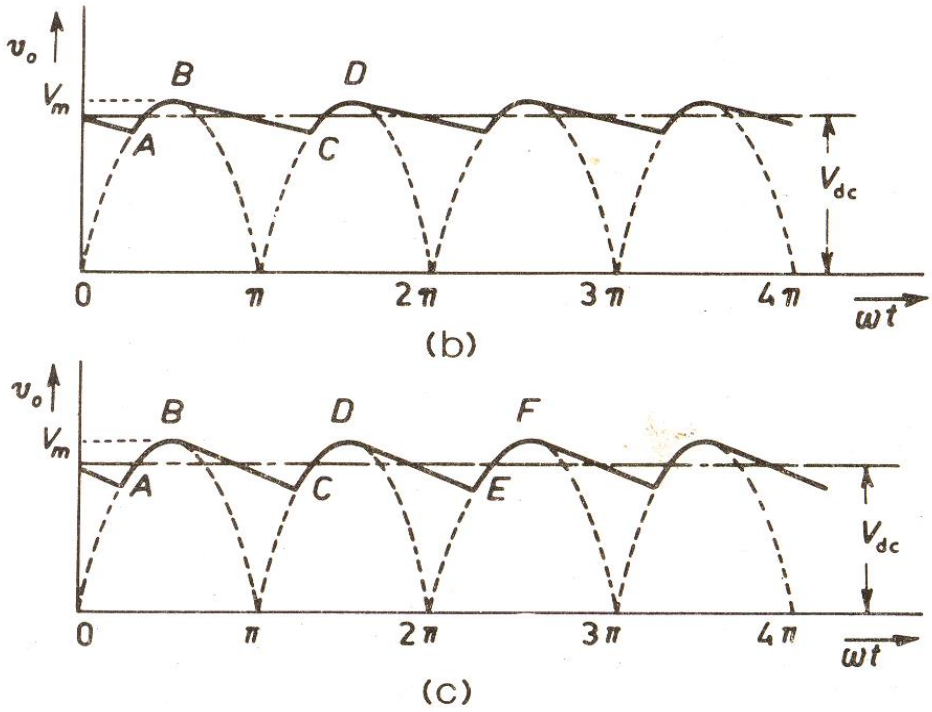
With filter:

1. Connect the circuit as per the circuit diagram
2. Measure the voltages at the Load resistors
   (a) Keep the DMM in DC mode to measure dc voltage
   (b) Keep the DMM in AC mode to measure RMS voltage
3. Compare the theoretical and practical values.
4. Tabulate the observations
5. Observe the voltage wave form across the secondary of the transformer and also across the output in CRO.

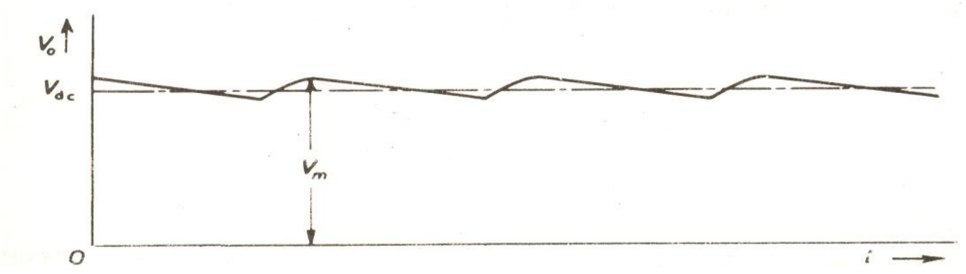
Graph:



Centre-tap full-wave rectifier



Full-wave rectifier with shunt capacitance filter



6. OBSERATION TABLE

Sl No.	Parameters	Theoretical value	Practical value	Difference
1	Ripple factor			
2	Average voltage			

7. INFERENCE

As diode can be used as a switch so it is used in rectifier circuit to convert AC signal to DC signal, but not perfect DC it is pulsating DC.

8. PRECAUTIONS

1. Waveforms should be observed on CRO keeping in DC mode.
2. Use digital meter instead of analog meter.

9. TROUBLE SHOOTINGS

No meter reading then check if there are any loose connection.

10. RESULT:

Ripple factor = $\sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$ = ____________________

$$\text{Percentage regulation} = \frac{V_{noload} - V_{fullload}}{V_{fullload}} x100\% = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

11. EXTENSSION

Efficiency of the circuit is less so we go for fullwave rectifier.

12. APPLICATIONS

1. Used to convert AC signal to pulsating DC.
2. Clippers.

13. QUESTION

1. Explain the operation of half wave rectifier.
2. Derive rms & avg value of output of full wave rectifier.
3. Derive ripple factor of full wave rectifier.
4. Derive efficiency of full wave rectifier
5. What is peak factor, form factor of full wave rectifier?

6. What is TUF of full wave rectifier?
7. What should be PIV of diode in full wave rectifier?

3. COMMON EMITTER AMPLIFIER

1. AIM

1. To study and plot the frequency response curve of CE amplifier
2.Measure the bandwidth and voltage gain of the amplifier in mid frequency range .
3. Measure the operating point, input and output impedances .

2 i. APPARATUS REQUIRED

APPARATUS

1. Regulated dual power supply (0 – 30 V)	– 1 No.
2. Function generator	– 1 No.
3. CRO (20MHZ) Dual trace	- 1 No. each

ii. COMPONENTS

1. Transistor BC 107	- 1 No
2. Resistor 10k Ω ,33K Ω, 4.7K Ω, 560Ω, 2.2 K Ω	– 1 each.
3. Capacitors 10μF	-2
4. Capacitor 100μF	-1
5. Bread Board & Connecting Wires	-

iii. SPECIFICATIONS:

BC 107 is an N-P-N
H_{fe} = 500 at I_C= 2mA, V_{CE} = 5V
I_{CBO}=15 micro amps
I_{CM} = 200 mA
V_{CEO} =45V
Ti=175 degree C.

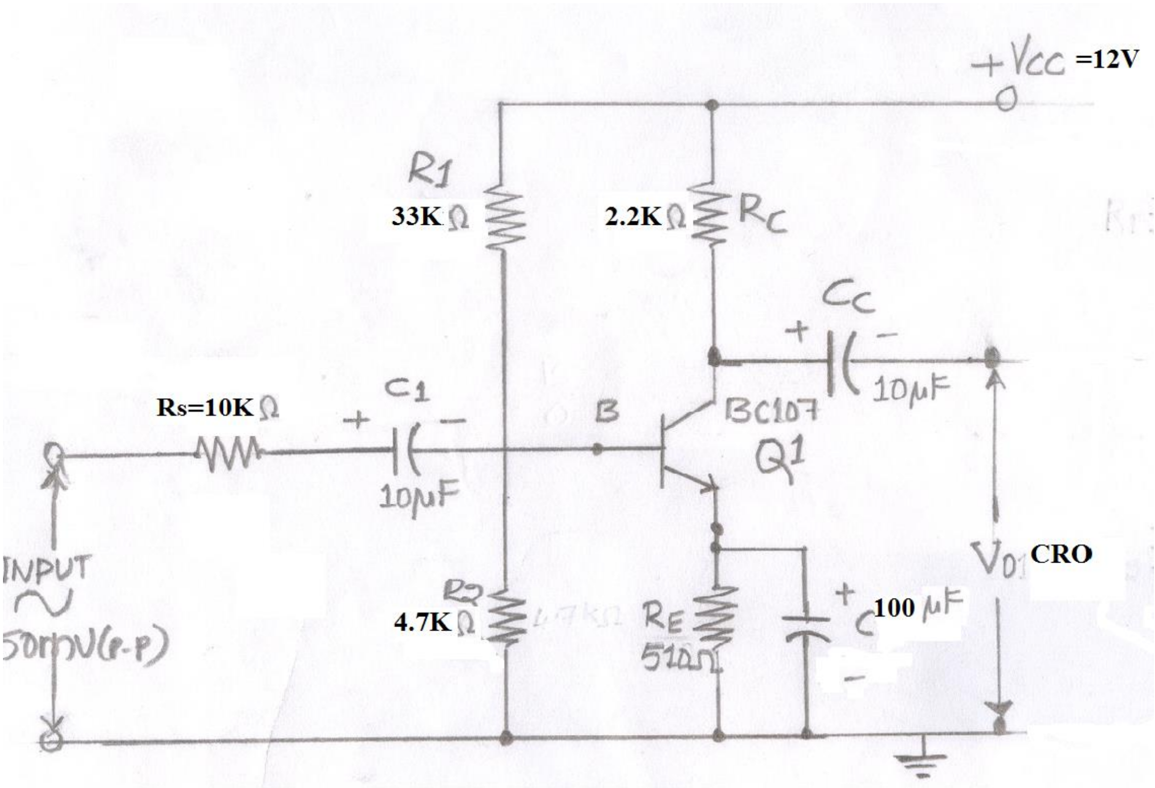
3 THEORY

In the amplifier circuit shown in the figure, The resistor R_1,R_2 and R_E fix the operating point. The resistor R_E stabilizes it against temperature variations. The capacitor C_E bypasses the resistor R_E for the ac signal. As it offers very low impedance path for ac, The emitter terminal is almost at ground potential. When the ac signal is applied to the base, The base-emitter voltage changes, because of which the the base current changes. Since the collector current depends on the base current, the collector current also changes. When this collector current flows through the load resistor, ac voltage is produced at the output. As the output voltage is much greater than the input voltage, the circuit works as an amplifier.

The voltage gain of the amplifier is given by the formula

$Av = \frac{\beta R_{ac}}{r_{in}} \angle 180^0$ where r_{in} is the dynamic input impedance, β is the current amplification factor and R_{ac} is the ac load resistance in the circuit.

4 CIRCUIT DIAGRAM



5 PROCEDURE

i.Operating point

1. Disconnect the signal generator, apply Vcc = 12V.
2. Measure the voltage between collector and emitter terminals of the transistor(V_{CE}).
3. Measure the voltage between collector of the transistor and ground(Vc).
4. Calculate the collector current using the following expression

$$Ic = \frac{Vcc - Vc}{R_C}$$

Make sure that the transistor is operating in the active region by noting that V_{CE} is about half of Vcc.

ii.Frequency response & Impedances.

1. Make the circuit connections as show in the figure.
2. set input ac signal at 1KHz using the signal generator and observe the amplified waveform on CRO.Increase the input signal till the output wave shape starts distorted. Measure this input signal. this is the maximum signal that the amplifier can amplify without distortion.
3. Set V_{in}= 50mv (say), using the signal generator.

4. Set the frequency of signal generator at 1KHz, measure the input current Ii through the resistor Rs and find the input impedance r_{in}.
1. Measure the output voltage V_0 & current Ic and find the output impedance r_o.
2. Keeping the input voltage constant, vary the frequency from 50 HZ to 1 MHZ in regular steps and note down the corresponding output voltage.
7. Plot the graph of gain v/s frequency.
8. Find the bandwidth and voltage gain at mid frequency range.

6. OBSERVATIONS

i.Operating point

V_{CE} = ______________, Vc = ___________ Ic = ________________.

ii.Frequency response

1. *Maximum signal that can be handled by the* the amplifier without introducing distortion = _________mV at the input frequency of 1KHz.

2. At Vm = 50mv, Frequency = 1KHz

V_{in} = _____________ Ii = ___________, r_{in} = ________________,

V_0 = _____________ Ic = ___________, r_o = ________________,

S.No	Frequency	V_0(Volt)	Gain = V_0/Vin	Gain (db) = 20 log V_0/Vin
1	50 HZ			
2	100 HZ			
3	200 HZ			

7. CALCULATIONS

$$Ic = \frac{Vcc - Vc}{R_C} = \_\_\_\_\_\_\_\_\_\_\_$$

$$r_{in} = \frac{V_{in}}{I_i} = \_\_\_\_\_\_\_\_\_\_$$

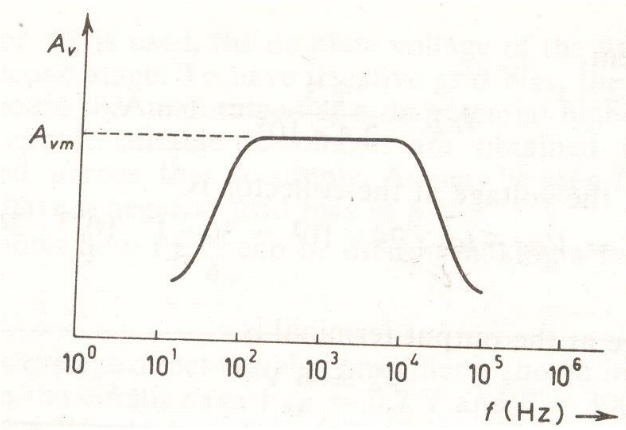
$$r_o = \frac{V_0}{I_c} = \_\_\_\_\_\_\_\_\_\_\_$$

Band width = f_H - f_L = _____________

| A | max (dB) =____________

- 3dB | A | max = ___________

8. GRAPH



9. INFERENCE

Emitter bypass capacitors are used to short circuit the emitter resistor and thus increase the gain at high frequency. These coupling and bypass capacitors cause the fall off in the low frequency response of the amplifier because their impedance becomes large at low frequencies. In the mid frequency, the large capacitors are effective short circuits and the stray capacitors are open circuits, so that no capacitance appears in the mid frequency range.Hence the mid band gain is maximum. At the high frequencies the bypass and coupling capacitors are replaced by short circuits and stray capacitors cause the fall in the gain.

10. PRECAUTIONS

1. Note down the type number of the transistor. Note the important specifications of the transistor from the data book.
2. Do not exceed the maximum values specified in data book
3. Do not install a transistor or remove one from a circuit with power ON.
4. Identify the terminals of the transistors.
5. Check the transistors.
6. Set the function generator just below the point of distortion, so that the maximum undistorted sine wave appears.
7. Adjust the oscilloscope for proper viewing.

11 TROUBLE SHOOTING:

1. Check the transistor.
2. Check the battery connections.
1. Measure VBE and VCE (=V_{CC}/2) with the DMM..
2. Check weather undistorted input signal can be viewed on the CRO.
3. Check the CRO probe.

12 RESULT / CONCLUSION

1. Frequency response is plotted
2. Operating point Q(V_{CE},I_C) = ______________
3. Input impedance r_{in} = _______________
4. Output impedance r_o = ____________
5. Bandwidth = ___________.
6. Mid frequency gain = _________
7. *Maximum signal handling capacity* = ______________mV at the input frequency of 1KHz.

13 EXTENSION

1. Multistage amplifier.

14. APPLICATIONS

1. Amplifiers.
2. Modulation.
3 Waveform generation.
4. Switching etc.

15. QUESTIONS

1. What is meant by Q point?
2. What is the need for biasing a transistor?
3. What factors are to be considered for selecting the operating point for an amplifier?
4. What is thermal runaway? How it can be avoided.
5. What three factors contribute to thermal instability?
6. Define stability factor.
7. What is thermal resistance? What is the unit of thermal resistance?
8. What is a heat sink? How does it contribute to increase in power dissipation
9. Name different biasing circuits?
10. What are the advantages of self biasing over the other biasing circuits?

4. RC PHASE SHIFT OSCILLATOR

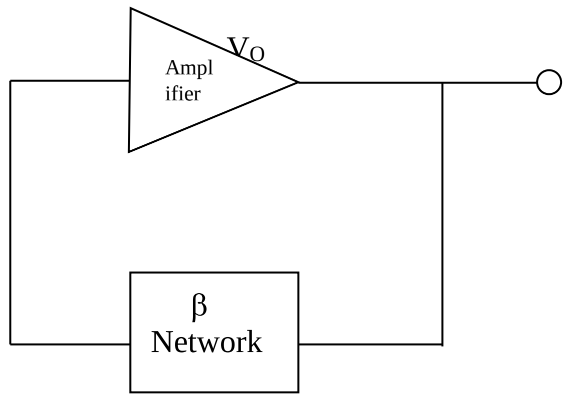
AIM: To study the RC phase shift oscillator

APPARATUS:

Equipment	Range	Quantity
RC Phase Shift Oscillator Circuit Kit		1
CRO	(0-20) MHz	1
Patch Cards		

THEORY:

INTRODUCTION



POSITIVE – FEEDBACK NETWORK TO PRODUCE OSCILLATION

The above figure shows an amplifier with its output connected back to its input through a feedback network called β – network. We know that there are random noise voltages existing at the input resistors of amplifiers. These random noise voltages are created due to the thermal vibrations and are seen to contain all frequencies from 0Hz to about 10^{13} Hz. The β - network selects one of these frequencies at which it resonates and passes it on to the input of the amplifier. The amplifier amplifies this frequency and passes it back to the β - network, which attenuates and applies it again to the input of the amplifier. This process of amplification and attenuation of the single frequency selected by the β - network is cumulative and continues till the attenuation is just counter balanced by the amplification. This results in sustained oscillations.

If gain A of the amplifier is just sufficient to over come the attenuator β of the β - network. We get sinusoidal oscillations. Mathematically

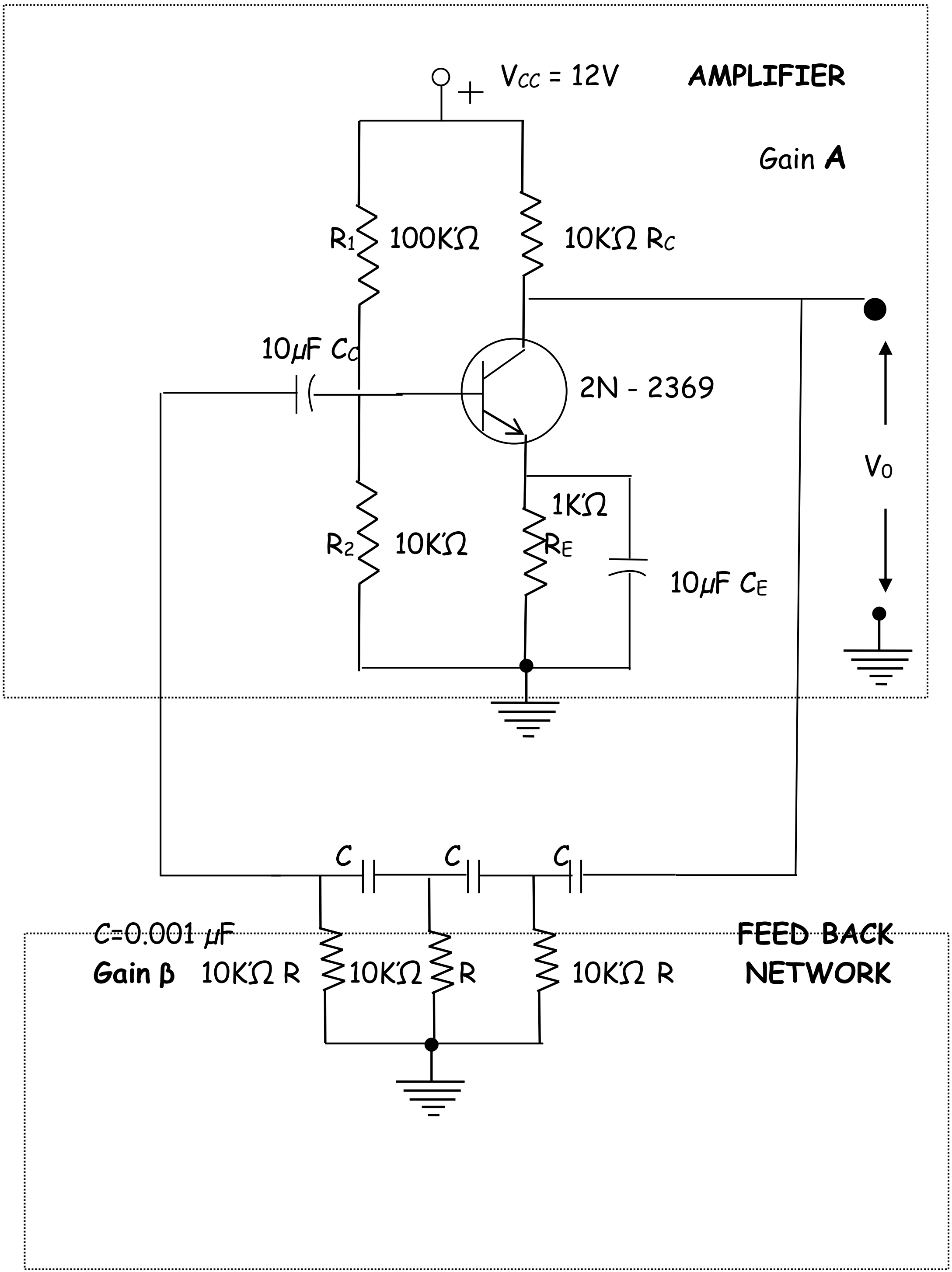
$$A\beta = 1$$

If Aβ is for greater than 1 square wave results in however, if Aβ is less than 1 no oscillations will occur.

RC PHASE SHIFT OSCILLATOR

RC Phase shift oscillator consists of an amplifier with three – lead network in the feed back pattern. Since an amplifier introduces 180^0 phase shift between input and output, the remaining 180^0 phase shift is compensated by connecting three RC combinations [$180^0/3 = 60^0$ each]. Phase shift oscillator finds application in low – frequency range.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Rig up the circuit as per the circuit diagram.
2. Switch on the power supply and observe the output on the CRO (sine wave).
3. Note down the practical frequency and compare it with its theoretical frequency.

RESULT:

THEORETICAL FREQUENCY $f_T = \frac{1}{2\prod RC\sqrt{6}}$	**PRACTICAL FREQUENCY** $f_P = \frac{1}{\text{TIME PERIOD}}$

5. CLASS-A POWER AMPLIFIER

AIM: To study the operation of Class-A power amplifier and find out the efficiency of the amplifier for a given load

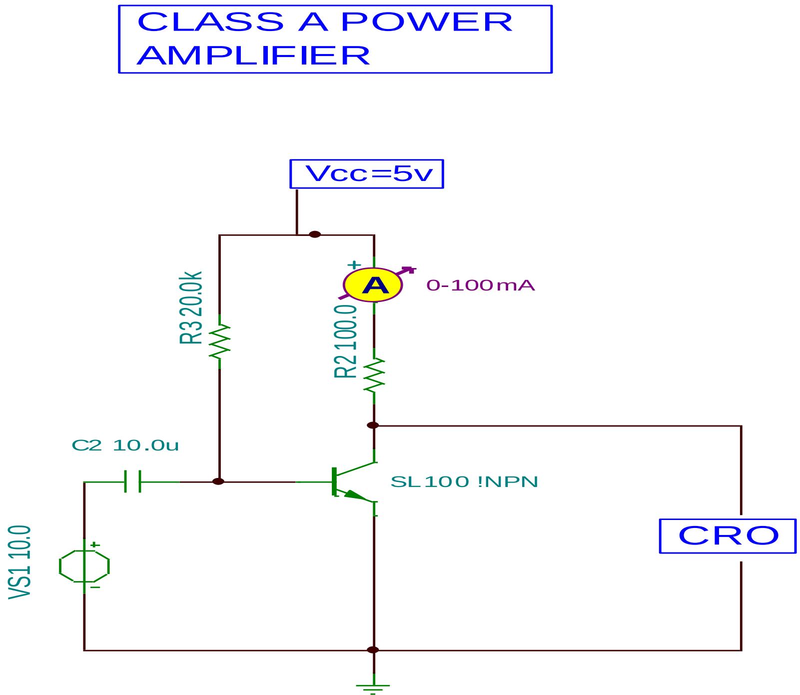
APPARATUS REQUIRED:

1. Class-A power amplifier trainer
2. Power meter
3. CRO
4. 0- 200 mA DC Ammeter…1 No

THEORY:

In class-A operation, the transistor stays in the active region and conducts for full 360^0 of the input cycle. The output signal varies for full 360 cycle of the input. In this case, the Q point is biased almost at the half of the DC load line. A class-A, amplifier, with the DC bias at one half of the supply voltage uses a good amount of power to maintain bias even with no signal applied. This results in very poor efficiency. When very little ac power is delivered to the load a large amount of power is dissipated in the collector resistance and transistor. This results in a maximum efficiency of only 30% by replacing the collector resistance by a inductor, the maximum efficiency can be increased to 50%. A practical transformer coupled class-A amplifier is shown in below figure. Resistors R1,R2 and Re maintains the biasing to the transistor Q1 and primary winding of the transformer is connected in the collector circuit and output has been taken from secondary winding.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Take the trainer and trace the given circuit and note down the values of all the components.
2. Switch on the trainer and verify the output of the regulated power supply i.e. +12V.
3. Connect Ammeter in the circuit with proper polarities.
4. Feed the ac signal of 60mV at the input. Keep the frequency at 3 KHz.
5. Connect power meter and CRO at the output of the amplifier, and select power meter impedance to 3 Ohm. See the wave shape of the output voltage on the CRO. Increase the input signal voltage till the output wave shape starts getting distorted. Note this input-signal voltage. Now reduce the input signal to a value slightly below this voltage.
6. In this condition measure and note down the current meter reading as **I dc** and output power meter reading as **Pac**.
7. Calculate the input dc power. Input dc power **Pdc = Vcc X I dc**
   Where Vcc = 12V and I dc = current meter reading

Find out the collector efficiency, % Efficiency = (AC Output power (Pac) / DC Input power (Pdc)) x 100.

6. MICROPROCESSORS

16-BIT ADDITION

AIM: To write a program for 16-bit addition.

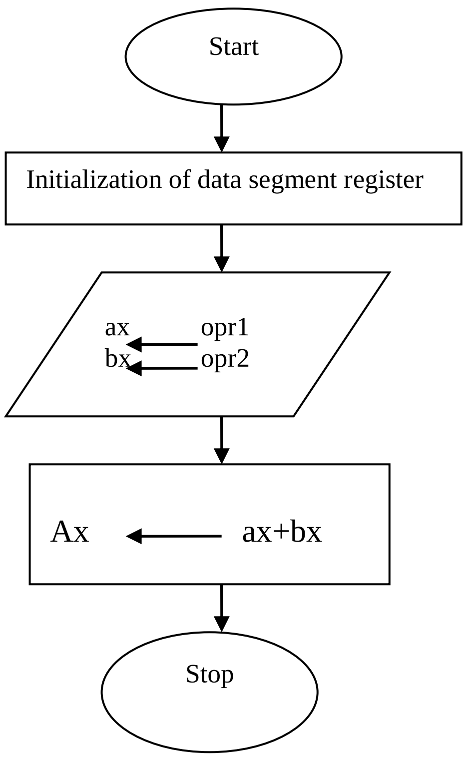
PROGRAM:

Assume ds: data cs: code

Address	Hex-code	Statement
0000	-	Data segment
0000	0008	Opr1 dw 0008h
0002	0004	Opr2 dw 0004h
0004	-	Data ends

Address	Hex-code	Instructions
0000	-	Code segment
0000	B8 0000s	Start: Mov ax1 data
0003	8E D8	Mov ds, ax
0005	A1 0000r	Mov ax, opr1
0008	8B 1E 0002r	Mov bx, opr2
000c	03 c3	Add ax, bx
000E	CC	Int 3
000F	-	Code ends
End start		

FLOW CHART



RESULT :

16-BIT SUBTRACTION

AIM: To write a program for 16-bit subtraction.

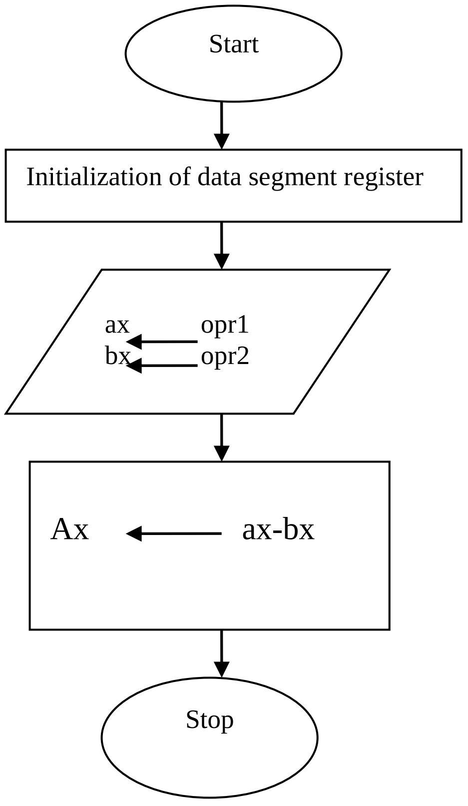
PROGRAM:

Assume ds: data cs: code

Address	Hex-code	Statement
0000	-	Data segment
0000	0008	Opr1 dw 0008h
0002	0004	Opr2 dw 0004h
0004	-	Data ends

Address	Hex-code	Instructions
0000	-	Code segment
0000	B8, 0000s	Start: Mov ax1 data
0003	8E D8	Mov ds, ax
0005	A1 0000r	Mov ax, opr1
0008	8B 1E 0002r	Mov bx, opr2
000c	03 c3	Sub ax, bx
000E	CC	Int 3
000F	-	Code ends
End start		

FLOW CHART



RESULT :

WORD/BYTE DIVISION

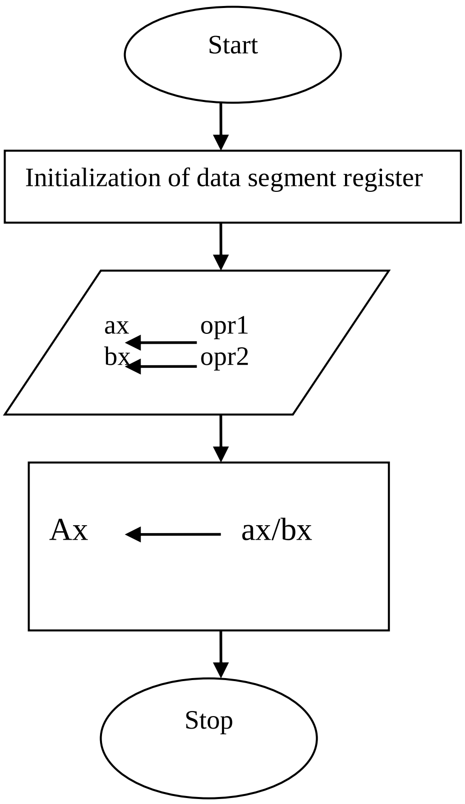
AIM: To write a program for word/byte division.

PROGRAM:

Assume ds: data cs: code

Address	Hex-code	Statement
0000	-	Data segment
0000	0012	Opr1 dw 0012h
0002	08	Opr2 db 08h
0003	-	Data ends
0000	-	Code segment
0000	B8 0000s	Start: Mov ax, data
0003	8E D8	Mov ds, ax
0005	A1 0000r	Mov ax, opr1
0008	8A 1E 0002r	Mov bx, opr2
000C	F6 F3	Div bx
000E	CC	Int 3
000F	-	Code ends
End start		

FLOW CHART



RESULT:

16-BIT MULTIPLICATION

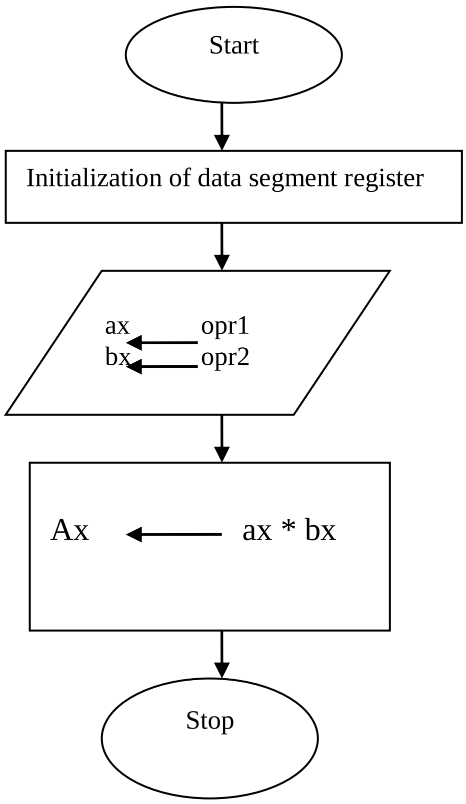
AIM: To write a program for 16-Bit Multiplication

PROGRAM:

Assume ds: data cs: code

Address	Hex-code	Statement
0000	-	Data segment
0000	1234	Opr1 dw 1234h
0002	1238	Opr2 db 1238h
0004	-	Data ends
0000	-	Code segment
0000	B8 0000s	Start: Mov ax, data
0003	8E D8	Mov ds, ax
0005	A1 0000r	Mov ax, opr1
0008	8A 1E 0002r	Mov bx, opr2
000C	F7 E3	Mul bx
000E	CC	Int 3
000F	-	Code ends
End start		

FLOW CHART



APPENDIX – I

PART –A

ELECTRONIC DEVICES AND CIRCUITS LAB

PART A: (Only for viva voce Examination)

ELECTRONIC WORKSHOP PRACTICE (in 3 lab sessions):

1. Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Switches (SPDT, DPDT and DIP), Coils, Gang Condensers, Relays, Bread Boards.
2. Identification, Specifications and Testing of Active Devices, Diodes, BJT's, Low power JFET's, MOSFET's, Power Transistors, LED's, LCD's, SCR, UJT.
3. Study and operation of
   - Multimeters (Analog and Digital)
   - Function Generator
   - Regulated Power Supplies
   - CRO

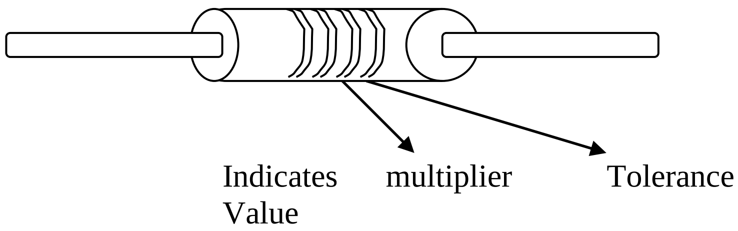
APPENDIX: PART –A

Experiment 1: Identification, specification, testing of R, L, C components (Color codes), Potentiometer, switches (SPDT, DPDT and DTP), Coils, Gang Condensers, Relays and Bread Boards.

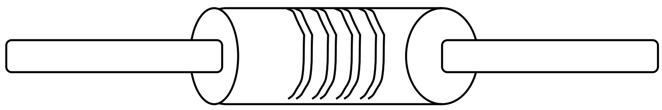
RESISTOR:
Resistor is an electronic component whose function is to limit the flow of current in an electric circuit.It is measured in units called ohms. The symbol for ohm is Ω (omega).
They are available in different values, shapes and sizes. Every material has some resistance. Some materials such as Rubber, Glass and air have very high opposition to current to flow .These materials are called insulators. Other materials such as Copper, Silver and Aluminum etc. Has very low resistance, they are called Conductors.

IDENTIFICATION:-

1) Color Coded Resistor



2) Printed Resistor



Color codes
The most common type has color bands to indicate its resistance. The code is a standard one adopted by manufactures through their trade association, the electronic Industries Association (EIA).

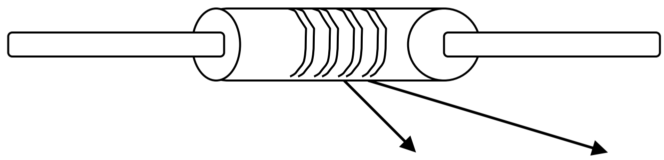
Color code and its value, multipliers

Bl --	Black	→ 0	10^0
Br --	Brown	→ 1	10^1
R --	Red	→ 2	10^2
O --	Orange	→ 3	10^3
Y --	Yellow	→ 4	10^4
G --	Green	→ 5	10^5
B --	Blue	→ 6	10^6
V --	Violet	→ 7	10^7
G --	Gray	→ 8	10^8
W --	White	→ 9	10^9

Multipliers, Tolerance

Br --	Brown	→	± 1%
R --	Red	→	± 2%
G --	Gold	→	0.1, ± 5%
S --	Silver	→	0.01, ± 10%
No color		→	± 20%
Pink		→	High stability

Resistor



First color band tells the first significant figure of the resistors value.
Second color band indicates the second significant figure in the resistors value.
Third color band indicates the no. of zeros to add to the first two significant numbers often called as multiplier. Fourth color band indicates the tolerance.

Estimation of resistance value using color code for eg:a resistor has a color band of Brown, Green, and Orange with a tolerance band Gold

Then

Br → 1
G → 5
O → 3

First two colors is the value 15
Third color is multiplier, therefore x 10^3
i.e., 15 x 10^3 = 15000 → 15 kΩ
Fourth band Gold implies Tolerance of ± 5%
Therefore 15 kΩ ± (5% of 15k)

Note:
By tolerance we mean that acceptable deviation or the actual value of the resistor may be 5% more or less then the coded value.

If the resistor contains 5 color bands ,then the first three color bands indicates the first ,second and third significant figure in the resistors value , the fourth color band is the multiplier and the fifth color band indicates tolerance.

SPECIFICATIONS:
Carbon composition resistors are available from few ohms to several mega ohms.
Typical resistor wattage sizes are 1/8, 1/4, 1/2, 1, 2, 5, 10 and 20 (w) units, depending on thickness of leads Wattage of resistors can be decided.
In writing the values of resistors, the following designation are used Ω, KΩ, MΩ
K → kilo → 10^3
M → Mega → 10^6
Commonly available wire wound Resistors have resistance values ranging from 1Ω to 100KΩ with power rating upto about 200W.
All resistance materials have a change in resistance with temperature.
$R_{T1} = R_{T2}\,[1 + \alpha\,(T1 - T2)]$
Where RT1 is resistance at T_1 ^0C
α is the temperature coefficient
R_{T2} is resistance at T_2 ^0C.

Temperature coefficient is important to designer so as to perform satisfactorily when the circuit is exposed to temperature variations.

Voltage coefficient: Resistances other than wire wound have a slight change with the applied voltage, generally it decreases with increase in voltage.

Voltage coefficient In PPM (Parts Per Million) =

$$\frac{R1 - R2}{R2} * \frac{1}{V1 - V2} * 10^{6}$$

Testing:

Determine the resistance value of various resistors using color code and DMM .
Measure the resistance of each resistor and complete the below table.

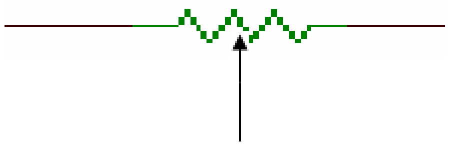
S.NO	Color Coded Resistance Value	Color Coded Tolerance	Measured Value(using DMM)

Note:
1) The measured Resistance and the color coded resistance should agree with in the the tolerance range of the resistor.
2) Do not touch both resistor leads while making the measurement, if you do so, DMM will measure your body resistance as well as the resistor.

APPLICATIONS:
It is widely used in electronic circuits to limit the current.

POTENTIOMETERS:
The variable resistors are usually called Rheostats and the smaller variable resistors commonly used in electronic circuits are called potentiometers called pot.

The symbol for pot is



The arrow indicates a movable contact on a continuous resistance element. A potentiometer can be either linear or non-linear.

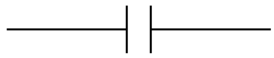
APPLICATIONS:
Pots are used to change the volume of sound and brightness of picture.

<u>CAPACITORS</u>:
It is a device which stores a charge. It does not pass direct current (dc) but will effectively allow the flow of alternating current (ac). The reactance of a capacitor 'C' is dependent on the freq of the ac signal and is given by

$$X_C = \frac{1}{2\pi fc}$$

A capacitor 'c' when charged to a voltage has a stored energy of $\frac{1}{2}$ CV^2 Joules. A capacitor essentially consists of two conducting plates separated by a dielectric medium.

Symbol:



Capacitance of a capacitor 'c' is given by

$$C = \frac{\in A}{d} F$$

The SI unit of capacitance is Farad (F)

The Farad is the capacitance of a capacitor that contains a charge of 1 Couloumb when the potential difference between its terminals is 1Volt and it stores energy, capacitor does not pass Direct current but allows the flow of alternating current.

IDENTIFICATION:

Capacitors dielectric is largely responsible for determining its most important characteristics. Hence capacitor is usually identified by the type of dielectric used.

Ex: Air capacitors, mica capacitor, ceramic capacitor, plastic film capacitor, electrolytic capacitor, and tantalum capacitors.
There are two types of capacitors
1) electrolytic
2) non-electrolytic
The electrolytic capacitors use insulation (dielectric) which is chemically active. The capacitor is marked with a +ve & -ve lead polarity.
<u>Note</u>: Be sure to connect any capacitor with marked plus & minus(-) leads to correct polarity.
Non electrolytic capacitors can be connected to the circuit with any polarity.
<u>Note</u>: 1) <u>Charging of capacitor</u>
When a capacitor is connected to a power source it is charged, and maintains the charge even after the power source is disconnected.
2) <u>Discharging of capacitor</u>

When capacitor leads are connected to a resistor or short circuited the stored charge results in current flow and when stored charge is removed the capacitor is said to be discharged.

Color code:

COLOR	SIGNIFICANT FIGURE	TOLERANCE (%)
Black	0	20
Brown	1	1
Red	2	2
Orange	3	3
Yellow	4	4
Green	5	5
Blue	6	6
Voilet	7	7
Grey	8	8
White	9	9
Silver	0.01	10
Gold	0.1	5
No band	----	20

1. It is measured in units called Farad (F).

2. Symbol = +——||——–

3. Values of capacitors can be designated as μF, pF, nF
   μF = micro farads = 10^{-6}F
   pF = pico farads = 10^{-12}F
   nF = nano farads = 10^{-9}F

4. The dielectric constant of the capacitor is a function of temperature, frequency & voltage of operation. The value decreases with frequency while the changes with temperature may be either +ve or –ve. The temperature co-efficient values for the various capacitor dielectrics are approximately given below
   Mica = 100 ppm/^{o} C
   Ceramic – low ε + 80 – 120 ppm/C
   Medium ε - 500 to -800 ppm/^{o}C

5. The power factor of a capacitor is theoretically zero, since p.f = R/Z & R is zero for a pure capacitor.

The various dielectric material & the ranges of values these dielectrics can provide are shown

Dielectric	**E**	**Capacitance in μF per cubic cm.**			**Available range μF**
		For 100V	500V	1000 V	
1.Natural Mica	6	0.004	0.001	0.0007	10 pF – 0.1μF
2.Ceramic	100-5000	0.2	0.02	0.007	10pF – 0.01μF

3.Electrolytic	7	08.	0.2	0.06	1 to 1000 μF

Testing for capacitance:

1. Determine the value and type of each capacitor from its colour code.
2. Measure the value of capacitance using DMM. And complete the below table.

S.NO	Capacitor type	ColorCoded Tolerance	Measured capacitance (using DMM)

APPLICATIONS:
1. In tuned circuits.
2. As bypass capacitors to by pass ac through it.
3. Blocking capacitor to block dc components.

Ganged Condensers:
In tuning circuits it is desired to change the value of capacitance readily, this is done by means of variable capacitors. The most common variable capacitor is the air ganged capacitor. By rotating the shaft, we can change the distance between movable and fixed sets of plates like that capacitance value is changed.

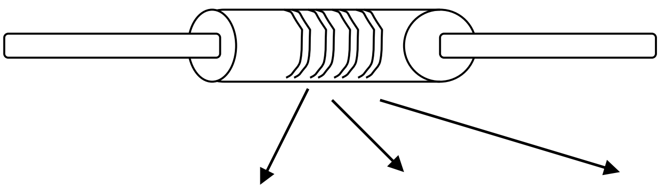
Applications:
Used in tuning circuits

Inductors:
When current flow through a wire that has been coiled, it generates a MF which opposes any change in the current this keeps the current flow at a steady rate, its reaction of MF is known as inductance.

The electronic component producing inductance is called inductor.inductance is measured in henry.

Identification:

Types of inductors are
1. air core
2. ferromagnetic core
3. molded inductors
4. thin film inductors



Indicates Value in micro henry   no. of zeros   Tolerance

Color code:

COLOR	SIGNIFICANT FIGURE	TOLERANCE (%)
Black	0	
Brown	1	
Red	2	
Orange	3	
Yellow	4	
Green	5	
Blue	6	
Voilet	7	
Grey	8	
White	9	
Silver		10
Gold	decimal point	5
No band		20

Specifications:
Typical values range from milli Henry to micro Henry.

Testing for inductor:

Measure the value of inductor using LCR tester and complete the below table.

S.NO	inductor type	Color Coded value	Measured inductor (using LCR)

Applications:

1. Filter chokes for smoothing and pulsating currents produced by rectifiers.
2. Audio frequency chokes, to provide high impedance at audio frequencies.

Switches:

A switch is a device which can connect two points in a circuit (or) disconnect two points. If the switch is acting so has to connect two points. It is said to be in ON position. If the switch is acting so has to disconnect two points. It is said to be in OFF position.

SPDT:- (Single Pole Double Throw):
If there are two independent circuits to be connected using two throws but still connecting one poll then it is called single pole double throw.

DPDT: (Double Pole Double Throw):
The switch shown in figure below. That switch is capable of connecting the receiver to either Antenna-I or Antenna-II at the same time it connects two poles and hence the DPDT switch.

RELAYS:
Switches closes its contacts by the mechanical activation of its lener, the relay do this by an electromagnetic coil pulling its contacts current and wound over a core of soft magnet. The moving armature of core causes the contact closure.

Relays can have several poles and several contacts.

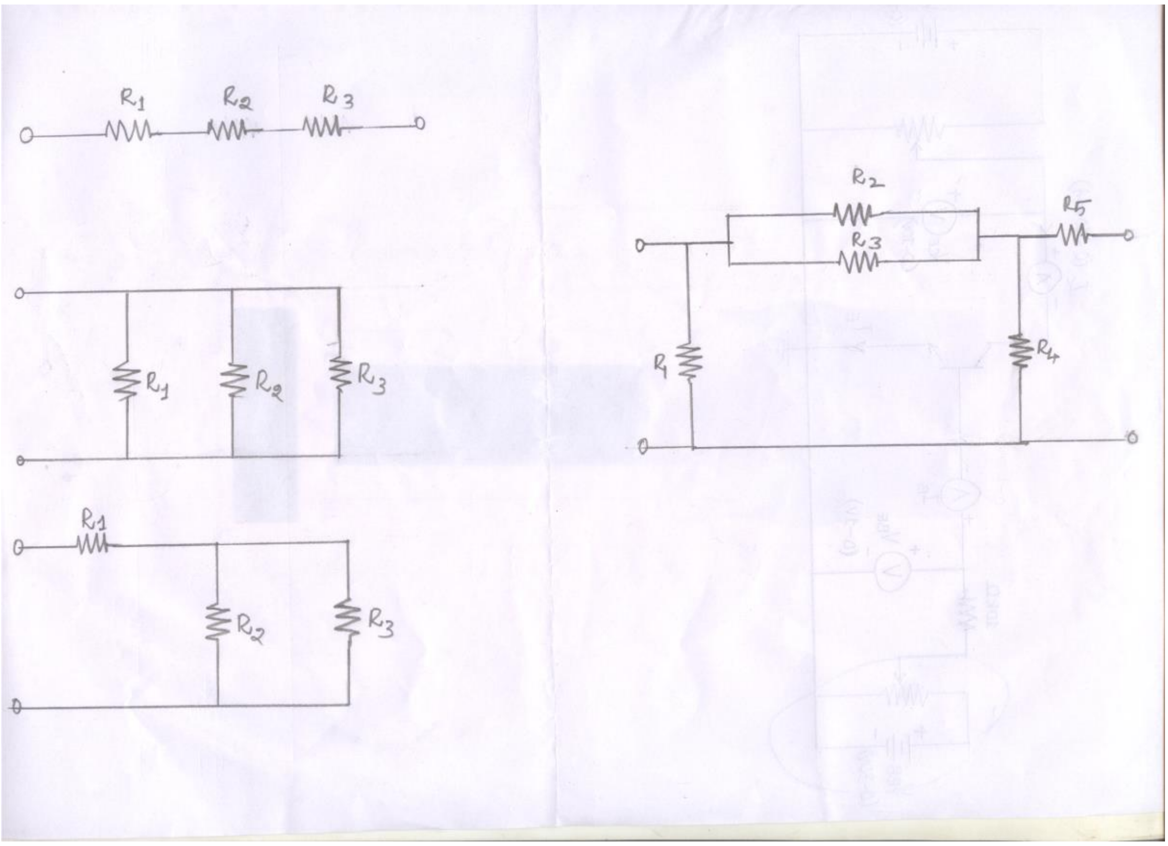
Types of Relays are
1. Reed Relays
2. Solid State Relays
3. Over load relays etc.

APPLICATIONS:
In telephone networks

Bread Boards:
This is the platform (or chasis) on which any circuit can be ringed up to provide inter connections between electronics components and devices.

The advantage of bread board is, the components can be connected (or) disconnected easily. It has holes both horizontally and vertically as shown in the figure.

The horizontal holes at the top and bottom are having internal shorts where as in the remaining part vertical holes are shorted internally



Experiment - 2

Identification, specifications and testing of active devices, diodes, BJTs, Low power JFETs, MOSFETs, Power transistors, LEDs, LCDs, Optoelectronic devices, SCR, UJT, DIACs, TRIACs, Linear and Digital Ics.

Diode: A popular semiconductor device called a diode is made by combining P & N type semiconductor materials. The doped regions meet to form a P-N junction. Diodes are unidirectional devices that allow current to flow through them in one direction only.

The schmatic symbol for a semiconductor diode is shown in fig-1. The P-side of the diode is called the anode(A), while the N-side of the diode is called the cathode(K).

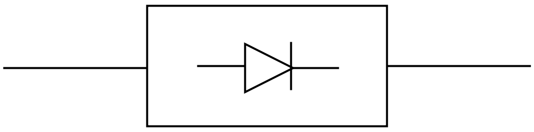


Fig-1 : symbol of P-N diode.

Diode specifications:

Breakdown voltage rating V_{BR}

The Breakdown voltage rating V_{BR} is the voltage at which avalanche occurs. This rating can be designed by any of the following: Peak Inverse Voltage (PIV); Peak Reverse Voltage (PRV); Break down voltage rating V_{BR} or Peak Reverse Voltage Maximum (VRRM).

Average forward – current rating, I_0

This important rating indicates the maximum allowable average current that the diode can handle safely, the average forward current rating is usually designated as I_0

Maximum reverse current, I_R

IN4002 silicon diode specifies a typical I_R of 0.05 μA for a diode junction. Temperature of T_J of 25^0C and a reverse voltage V_R of 100 V.

The maximum rating of a diode should never be exceeded.

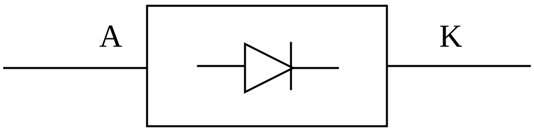
Testing of diode:

a) Using an ohmmeter to check a diode: when using an analog meter, check the resistance of the diode in one direction, the reverse the meter leads and measure the resistance of the diode in the other direction. If the diode is good it should measure a very high resistance in one direction, and a low resistance in the other direction. For a silicon diode the ratio of reverse resistance RR , to forward resistance RF should be very large, such as 1000:1 or more.

If the diode is shorted it will measure a low resistance in both the directions. If the diode is open, it will measure a high resistance in both the directions.

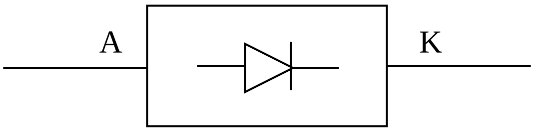
b) Using a DMM to check a diode: Most digital multimeters provide a special range for testing the diodes. This range is called the diode range. This is the only range setting on the DMM that can provide the proper amount of forward bias for the diode being tested. It is important to note that when the digital multimeter forward biases the diode being tested, the digital display will indicate the forward voltage dropped across the diode rather that the forward resistance, RF. A good silicon diode tested with the DMM should show a voltage somewhere between 0.6 – 0.7 V for one connection of the meter leads, and an overrange condition for opposite connections of the leads. An open diode will show the overrange condition for both connections of the meter leads, while a shorted diode will show a very low or zero reading for both connections of the meter leads.

Identification:



By 127

Round end indicates the cathode and the other terminal indicates the Anode.



OA79

Black ring or dot near one end indictes cathode.

<u>APPLICATIONS:</u>

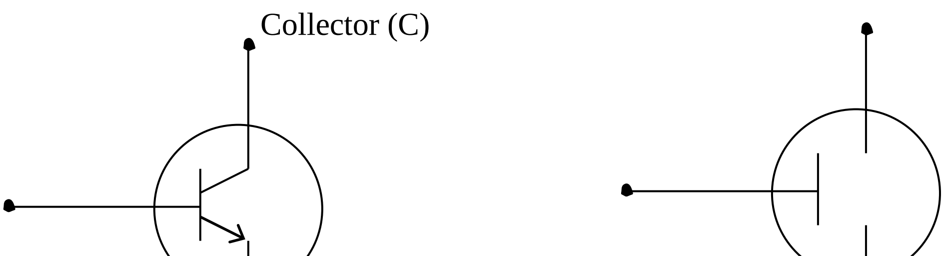
1. Power supply rectifier.
2. Signal detector.
3. Digital logic gates.

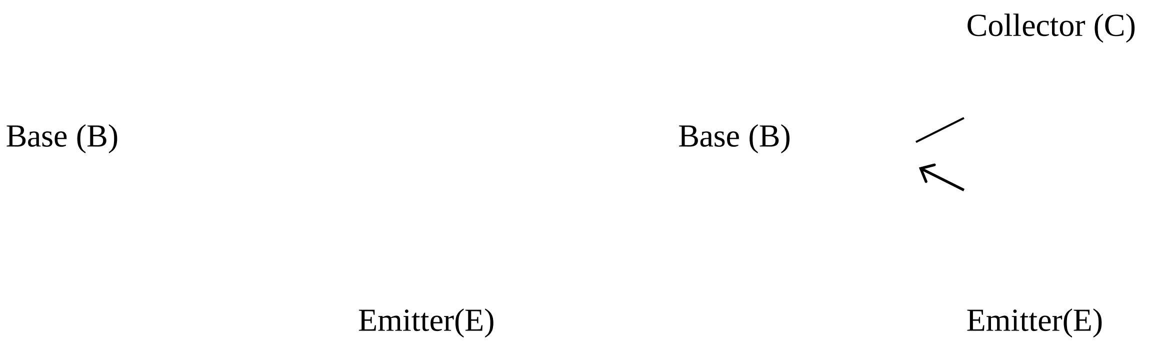
<u>Bipolar Junction transistor (BJT):</u>

A transistor has three doped regions there are two types of transistors one is npn and other is pnp. Notice that for both types, the base is narrow region sandwiched between the larger collector and emitter regions.

In npn transistors, the majority current carriers are free electrons in the emitter and collector, while the majority current carriers are holes in the base. The opposite is true in the pnp transistor where the majority current carriers are holes in the emitter and collector, and the majority current carriers are free electrons in the base.

1. Emitter 2. Base 3. Collector





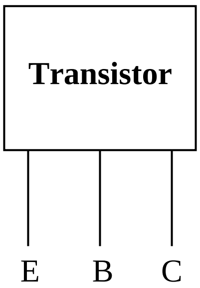
Schematic symbols for transistors (a) npn transistor (b) pnp transistor

In order for a transistor to function properly as an amplifier, the emitter-base junction must be forward biased and the collector base junctions must be reverse biased.

Identification:

Transistor lead Identification:

There are three leads in a Transistor called collector or emitter and base. When a transistor is to be connected in a circuit it is necessary to know which terminal is which. The identification of the heads of transistor varies with manufacturer. There are three systems in general.

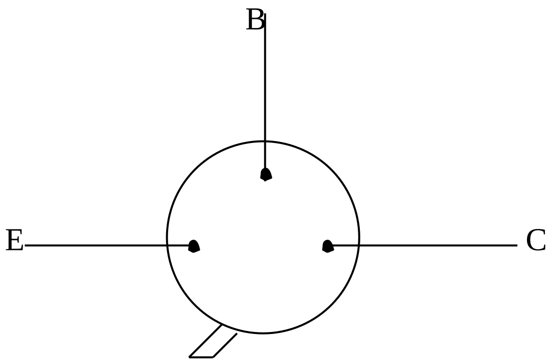


i) When the lead of a transistor is in the same plane and unevenly as in fig., they are identified by the position and spacing of leads. The central lead is the base lead. The collector lead is identified by the large spacing existing between it and the base lead. The remaining is the emitter.

ii) When the leads of a transistor are in the same plane but evenly spaced, the central lead is the base, the lead identified by dot is the collector and the remaining lead is the emitter.

BC 547

iii) When the leads of a transistor are spaced around the circumference of a circle, the three leads are generally in E-B-C order clockwise from a gap.



BC107

Specification:

In all cases, the maximum ratings are given for collector-base voltage, collector emitter voltage, emitter base voltage, collector current and power dissipation.

Power dissipation rating Pd (Max):

The product of VCE and IC gives the power dissipation, Pd of the transistor. The product of VCE x IC must not exceed the maximum power dissipation rating, Pd (Max) of the transistor.

Derating factor:

Manufacturers usually supply derating factors for determining the power dissipation rating at any temperature above 25 0C. The derating factor is specified in W/0C. For example if a transistor has a derating factor of 2 mW/0C, then for each 10C rise in junction temperature the power rating of the transistor is reduced by 2 mW.

Breakdown voltage ratings;

A data sheet lists the breakdown voltage ratings for the emitter-base, collector-base, and collector-emitter junctions. Exceeding these voltage ratings can destroy the transistor.

Testing of BJTs:

(a) Checking a transistor with an ohmmeter:

To check the base-emitter junction of an npn transistor, first connect the ohmmeter and then reverse the ohmmeter leads. The resistance indicated by the ohmmeter should be low since the base emitter junction is forward biased. The resistance indicated by the ohmmeter should read high because the base emitter junction is reversing biased. For a good pn junction made of silicon the ration RR/RF should be equal to or greater than 1000:1.

To check the collector-base junction, repeat the process described for the base-emitter junction.

Shorted and open junctions:

A low resistance across the junction in both direction implies that the emitter-base or collector-base junctions are shorted. If the ohmmeter indicates a high resistance in both directions, then the junctions are open. In both cases the transistor is defective and must be replace.

b) Checking a transistor with a Digital Multimeter (DMM):

When using a DMM to check the diode junctions in a transistor, the diode range must be used. However, the meter will show the forward voltage dropped across the pn junction being tested rather than the actual value of forward or reverse resistance. For a forward biased, emitter-base or collector-base, silicon pn junction, the DMM usually indicates a voltage somewhere between 0.6 and 0.7 V, for the reverse bias condition, the meter indicates an over range condition.

Applications:

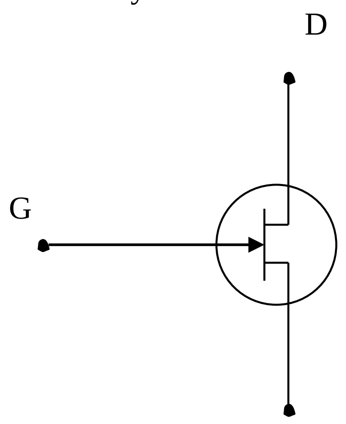
1. Amplifiers.
2. Oscillators.
3. Switches.

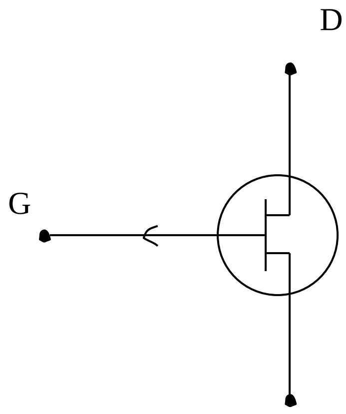
<u>Field effect transistors (FETs):</u>

The field effect transistor(FET) is a three terminal device similar to the bipolar junction transistor. The FET, however, is a unipolar device, which depends on only one type of charge carriers; either electrons or holes. There are basically two types of FETs. The junction field effect transistor, abbreviated JFET, and the metal oxide semiconductor field effect transistor, abbreviated MOSFET.

A junction field effect Transistor is a three terminal semiconductor device in which current conduction is by one type of carriers i.e., electrons or holes.
There are two basic types of FET
(i) Junction field effect transistor (JFET)
(ii) Metal oxide field effect transistor (MOSFET)

Schematic symbol of JFET



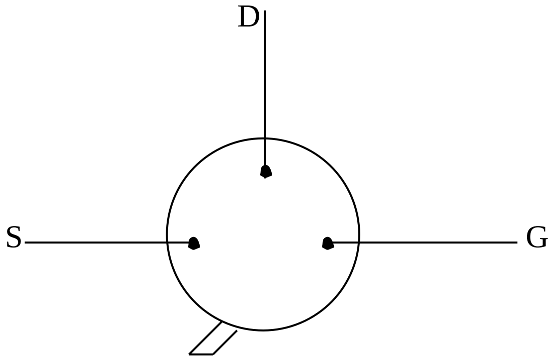


S S
n-channel JFET p-channel JFET

i. a.c. drain resistance (r_d): drain resistance has a large value, ranging from 10kΩ to 1MΩ
ii. Transconductance (g_{fs}): It is expressed in mA/V
iii. Amplification factor (μ): Amplification factor of a JFET indicates how much more central the gate voltage has over drain current than has the drain voltage.

<u>Note</u>: 1) When $V_{GS} = 0$, $I_D = I_{DSS}$ (max drain current)
2) When $V_{GS(off)} = -2$, $I_D=0$ (min drain current)

Identification:



BFW10

Specifications:
VDS = 30 V(max)
Gate source voltage with drain open VGS = 30 V
Drain current at Vds = 15 V and VGS = 0
8 ma < IDSS < 20 mA
Gate source cutoff voltage when ID = 0.5 mA and VDS = 15 V V(P) GS < 8 V

Pinchoff voltage;

The value vp is the start of the interval VP to VDS max during which ID remain constant.

As VDS is increased from 0V to VD called the pinch off voltage, ID increases from 0 to the maximum drain current that can be attained without destroying the JFET, the voltage IDSS.

VGS(off)

Maximum drain current flows when VGS = 0 and minimum drain current when VGS = VGS (off).

Testing:

1. In case of FET, drain to source should be a fixed resistance in either direction.
2. Gate to drain or gate to source should be an open circuit or a very high resistance.

Applications:

1. Used in tuners of radio and TV receivers
2. In DMM.

MOSFETs:

The metal-oxide semiconductor field effect transistor has a gate, source and drain just like JFET. Like a JFET, the drain current in a MOSFET is controlled by the gate-source voltage VGS. There are two basic types of MOSFETs. The enhancement type and depletion type. The enhancement type MOSFET is usually referred to as an E-MOSFET and the depletion type MOSFET is referred to as a D-MOSFET.

The key difference between JFETs and MOSFETs is that the gate terminal in a MOSFET is insulated from the channel. Because of this, MOSFETs are sometimes referred to as insulated gate FETs or IGFETs. Because of the insulated gate, the input impedance of a MOSFET is many times higher that that of a JFET.

Picture

Fig(1) (a) n channel MOSFET (b) P-channel MOSFET

Identification:

Specifications:

A typical MOSFET is the 3N200 made by BEL. It has two independent gates against only one in a common MOSFET. Its specifications are drain to source voltage VDS= 0.2V to 20 V. Gate 1 to source voltage V G1S = 0.6 V to +3 V
Gate 2 to source voltage V G2S = 0.6 V to +6 V
Drain to gate 2 voltage VDG2 = +20V
Drain current ID = 50 mA
Transistor dissipation PT = 330 mw
Derating = 2.2 m2/0C

Testing:

1. In case of MOSFET, drain to source should be a fixed resistance in either direction
2. Gate to drain or gate to source should be an open circuit or a very high resistance (greater than FET).

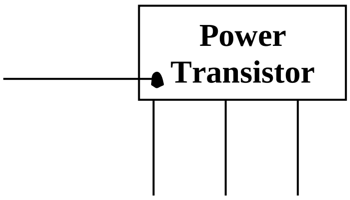
The device under test in the given circuit is a depletion type N-channel JFET, with the gate circuit kept open, the magnitude of the drain current is sufficient to make the ID R2 drop large enough. So that the BJT is forward biased and driven into its ON state. Therefore the lamp glows. The switch SW is now closed. The bias on the FET gate then causes depletion of its channel. This lowers the IDR2 drop to the poing where conduction through the BJT output circuit fails to keep the bulb glowing. All this will happen if the FET is in good condition. On th other hand, a short circuited FET will deep the lamp On in either position of switch SW, while an open FET will fail to switch the indicator lamp ON.

Power Transistors:

The two types of power transistors made now are of the alloy junction type and the silicon planar type. However, large power means a high current circulating through the device, requiring bigger areas for a given current density, the active emitter and collector areas can be over 10 mm2.

Identification:

Dot



AC 125

Specifications:

One way to distinguish transistors is by the number marked on ther. Thus low frequency, low power transistors bears the numbers AC125, AC126, BC147 and BC148. An example of a high frequency, low power transistor is BF115; power transistors are BD138, AD149, 2N3055 etc. Similarly, germanium and silicon transistors are distinguished by the first letters A and B respectively.

Absolute Maximum Ratings

Type	**BVcbo**	**BVceo**	**BVebo**	**Ic**	**Maximum Collector Dissipation at 25º C**	**β**	**Vce**	**Ic**	**Icbo**
2N696 Medium level	60	40	5	0.3	0.6	20-60	10	150	1

BV_{CEO} : maximum value of voltage across collector-emitter circuit with base open.
BV_{CBO} : maximum value of voltage across collector-base circuit with emitter open.
BV_{EBO} : maximum value of voltage across emitter-base circuit with collector open.
I_{Cmax} : maximum value of DC collector current.
P_T : max. power dissipation in absence of heat sinks at ambient temperature.
F_T : gain bandwidth
I_{CBO}: leakage current.

Testing:

Follow the same procedure as the ordinary BJT-testing using multimeter.

The characteristics of a BJT under different configurations can be observed directly on a CRT screen. The transistors leads are simply inserted in the three sockets of a device called a curve tracer.

Light emitting diodes LEDs:

As opposed to other diodes that give off heat when conducting, LEDs emit light. In the latter, the recombination of charge carriers across the PN junction releases optical energy when the electrons fall from the conduction to the valence band. The heat emission is negligible in light emitting materials like gallium arsenic phosphide and gallium phosphoide.
LEDs must, of course, be covered in a transparent or translucent material. The wavelength of the radiation for a given colour is given by the relation d = 1.23/Eg. Where Eg is the energy gap between conduction and valence bands. Its value is 1.45 ev for GaAs, 3 ev for GaAsP and 2.25 ev for Gap. The colours obtained from these materials are red, yellow and green respectively.

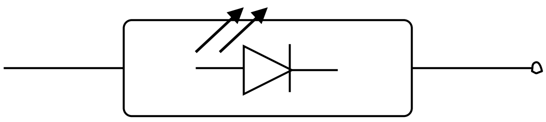
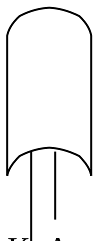


Fig (1) symbol of LED.

Identification:



K A

Longer terminal is cathode and the other is Anode.

Specifications:

1. VF operating : 1.3 v to 2.5 v
2. Forward voltage(max): 5 v.
3. Forward current 5 mA to 15 mA
4. Reverse breakdown : 10 v to 12 V
5. Operating life : 100,000 hours.
6. Turn on time : 10-20 nsec.
7. Turn off time: 80-100 nsec.

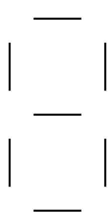
Testing:

The diode is simply put across a multimeter to see if the reading is different when the polarity is reversed. The LED will glow and show a resistance between 30 ohms and 50 ohms when forward biased.

2-h : Liquid crystal display (LCD):

As the name implies, liquid crystals are materials which have the properties of both liquids and solids crystals. Instead of a melting poing, they have a temperature range called a mesophase with in which the molecules are mobile as in a liquid although remaining grouped as in a solid. When thin layers of these materials are subjected to light radiation under the influence of an electric field, it is possible to change opaque areas into transparent ones and vise-versa.

Identification:



Specifications of a dynamic light scattering LCD:

1. Operating voltage: 15 V to 30 V
2. Frequency range: 50 Hz to 60 Hz
3. Current required: 60 μA.
4. Rise time = 25 x 10^{3} S
5. Contrast ratio: 20 :1

Specification of twisted nematic field effect LCD:

1. Operating voltage: 3 V
2. Operating frequency: 30 Hz to 1500 Hz
3. Effective current : 5 μA to 6 μA
4. Rise time = 100 x 10^{3} S
5. Contrast ratio: 50 : 1

SCR:

AIM: To identify, study specifications and test SCR.

Identification:
The basic structure and circuit symbol of SCR is shown below. It is a four layer three terminal device in which the end P-layer acts as anode the end N-layer acts as cathode and P-layer nearer to cathode acts as a gale. As leakage current in silicon is very small compared to Germanium SCRs are made of silicon and not Germanium.

Specifications:
The following is a list of some important SCR specifications:

1. Latching Current (I_L):

Latching current is the minimum current required to latch or trigger the device from its OFF-state to its ON-state.

2. Holding Current (I_H):
Holding current is the minimum value of current to hold the device in ON-state. For turning the device OFF, the anode current should be lowered below I_H by increasing the external circuit resistance.

3. Gate Current (Ig):
Gate current is the current applied to the gate of the device for control purposes. The minimum gate current is the minimum value of current required at the gate for triggering the device the maximum gate current is the maximum value of current applied to the device without damaging the gate. Move the gate current earlier is the triggering of the device and vice versa.

Voltage safety factor (Vf) voltage safety factor Vf is a ratio which is related to the PIV, the RMS value of the normal operating voltage as

$$Vf = \frac{Peakinversevoltage(PIV)}{\sqrt{2}XRMSvalueoftheoperatingvalue}$$

The value of Vf normally lies between 2 and 2.7 for a safe operation, the normal working voltage of the device is much below its PIV.

Testing:
1. The SCR should be switched on and voltage measured between anode and cathode, which should be approximately volt and the voltage between gate and cathode should be 0.7 volt.

2. An ohmmeter can also be used to test SCR the gate –cathode of a thyristor has a similar characteristic to a diode with the gate positive with respect to the cathode, a low resistance (typically below 100Ω) should be indicated on the other hand with the gate negative with respect to the cathode a high resistance (greater than 100kΩ) will be indicated. A high resistance is indicated in either direction for the anode to cathode connections.

Applications:
These are used in power control applications such as lamp dimmers motor speed control, temperature control and invertors.

They are also employed for over voltage protection in DC power supplies.

DIAC

Identification:

The construction and symbol of diac are as shown below. Diac is a three layer two terminal semiconductor device MT_1 and MT_2 are the two main terminals which are interchangeable. It act as a bidirectional Ava lanche diode. It does not have any control terminal. It has tow junctions J_1 and J_2. Though the Diac resembles a bipolar transistor, the central layer is free from any connection with the terminals.

It acts as a switch in both directions. As the doping level at the two ends of the device is the same, the Diac has identical characteristics for the both positive and negative half of an AC cycle

Specifications:

V_{BO} Break over voltage: When the applied voltage level reaches the break over voltage, the device starts conducting and it exhibits negative resistance characteristics i.e. the current flowing the device starts increasing and the voltage across it starts decreasing.

I_{BO} (Leakage Current): At voltage less than the break over voltage, a very small amount of current called the leakage current flows through the device and the device remains in OFF state.

Testing:
The DIAC behaves as an ava lanche diode with MT_1 positive with respect to MT_2 a low resistance (less than 100Ω) is indicated.

With MT_1 negative with respect to MT_2 a high resistance (greater than 100Ω) is indicated.

Applications:
Diac is not a control device. It is used as triggering device in triac phase control circuits used for light dimming, motor speed control and heater control.

TRIAC

Identification:

Triac is a three terminal semiconductor switching device which can control alternating current in a load. Its three terminals are MT_1 and MT_2 and the gate (G). The basic structure and circuit symbol of Triac are shown below.

Specs: Same as SCR

Applications:
Triac is used for Illumination control, temperature control liquid level control, and motor speed control and as static switch to turn AC power ON and OFF.

Testing:
1. The voltage measured between MT, and cathode which should be approximately 1 volt and the voltage between MT_2 and cathode should be 0.7 v.

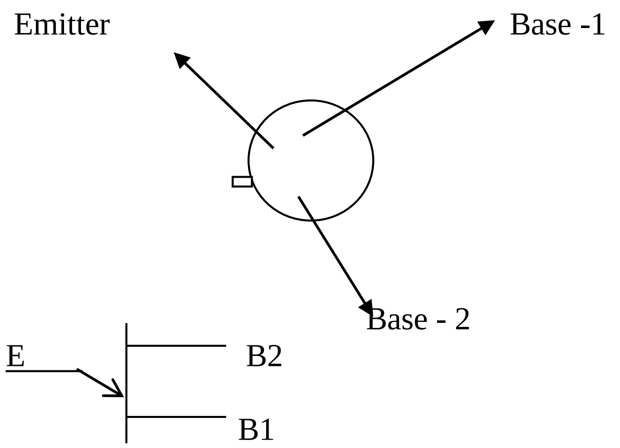
2. With the gate positive with respect to the MT_2 a low resistance (typically below 100Ω) should be indicated on the other hand with the gate negative with respect to the MT_2 a high resistance (greater than 100Ω) will be indicated.

UJT

IDENTIFICATION:
UJT is a three terminal semiconductor switching device. As it has only one PN junction and three leads it is commonly called as uni-junction transistors.

The basic structure of UJT is as shown below.

PICTURE



Specifications:

Intrinsic standoff ratio: It is a ratio given by $\frac{R_{B1}}{R_{B1}+R_{B2}}$ and is usually designated as ς (eta). Typical values of ηrange from 0.47 to about 0.85.

Inter base resistance: It is the resistance of the n type silicon bar it is designated by R_{BB}. The value of R_{BB} is dependent upon the doping level and physical dimensions of the si bar. If emitter E is open, then the voltage V_{BB} between B1 and B2 will get divided across R_{B1} and R_{B2}.

The voltage V_1 across R_{B1} will be $V_1 = \frac{R_{B1}}{R_{B1}+R_{B2}} V_{BB}$

$$= n\ V_{BB}$$

Testing:
1. In case of UJT, emitter to base, (cont1) and emitter to base2 (confg2) should be exhibit a typical diode characteristics except that the diode resistance in forward and reverse cases is different for the two configurations.

2. The resistance across base1 to base2 should be fixed resistance in either direction.

Applications:
UJT can be used as relaxation oscillator and phase control circuit.

Linear and Digital ICs:

Identification:

The desire to miniaturize an electronic circuit in a single chip which contains AC transistors, diodes, resistors all connected internally with only outside terminals has given to rise to the concept of integrated circuit. Basically integrated circuits can be classified into Linear and Digital ICs. Linear ICs are also called as Analog ICs. Here operating points are very accurate output levels are fixed. In case of digital ICs accurate operating points are not necessary.

The ICs are represented in one of the two methods.
i) IC is represented by a rectangle with pin numbers shown along with each pin. The identification number of the IC is listed on the schematic.

Representation of the IC in terms of its simple logic elements. For example, IC 742574 is Q and 2-input and gate and when it is represented as ¼ 742508.

An IC can be identified from the information given on the IC itself. The numbering system through has been standardized has some variations from manufacturer to manufacturers usually an IC has the following markings on its surface.

Core Number: Identifies the logic family and its functions in 742551 the first two numbers indicate that the IC is a member of the 7400 series IC family. Last letters give the function of the IC. Letters inserted in the centre of the core number show the logic subfamily.

The same numbered ICs in each family perform the same function and have the same pin numbers.

Prefix to the core number identifies the manufacturer.

Suffix to the core number indicates package type at least range etc.

Specifications:
The number of pins their working and applications are specified along with the data sheet for the IC.

Testing:
The ICs are tested by a linear IC tester or digital IC tester.

Applications:
ICs have a wide range of applications from gates to microprocessors.

SOLDERING TECHNIQUES

Soldering Practical, simple circuits using active and passive components

Soldering is required to ensure permanent electric connections. Wires and terminals are wrapped or twisted together, and then solder is melted into the heated joint. When the heat is removed, the solder and wire cool making the soldered joint look like a solid piece of metal.

Solder is an alloy of lead and tin. It has a low melting point and comes in wire form for electronic use. Electronic solder is made-up of 60% tin and 40% lead, though the composition may vary for certain applications.

Rosin-core and resin-core solders are used for soldering electronic components. Rosin and resin are fluxes which flow onto circuit being soldered. A flux is a cleaning agent which helps to clean the surface to be soldered, ensuring a more perfect union.
Proper soldering requires the following:-

1. Clean metallic surfaces.
2. Sufficient heat applied to the joint to melt solder when solder is applied to the heated wire surface.

The solder must not come in direct contact with the tip of the soldering iron or gun because it will melt rapidly. If the wires or terminals to be soldered have not been preheated sufficiently, the melten solder will not stick to their surface.

Soldering in printed circuits :

The network of inter connecting conductive paths on a PCB consists of thin copper strips and pads bonded to the plastic board. Leads of components mounted on the board are inserted through holes in the board and the conductive copper. These leads are soldered to the copper at the end of the hole through which they emerge. If the excessive heat is applied to the copper, it may lift from the board, or the miniature components mounted on the board may be damaged.

A 30w soldering pencil is therefore used to heat the junction. This low voltage iron provides an effective means of controlling heat. Components leads should be cleaned and tinned prior to soldering. Avoid excess solddder to prevent bridging the gap between two copper paths. Excess solder should be avoided in hard-wired cicuits.

Rules for soldering :

Good soldering is part of a technicians skills. Solder connections must be mechanically strong, joints mechanically secure, so that they will not slake loose and cause loss of signal and possible damage to parts. Electrically solder contacts must have low resistance to current flow for proper signal transfer.

Some basic soldering rules are :

1. Soldering tip must be tinned and clean.
2. Metals to be soldered must be clean.
3. Support the joint mechanically where possible.
4. Tin large areas before soldering them together.

5. Apply solder to joint, not to gun or iron tip, solder must flow freely and have a shiny, smooth appearance.
6. Use only enough solder to make a solid connection.
7. Where additional flux is used, apply to joint, not to soldering tip. Use only rosin or resin flux.
8. Solder rapidly and do not permit components or insulation to burn or overheat

Single layer and multi layer PCBs

A PCB interconnects electronic components using conductive traces laminated onto a nonconductive substrate. Alternate names are printed using board or etched wiring board. A PCB consists of a conductors attached to a sheet of insulator. The conductive path ways are called traces or tracks. The insulator is substrate. The vast majority of pcb are made by adhering a layer of topper over the entire substrate sometimes on both the sides then removing unwanted copper after applying temperature mask leaving only the desired copper traces. A few PCB's are made by adding traces to the bare substrate usually by complex process of multiple electroplating. Some PCB's have traces layers inside the PCB and are called multiplier PCB's . These are formed by bonding together seperatly etched thin boards, after the circuit boards has been manufactured, components are connected to traces by soldering them to the board.

PCB design is a specialized skill. There are numerous techniques and standards used to design a PCB that is easy to manufacture and yet small and inexpensive. Most PCB's have between 1 and 16 conductive layers laminated together.

Surface mount technology was developed in 1960's and became widely used in late 1980's. Components were mechanically resigned nto have small metal tabs or end caps that could be directly soldered to the surface of PCB. Components became much smaller and component placement on both sides of the board became far more common with surface mounting leads itself well to a high degree of automation.

Experiment 3:

Study and operation of

a. **Multimeters (analog and digital)**
b. **Function generators**
c. **Regulated power supplies**
d. **CRO**

MULTIMETRES :

AIM: 1. To accurately read voltages using analog voltmeter and DMM.
2. To learn how to eliminate analog voltmeter readings due to parallaX ERRORS.

APPARATUS: DMM
Analog voltmeter
Power supply
Connecting wires.

THEORY : Analog Voltmeter:

Although digital meters are used extensively through out the electronic industry. There are many analog meters also in use. The DC voltage scales on analog voltmeter are linear that is the distance between equal values (adjacent divisions) marked on the meter scale are of same length.
Ex:- If the scale is from 0V to 10V then there are 10 equally spaced divisions between these two values each division represents 0.2V.

ZERO ADJUSTMENT:-
Before use make any measurement with the voltmeter, be certain that the meter indication 0V.

In analog voltmeter, control (screw) is placed on the front panel of the meter for the purpose of zeroing the meter.

Parallex error:

It results when the person making the measurement is not directly over the meter pointer.

DIGITAL MULTIMETER :

Procedure

1. Turn on the power supply, set the voltage control for a maximum of 30V.
2. Connect analog voltmeter across the output terminals of regulated DC power supply.
3. Measure and record the power supply built in meter reading and analog voltmeter reading.
4. Gradually reduce the supply voltages in steps of 5V and record the values in the following table.
5. Repeat the above steps using DMM and record the measurements in table2.

Observation Table 1:

1 S.No	2 Power supply built in meter reading	3 Analog voltmeter reading	4 error (2-3)

Table 2:

1 S.No	2 Power supply built in meter reading	3 DMM voltage reading	4 error (2-3)

DMM (DIGITAL MULTIMETER):

THEORY:

Digital multimeter is abbreviated as DMM. It has 3 ½ Digital LCD (liquid crystal display)
½ digit means it will display '0' or '1'.
3 digits reads any number in the range of 000 to 999.

DMM can read AC, DC voltages and currents in many ranges. It can also check diode polarities, read β value of transistor. Measuring the value of capacitance and resistance

DMM can be used for checking continuity of multimeter probes, test leads, power chords and cables etc.

CRO (Cathode Ray Oscillation)

1. <u>AIM:</u>

To study the font panel controls of the CRO and to use the CRO to measure.
i. D.C voltages ii. AC voltages iii. Frequency and iv. Phase angle by Lissajous figures.

2. <u>EQUIPMENT AND COMPONENTS</u>:

i. Apparatus:

1. DC regulated power supply 0-30v DC/1Amp – 1 No.
2. Signal Generator 100 KHz (Sine Wave) - 1 No.
3. Capacitor 1µf – 1 No.
4. Decode Resistance Box (DRB) – 1 No.

3. <u>THEORY:-</u>

CRO is one of the most widely used measuring device in electronic and testing lab oratories CRO gives visual display of an input signal current or voltages). This enables not only measurement of the quantity, but also analysis and manipulation of its waveform.

<u>Lissajous patters:</u>

If two sine waves are applied simultaneously to the vertical and horizontal defletion plates of CRO, the light spot on the screen would trace definite patterns depending on the frequencies, amplitude and phase difference. These patterns are termed as lissajous figures.

4. <u>PROCEDURE:</u>

<u>i. Measurement of D.C Voltages:</u>

1. Set the CRO to lead high frequency (small time base period)
2. Align the horizontal trace with one of the horizontal time.
3. Apply the unknown DC voltage to one of the channels keeping the CRO in DC mode.
4. Measure the No. of vertical dims ions shifted by the beam from the reference horizontal line.
5. Repeat the same for 4 to 5 unknown DC voltage values and note the readings in a tabular form in table 1 and find out the voltage

Sl.No.	Applied voltage (votts)	No. of divisions deflected D	Vertical scale of CRO (S)	Measured voltage in (volts) V = D.S

ii. Measurement of AC voltages:

1. Keep the signal generator in 1 KHz.
2. Set the oscilloscope horizontal time base to read 1 KHz signal.
3. Now apply an unknown amplitude A.C signal to one channel.
4. Measure the No. of divisions between peak to peak of the A.C signal and tabulate the readings.
5. Note the vertical scale used souressp to that.
6. Now the voltage of unknown amplitude is obtained by multiplying the No. of divisions by the vertical scale used.
7. Repeat the above by giving 4 to 5 unknown amplitudes of the AC signal from the signal generator and tabulate the readings.

Table 2

Sl.No.	No. of vertical divisions between peak to peak (p)	Vertical scale of the channel	Measured value of the AC signal (p.p) in volts = p.s

iii. Measurement of frequency (Time Period)

1. Apply a signal of unknown frequency for the signal generator to one of the channels of the CRO.
2. Set horizontal time base scale to observe at least 4 cycles of the signals.
3. Measure the No of horizontal divisions between two successive peaks of the signal on the CRO screen.
4. Note the time base scale used.
5. Now the time period (T) in seconds of the signal is obtained by multiplying the horizontal divisions by the time base scale in seconds.
6. The frequency of unknown signal f = 1/T (Hz)
7. Repeat the above 4 to 5 unknown frequencies of the signal for the signal generator and tabulate the readings in table 3.

Sl.No.	Frequency set (Hz)	No. of divisions Between 2	Time scale of the time base in	Time period T = H.S	Measured frequency in Hz

		peaks (H)	**set(s)**		

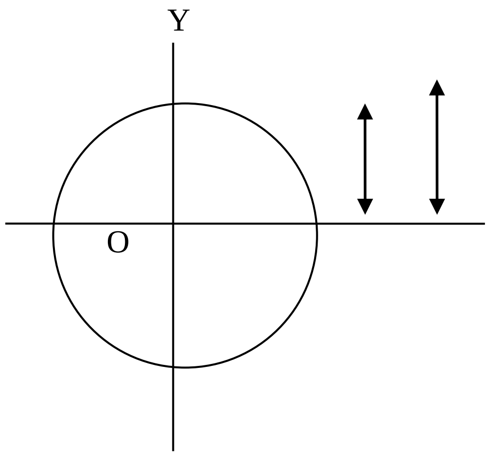
iv. Measurement of phase angle by Lissajeous figures

1. Draw the RC network by using the formula tan θ = 1/WRC. For this f = 1 KHz, C = 1 μf.
   θ = 45 degrees for R.

2. Connect the circuit diagram as shown in fig.1

3. Keep the CRO in XY mode. Bring the spot of the CRO to centre of the screen with zero signal on both the channels and apply signals to both the channels as shown in the figure – 1.

4. We will get an elliptical trace as shown in fig 2



5. Measure A & B.
6. The phase difference between the applied two signals is measured as
   $\theta = \sin^{-1}$ (B/A).
7. Repeat the above experiment with different resistance (R) values and compute the resulting phase difference by tabulating the readings in table 4.

Table – 4

Sl.No.	In Rohms	Divisions	B (Divisions)	$\theta = \sin^{-1}(B/A)$

7. OBSERVATIONS:

8. **GRAPH:**

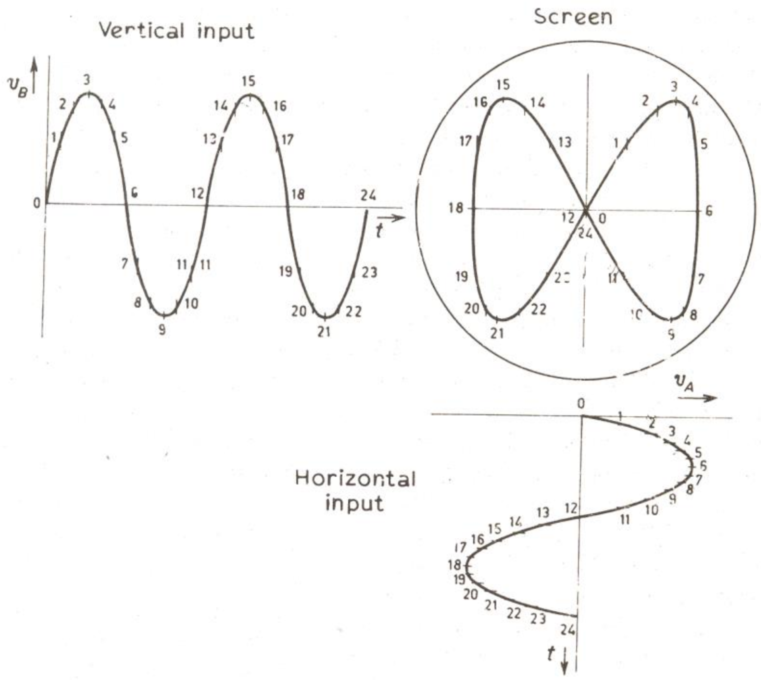


Fig. 14.28 Graphical construction of Lissajous pattern, when the ratio of frequencies is 1 : 2

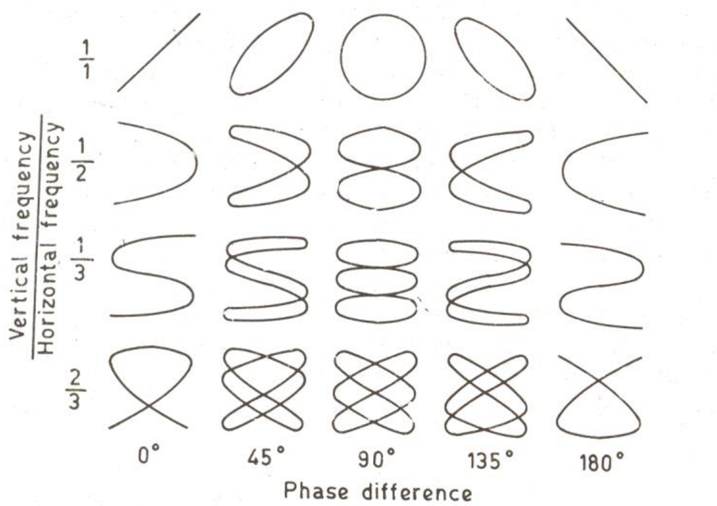


Fig. 14.29 Lissajous pattern for different frequency ratios and phase differences

9. RESULT:

Using CRO the following are measured 1. D.C voltage 2. AC voltage 3. Frequency 4. Phase angle by Lissajous patterns.

10. INFERENCES:

For Lissajous figures for different angles between two sinusoidal signals, different patterns are obtained.

If θ = 0 degree, we get set line

If θ = 30 degrees, we get ellipse

If θ = 90 degrees, we get circle

If θ = 150 degrees, we get ellipse

If θ = 180 degrees, we get straight line

11. PRECAUTIONS:

1. Content wires must be checked before use.
2. All contacts must be in tact.
3. The readings must be taken accurately.

12. APPLICATIONS:

1. It is mainly used for studying the waveforms of currents and voltages.
2. It can also be used for measuring the frequency, amplitude, and phase and time period of a voltage or current.

13. EXTENSION:

14. TROUBLE SHOOTING:

15. QUESTIONS:

1. Define deflection sensitivity in relation to CRO.
2. What is a storage Oscilloscope?
3. What are lissajous figures?
4. What are the different patterns obtained for different phase differences between two sinusoidal signals?
5. If three loops are obtained then what is the relation between frequency of reference wave and unknown wave?

<u>RESISTOR</u>:

<u>Definition</u>:Resistor is an electronic component whose function is to limit the flow of current in an electric circuit.

Specifications:It is measured in units called ohms.
The symbol for ohm is Ω (omega).
They are available in different values, shapes and sizes.
Typical resistor wattage sizes are 1/8, 1/4, 1/2, 1, 2, 5, 10 and 20 (w) units
In writing the values of resistors, the following designation are used Ω, KΩ, MΩ
K → kilo → 10^3
M → Mega → 10^6

The most common type has color bands to indicate its resistance. The code is a standard one adopted by manufactures through their trade association, the electronic Industries Association (EIA).

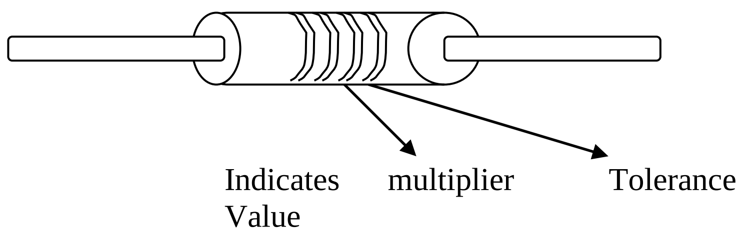
Color code and its value

Bl --	Black	→ 0
Br --	Brown	→ 1
R --	Red	→ 2
O --	Orange	→ 3
Y --	Yellow	→ 4
G --	Green	→ 5
B --	Blue	→ 6
V --	Violet	→ 7
G --	Gray	→ 8
W --	White	→ 9

Tolerance

Br --	Brown	→	± 1%
R --	Red	→	± 2%
G --	Gold	→	± 5%
S --	Silver	→	± 10%
No color		→	± 20%
Pink		→	High stability

Resistor



Estimation of resistance value using color code for eg:a resistor has a color band of Brown, Green, Orange with a tolerance band Gold

Then

Br → 1
G → 5
O → 3

First two colors is the value 15
Third color is multiplier, therefore x 10^3

i.e., 15 x 10^3 = 15000 → 15 kΩ
Fourth band Gold implies Tolerance of ± 5%
Therefore 15 kΩ ± (5% of 15k)

Note:
By tolerance we mean that acceptable deviation or the actual value of the resistor may be 5% more or less then the coded value.

CAPACITOR:
It is a device which stores a charge. It does not pass direct current (dc) but will effectively allow the flow of alternating current (ac). The reactance of a capacity 'C' is dependent on the freq of the ac signal and is given by

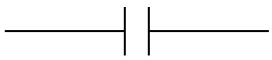
$$X_C = \frac{1}{2\pi fc}$$

A capacitor 'c' when charged to a voltage has a stored energy of $\frac{1}{2}$ CV^2 Joules. A capacitor essentially consists of 2 conducting plates separated by a dielectric medium.

Capacitance of a capacitor 'c' is given by $C = \frac{\in A}{d} F$

The unit of capacitor is Farad (F)

Symbol:



The various dielectric material & the ranges of values these dielectrics can provide are shown

Dielectric	**E**	**Capacitance in μF per cubic cm.**			**Available range μF**
		For 100V	500V	1000 V	
1.Natural Mica	6	0.004	0.001	0.0007	10 pF – 0.1μF
2.Ceramic	100-5000	0.2	0.02	0.007	10pF – 0.01μF
3.Electrolytic	7	08.	0.2	0.06	1 to 1000 μF

Specifications:

1. It is measured in units called Farad (F).

2. Symbol = +——| |——–

3. Values of capacitors can be designated as μF, pF, nF
   μF = micro farads = 10^{-6}F
   pF = pico farads = 10^{-12}F
   nF = nano farads = 10^{-9}F

4. The dielectric constant of the capacitor is a function of temp, freq & voltage of operation. The value decreases with freq while the changes with temp may be either +ve or –ve. The temperature co-efficient values for the various capacitor dielectrics are approximately given below
   Mica = 100 ppm/^{o}C
   Ceramic – low ε + 80 – 120 ppm/C
   Medium ε - 500 to -800 ppm/^{o}C

5. The power factor of a capacitor is theoretically zero, since p.f = R/Z & R is zero for a pure capacitor.

Identification of Capacitors:

There are two types of capacitors

3) electrolytic
4) non-electrolytic

The electrolytic capacitors use an insulation (dielectric) which is chemically active. The capacitor is marked with a +ve & -ve lead polarity.

Note: Be sure to connect any capacitor with marked plus & minus(-) leads to correct polarity.

Non electrolytic capacitors can be connected to the circuit with any polarity.

Note: 1) Charging of capacitor

When a capacitor is connected to a power source it is charged, and maintains the charge even after the power source is disconnected.

2) Discharging of capacitor

When capacitor leads are connected to a resistor or short circuited the stored charge results in current flow and when stored charge is removed the capacitor is said to be lac discharge.

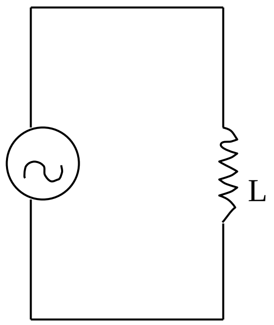
INDUCTOR:

A wire of certain length, when twisted in to a coil becomes a basic inductor. If current is make to pass through an inductor, an electromagnetic field as formed

$$V = L\frac{di}{dt}$$

The unit of inductance is Henry (H)
Symbol:

It is a passive element which does not consume energy ideally but is capable of storing energy. Once it stores energy, it is then capable of supplying this energy to external devices. It resists flow of alternating current, but readily allows direct current.
An inductance circuit



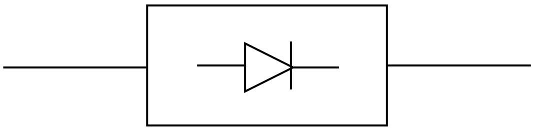
- The property of the coil which opposes changes in current flow through it is called inductance
- Unit of inductance is Henry (H)
- The amount of opposition offered by the inductor is called it inductive reactance (X_L)

  X_L =- $2\pi FL$
- Determining X_L

  $$X_L = \frac{V}{I}$$

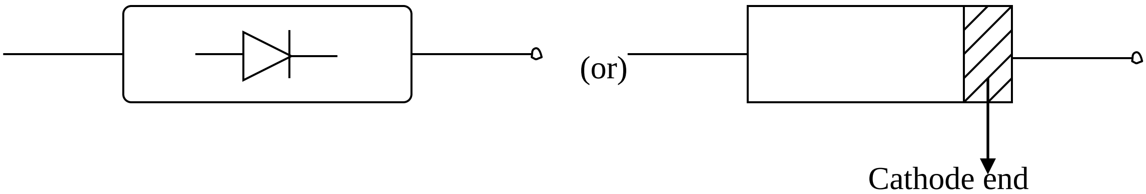
<u>DIODE</u>:

A pn junction is known as semiconductor or crystal diode. The outstanding property of crystal diode to conduct in one direction only permits it to be used as a rectifier.
<u>Specifications</u>: -
→ A diode is represented by symbol: -



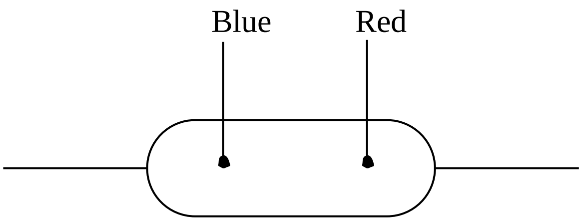
Mainly there are 2 types of Ge and Si diodes
→ Barrier voltage is 0.7 volts for silicon & 0.3 volts for Germanium (also referred as threshold)

<u>Identification of crystal diode terminals</u>
While using a crystal diode, it is often necessary to know which end is arrowhead & which end is Bar. The following methods are available
i) Some manufactures actually paint the symbol on the body of the diode or a bar is placed
Ex:BY127



ii) Sometimes red & blue marks are used on the body of the crystal diode
Diode Red mark denotes arrow whereas blue mark indicates bar

Ex: 0A80

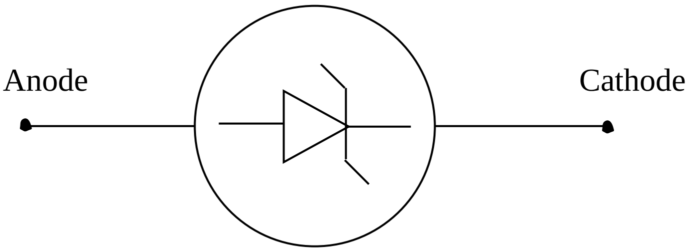


<u>Zener Diode</u>: -
A properly doped crystal diode which has a sharp break down voltage is known as a Zener diode.

The American Scientist C.Zener gave an satisfactory explanation of this breakdown of the junction. Therefore, the breakdown voltage is sometimes called Zener voltage & the sudden increase in current is called Zener current

Specifications:

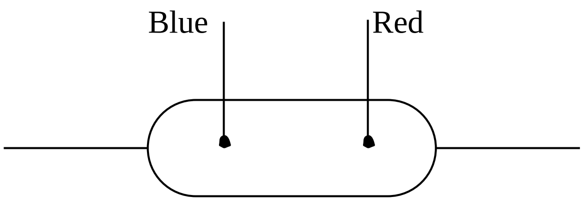
1) Symbol:



It may be seen that it is just like a ordinary diode except that the bar is turned in to Z shape

Identification of Zener diode

Red and blue marks are used on the body of the crystal diode. Red mark denotes arrow. Whereas blue mark indicates Bar.

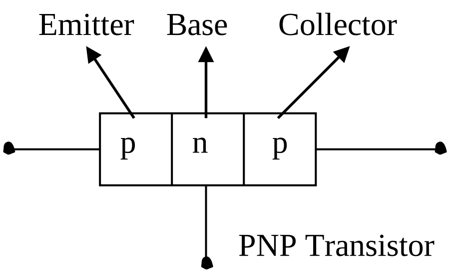


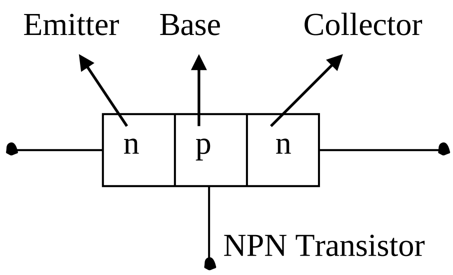
Specifications:

1. Zener voltage (V_Z) – reverse-biased voltage at which the diode begins to conduct
2. Zener voltage Tolerance – like the tolerance of a resistor, this figure gives the percentage above or below V_Z that is acceptable for the particular diode, for eg= 6.3V ± 5%
3. Max Zener Current (I_{Z1max}) – Maximum current allowed to flow while the diode is in its reverse biased conduction (Zener) mod
4. Max power dissipation (P_Z) – Maximum power for the Zener to dissipate
5. Impedance (Z_2) :impedance of the Zener while conduction in the zener mode
6. Maximum operating Temp:The highest temp at which the device will operate reliably.

TRANSISTORS:

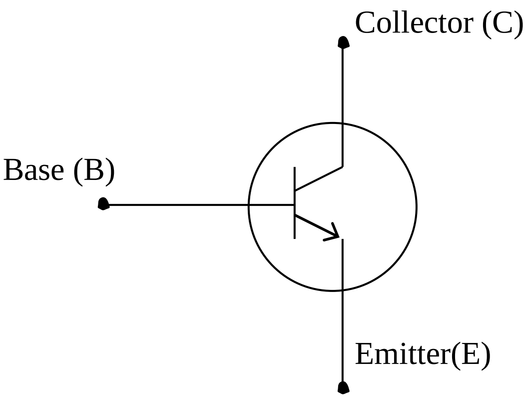
A transistor consists of two p-n junctions formed by sandwiching p type or n-type semiconductor between a pair of opposite types. Accordingly there are 2 type of transistors namely npn & pnp

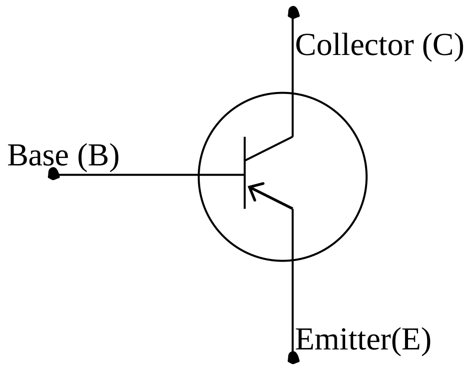




Transistor has 3 terminals namely

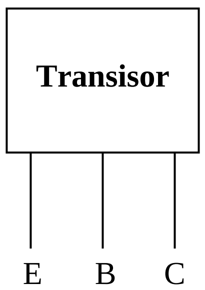
1. Emitter 2. Base 3. Collector





Transistor lead Identification:

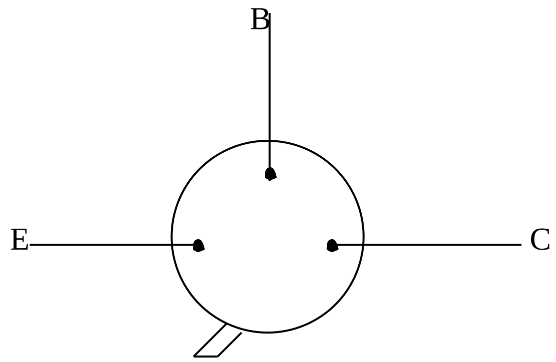
There are three leads in a Transistor called collector or emitter and base. When a transistor is to be connected in a circuit it is necessary to know which terminal is which. The identification of the heads of transistor varies with manufacturer. There are three systems in general.



(i) When the lead of a transistor is in the same plane and unevenly as in fig., they are identified by the position and spacing of leads. The central lead is the base lead. The collector lead is identified by the large spacing existing between it and the base lead. The remaining is the emitter.

(ii) When the leads of a transistor are in the same plane but evenly spaced, the central lead is the base, the lead identified by dot is the collector and the remaining lead is the emitter.

(iii) When the leads of a transistor are spaced around the circumference of a circle, the three leads are generally in E-B-C order clockwise from a gap.



BREAD BOARDS:

This is the platform (or chasis) on which any circuit can be ringed up to provide inter connections between electronics components and devices.

The advantage of bread board is, the components can be connected (or) disconnected easily. It has holes both horizontally and vertically as shown in the figure.

The horizontal holes at the top and bottom are having internal shorts where as in the remaining part vertical holes are shorted internally

DMM (DIGITAL MULTIMETER):

Digital multimeter is abbreviated as DMM. It has 3 ½ Digital LCD (liquid crystal display) ½ digit means it will display '0' or '1'.
3 digits reads any number in the range of 000 to 999.

DMM can read AC, DC voltages and currents in many ranges. It can also check diode polarities, read β value of transistor. Measuring the value of capacitance and resistance

DMM can be used for checking continuity of multimeter probes, test leads, power chords and cables etc.