Electronic Devices and Circuits

LAB MANUAL

Course Code	:	AECB09
Regulations	:	IARE - R18
Class	:	III Semester (ECE)

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ELECTRONICS & COMMUNICATION ENGINEERING

Program Outcomes	
PO1	**Engineering knowledge**: An ability to apply knowledge of basic sciences, mathematical skills, engineering and technology to solve complex electronics and communication engineering problems (**Fundamental Engineering Analysis Skills**).
PO2	**Problem analysis**: An ability to identify, formulate and analyze engineering problems using knowledge of Basic Mathematics and Engineering Sciences. (**Engineering Problem Solving Skills**).
PO3	**Design/development of solutions**: An ability to provide solution and to design Electronics and Communication Systems as per social needs **(Social Awareness)**
PO4	**Conduct investigations of complex problems**: An ability to investigate the problems in Electronics and Communication field and develop suitable solutions (**Creative Skills**).
PO5	**Modern tool usage** An ability to use latest hardware and software tools to solve complex engineering problems (**Software and Hardware Interface**).
PO6	**The engineer and society**: An ability to apply knowledge of contemporary issues like health, Safety and legal which influences engineering design (**Social Awareness**).
PO7	**Environment and sustainability** An ability to have awareness on society and environment for sustainable solutions to Electronics & Communication Engineering problems(**Social awareness**).
PO8	**Ethics**: An ability to demonstrate understanding of professional and ethical responsibilities(**Engineering impact assessment skills**).
PO9	**Individual and team work**: An ability to work efficiently as an individual and in multidisciplinary teams(**Team Work**).
PO10	**Communication**: An ability to communicate effectively and efficiently both in verbal and written form(**Communication Skills**).
PO11	**Project management and finance**: An ability to develop confidence to pursue higher education and for life-long learning(**Continuing education awareness**).
PO12	**Life-long learning**: An ability to design, implement and manage the electronic projects for real world applications with optimum financial resources**(Practical engineering analysis skills**).
Program Specific Outcomes	
PSO1	**Professional Skills:** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.
PSO2	**Problem-solving skills:** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.
PSO3	**Successful career and Entrepreneurship:** An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

ELECTRONIC DEVICES AND CIRCUITS LAB SYLLABUS

Recommended Systems/Software Requirements:
Intel based desktop PC with minimum of 166 MHZ or faster processor with at least 64 MB RAM and 100MB free disk space. C compiler.

***Content beyond the university prescribed syllabi**

ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

Exp. No.	Experiment	Program Outcomes Attained	Program Specific Outcomes Attained
1	Electronic workshop practice	PO1, PO5	-
2	Electronic workshop practice	PO1	-
3	PN Junction diode characteristics A. Forward bias B. Reverse bias.	PO1, PO2	PSO1, PSO2
4	Zener diode characteristics and voltage regulator	P01, PO5	PSO1, PSO2
5	Halfwave Rectifier with and without filter.	PO1, PO11	PSO1, PSO2
6	Fullwave Rectifier with and without filter.	PO1, PO 12	PSO1, PSO2
7	Transistor CB characteristics (Input and Output) & h-parameter calculation	PO1	PSO1, PSO2
8	Transistor CE characteristics (Input and Output) & h-parameter calculation	PO1, PO2	PSO1, PSO2
9	frequency response of CE Amplifier	PO1, PO5	PSO1, PSO2
10	frequency response of CC Amplifier (Emitter Follower).	PO1, PO11	PSO1, PSO2
11	UJT characteristics.	PO1, PO5	-
12	SCR characteristics	PO1, PO5	-
13	FET Characteristics	PO1, PO2	PSO1, PSO2
14	Frequency response of CS amplifier	PO5, PO 11	PSO1, PSO2
15	Frequency response of CD amplifier	PO1, PO 12	PSO1, PSO2
Content Beyond Syllabi			
1	Transistor as a switch	PO1, PO5, PO 12	PSO 1,PSO 2
2	UJT relaxation oscillator	PO1, PO5, PO 12	PSO 1,PSO 2

***Content beyond the University prescribed syllabi**

ELECTRONIC DEVICES & CIRCUITS LABORATORY

COURSE OBJECTIVES:

The course should enable the students to:	
I	Implement and study the characteristics of Diodes and Transistors.
II	Illustrate the concept of rectification using half wave and full wave rectifiers
III	Design and Construct different amplifier circuits.

COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Identify and understand different electronic components used in the laboratory.	CLO 1	Understand identification, specifications, testing of R, L, C components (Color Codes), potentiometers, switches (SPDT, DPDT and DIP), coils, gang condensers, relays, bread boards, PCBs, identification, specifications and testing of active devices, diodes, BJTs, low power JFETs, MOSFETs, power transistors, LEDs, LCDs, optoelectronic devices, SCR, UJT,DIACs.
		CLO 2	Study and operation of a. Multimeters (Analog and Digital) b. Function Generator c. Regulated Power Supplies d. Study and Operation of CRO
CO 2	Verify V-I characteristics of PN and Zener diode and its use in rectifier circuits.	CLO 3	Verification of V-I characteristics of PN diode and calculate static and dynamic resistance using hardware and digital simulation.
		CLO 4	Verification of V-I characteristics of Zener diode and perform Zener diode as a Voltage regulator using hardware and digital simulation.
		CLO 5	Verification of half wave rectifier without and with filters using hardware and digital simulation.
		CLO 6	Verification of Full Wave Rectifier without and with filters using hardware and digital simulation.
CO 3	Verify input and output characteristics of CB,CE configuration and their use in amplifiers.	CLO 7	Verification of Input and Output characteristics of CB configuration using hardware and digital simulation.
		CLO 8	Verification of Input and Output Characteristics of CE configuration using hardware and digital simulation.
		CLO 9	Determine the Gain and Bandwidth of CE amplifier using hardware and digital simulation.
		CLO 10	Determine the Gain and Bandwidth of CC amplifier using hardware and digital simulation.

CO 4	Verify V-I Characteristics of UJT and SCR.	CLO 11	Verification of V-I Characteristics of UJT using hardware and digital simulation.
		CLO 12	Verification of V-I Characteristics of SCR using hardware and digital simulation.
CO 5	Verify V-I Characteristics of FET and its use in amplifiers.	CLO 13	Verification of V-I Characteristics of FET using digital simulation.
		CLO 14	Determine the Gain and Bandwidth of CS amplifier using digital simulation
		CLO 15	Determine the Gain and Bandwidth of CS amplifier using digital simulation.

EXPERIMENT NO: 1

ELECTRONIC WORKSHOP PRACTICE

1.1 AIM

To understand identification, specifications, testing of R, L, C components (Color Codes), potentiometers, switches (SPDT, DPDT and DIP), coils, gang condensers, relays, bread boards, PCBs, identification, specifications and testing of active devices, diodes, BJTs, low power JFETs, MOSFETs, power transistors, LEDs, LCDs, optoelectronic devices, SCR, UJT,DIACs.

1.2 COLOUR CODING OF RESISTOR:

Colour Codes are used to identify the value of resistor. The numbers to the Colour are identified in the following sequence which is remembered as **BBROY GREAT BRITAN VERY GOOD WIFE (BBROYGBVGW)** and their assignment is listed in following table.

Black	**Brown**	**Red**	**Orange**	**Yellow**	**Green**	**Blue**	**Violet**	**Grey**	**White**
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Table1: Colour codes of resistor

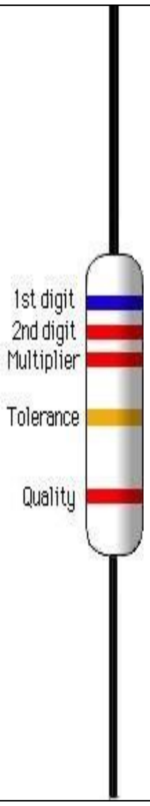
	First find the tolerance band, it will typically be gold (5%) and sometimes silver (10%).
	Starting from the other end, identify the first band - write down the number associated with that color
	Now read the next color, so write down a its value next to the first value.
	Now read the third or 'multiplier exponent' band and write down that as the number of zeros.
	If the 'multiplier exponent' band is Gold move the decimal point one to the left. If the 'multiplier exponent' band is Silver move the decimal point two places to the left. If the resistor has one more band past the tolerance band it is a quality band.
	Read the number as the '% Failure rate per 1000 hour' This is rated assuming full wattage being applied to the resistors. (To get better failure rates, resistors are typically specified to have twice the needed wattage dissipation that the circuit produces). Some resistors use this band for temco information. 1% resistors have three bands to read digits to the left of the multiplier. They have a different temperature coefficient in order to provide the 1% tolerance. At 1% the temperature coefficient starts to become an important factor. at +/-200 ppm a change in temperature of 25 Deg C causes a value change of up to 1%

Table2: Procedure to find the value of resistor using colour codes

1.3 COLOUR CODING OF CAPACITORS

An electrical device capable of storing electrical energy. In general, a capacitor consists of two metal plates insulated from each other by a dielectric. The capacitance of a capacitor depends primarily upon its shape and size and upon the relative permittivity ε_r of the medium between the plates. In vacuum, in air, and in most gases, ε_r ranges from one to several hundred.One classification of capacitors comes from the physical state of their dielectrics, which may be gas (or vacuum), liquid, solid, or a combination of these. Each of these classifications may be subdivided according to the specific dielectric used. Capacitors may be further classified by their ability to be used in alternating-current (ac) or direct- current (dc) circuits with various current levels.

- **Capacitor Identification Codes:** There are no international agreements in place to standardize capacitor identification. Most plastic film types (Figure1) have printed values and are normally in microfarads or if the symbol is n, Nanofarads. Working voltage is easily identified. Tolerances are upper case letters: M = 20%, K = 10%, J = 5%, H = 2.5% and F = ± 1pF.

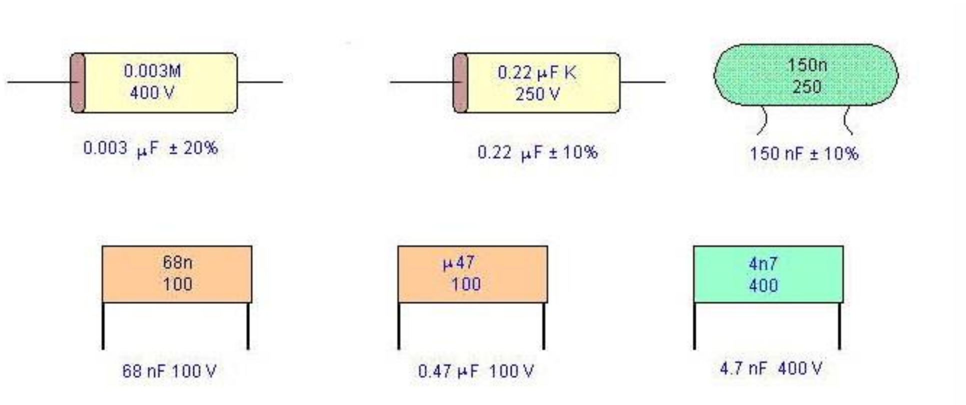


Figure 1: Plastic Film Types

A more difficult scheme is shown in Figure 2 where K is used for indicating Picofarads. The unit is picofarads and the third number is a multiplier. A capacitor coded 474K63 means 47 × 10000 pF which is equivalent to 470000 pF or 0.47 microfarads. K indicates 10% tolerance. 50, 63 and 100 are working volts.

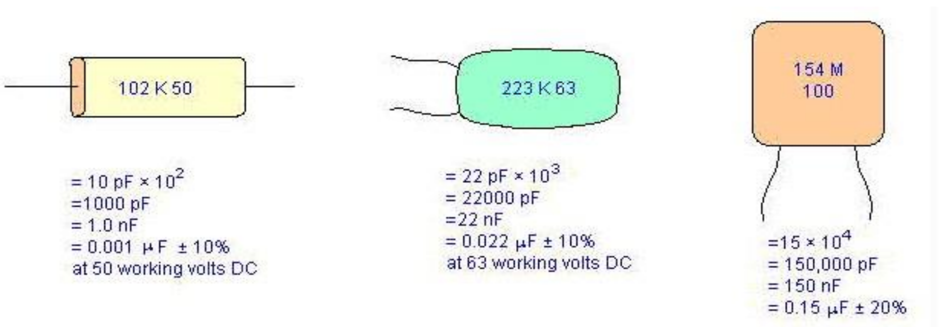


Figure 2: Picofarads Representation

Ceramic disk capacitors have many marking schemes. Capacitance, tolerance, working voltage and temperature coefficient may be found which is as shown in figure 3. Capacitance values are given as number without any identification as to units. (uF, nF, pF) Whole numbers usually indicate pF and decimal numbers such as 0.1 or 0.47 are microfarads. Odd looking numbers such as 473 is the previously explained system and means 47nf

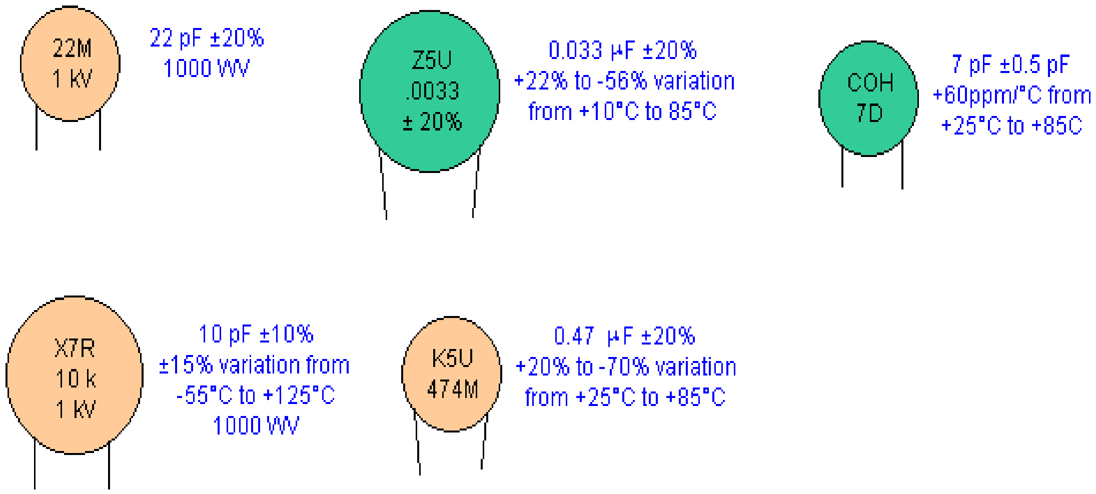


Figure3: Ceramic Disk Capacitor

Figure 4 shows some other miscellaneous schemes.

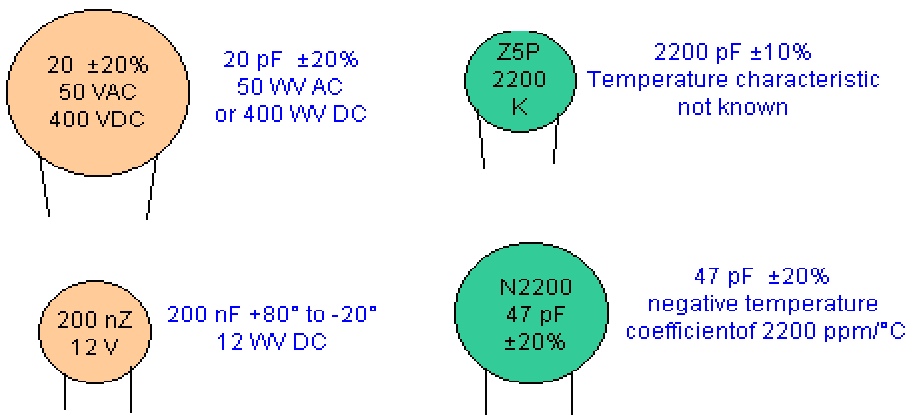


Figure 4: Miscellaneous Schemes.

- **Electrolytic capacitor properties**

There are a number of parameters of importance beyond the basic capacitance and capacitive reactance when using electrolytic capacitors. When designing circuits using electrolytic capacitors it is necessary to take these additional parameters into consideration for some designs, and to be aware of them when using electrolytic capacitors

- **ESR Equivalent series resistance:** Electrolytic capacitors are often used in circuits where current levels are relatively high. Also under some circumstances and current sourced from them needs to have low source impedance, for example when the capacitor is being used in a power supply circuit as a reservoir capacitor. Under these conditions it is necessary to consult the manufacturers' datasheets to discover whether the electrolytic capacitor chosen will meet the requirements for the circuit. If the ESR is high, then it will not be able to deliver the required amount of current in the circuit, without a voltage drop resulting from the ESR which will be seen as a source resistance.
- **Frequency response:** One of the problems with electrolytic capacitors is that they have a limited frequency response. It is found that their ESR rises with frequency and this generally limits their use to frequencies below about 100 kHz. This is particularly true for large capacitors, and even the smaller electrolytic capacitors should not be relied upon at high frequencies. To gain exact details it is necessary to consult the manufacturer's data for a given part.
- **Leakage:** Although electrolytic capacitors have much higher levels of capacitance for a given volume than most other capacitor technologies, they can also have a higher level of leakage. This is not a problem for most applications, such as when they are used in power supplies. However under some circumstances they are not suitable. For example they should not be used around the input circuitry of an operational amplifier. Here even a small amount of leakage can cause problems because of the high input impedance levels of the op-amp. It is also worth noting that the levels of leakage are considerably higher in the reverse direction.
- **Ripple current:** When using electrolytic capacitors in high current applications such as the reservoir capacitor of a power supply, it is necessary to consider the ripple current it is likely to experience. Capacitors have a maximum ripple current they can supply. Above this they can become too hot which will reduce their life. In extreme cases it can cause the capacitor to fail. Accordingly it is necessary to calculate the expected ripple current and check that it is within the manufacturer's maximum ratings.
- **Tolerance:** Electrolytic capacitors have a very wide tolerance. Typically this may be -50% + 100%. This is not normally a problem in applications such as decoupling or power supply smoothing, etc. However they should not be used in circuits where the exact value is of importance.
- **Polarization:** Unlike many other types of capacitor, electrolytic capacitors are polarized and must be connected within a circuit so that they only see a voltage across them in a particular way.

The physical appearance of electrolytic capacitor is as shown in Figure 5.The capacitors themselves are marked so that polarity can easily be seen. In addition to this it is common for the can of the capacitor to be connected to the negative terminal.

Figure 5: Electrolytic Capacitor

It is absolutely necessary to ensure that any electrolytic capacitors are connected within a circuit with the correct polarity. A reverse bias voltage will cause the centre oxide layer forming the dielectric to be destroyed as a result of electrochemical reduction. If this occurs a short circuit will appear and excessive current can cause the capacitor to become very hot. If this occurs the component may leak the electrolyte, but under some circumstances they can explode. As this is not uncommon, it is very wise to take

precautions and ensure the capacitor is fitted correctly, especially in applications where high current capability exists.

1.4 COLOUR CODING OF INDUCTORS

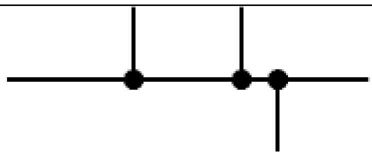
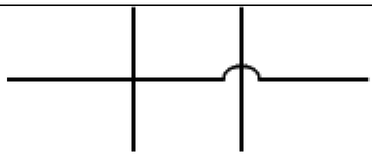
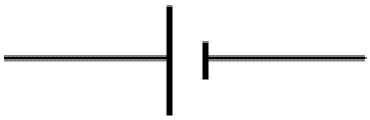
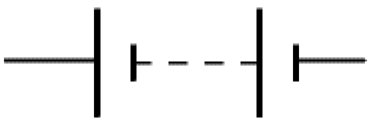
Inductor is just coil wound which provides more reactance for high frequencies and low reactance for low frequencies.

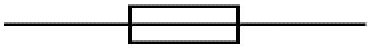
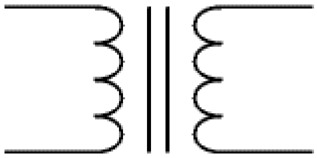
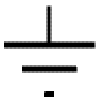
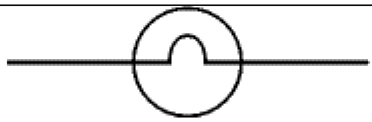
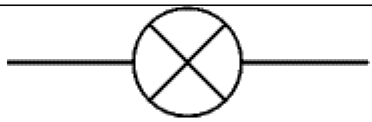
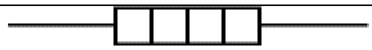
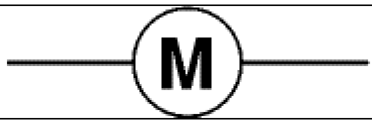
Molded inductors follow the same scheme except the units are usually micro henries. A brown-black-red inductor is most likely a 1000 uH. Sometimes a silver or gold band is used as a decimal point. So a red-gold-violet inductor would be a 2.7 uH. Also expect to see a wide silver or gold band before the first value band and a thin tolerance band at the end. The typical Colour codes and their values are shown in Figure 6.

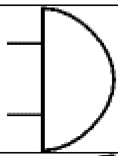
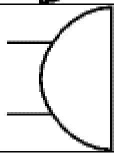
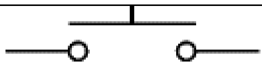
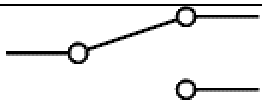
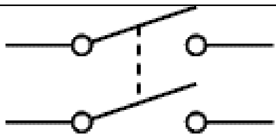
1000uH (1millihenry), 2%

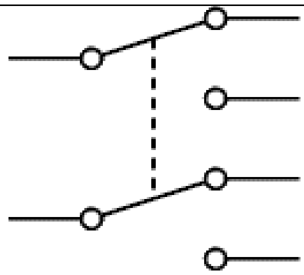
6.8 uH, 5%

Figure 6: Typical inductors colour coding and their values.

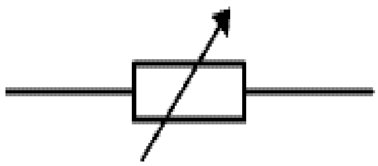
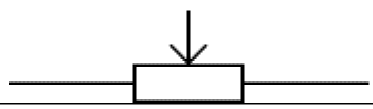
WIRES AND CONNECTIONS			
S.NO	**COMPONENT NAME**	**CIRCUIT SYMBOL**	**FUNCTION**
1	WIRE		To pass current very easily from one part of a circuit to another.
2	WIRES JOINED		A 'blob' should be drawn where wires are connected (joined), but it is sometimes omitted. Wires connected at 'crossroads' should be staggered slightly to form two T-junctions, as shown on the right.
3	WIRES NOT JOINED		In complex diagrams it is often necessary to draw wires crossing even though they are not connected. I prefer the 'bridge' symbol shown on the right because the simple crossing on the left may be misread as a join where you have forgotten to add a 'blob'.
POWER SUPPLIES			
S.NO	**COMPONENT NAME**	**CIRCUIT SYMBOL**	**FUNCTION**
1	CELL		Supplies electrical energy. The larger terminal (on the left) is positive (+). A single cell is often called a battery, but strictly a battery is two or more cells joined together
2	BATTERY		Supplies electrical energy. A battery is more than one cell. The larger terminal (on the left) is positive (+).
3	DC SUPPLY		Supplies electrical energy. DC = Direct Current, always flowing in one direction.

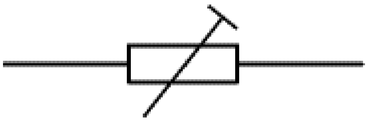
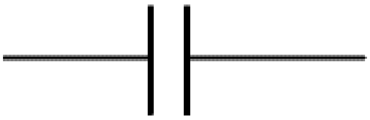
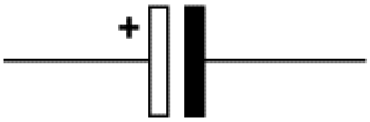
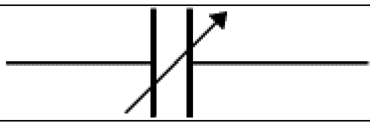
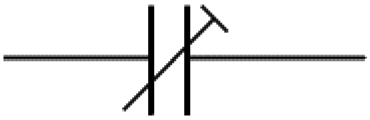
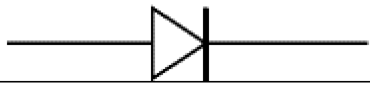
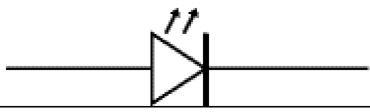
4	AC SUPPLY		Supplies electrical energy. AC = Alternating Current, continually changing direction.
5	FUSE		A safety device which will 'blow' (melt) if the current flowing through it exceeds a specified value.
6	TRANSFORMER		Two coils of wire linked by an iron core. Transformers are used to step up (increase) and step down (decrease) AC voltages. Energy is transferred between the coils by the magnetic field in the core. There is no electrical connection between the coils.
7	EARTH(GROUND)		A connection to earth. For many electronic circuits this is the 0V (zero volts) of the power supply, but for mains electricity and some radio circuits it really means the earth. It is also known as ground.
Output Devices: Lamps, Heater, Motor, etc.			
S.NO	**COMPONENT NAME**	**CIRCUIT SYMBOL**	**FUNCTION**
1	LAMP(LIGHTING)		A transducer which converts electrical energy to light. This symbol is used for a lamp providing illumination, for example a car headlamp or torch bulb
2	LAMP(INDICATOR)		A transducer which converts electrical energy to light. This symbol is used for a lamp which is an indicator, for example a warning light on a car dashboard.
3	HEATER		A transducer which converts electrical energy to heat.
4	MOTOR		A transducer which converts electrical energy to kinetic energy (motion).

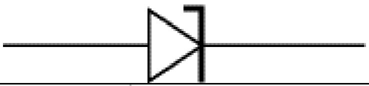
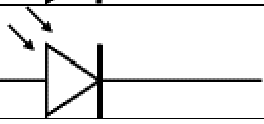
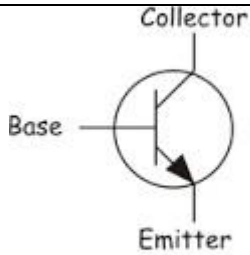
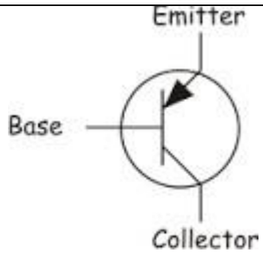
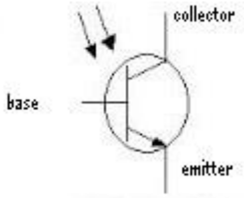
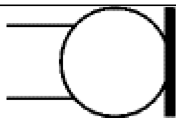
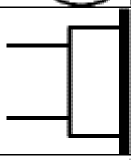
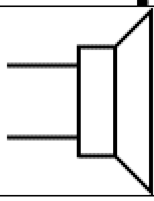
5	BELL		A transducer which converts electrical energy to sound.
6	BUZZER		A transducer which converts electrical energy to sound.
7	INDUCTOR(SOLINOID,COIL)		A coil of wire which creates a magnetic field when current passes through it. It may have an iron core inside the coil. It can be used as a transducer converting electrical energy to mechanical energy by pulling on something.
		Switches	
S.NO	**COMPONENT NAME**	**CIRCUIT SYMBOL**	**FUNCTION**
1	PUSH SWITCH(PUSH TO MAKE)		A push switch allows current to flow only when the button is pressed. This is the switch used to operate a doorbell.
2	PUSH TO BREAK SWITCH		This type of push switch is normally closed (on), it is open (off) only when the button is pressed.
3	ON/OFF SWITCH(SPST)		SPST = Single Pole, Single Throw. An on-off switch allows current to flow only when it is in the closed (on) position.
4	2 WAY SWITCH(SPDT)		SPDT = Single Pole, Double Throw. A 2-way changeover switch directs the flow of current to one of two routes according to its position. Some SPDT switches have a central off position and are described as 'on-off-on'.
5	DUAL ON-OFF SWITCH(DPST)		DPST = Double Pole, Single Throw. A dual on-off switch which is often used to switch mains electricity because it can isolate both the live and neutral connections.

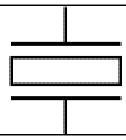
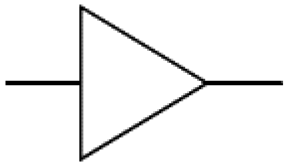
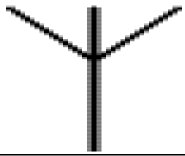
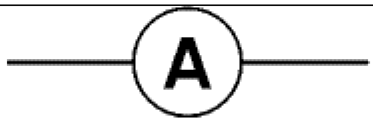
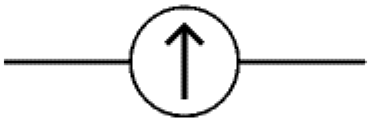
6	REVERSING SWITCH(DPDT)		DPDT = Double Pole, Double Throw. This switch can be wired up as a reversing switch for a motor. Some DPDT switches have a central off position.
7	RELAY		An electrically operated switch, for example a 9V battery circuit connected to the coil can switch a 230V AC mains circuit. NO = Normally Open, COM = Common, NC = Normally Closed.

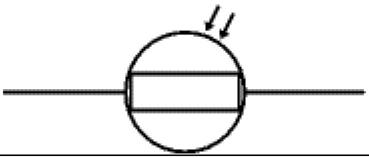
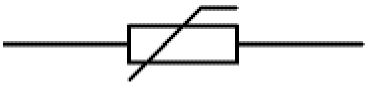
RESISTORS

S.NO	COMPONENT NAME	CIRCUIT SYMBOL	FUNCTION
1	RESISTOR	 **Or** 	A resistor restricts the flow of current, for example to limit the current passing through an LED. A resistor is used with a capacitor in a timing circuit.
2	VARIABLE RESISTOR(RHEOSTAT)		This type of variable resistor with 2 contacts (a rheostat) is usually used to control current. Examples include: adjusting lamp brightness, adjusting motor speed, and adjusting the rate of flow of charge into a capacitor in a timing circuit.
3	VARIABLE RESISTOR(POTENTIOMETER)		This type of variable resistor with 3 contacts (a potentiometer) is usually
			used to control voltage. It can be used like this as a transducer converting position (angle of the control spindle) to an electrical signal
4	VARIABLE		This type of variable resistor (a preset) is operated with a small screwdriver or similar tool. It is designed to be set when the

	RESISTER(PRESET)		circuit is made and then left without further adjustment. Presets are cheaper than normal variable resistors so they are often used in projects to reduce the cost
CAPACITORS			
S.NO	**NAME OF THE COMPONENT**	**CIRCUIT SYMBOL**	**FUNCTION OF THE COMPONENT**
1	CAPACITOR		A capacitor stores electric charge. A capacitor is used with a resistor in a timing circuit. It can also be used as a filter, to block DC signals but pass AC signals.
2	CAPACITOR POLARISED		A capacitor stores electric charge.This type must be connected the correct way round. A capacitor is used with a resistor in a timing circuit. It can also be used as a filter, to block DC Signals but pass AC signals.
3	VARIABLE CAPACITOR		A variable capacitor is used in a radio tuner.
4	TRIMMER CAPACITOR		This type of variable capacitor (a trimmer) is operated with a small screwdriver or similar tool. It is designed to be set when the circuit is made and then left without further adjustment
DIODES			
S.NO	**NAME OF THE COMPONENT**	**CIRCUIT SYMBOL**	**FUNCTION OF THE COMPONENT**
1	DIODE		A device which only allows current to flow in one direction
2	LED(LIGHT EMITTING DIODE)		A transducer which converts electrical energy to light.

3	ZENER DIODE		A special diode which is used to maintain a fixed voltage across its terminals
4	PHOTO DIODE		A light-sensitive diode.
		TRANSISTORS	
S.NO	**NAME OF THE COMPONENT**	**CIRCUIT SYMBOL**	**FUNCTION OF THE COMPONENT**
1	TRANSISTOR NPN		A transistor amplifies current. It can be used with other components to make an amplifier or switching circuit.
2	TRANSISTOR PNP		A transistor amplifies current. It can be used with other components to make an amplifier or switching circuit.
3	PHOTO TRANSISTOR		A light-sensitive transistor.
		AUDIO AND RADIO DEVICES	
S.NO	**NAME OF THE COMPONENT**	**CIRCUIT SYMBOL**	**FUNCTION OF THE COMPONENT**
1	MICROPHONE		A transducer which converts sound to electrical energy.
2	EARPHONE		A transducer which converts electrical energy to sound.
3	LOUD SPEAKER		A transducer which converts electrical energy to sound.

4	PIEZO TRANSDUCER		A transducer which converts electrical energy to sound.
5	AMPLIFIER(GENERAL SYMBOL)		An amplifier circuit with one input. Really it is a block diagram symbol because it represents a circuit rather than just one component.
6	ARIEL (ANTENNA)		A device which is designed to receive or transmit radio signals. It is also known as an antenna
S.NO	**NAME OF THE COMPONENT**	**CIRCUIT SYMBOL**	**FUNCTION OF THE COMPONENT**
1	VOLTMETER		A voltmeter is used to measure voltage. The Proper name for voltage is 'potential difference', but most people prefer to say voltage.
2	AMMETTER		An ammeter is used to measure current
3	GALVANOMETER		A galvanometer is a very sensitive meter which is used to measure tiny currents, usually 1mA or less
4	OHMMETER		An ohmmeter is used to measure resistance. Most multimeters have an ohmmeter setting.

5	OSCILLOSCOPE		An oscilloscope is used to display the shape of electrical signals and it can be used to measure their voltage and time period.
Sensors (input devices)			
S.NO	**NAME OF THE COMPONENT**	**CIRCUIT SYMBOL**	**FUNCTION OF THE COMPONENT**
1	LDR		A transducer which converts brightness (light) to resistance (an electrical property). LDR = Light Dependent Resistor
2	THERMISTOR		A transducer which converts temperature (heat) to resistance (an electrical property).

EXPERIMENT NO: 2

ELECTRONIC WORKSHOP PRACTICE

1.1 AIM

To study the operation of a. Multimeters (Analog and Digital) b. Function Generator c. Regulated Power Supplies d. Study and Operation of CRO.

1.2. STUDY OF CRO

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 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.

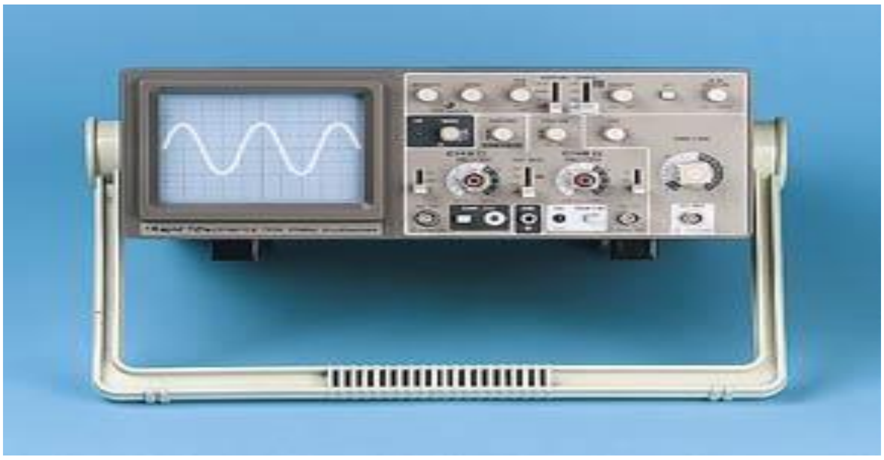


Figure1: Front Panel of CRO

- **BASIC OPERATION:**

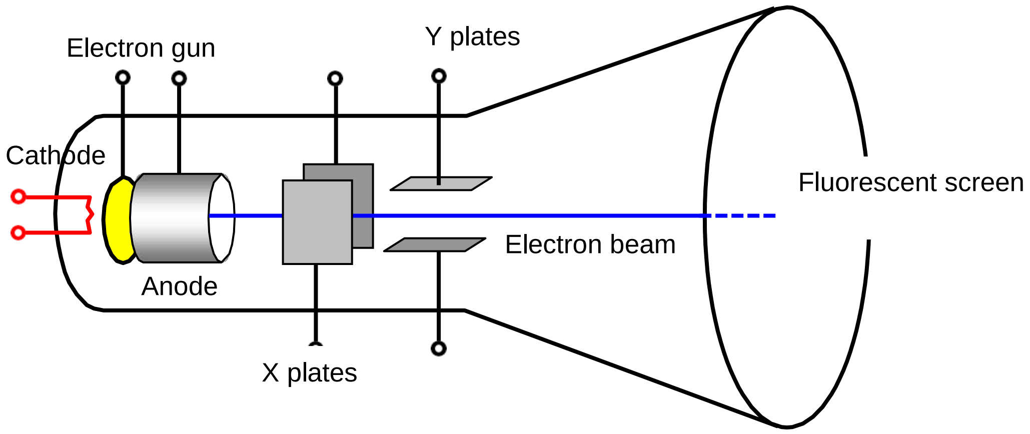


Figure2: Internal Blocks of CRO

- **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 need to 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.

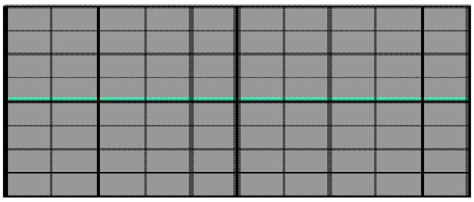


Figure 3: Absence of input signal

- **Connecting an oscilloscope:**

The Y INPUT lead to an oscilloscope should be a co-axial lead and the figure 4 shows its construction. The central wire carries the signal and the screen is connected to earth (0V) to shield the signal from electrical interference (usually called noise).

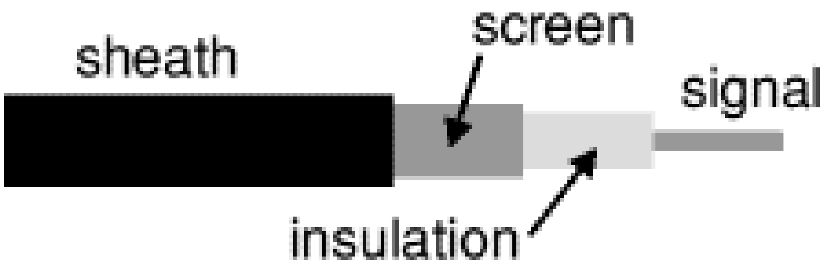


Figure 4: Construction of a co-axial lead

Most oscilloscopes have a BNC socket for the y input and the lead is connected with a push and twist action, to disconnect we need to twist and pull. Professionals use a specially designed lead and probes kit for best results with high frequency signals and when testing high resistance circuits, but this is not essential for simpler work at audio frequencies (up to 20 kHz).

Figure 5: Oscilloscope lead and probes kit

- **Obtaining a clear and stable trace:**

Once if we connect the oscilloscope to the circuit, it is necessary to adjust the controls to obtain a clear and stable trace on the screen in order to test it.

- The Y AMPLIFIER (VOLTS/CM) control determines the height of the trace. Choose a setting so the trace occupies at least half the screen height, but does not disappear off the screen.
- The TIMEBASE (TIME/CM) control determines the rate at which the dot sweeps across the screen. Choose a setting so the trace shows at least one cycle of the signal across the screen. Note that a steady DC input signal gives a

horizontal line trace for which the time base setting is not critical.

- The TRIGGER control is usually best left set to AUTO.

The trace of an AC signal with the oscilloscope controls correctly set is as shown in Figure 6.

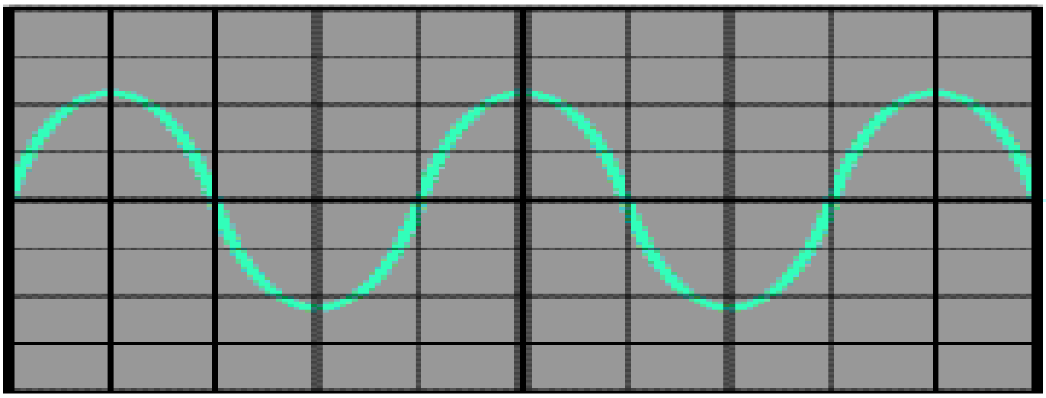


Figure 6 : Stable waveform

- **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

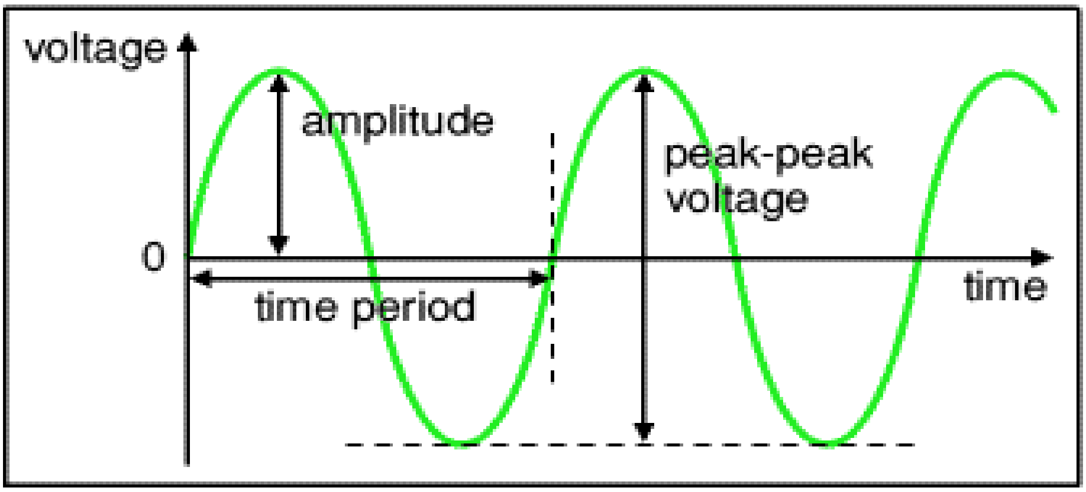


Figure7: Properties of trace

- **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

STUDY OF FUNCTION GENERATOR

A function generator is a device that can produce various patterns of voltage at a variety of frequencies and amplitudes. It is used to test the response of circuits to common input signals. The electrical leads from the device are attached to the ground and signal input terminals of the device under test.

Figure 1: A typical low-cost function generator.

- **Features and controls :**

Most function generators allow the user to choose the shape of the output from a small number of options.

- Square wave - The signal goes directly from high to low voltage.

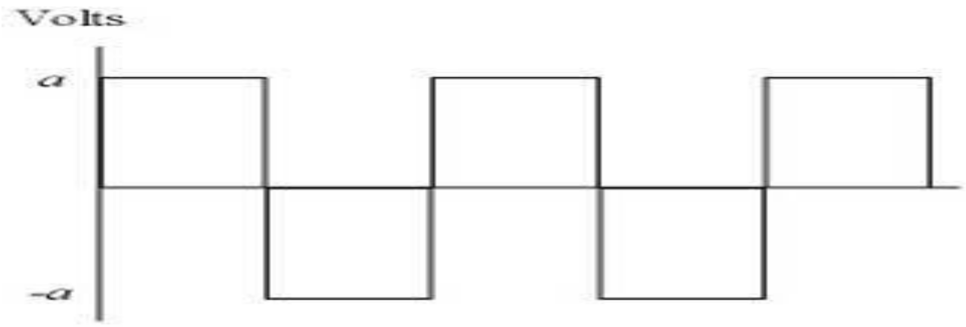


Figure 2: Square wave

The duty cycle of a signal refers to the ratio of high voltage to low voltage time in a square wave signal.

- Sine wave - The signal curves like a sinusoid from high to low voltage.

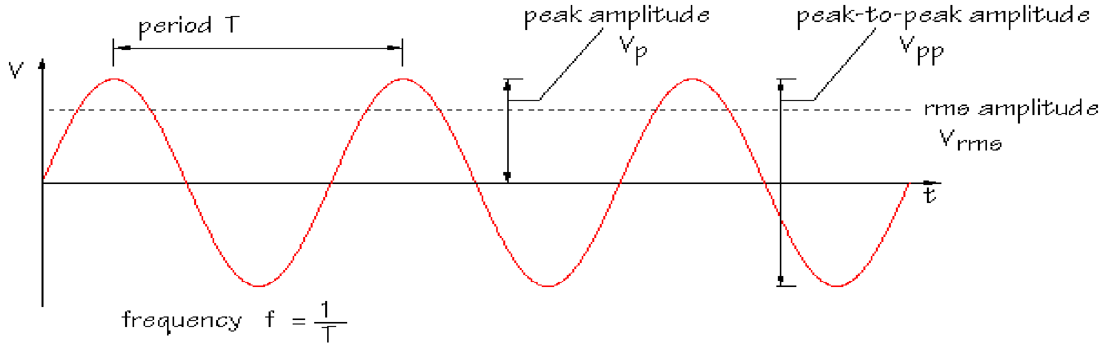


Figure3: Sine Wave

- Triangle wave - The signal goes from high to low voltage at a fixed rate.

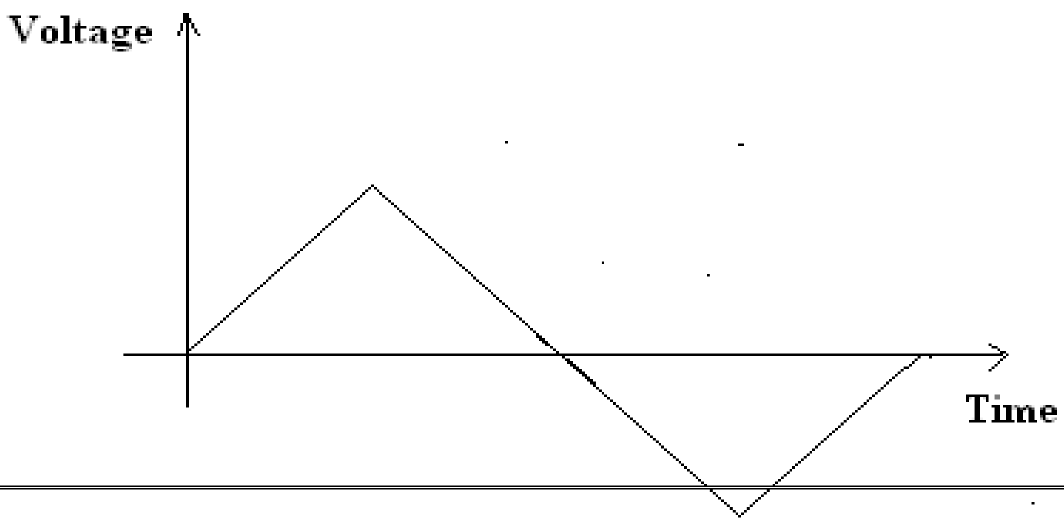


Figure 4: Triangular Wave

The amplitude control on a function generator varies the voltage difference between the high and low voltage of the output signal. The direct current (DC) offset control on a function generator varies the average voltage of a signal relative to the ground.
The frequency control of a function generator controls the rate at which output signal oscillates. On some function generators, the frequency control is a combination of different controls. One set of controls chooses the broad frequency range (order of magnitude) and the other selects the precise frequency. This allows the function generator to handle the enormous variation in frequency scale needed for signals.

- **How to use a function generator**

After powering on the function generator, the output signal needs to be configured to the desired shape. Typically, this means connecting the signal and ground leads to an oscilloscope to check the controls. Adjust the function generator until the output signal is correct, then attach the signal and ground leads from the function generator to the input and ground of the device under test. For some applications, the negative lead of the function generator should attach to a negative input of the device, but usually attaching to ground is sufficient.

STUDY OF REGULATED POWER SUPPLY

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. For example a 5V regulated supply:

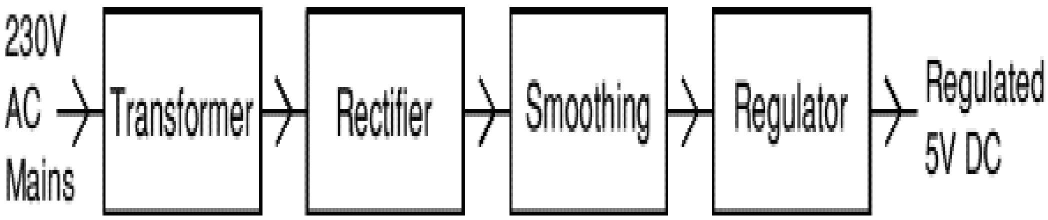


Figure1: Block Diagram Of Regulated Power Supply

Each of the blocks is described in more detail below:

- Transformer: Steps down high voltage AC mains to low voltage AC.
- Rectifier: Converts AC to DC, but the DC output is varying.
- Smoothing: Smooths the DC from varying greatly to a small ripple.
- Regulator: Eliminates ripple by setting DC output to a fixed voltage.

- **Dual Supplies:** Some electronic circuits require a power supply with positive and negative outputs as well as zero volts (0V). This is called a 'dual supply' because it is like two ordinary supplies connected together as shown in the diagram. Dual supplies have three outputs, for example a ±9V supply has +9V, 0V and -9V outputs.

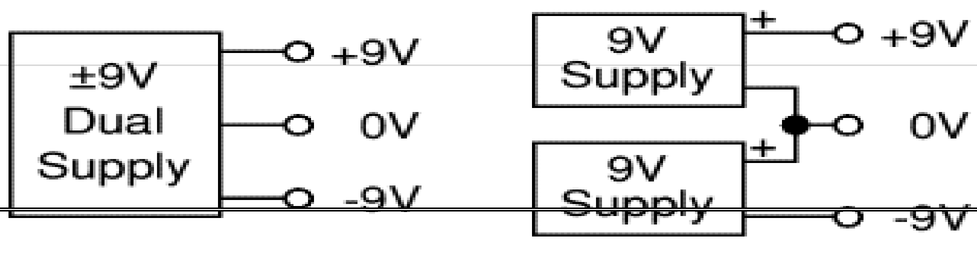


Figure 2: Dual Supply

TYPES OF CIRCUIT BOARD

- **Breadboard:** This is a way of making a temporary circuit, for testing purposes or to try out an idea. No soldering is required and all the components can be re-used afterwards. It is easy to change connections and replace components. Almost all the Electronics Club projects started life on a breadboard to check that the circuit worked as intended. The following figure depicts the appearance of Bread board in which the holes in top and bottom stribes are connected horizontally that are used for power supply and ground connection conventionally and holes on middle stribes connected vertically. And that are used for circuit connections conventionally**.**

- **Strip board:**

Figure 1: Bread board

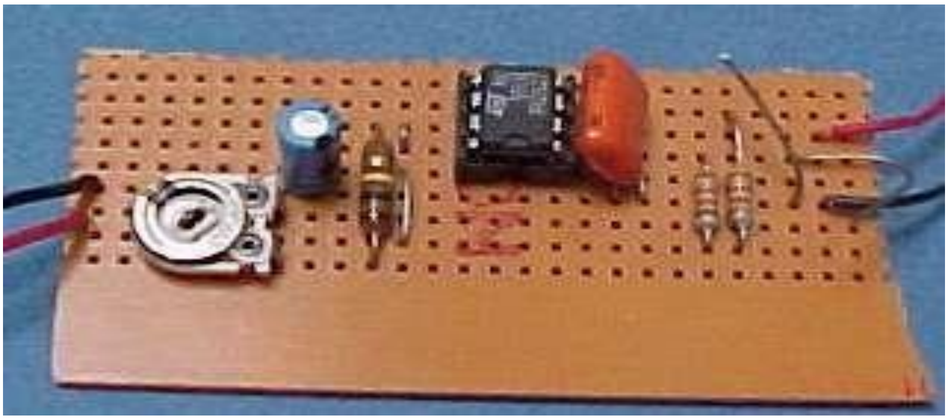


Figure 2: Strip Board

Stripboard has parallel strips of copper track on one side. The strips are 0.1" (2.54mm) apart and there are holes every 0.1" (2.54mm). Stripboard requires no special preparation other than cutting to size. It can be cut with a junior hacksaw, or simply snap it along the lines of holes by putting it over the edge of a bench or table and pushing hard.

Printed Circuit Board: A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or traces etched from copper sheets laminated onto a non-conductive substrate. It is also referred to as printed wiring board (PWB) or etched wiring board. A PCB populated with electronic components is a printed circuit assembly (PCA), also known as a printed circuit board assembly (PCBA).

Printed circuit boards have copper tracks connecting the holes where the components are placed. They are designed especially for each circuit and make construction very easy. However, producing the PCB requires special equipment so this method is not recommended if you are a beginner unless the PCB is provided for you.

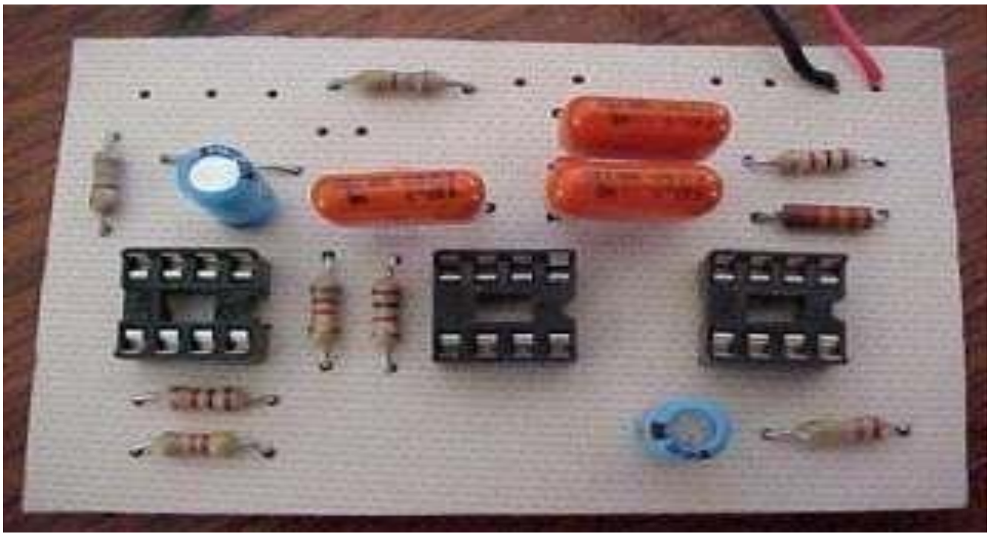


Figure 3: Printed circuit board

PCBs are inexpensive, and can be highly reliable. They require much more layout effort and higher initial cost than either wire-wrapped or point-to-point constructed circuits, but are much cheaper and faster for high-volume production. Much of the electronics industry's PCB design, assembly, and quality control needs are set by standards that are published by the IPC organization.

EXPERIMENT NO: 3

PN JUNCTION DIODE CHARACTERISTICS

3.1 AIM

To plot the V-I characteristics of a PN junction diode in both forward and reverse directions. Find cut in voltage (knee voltage), static and dynamic resistance in forward direction at forward current of 2mA & 8mA respectively.Find static and dynamic resistance at 10V in reverse bias condition.

3.2 COMPONENTS & EQUIPMENT REQUIRED

S.No	Device	Range /Rating	Quantity (in No.s)
1.	Semiconductor diode trainer Board Containing DC Power Supply. Diode (Silicon) Diode (Germanium) Carbon Film Resistor	 (0-15) V 1N 4007 OA79 1 KΩ, 1/2 W	 1 1 1 1
2.	DC Voltmeter DC Voltmeter	(0-1) V (0-20) V	1 1
3.	DC Ammeter DC Ammeter	(0-200) μA (0-20) mA	1 1
4.	Connecting wires	5A	10

3.3 THEORY

A p-n junction diode conducts only in one direction. The V-I characteristics of the diode are curve between voltage across the diode and current through the diode. When external voltage is zero, circuit is open and the potential barrier does not allow the current to flow. Therefore, the circuit current is zero. When P-type (Anode is connected to +ve terminal and n- type (cathode) is connected to –ve terminal of the supply voltage, is known as forward bias. The potential barrier is reduced when diode is in the forward biased condition. At some forward voltage, the potential barrier altogether eliminated and current starts flowing through the diode and also in the circuit. The diode is said to be in ON state. The current increases with increasing forward voltage.When N-type (cathode) is connected to +ve terminal and P-type (Anode) is connected –ve terminal of the supply voltage is known as reverse bias and the potential barrier across the junction increases. Therefore, the junction resistance becomes very high and a very small current (reverse saturation current) flows in the circuit. The diode is said to be in OFF state. The reverse bias current due to minority charge carriers.

3.4 PROCEDURE

Forward Bias

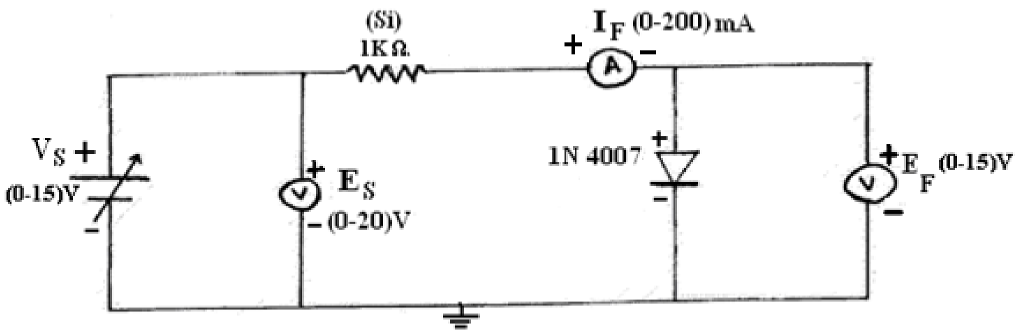
1. Connect the circuit as shown in figures (1)
2. Vary the supply voltage E_s in steps and note down the corresponding values of E_f and I_f as shown in the tabular column.

Reverse Bias

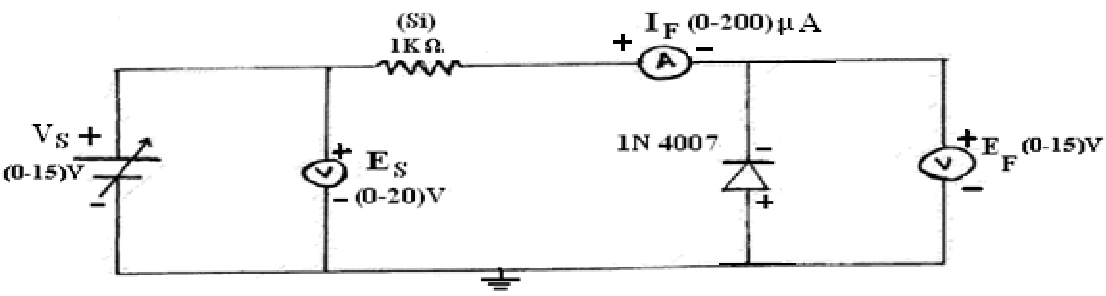
1. Connect the circuit as shown in figure (2).
2. Repeat the procedure as in forward bias and note down the corresponding Values of E_r and I_r as shown in the tabular column.

3.5 CIRCUIT DIAGRAMS

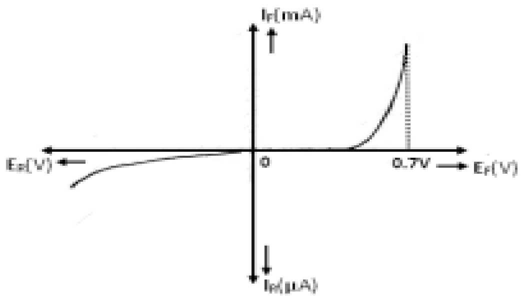
Forward Bias



Reverse Bias



3.6 EXPECTED GRAPHS



3.7 TABULAR COLUMN

Forward Bias

E_s (volts)	E_f (volts)	I_f (mA)
0.1		
0.2		
0.3		
0.4		
0.5		
0.6		
0.7		
0.8		
0.9		
1		
2		
4		
6		
8		
10		
12		
14		

Reverse Bias

E_s (volts)	E_r (volts)	I_r (µA)
0.1		
0.2		
0.3		
0.4		
0.5		
0.6		
0.7		
0.8		
0.9		
1		
2		
4		
6		
8		
10		
12		
14		

3.8 PRECAUTIONS

1. Ensure that the polarities of the power supply and the meters as per the circuit diagram.
2. Keep the input voltage knob of the regulated power supply in minimum position both when switching ON or switching OFF the power supply.
3. No loose contacts at the junctions.
4. Ensure that the ratings of the meters are as per the circuit design for precision.

3.9 CALCULATIONS

Forward Bias

Static Resistance at 8mA= E_f/ I_f =

Static resistance at 2mA= E_f/ $I_{f\_}$ =

Dynamic resistance at 8mA=Δ E_f / Δ I_f =

Dynamic resistance at 8mA=Δ E_f / Δ I_f =

Reverse Bias

Static Resistance at (10V)= E_r/ I_r =

Dynamic resistance at (10V)=Δ E_r / Δ I_r =

3.10 PRE LAB QUESTIONS

1. Define depletion region of a diode?
2. What is meant by transition & space charge capacitance of a diode?
3. Is the V-I relationship of a diode Linear or Exponential?
4. Draw the ideal characteristics of P-N junction diode?
5. What is the diode equation?

3.11 LAB ASSIGNMENT

1. To plot the V-I characteristics of a PN junction (Germanium) diode in both forward and reverse directions by using multisim.

3.12 POST LAB QUESTIONS

1. Define cut-in voltage of a diode and specify the values for Si and Ge diodes?
2. What are the applications of a p-n diode?
3. What is PIV?
4. What is the break down voltage?
5. What is the effect of temperature on PN junction diodes?

3.13 RESULT

V-I characteristics of PN junction are plotted and verified in both forward and reverse directions.

Forward direction

(i) Cut-in-voltage=0.7V

(ii) a) Dynamic Resistance (at 8 mA) =

b) Dynamic Resistance (at 2mA) =

(iii) a) Static Resistance(at 8mA) =

b) Static Resistance (at 2mA) =

1. Reverse Direction =

   (i) Static Resistance (at 10V) =

   (ii) Dynamic Resistance (at 10 V) =

EXPERIMENT NO: 4

ZENER DIODE CHARACTERISTICS AND VOLTAGE REGULATOR

4.1 AIM

Plot the V-I characteristics of a Zener diode, find zener breakdown voltage in reverse bias condition, find static and dynamic resistance in both forward and reverse bias conditions and perform zener diode voltage regulator.

4.2 COMPONENTS & EQUIPMENT REQUIRED

S.NO	DEVICES	RANGE /RATING	QUANTITY (in No.s)
1.	Zener diode trainer Board Containing a) DC Power Supply. b) Zener Diode c) Zener Diode d) Carbon Film Resistor	 (0-15) V 4.7 V 6.2 V 1 KΩ, 1/2 W	 1 1 1 1
2.	DC Voltmeter DC Voltmeter	(0-1) V (0-20) V	1 1
3.	a) DC Ammeter b) DC Ammeter	(0-200) μA (0-20) mA	1 1
4.	Connecting wires	5A	10

4.3 THEORY

A zener diode is heavily doped p-n junction diode, specially made to operate in the break down region. A p-n junction diode normally does not conduct when reverse biased. But if the reverse bias is increased, at a particular voltage it starts conducting heavily. This voltage is called Break down Voltage. High current through the diode can permanently damage the device.

To avoid high current, we connect a resistor in series with zener diode. Once the diode starts conducting it maintains almost constant voltage across the terminals whatever may be the current through it, i.e., it has very low dynamic resistance. It is used in voltage regulators.

4.4 PROCEDURE

Forward Bias

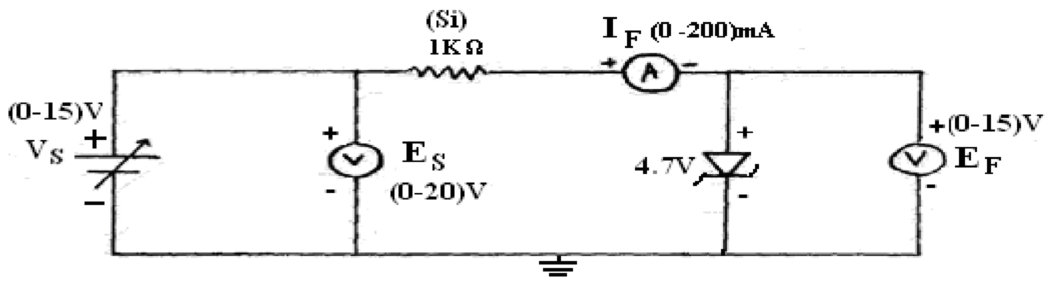
1. Connect the circuit as shown in figures (1)
2. Vary the supply voltage E_s in steps and note down the corresponding values of E_f and I_f as shown in the tabular column.

Reverse Bias

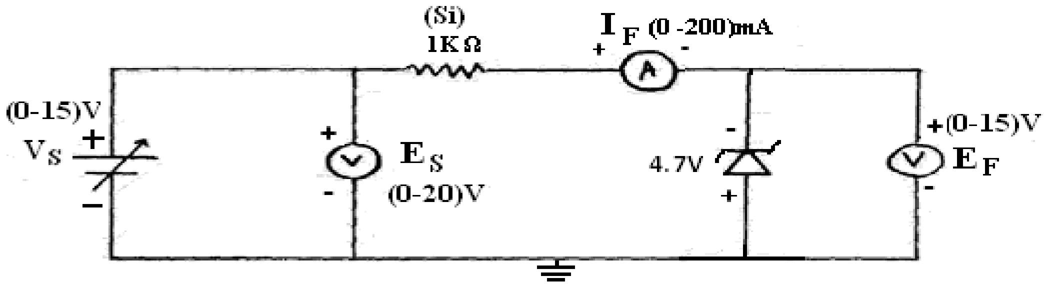
1. Connect the circuit as shown in figure (2).
2. Repeat the procedure as in forward bias and note down the corresponding values of E_r and I_r as shown in the tabular column.

4.5 CIRCUIT DIAGRAMS

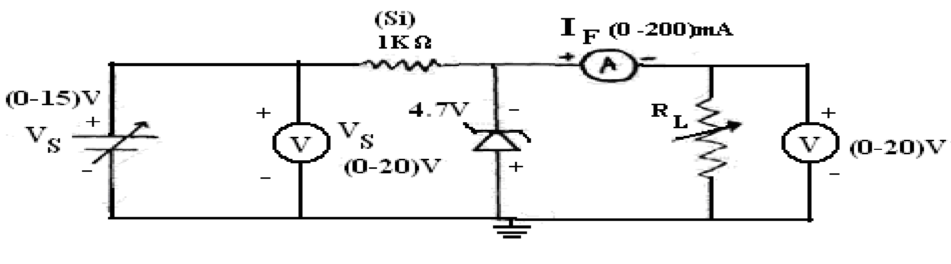
Forward Bias



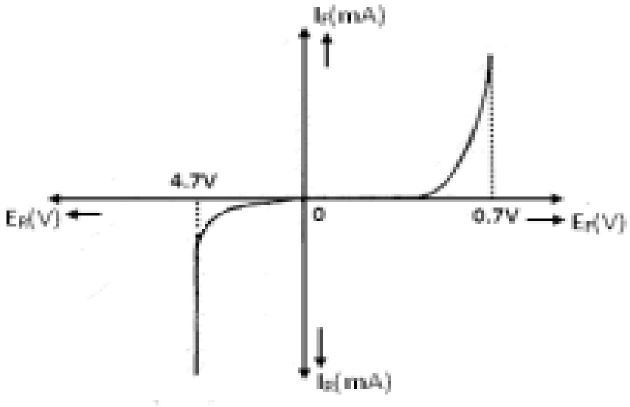
Reverse Bias



Zener Doide As Voltage Regulator



4.6 EXPECTED GRAPH



4.7 TABULAR COLUMN

Forward Bias

E_s (volts)	E_f (volts)	I_f (mA)
0.1		
0.2		
0.3		
0.4		
0.5		
0.6		
0.7		
0.8		
0.9		
1		
2		
4		
6		
8		
10		
12		
14		

Reverse Bias

E_s (volts)	E_r (volts)	I_r (mA)
0.1		
0.2		
0.3		
0.4		
0.5		
0.6		
0.7		
0.8		
0.9		
1		
2		
4		
6		
8		
10		
12		
14		

Zener Doide As Voltage Regulator:

V_{in}=15V , V_{NL}=____ R_L=15K

$R_L(\Omega)$	V_{FL}(volts)	I_L (mA)	%Regulation
100			
200			
500			
1K			
2K			
5K			
10K			
20K			

E_s (volts)	E_{FL} (volts)	I_L (mA)
1		
2		
4		
6		
8		
10		
12		
14		

4.8 PRECAUTIONS

1. Ensure that the polarities of the power supply and the meters as per the circuit diagram.
2. Keep the input voltage knob of the regulated power supply in minimum position both when switching ON or switching OFF the power supply.
3. No loose contacts at the junctions.
4. Ensure that the ratings of the meters are as per the circuit design for precision.

4.9 CALCULATIONS

Forward Static resistance at 6 mA= E_f / I_f

Forward Dynamic resistance at 6mA=$\Delta E_f / \Delta I_f$

Reverse Static resistance at 6 mA= E_f / I_f

Reverse Dynamic resistance at 6mA=$\Delta E_f / \Delta I$

4.10 PRE LAB QUESTIONS

1. What type of temperature Coefficient does the zener diode have?
2. If the impurity concentration is increased, how the depletion width effected?
3. How the breakdown voltage of a particular diode can be controlled?
4. What type of temperature coefficient does the Avalanche breakdown has?

4.11 LAB ASSIGNMENT

1. To plot the V-I characteristics of a Zener diode (6.1V) in both forward and reverse directions by using multisim.

4.12 POST LAB QUESTIONS

1. Explain briefly about avalanche and zener breakdowns?
2. Draw the zener equivalent circuit?

3. Differentiate between line regulation & load regulation?
4. In which region zener diode can be used as a regulator?

4.14 RESULT

1. V-I characteristics of Zener diode are plotted and verified in both forward and reverse directions.
2. Zener breakdown voltage for 4.7V zener diode = 4.7V.
3. (i) Forward Bias:
    a) Static resistance at 6 mA =
    b) Dynamic resistance at 6 mA=

   (ii) Reverse Bias:

   Static resistance at 6 mA=

   Dynamic resistance at 6 mA=

EXPERIMENT NO: 5

HALFWAVE RECTIFIERS WITH/WITHOUT FILTERS

5.1 AIM

Examine the input and output waveforms of a half wave rectifier without and with filters.

Calculate the ripple factor with load resistance of 500Ω, 1 KΩ and 10 KΩ respectively.

Calculate ripple factor with a filter capacitor of 100μF and the load of 1KΩ, 2KΩ and 10KΩ respectively.

5.2 COMPONENTS & EQUIPMENT REQUIRED

S.No	Device	Range/Rating	Quantity in No.
1.	Rectifier and Filter trainer Board Containing a) AC Supply. b) Silicon Diodes c) Capacitor	 (9-0-9) V 1N 4007 0.47μF	 1 7 1
2.	a) DC Voltmeter b) AC Voltmeter	(0-20) V (0-20) V	1 1
3.	DC Ammeter	(0-50) mA	1
4.	Cathode Ray Oscilloscope	(0-20) MHz	1
5	Decade Resistance Box	10Ω-100KΩ	1
4.	Connecting wires	5A	12

5.3 THEORY

During positive half-cycle of the input voltage, the diode D1 is in forward bias and conducts through the load resistor R1. Hence the current produces an output voltage across the load resistor R1, which has the same shape as the +ve half cycle of the input voltage.

During the negative half-cycle of the input voltage, the diode is reverse biased and there is no current through the circuit. i.e, the voltage across R1 is zero. The net result is that only the +ve half cycle of the input voltage appears across the load. The average value of the half wave rectified o/p voltage is the value measured on dc voltmeter.

For practical circuits, transformer coupling is usually provided for two reasons.

1. The voltage can be stepped-up or stepped-down, as needed.

2. The ac source is electrically isolated from the rectifier. Thus preventing shock hazards in the secondary circuit.

5.4 PROCEDURE

Half Wave Rectifier without filter

1. Connect the circuit as shown in figure (a).
2. Adjust the load resistance, R_L to 500Ω, and note down the readings of input and output voltages through oscilloscope.
3. Note the readings of dc current, dc voltage and ac voltage.
4. Now, change the resistance the load resistance, RL to 1 KΩ and repeat the procedure as above. Also repeat for 10 KΩ.
5. Readings are tabulated as per the tabular column.

Half Wave Rectifier with filter

1. Connect the circuit as shown in figure (b) and repeat the procedure as for half wave rectifier without filter.

5.5 CIRCUIT DIAGRAMS

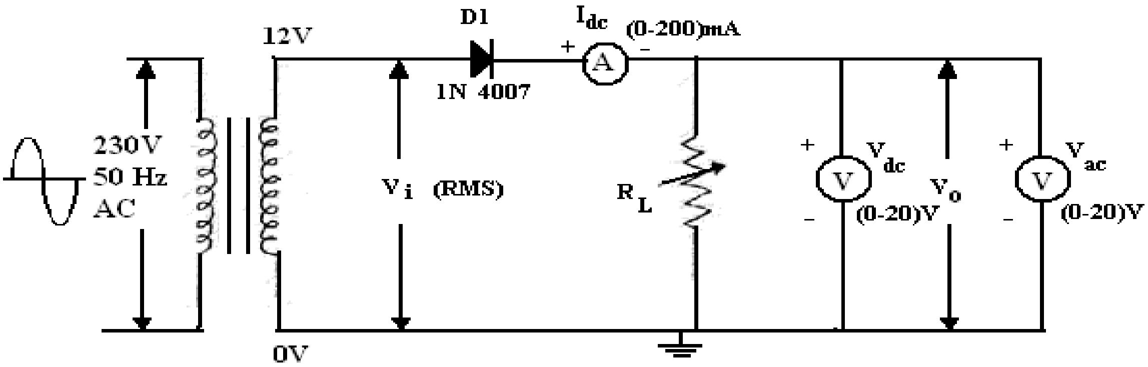


Figure (a) :Half Wave Rectifier without Filter

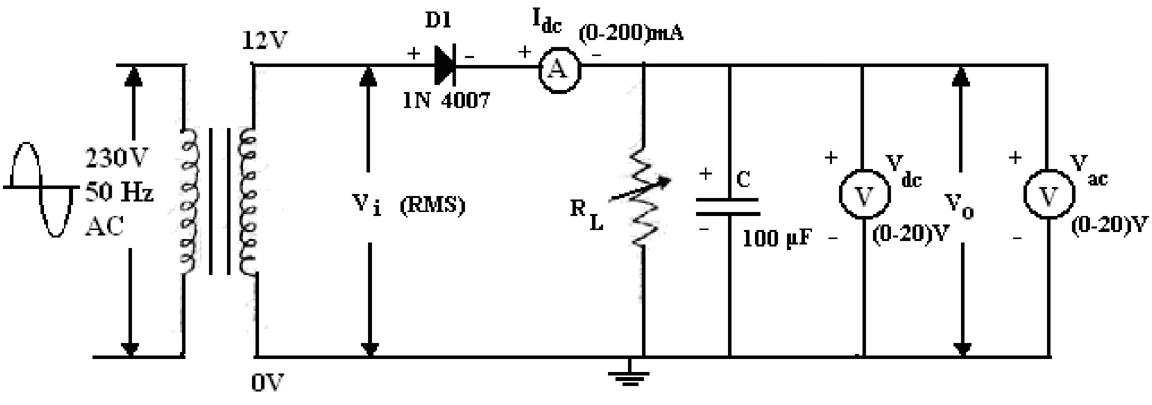
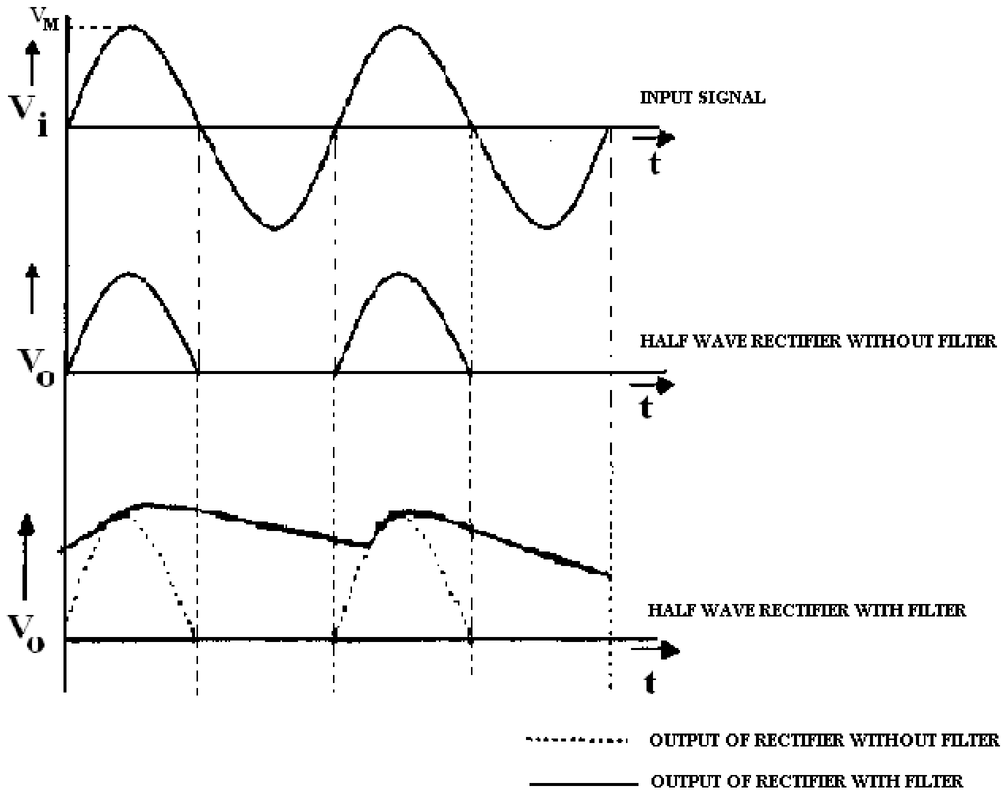


Figure (b):Half Wave Rectifier with Filter

5.6 EXPECTED GRAPHS



5.7 PRECAUTIONS

1. No loose contacts at the junctions.
2. Meters of correct ranges must be used for precision

5.8 TABULAR COLUMNS

Half Wave Rectifier without Filter

S.No	Load Resistance (R_L)	Input Voltage Peak (V_m)	Output Voltage Peak (V_o)	Average dc current (I_{dc})	Average Dc voltage (V_{dc})	RMS Voltage (V_{ac})	Ripple Factor $\gamma=\frac{V_{ac}}{V_{dc}}$

1.	500Ω						
2.	1KΩ						
3.	10KΩ						

Half Wave Rectifier with Filter C=10µF

S.No	Load Resistance (R_L)	Input Voltage Peak (V_m)	Output Voltage Peak (V_o)	Average dc current (I_{dc})	Average Dc voltage (V_{dc})	RMS Voltage (V_{ac})	Ripple Factor $\gamma = \frac{V_{ac}}{V_{dc}}$
1.	1KΩ						
2.	2KΩ						
3.	10KΩ						

5.9 PRE LAB QUESTIONS

1. What is a rectifier?
2. How Diode acts as a rectifier?
3. What is the significance of PIV? What is the condition imposed on PIV?
4. What is meant by regulation?

6. What is meant by time constant?

5.10 LAB ASSIGNMENT

Plot the wave forms of Half wave rectifier with RL=5000 ohms, C = 680µF.

5.11 POST LAB QUESTIONS

1. Draw the o/p wave form without filter?
2. Draw the o/p wave form with filter?

3. What is meant by ripple factor? For a good filter whether ripple factor should be high or low?
4. What happens to the o/p wave form if we increase the capacitor value?
5. What happens if we increase the capacitor value?

5.12 RESULT

1. Input and Output waveforms of a half-wave with /without filter are observed and plotted.
2. For Half-wave rectifier without filter-

   γ, Ripple factor at 500Ω=

   1KΩ=

   10 KΩ=

3. For Half-wave rectifier with filter:-

   γ, Ripple factor at 1KΩ, 100μF =

   2KΩ, 100μF =

   10 KΩ, 100μF =

EXPERIMENT NO: 6

FULLWAVE RECTIFIERS WITH/WITHOUT FILTER

6.1 AIM

Examine the input and output waveforms of a full wave (center tapped) rectifier without and with filters.Calculate the ripple factor with load resistance of 500Ω, 1 KΩ and 10 KΩ respectively. Calculate ripple factor with a filter capacitor of 100µF and the load of 1KΩ, 2KΩ and 10KΩ respectively.

6.2 COMPNENTS& EQUIPMENTS REQUIRED

S.No	Device	Range /Rating	Quantity (in No.s)
1.	Rectifier and Filter trainer Board Containing a) AC Supply. b) Silicon Diodes c) Capacitor	 (9-0-9) V 1N 4007 0.47µF	 1 7 1
2.	a) DC Voltmeter b) AC Voltmeter	(0-20) V (0-20) V	1 1
3.	DC Ammeter	(0-50) mA	1
4.	Cathode Ray Oscilloscope	(0-20) MHz	1
5	Decade Resistance Box	10Ω-100KΩ	1
6.	Electrolytic Capacitor	100µF	1
7.	Connecting wires	5A	12

6.3 THEORY

The circuit of a center-tapped full wave rectifier uses two diodes D1&D2. During positive half cycle of secondary voltage (input voltage), the diode D1 is forward biased and D2is reverse biased.

The diode D1 conducts and current flows through load resistor R_L. During negative half cycle, diode. D2 becomes forward biased and D1 reverse biased. Now, D2 conducts and current flows through the load resistor R_L in the same direction. There is a continuous current flow through the load resistor R_L, during both the half cycles and will get unidirectional current as show in the model graph. The difference between full wave and half wave rectification is that a full wave rectifier allows unidirectional (one way) current to the load during the entire 360 degrees of the input signal and half-wave rectifier allows this only during one half cycle (180 degree).

6.4 PROCEDURE

Full-wave Rectifier without filter

1. Connect the circuit as shown in the figure (a).
2. Adjust the load resistance R_L to 500Ωand connect a capacitor of 100μF value in parallel with the load and note the readings of input and output voltages through Oscilloscope.
3. Note the readings of DC current, DC voltage and AC voltage.
4. Now change the load resistance RL to 2000Ω and repeat the procedure as the above.
5. Readings are tabulate as per the tabular column.

Full-wave Rectifier with filter

1. Connect the circuit as shown in the figure (b).
2. Adjust the load resistance R_L to 1KΩand connect a capacitor of 100μF values in parallel with the
load and note the readings of input and output voltages through Oscilloscope.
3. Note the readings of DC current, DC voltage and AC voltage.
4. Now change the load resistance R_L to 2KΩ and repeat the procedure as the above. Also repeat for 10K, 100μF values.
4. Readings are tabulate as per the tabular column.

6.5 CIRCUIT DIAGRAMS

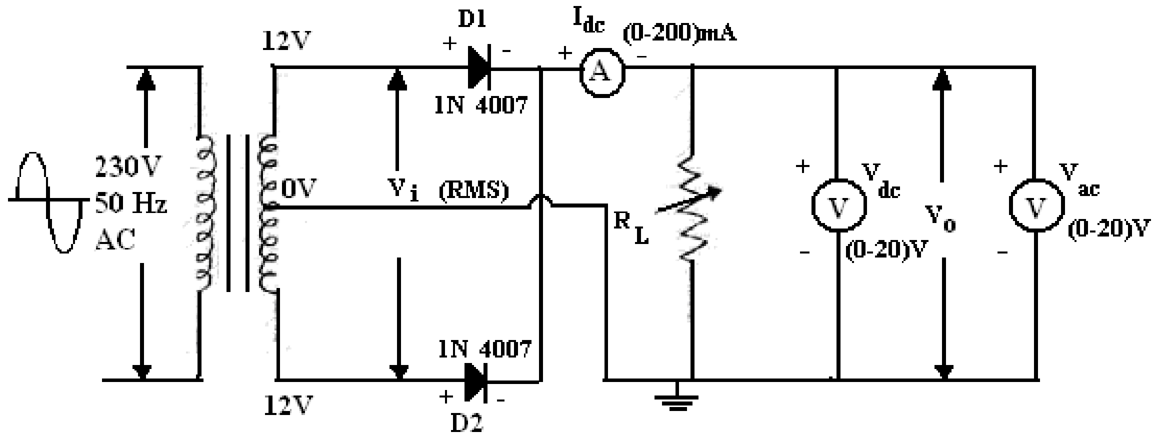


Figure (a): Full Wave Rectifier (Center-tap) Without Filter

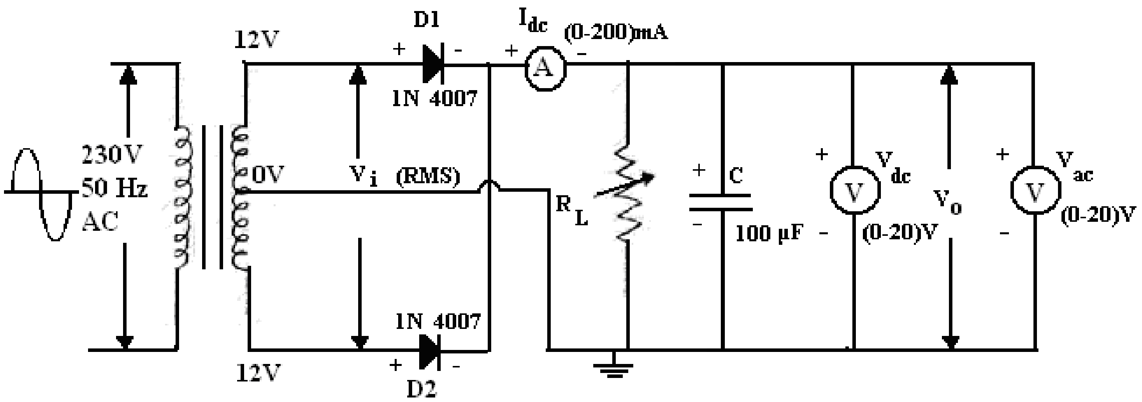
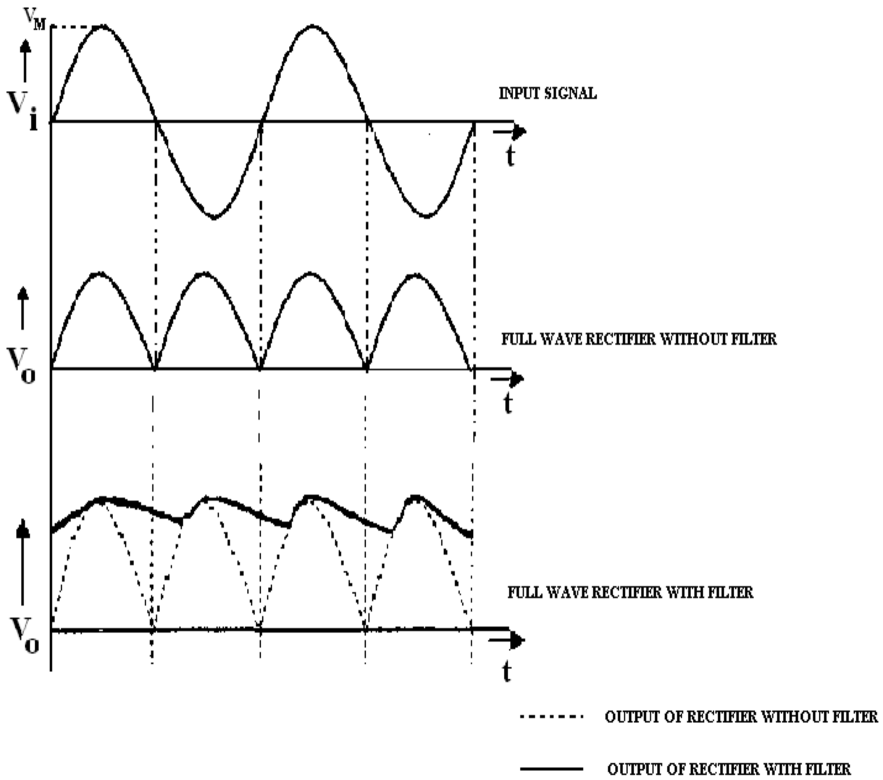


Figure (b): Full Wave Rectifier (center-tap) With Filter

6.6 EXPECTED GRAPHS



6.7 PRECAUTIONS

1. No loose contacts at the junctions.
2. Meters of correct range must be used for precision.

6.8 TABULAR COLUMNS

Full wave Rectifier (Center-tap) Without Filter

S.No	Load Resistance (R_L)	Input Voltage Peak (V_m)	Output Voltage Peak (V_o)	Average dc current (I_{dc})	Average Dc voltage (V_{dc})	RMS Voltage (V_{ac})	Ripple Factor $\gamma = \frac{V_{ac}}{V_{dc}}$
1	500Ω						
2	1KΩ						
3	10KΩ						

Full wave Rectifier (Center-tap) With Filter C = --- µF

S.No	Load Resistance (R_L)	Input Voltage Peak (V_m)	Output Voltage Peak (V_o)	Average dc current (I_{dc})	Average Dc voltage	RMS Voltage (V_{ac})	Ripple Factor

					(V_{dc})		$\gamma=\frac{V_{ac}}{V_{dc}}$
1	500Ω						
2	1KΩ						
3	10K						

6.9 PRE LAB QUESTIONS

1. What is a full wave rectifier?
2. How Diode acts as a rectifier?
3. What is the significance of PIV requirement of Diode in full-wave rectifier?
4. Compare capacitor filter with an inductor filter?
5. What is the theoretical maximum value of ripple factor for a full wave rectifier?

6.10 LAB ASSIGNMENT

Plot the wave forms of fulle wave rectifier with RL=500 ohms, C = 470µF.

6.11POST LAB QUESTIONS

1. Draw the o/p wave form without filter? Draw the O/P? What is wave form with filter?
2. What is meant by ripple factor? For a good filter whether ripple factor should be high or low? What happens to the ripple factor if we insert the filter?
3. What is meant by regulation? Why regulation is poor in the case of inductor filter?
4. What is meant by time constant?
5. What happens to the o/p wave form if we increase the capacitor value? What happens if we increase the capacitor value?

6.12 RESULT

1. Input and Output waveforms of a full-wave (center tapped) and bridge rectifier with /without filters are observed and plotted.
2. For Full-wave rectifier(center tapped) without filter-
   i. γ, Ripple factor at 500Ω, 100µF =

a. 2KΩ, 100μF =

3. For full-wave rectifier (Center tapped) with filter-

   i. γ, Ripple factor at 500Ω, 100μF =

      a. 2KΩ, 100μF =

EXPERIMENT NO: 7

TRANSISTOR CB CHARACTERISTICS AND H PARAMETER CALCULATIONS

7.1 AIM

Plot the input and output characteristics of a transistor connected in Common Base configuration.

Calculate the input resistance R_i at I_e= 12 mA, output resistance R_o at V_{CB}=8V and current gain at V_{CB} =6V.

7.2 COMPONENTS & EQUIPMENT REQUIRED

S.No	Device	Range /Rating	Quantity (in No.s)
1.	Transistor CB trainer Board Containing a) DC Power Supply. b) PNP Transistor c) Carbon Film Resistor	 (0-12) V CK100 470Ω, 1/2 W	 2 1 2
2.	a) DC Voltmeter b) DC Voltmeter	(0-1) V (0-20) V	1 1
3.	DC Ammeter	(0-50) mA	2
4.	Connecting wires	5A	12

7.3 THEORY

A transistor is a three terminal active device. T he terminals are emitter, base, collector. In CB configuration, the base is common to both input (emitter) and output (collector). For normal operation, the E-B junction is forward biased and C-B junction is reverse biased.

In CB configuration, I_E is +ve, I_C is –ve and I_B is –ve.

So, $V_{EB}=f1\ (V_{CB}, I_E)$ and $I_C=f2\ (V_{CB}, I_B)$

With an increasing the reverse collector voltage, the space-charge width at the output junction increases and the effective base width 'W' decreases. This phenomenon is known as "Early effect". Then, there will be less chance for recombination within the base region. With increase of charge gradient within the base region, the current of minority carriers injected across the emitter junction increases. The current amplification factor of CB configuration is given by,

$$\alpha= \Delta I_C / \Delta I_E$$

7.4 PROCEDURE

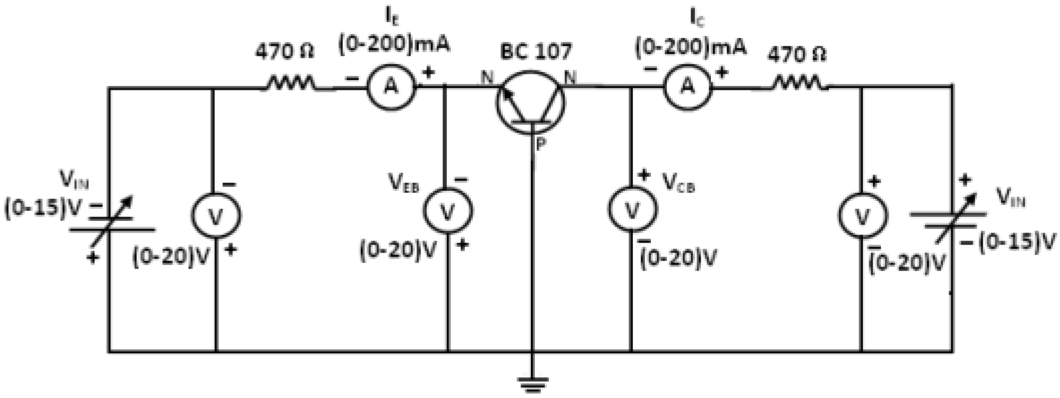
Input Characteristics:

1. Connect the transistor as shown in figure.
2. Keep the V_{CB} constant at 4V and 8V.Vary the V_{EB} in steps and note corresponding I_E values as per tabular form.

Output Characteristics:

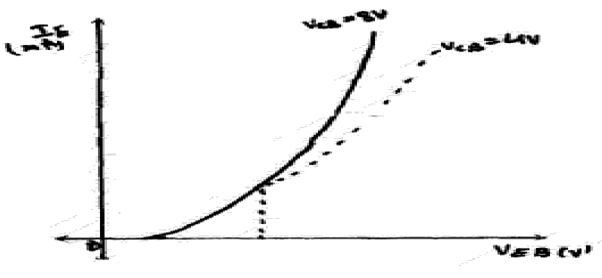
1. Keep the I_E constant at 4mA and 8mA.Vary the V_{CB} in steps and note corresponding I_C values.
2. Readings are tabulated as shown in tabular column.

7.5 CIRCUIT DIAGRAM

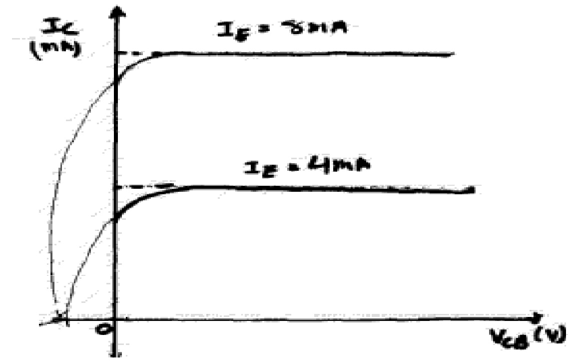


7.6 EXPECTED GRAPHS

Input Characteristics



Output characteristics:



7.7 PRECAUTIONS

1. Keep the knobs of supply voltages V_{EB} & V_{CB} at minimum positions when switching ON or switching OFF the power supply.
2. No loose contacts at the junctions.
3. Do not overload the meters above its rated ranges.

7.8 TABULAR COLUMN

Input Characteristics

V_{CB} = -4V		V_{CB} = -8V	
V_{EB} (Volts)	I_E (mA)	V_{EB} (Volts)	I_E (mA)

Output Characteristics

I_E = 8mA		I_E = 4mA	
V_{CB} (Volts)	I_C (mA)	V_{CB}(Volts)	I_C(mA)

7.9 CALCULATIONS

Input Resistance (I_E =12 mA) = $\Delta V_{EB}/\Delta I_E$ =
At V_{EB} = 4V

Input Resistance (I_E =12 mA) = $\Delta V_{EB}/\Delta I_E$ =
At V_{EB} = 8V
Output resistance (I_E =8mA) = $\Delta V_{CB}/\Delta I_C$ =
At V_{CB} = -8V.
Output resistance (I_E =4mA) = $\Delta V_{CB}/\Delta I_C$ =
At V_{CB} = -8V.
Current Amplification Factor 'α'= $\Delta I_C/\Delta I_E$ =

7.10 PRE LAB QUESTIONS

1. What is the range of α for the transistor?
2. Draw the input and output characteristics of the transistor in CB configuration?
3. Identify various regions in output characteristics?
4. What is the relation between α and β?

7.11 LAB ASSIGNMENT

Plot the I/O characteristics of CB configuration for Vcc = 12V, VEE = 6V, RE= 100K ohms, Rc = 1K ohms, α =0.98, Vbe = 0.7V.

7.12 POST LAB QUESTIONS

1. What are the applications of CB configuration?
2. What are the input and output impedances of CB configuration?
3. Define α(alpha)?
4. What is EARLY effect?
5. What is the power gain of CB configuration

7.13 RESULT

Input and output curves are plotted.

1. R_i Input Resistance:
   - (i) V_{EB} = 4V and I_E =12 mA, R_i =
   - (ii) V_{EB} = 8V and I_E =12 mA, R_i =
2. R_o Output Resistance:
   - (i) V_{CB} = 8V and I_E = 8 mA, R_o =
   - (ii) V_{CB} = 8V and I_E = 4 mA, R_o =
3. Current Amplification factor

   'α' =

   (at V_{CB} =6V)

EXPERIMENT NO: 8

TRANSISTOR CE CHARACTERISTICS AND H PARAMETER CALCULATIONS

8.1 AIM

Plot the input and output characteristics of a transistor connected in Common Emitter configuration.

Calculate the input resistance R_i at I_B= 20 μA, output resistance R_o at V_{CE}=10V and current gain at V_{CE} =10V.

8.2 COMPONENTS & EQUIPMENT REQUIRED

S.No	Device	Range /Rating	Quantity (in No.s)
1.	Transistor CE trainer Board Containing a) DC Power Supply. b) PNP Transistor c) Carbon Film Resistor	 (0-12) V BC 107 470Ω, 1/2 W 100KΩ,1/2 W	 2 1 1 1
2.	a) DC Voltmeter b)DC Voltmeter	(0-1) V (0-20) V	1 1
3.	DC Ammeter	(0-50) mA (0-200) μA	1 1
4.	Connecting wires	5A	12

8.3 THEORY

A transistor is a three terminal device. The terminals are emitter, base, collector. In common emitter configuration, input voltage is applied between base and emitter terminals and output is taken across the collector and emitter terminals.

Therefore the emitter terminal is common to both input and output.

The input characteristics resemble that of a forward biased diode curve. This is expected since the Base-Emitter junction of the transistor is forward biased. As compared to CB arrangement I_B increases less rapidly with V_{BE} . Therefore input resistance of CE circuit is higher than that of CB circuit.

The output characteristics are drawn between I_c and V_{CE} at constant $I_{B.}$ the collector current varies with V_{CE} unto few volts only. After this the collector current becomes almost constant, and independent of $V_{CE.}$ The value of V_{CE} up to which the collector current changes with V_{CE} is known as Knee voltage. The transistor always operated in the region above Knee voltage, I_C is always constant and is approximately equal to $I_{B.}$

The current amplification factor of CE configuration is given by

$$B = \Delta I_C / \Delta I_B$$

8.4 PROCEDURE

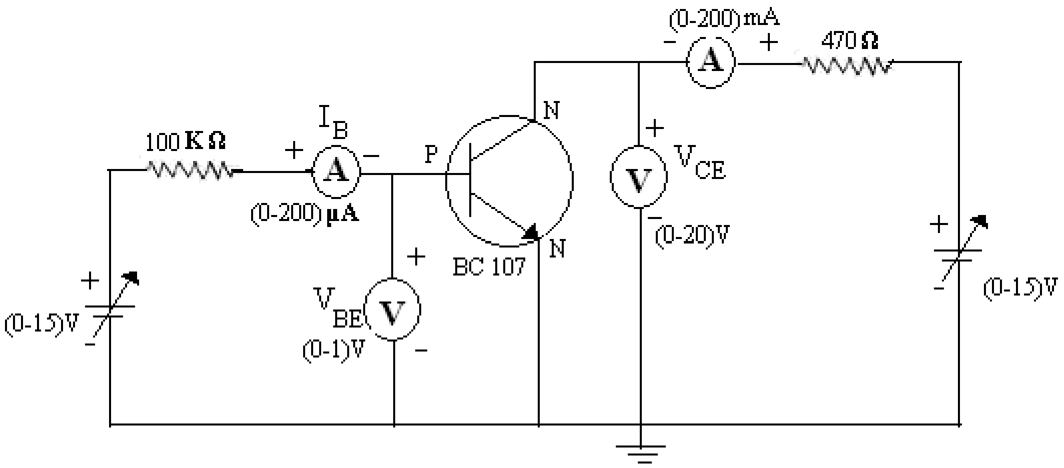
Input Characteristics:

1. Connect the transistor as shown in figure.
2. Keep the V_{CE} constant at 2V and 6V.
3. Vary the I_B in steps and note down the corresponding V_{EB} values as per tabular column.

Output Characteristics:

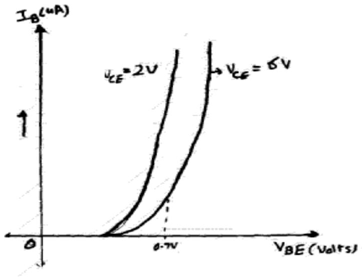
1. Keep the I_B constant at 20 μA and 40 μA.
2. Vary the V_{CE} in steps and note corresponding I_C values.
3. Readings are tabulated as shown in tabular column.

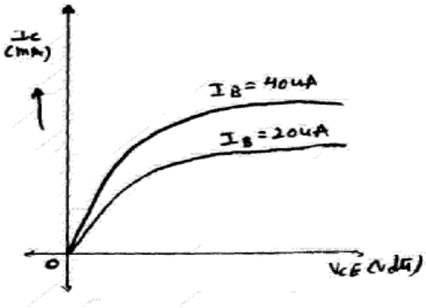
8.5 CIRCUIT DIAGRAM



8.6 EXPECTED GRAPHS

Input Characteristics **Output Characteristics**





8.7 PRECAUTIONS

1. Keep the knobs of supply voltages V_{BE} & V_{CE} at minimum positions when switching ON or switching OFF the power supply.
2. No loose contacts at the junctions.
3. Do not overload the meters above its rated ranges.

8.8 TABULAR COLUMN

Input Characteristics

V_{CB} = 2V		V_{CB} = 6V	
V_{BE} (Volts)	I_B (µA)	V_{BE} (Volts)	I_B (µA)

Output Characteristics

I_B = 20µA		I_B = 40µA	
V_{CE} (Volts)	I_C (mA)	V_{CE} (Volts)	I_C (mA)

8.9 CALCULATIONS:

Input Resistance (I_B=20µA) = $\Delta V_{BE}/\Delta I_B$ =
At V_{CE} = 2V
Input Resistance (I_B =20µA) = $\Delta V_{BE}/\Delta I_B$ =
At V_{CE}= 6V
Output resistance (V_{CE}=10V) = $\Delta V_{CE}/\Delta I_C$ =
At I_B=20µA
Output resistance (V_{CE}=10V) = $\Delta V_{CE}/\Delta I_C$ =

At I_B=20μA
Current Amplification Factor 'β'= $\Delta I_C/\Delta I_B$ =

8.10 PRE LAB QUESTIONS

What is the range of ß for the transistor?

What are the input and output impedances of CE configuration?

Identify various regions in the output characteristics?

what is the relation between α *and* ß

8.11 LAB ASSIGNMENT

Plot the I/O characteristics of CE configuration for Vcc = 10V, VBB = 4V, Rb= 200K ohms, Rc = 2K ohms, β = 200, Vbe = 0.7V.

8.12 POST LAB QUESTIONS

1 Define current gain in CE configuration?

2 Why CE configuration is preferred for amplification?

3 What is the phase relation between input and output?

4 Draw diagram of CE configuration for PNP transistor?

5 What is the power gain of CE configuration?

6 What are the applications of CE configuration?

8.13 RESULT

1. Input and Output curves are plotted.
2. R_i, Input Resistance:
   a. V_{CE} = 2V and I_B =20 μA, R_i =
   b. V_{CE} = 6V and I_B =20 μA, R_i =
3. R_o, Output Resistance:
   a. V_{CE}= 10V and I_B = 20μA, R_o =
   b. V_{CE} = 10V and I_B = 40μA, R_o =
4. Current Amplification factor

   'β' = (at V_{CE} =10V)

EXPERIMENT NO: 9

FREQUENCY RESPONSE CE AMPLIFIER

9.1 AIM

Plot the frequency response of CE amplifier and calculate gain bandwidth.

9.2 COMPONENTS & EQUIPMENTS REQUIRED

S.No	Device	Range/Rating	Quantity (in No.s)
1	CE Amplifier trainer Board with (a) DC power supply (b) DC power supply (c) NPN transistor (d) Carbon film resistor (e) Carbon film resistor (f) Capacitor	 12V 5V BC 107 100KΩ, 1/2W 2.2KΩ, 1/2W 0.1μF	 1 1 1 1 1 2
2	Function Generator	0.l Hz- 1MHz	1
3	Dual trace C.R.O	0-20MHz	1
4.	Connecting Wires	5A	4

9.3 THEORY

The CE amplifier provides high gain &wide frequency response. The emitter lead is common to both input & output circuits and is grounded. The emitter-base circuit is forward biased. The collector current is controlled by the base current rather than emitter current. The input signal is applied to base terminal of the transistor and amplifier output is taken across collector terminal. A very small change in base current produces a much larger change in collector current. When +VE half-cycle is fed to the input circuit, it opposes the forward bias of the circuit which causes the collector current to decrease, it decreases the voltage more –VE. Thus when input cycle varies through a -VE half-cycle, increases the forward bias of the circuit, which causes the collector current to increases thus the output signal is common emitter amplifier is in out of phase with the input signal.

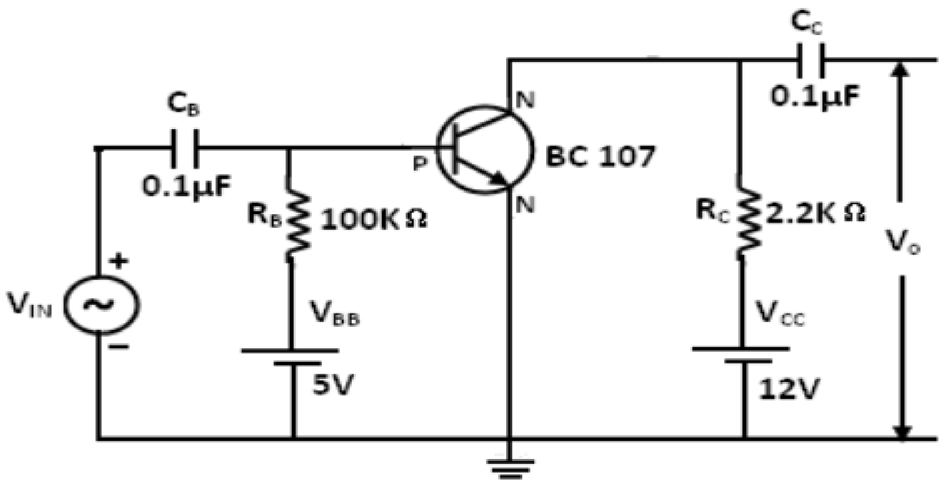
Bandwidth = f_H-f_L

9.4 PROCEDURE

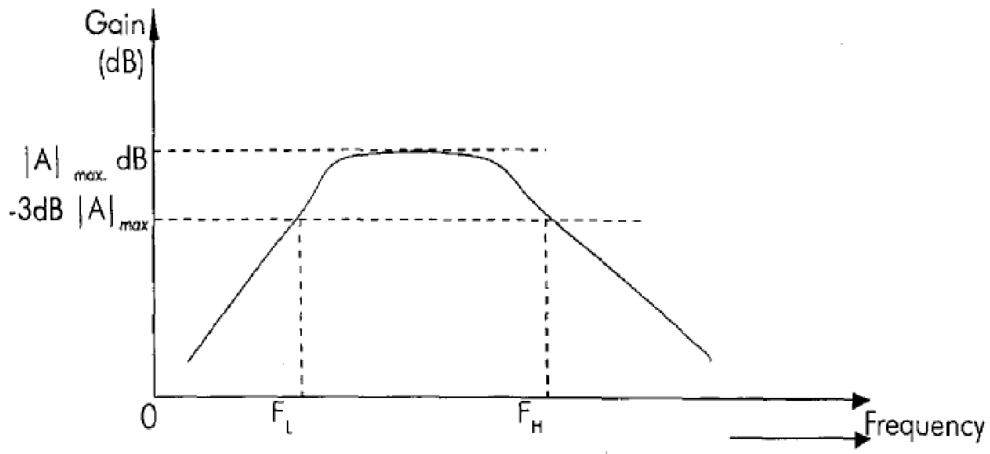
1. Connect the circuit diagram as shown in figure.
2. Adjust input signal amplitude in the function generator and observe an amplified voltage at the output without distortion.

3. By keeping input signal voltages at 50mV, vary the input signal frequency from 0 to 1MHz in steps as shown in tabular column and note the corresponding output voltages.

9.5 CIRCUIT DIAGRAM



9.6 EXPECTED GRAPH



9.7 PRECAUTIONS

1. Oscilloscope probes negative terminal should be at equipotential points (i.e. ground voltage= 0), because both terminals are internally shorted in dual trace oscilloscope.

2. Ensure that output voltage is exactly an amplified version of input voltage without any distortion (adjust input voltage amplitude to that extent).
3. No loose connections at the junctions.

9.8 TABULAR COLUMN

Input voltage: $V_i = 50mV$

Frequency (in Hz)	**Output (V_o) (Peak to Peak)**	**Gain $A_V=V_0/Vi$**	**Gain (in dB) = 20 log $_{10}$ V_O/V_i**
20			
600			
1K			
2K			
4K			
8K			
10K			
20K			
30K			
40K			
50K			
60K			
80K			
100K			
250K			
500K			
750K			
1000K			

9.9 PRE LAB QUESTIONS

1. What is an Amplifier?
2. How many types of an Amplifier?
3. What is meant Band width, Lower cut-off and Upper cut-off frequency?

9.10 LAB ASSIGNMENT

Draw the frequency response of CE amplifier using R_B =1000 ohms , R_{CE} = 4000 ohms.

9.11 POST LAB QUESTIONS

1. How much phase shift for CE Amplifier?
2. What are the applications?
3. Draw the Equivalent circuit for low frequencies?

9.12 RESULT

Frequency response of CE amplifier is plotted.

Gain, A_V = ________dB.

Bandwidth= f_H-f_L =________H

EXPERIMENT NO: 10

FREQUENCY RESPONSE OF CC AMPLIFIER

10.1 AIM

Plot the frequency response of CC amplifier and calculate gain bandwidth.

10.2 COMPONENTS & EQUIPMENTS REQUIRED

S.No	Device	Range/Rating	Quantity(in No.s)
1	CC Amplifier trainer Board with a) DC power supply b) DC power supply c) NPN transistor d) Carbon film resistor e) Carbon film resistor f) Capacitor	 12V 5V CL100 100KΩ, 1/2W 2.2KΩ, 1/2W 0.1μF	 1 1 1 1 1 2
2	Function Generator	0.l Hz- 1MHz	1
3	Dual trace C.R.O	0-20MHz	1
4.	Connecting Wires	5A	4

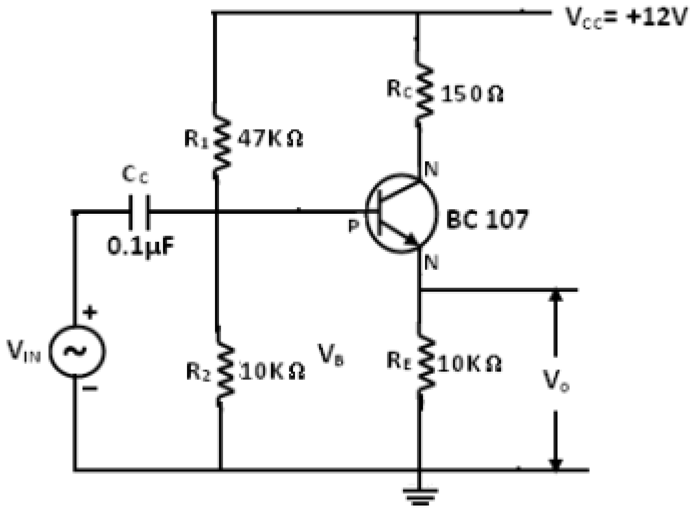
10.3 THEORY

In common-collector amplifier the input is given at the base and the output is taken at the emitter. In this amplifier, there is no phase inversion between input and output. The input impedance of the CC amplifier is very high and output impedance is low. The voltage gain is less than unity. Here the collector is at ac ground and the capacitors used must have a negligible reactance at the frequency of operation. This amplifier is used for impedance matching and as a buffer amplifier. This circuit is also known as emitter follower.

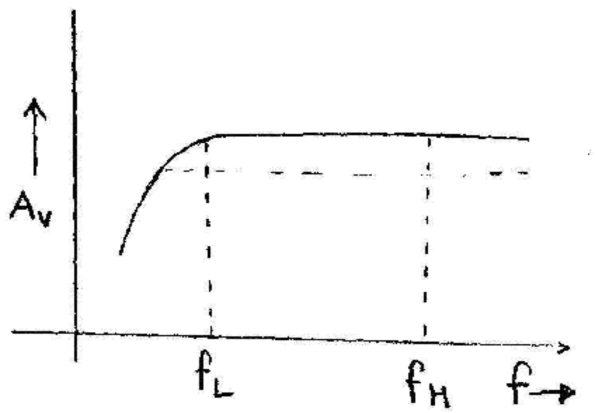
10.4 PROCEDURE

1. Connect the circuit diagram as shown in figure.
2. Adjust input signal amplitude in the function generator and observe an amplified voltage at the output without distortion.
3. By keeping input signal voltages at 50mV, vary the input signal frequency from 0 to 1MHz in steps
   as shown in tabular column and note the corresponding output voltages.

10.5 CIRCUIT DIAGRAM



10.6 EXPECTED GRAPH



10.7 PRECATIONS

1. Oscilloscope probes negative terminal should be at equipotential points (i.e. ground voltage= 0), because both terminals are internally shorted in dual trace oscilloscope.
2. Ensure that output voltage is exactly an amplified version of input voltage without any distortion (adjust input voltage amplitude to that extent)
3. No loose connections at the junctions.

10.8 TABULAR COLUMN

Input voltage: $V_i = 50mV$

Frequency (in Hz)	**Output (V_o) (Peak to Peak)**	**Gain $A_V=V_0/Vi$**	**Gain (in dB) = 20 log $_{10}$ V_O/ V_i**

20			
600			
1K			
2K			
4K			
8K			
10K			
20K			
30K			
40K			
50K			
60K			
80K			
100K			
250K			
500K			
750K			
1000K			

10.9 PRE LAB QUESTIONS

What is the other name for CC Amplifier?

What are the uses of CC Amplifier?

10.10 LAB ASSIGNMENT

Draw the frequency response of CC amplifier using R_s =900 ohms , R_l = 2000 ohms.

10.11 POST LAB QUESTIONS

Why this amplifier has got the name Emitter Follower?

What is the maximum Voltage gain of an Emitter Follower?

10.12 RESULT

Frequency response of CE amplifier is plotted.

Gain, A_V = ________dB.

Bandwidth= f_H-f_L =________Hz.

EXPERIMENT-NO-11

UJT CHARACTERSTICS

11.1 AIM

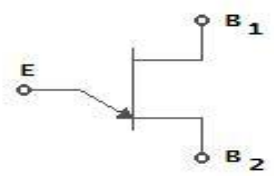
Demonstrate the Volt-ampere characteristics of silicon-controlled rectifier.

11.2 EQUIPMENT/COMPONENTS REQUIRED

S. No.	Device	Range/ Rating	Quantity
1	UJT Trainer Board Containing a) DC Power Supply b) Resistor c) UJT	 0-30V 100Ω 100KΩ	1 2 1 1 1
2	DC voltmeter	(0-20) V	2
3	DC ammeter	(0-200) mA (0-200)μA	1 1
4	Connecting wires	5A	10

11.3 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.



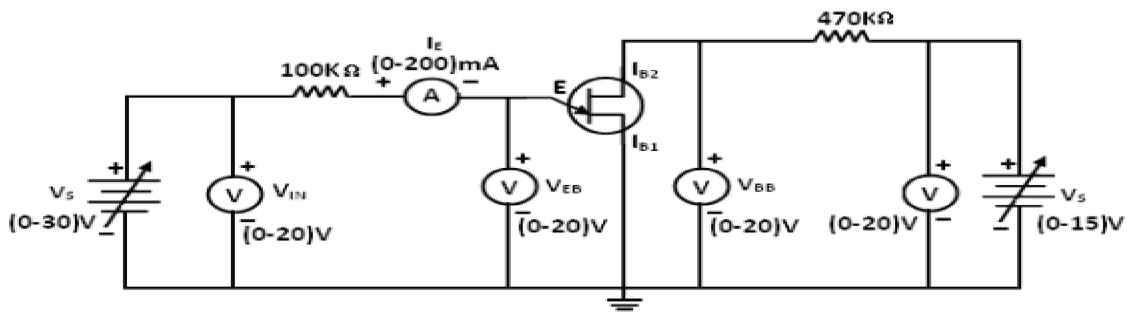
Circuit symbol

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. When the emitter voltage reaches V_p, the current starts to 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, VEB proportional to I_{E}..

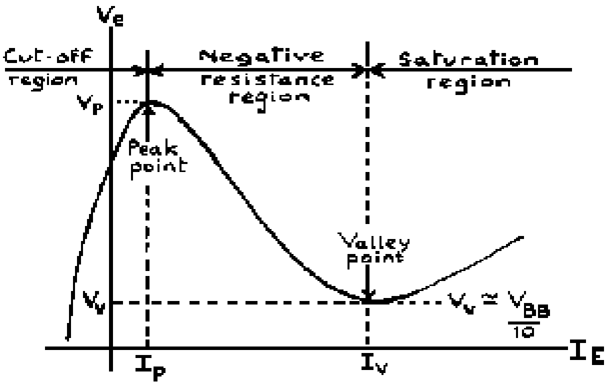
11.4 PROCEDURE

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}.

11.5 CIRCUIT DIAGRAM



11.6 EXPECTED GRAPH



11.7 TABULAR COLOUMN

V_{BB}=1V		V_{BB}=2V		V_{BB}=3V	
V_{EB}(V)	I_E(mA)	V_{EB}(V)	I_E(mA)	V_{EB}(V)	I_E(mA)

18.8 CALCULATIONS

$$V_P = \eta V_{BB} + V_D$$

$$\eta = (V_P - V_D) / V_{BB}$$

$$\eta = (\eta 1 + \eta_2 + \eta 3) / 3$$

11.9 PRE LAB QUESTIONS

What is the symbol of UJT?

Draw the equivalent circuit of UJT?

What are the applications of UJT?

Formula for the intrinsic standoff ratio?

What does it indicates the direction of arrow in the UJT?

11.10 LAB ASSIGNMENT

Plot the characteristics of UJT has a firing potential of 20V , it is connectec across the capacitor of a series RC circuit with R = 100k ohms and C = 1000Pfarads supply by a source of 40V Dc by using multisim.

11.11 POST LAB QUESTIONS

What is the difference between FET and UJT?

Is UJT is used an oscillator? Why?

What is the Resistance between B_1 and B_2 is called as?

What is its value of resistance between B_1 and $B_{2?}$

Draw the characteristics of UJT?

11.12 RESULT

The characteristics of UJT are observed and the values of Intrinsic Stand-Off Ratio are calculated.

EXPERIMENT NO: 12

SILICON CONTROLLED RECTIFIER CHARACTERSTICS

12.1 AIM

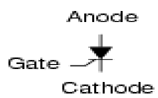
Demonstrate the Volt-ampere characteristics of silicon-controlled rectifier.

12.2 EQUIPMENT/COMPONENTS REQUIRED

S. No.	Device	Range/Rating	Quantity
1	SCR Trainer Board Containing a) DC Power Supply b) Resistor c) SCR	 0-30V 100Ω 100KΩ	1 2 1 1 1
2	DC voltmeter	(0-20) V	2
3	DC ammeter	(0-200) mA (0-200)μA	1 1
4	Connecting wires	5A	10

12.3 THEORY

It is a four layer semiconductor device being alternate of P-type and N-type silicon. It consists os 3 junctions J_1, J_2, J_3 the J_1 and J_3 operate in forward direction and J_2 operates in reverse direction and three terminals called anode A, cathode K , and a gate G. The operation of SCR can be studied when the gate is open and when the gate is positive with respect to cathode.



Schematic symbol

When gate is open, no voltage is applied at the gate due to reverse bias of the junction J_2 no current flows through R_2 and hence SCR is at cut off. When anode voltage is increased J_2 tends to breakdown.

When the gate positive, with respect to cathode J_3 junction is forward biased and J_2 is reverse biased .Electrons from N-type material move across junction J_3 towards gate while holes from

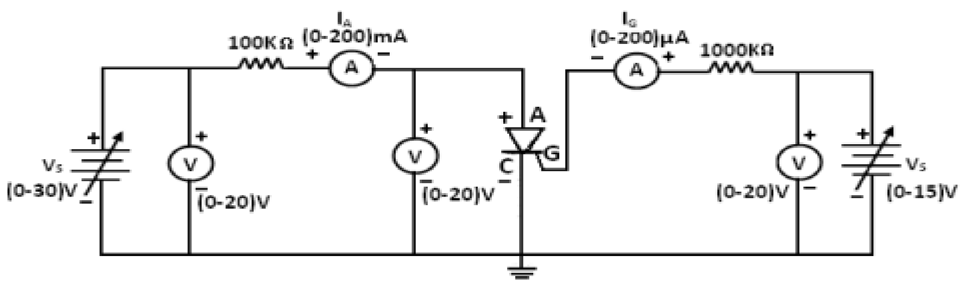
P-type material moves across junction J_3 towards cathode. So gate current starts flowing, anode current increase is in extremely small current junction J_2 break down and SCR conducts heavily.

When gate is open thee break over voltage is determined on the minimum forward voltage at which SCR conducts heavily. Now most of the supply voltage appears across the load resistance. The holding current is the maximum anode current gate being open, when break over occurs.

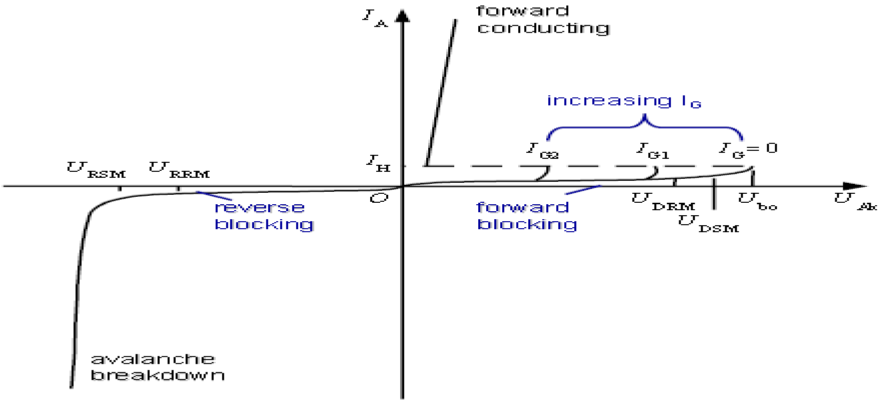
12.4 PROCEDURE

1. Connections are made as per the circuit diagram.
2. Set the both voltage sources to zero volts.
3. Switch on the SCR trainer kit.
4. Set the gate current of SCR at 60 μA in the ammeter b varying the gate power supply.
5. Now slowly vary the Anode voltage from 0 to 30 volts. Measure the voltage in the voltmeter, which is connected between anode and cathode.
6. Once SCR has fired for a particular gate current, note down anode to cathode voltage and down the gate current of SCR
7. Now increase the anode to cathode supply voltage and note down the Anode current.
8. Now repeat the steps 5 to 7 for gate currents 70 and 80μA
9. Draw the graph between Anode and Cathode voltages and the anode current for various gate currents.
10. Note down the latching and holding currents from the plot.

12.5 CIRCUIT DIAGRAM



12.6 EXPECTED GRAPH



12.7 TABULAR COLOUMN

S.No.	Gate current= ___µA		Gate current= ___µA	
	Anode to cathode voltage	**Anode current**	**Anode to cathode voltage**	**Anode current**

12.8 PRE LAB QUESTIONS

1. What the symbol of SCR?
2. IN which state SCR turns of conducting state to blocking state?
3. What is the value of forward resistance offered by SCR?

4. What is the condition for making from conducting state to non conducting state?

12.9 LAB ASSIGNMENT

Plot the reverse bias characteristics of SCR by using Multisim.

12.10 POST LAB QUESTIONS

1. What are the applications of SCR?
2. What is holding current?
3. What are the important type's thyristors?
4. How many numbers of junctions are involved in SCR?
5. What is the function of gate in SCR?
6. When gate is open, what happens when anode voltage is increased?

12.11 RESULT

1. For Gate current= 60μA Latching Current=
   Holding Current=

2. For Gate current= 60μA Latching Current =
   Holding Current=

3. For Gate current= 60μA Latching Current=
   Holding Current=

EXPERIMENT NO: 13

FET CHARACTERISTICS

13.1 AIM

a) To draw the drain and transfer characteristics of a given FET.

b) To find the drain resistance (r_d) amplification factor (μ) and TransConductance (g_m) of the given FET.

13.2 EQUIPMENT/COMPONENTS REQUIRED

S. No.	Device	Range/Rating	Quantity
1	FET BFW11 a) DC Power Supply b) Resistor c) SCR	 0-30V 100Ω 100KΩ	1 2 1 1 1
2	DC voltmeter	(0-20) V	2
3	DC ammeter	(0-200) mA (0-200)μA	1 1
4	Connecting wires	5A	10

13.3 THEORY

A FET is a three terminal device, in which current conduction is by majority carriers only. The flow of current is controlled by means of an Electric field. The three terminals of FET are Gate, Drain and Source. It is having the characteristics of high input impedance and less noise, the Gate to Source junction of the FETs 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 channel begins to remain constant. The V_{DS} at this instant is called "pinch of voltage". If the gate to source voltage (V_{GS}) is applied in the direction to provide additional reverse bias, the pinch off voltage ill is decreased. In amplifier application, the FET is always used in the region beyond the pinch-off.

FET parameters:

AC Drain Resistance, **$r_d = \Delta V_{DS} / \Delta I_D$** at constant V_{GS} Tran conductance,

$g_m = \Delta I_D / \Delta V_{GS}$ at constant V_{DS} Amplification,

$\mu = \Delta V_{DS} / \Delta V_{GS}$ at constant I_D Relation between above parameters

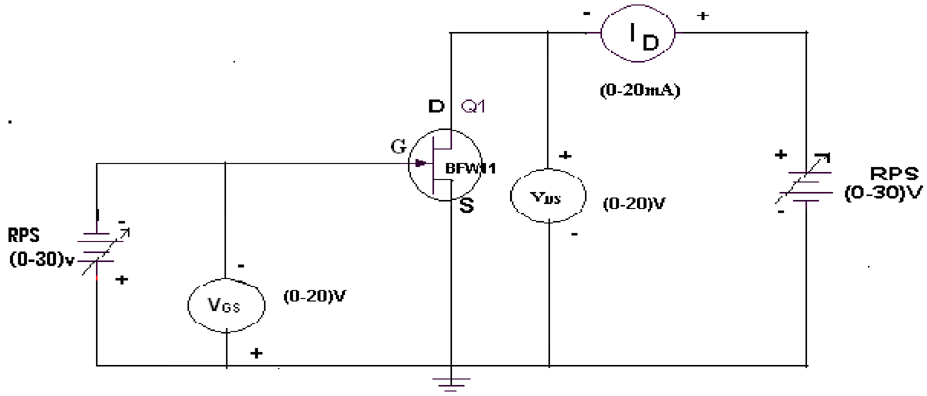
$$\mu = r_d * g_m$$

The drain current is given by

.

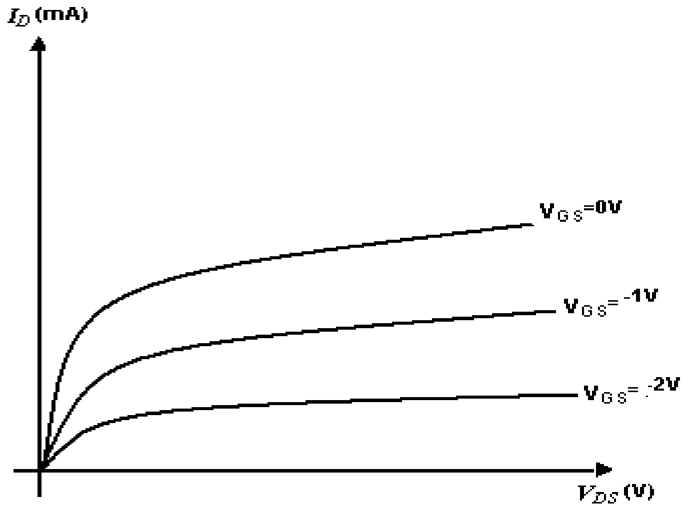
$$I_D = I_{DSS} (1 - V_{GS}/V_P)^2$$

13.4 CIRCUIT DIAGRAM:

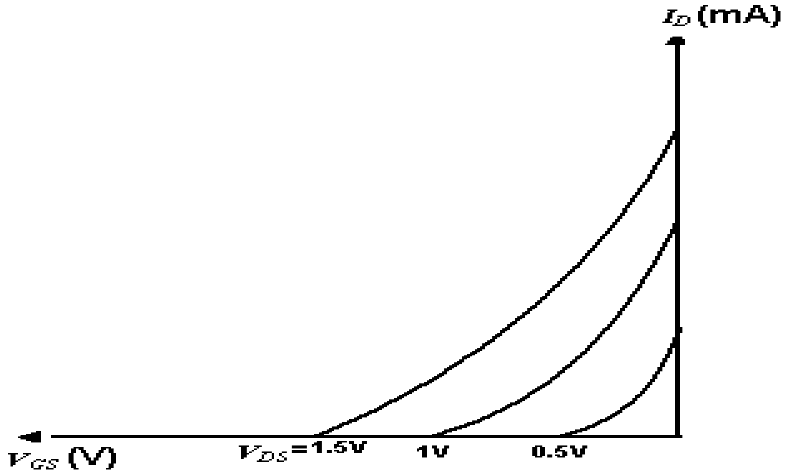


MODEL GRAPH:

A) DRAIN CHARCTERISTICS:



B) TRANSFER CHARACTERISTICS:



13.5 OBSERVATIONS:

A) DRAIN CHARACTERISTICS:

S.NO	VGS = 0V		VGS = 0.1V		VGS = 0.2V	
	VDS(V)	ID(mA)	VDS(V)	ID(mA)	VDS(V)	ID(mA)

B) TRANSFER CHARACTERISTICS:

S.NO	V_{DS} =0.5V		V_{DS} = 1V		V_{DS} = 1.5V	
	V_{GS} (V)	I_D(mA)	V_{GS} (V)	I_D(mA)	V_{GS} (V)	I_D(mA)

13.6 PROCEDURE:

1. All the connections are made as per the circuit diagram.
2. To plot the drain characteristics, keep V_{GS} constant at 0V.
3. Vary the V_{DD} and observe the values of V_{DS} and I_D.
4. Repeat the above steps 2, 3 for different values of V_{GS} at 0.1V and 0.2V.
5. All the readings are tabulated.
6. To plot the transfer characteristics, keep V_{DS} constant at 1V.
7. Vary V_{GG} and observe the values of V_{GS} and I_D.
8. Repeat steps 6 and 7 for different values of V_{DS} at 1.5 V and 2V.
9. The readings are tabulated.
10. From drain characteristics, calculate the values of dynamic resistance (r_d)
11. From transfer characteristics, calculate the value of transconductace (g_m)
12. And also calculate Amplification factor (μ).

13.7 PRECAUTIONS:

1. The three terminals of the FET must be carefully identified
2. Practically FET contains four terminals, which are called source, drain, Gate, substrate.
3. Source and case should be short circuited.
4. Voltages exceeding the ratings of the FET should not be applied.

13.8 RESULT:

13.9 VIVA QUESTIONS:

1. What are the advantages of FET?
2. Different between FET and BJT?
3. Explain different regions of V-I characteristics of FET?
4. What are the applications of FET?
5. What are the types of FET?
6. Draw the symbol of FET?
7. What are the disadvantages of FET?
8. What are the parameters of FET?

EXPERIMENT NO: 14

FREQUENCY RESPONSE OF COMMON SOURCE FET AMPLIFIER

14.1 AIM:

1. To obtain the frequency response of the common source FET Amplifier
2. To find the Bandwidth.

14.2 EQUIPMENT/COMPONENTS REQUIRED

S. No.	Device	Range/Rating	Quantity
1	FET BFW11 a) DC Power Supply b) Resistor c) SCR	 0-30V 100Ω 100KΩ	1 2 1 1 1
2	Function generator CRO CRO probes	0-25Mhz	1 1 2
3	DC voltmeter	(0-20) V	2
4	DC ammeter	(0-200) mA (0-200)µA	1 1
5	Connecting wires	5A	10

14.3 THOERY

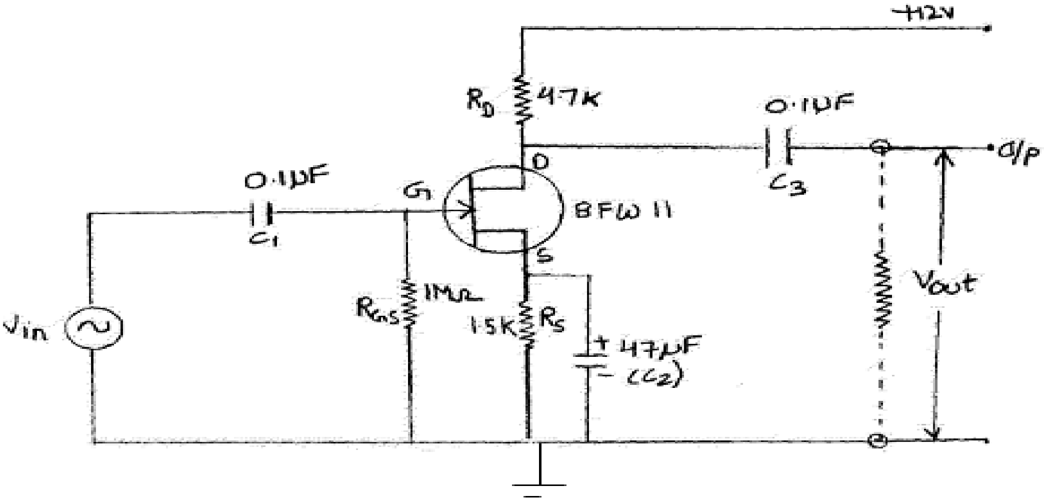
A field-effect transistor (FET) is a type of transistor commonly used for weak-signal amplification (for example, for amplifying wireless (signals). The device can amplify analog or digital signals. It can also switch DC or function as an oscillator. In the FET, current flows along a semiconductor path called the channel. At one end of the channel, there is an electrode called the source. At the other end of the channel, there is an electrode called the drain. The physical diameter of the channel is fixed, but its effective electrical diameter can be varied by the application of a voltage to a control electrode called the gate. Field-effect transistors exist in two major classifications. These are known as the junction FET (JFET) and the metal-oxide- semiconductor FET (MOSFET). The junction FET has a channel consisting of N-type semiconductor (N- channel) or P-type semiconductor (P-channel) material; the gate is made of the opposite semiconductor type. In P-type material, electric charges are carried mainly in the form of electron deficiencies called holes. In N-type material, the charge carriers are primarily electrons. In a JFET, the junction is the boundary between the channel and the gate. Normally, this P-N junction is reverse-biased (a DC voltage is applied to it) so that no current flows between the channel and the gate. However, under some conditions there is a small current through the junction during part of the input signal cycle. The FET has some advantages and some disadvantages relative to the bipolar transistor. Field-effect transistors are preferred for weak-signal work, for example in wireless, communications and broadcast receivers. They are also preferred in circuits and systems

requiring high impedance. The FET is not, in general, used for high-power amplification, such as is required in large wireless communications and broadcast transmitters.

Field-effect transistors are fabricated onto silicon integrated circuit (IC) chips. A single IC can contain many thousands of FETs, along with other components such as resistors, capacitors, and diodes.

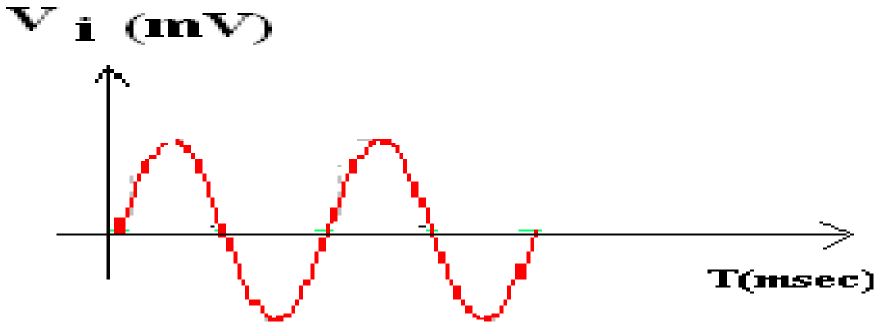
A common source amplifier FET amplifier has high input impedance and a moderate voltage gain. Also, the input and output voltages are 180 degrees out of Phase.

14.4 CIRCUIT DIAGRAM:

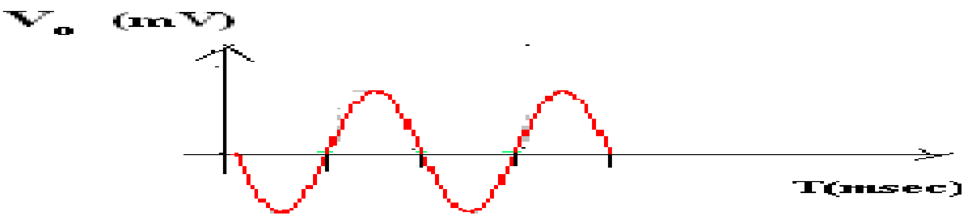


14.5 MODEL GRAPH:

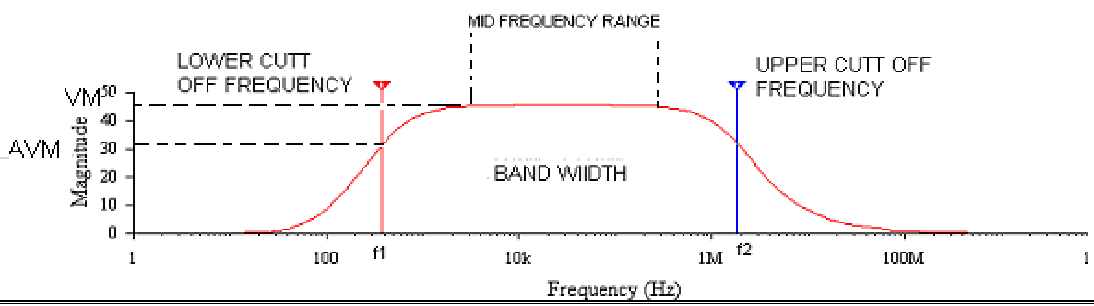
A) INPUT WAVEFORM



A) OUTPUT WAVEFORM



14.6 FREQUENCY RESPONSE PLOT:



14.7 OBSERVATIONS:

INPUT VOLTAGE (V_i) =50mv

Frequency (in Hz)	Output Voltage (V_o)	Gain $A_v=V_o/V_i$	Gain (in dB) = $20\log_{10}(V_o/V_i)$
20			
40			
80			
100			
500			
1000			
5000			
10K			
50K			
100K			
200K			
400K			
600K			
800K			

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. A signal of 1 KHz frequency and 20mV peak-to-peak is applied at the Input of amplifier.
3. Output is taken at drain and gain is calculated by using the expression,

$$A_V=V_0/V_i$$

4. Voltage gain in dB is calculated by using the expression,

$$A_V=20\log 10(V_0/V_i)$$

5. Repeat the above steps for various input voltages.
6. Plot A_V in dB Versus Frequency
7. The Bandwidth of the amplifier is calculated from the graph using the Expression,

Bandwidth BW=f2-f1

$$BW=f_2-f_1$$

Where f_1 is lower 3 dB
frequency f_2 is upper 3 dB
frequency

PRECAUTIONS:

1. All the connections should be tight.
2. Transistor terminals must be identified properly

RESULT:

VIVA QUESTIONS:

- What is the difference between FET and BJT?
- FET is unipolar or bipolar?
- Draw the symbol of FET?
- What are the applications of FET?
- FET is voltage controlled or current controlled?
- Draw the equivalent circuit of common source FET amplifier?
- What is the voltage gain of the FET amplifier?
- What is the input impedance of FET amplifier?
- What is the output impedance of FET amplifier?
- What are the FET parameters?
- What are the FET applications

EXPERIMENT NO: 15

FREQUENCY RESPONSE OF COMMON DRAIN FET AMPLIFIER

15.1 AIM

1. To obtain the frequency response of the common source FET Amplifier
2. To find the Bandwidth.

15.2 EQUIPMENT/COMPONENTS REQUIRED

S. No.	Device	Range/Rating	Quantity
1	FET BFW11 a) DC Power Supply b) Resistor c) SCR	 0-30V 100Ω 100KΩ	1 2 1 1 1
2	Function generator CRO CRO probes	0-25Mhz	1 1 2
3	DC voltmeter	(0-20) V	2
4	DC ammeter	(0-200) mA (0-200)μA	1 1
5	Connecting wires	5A	10

15.3 THOERY

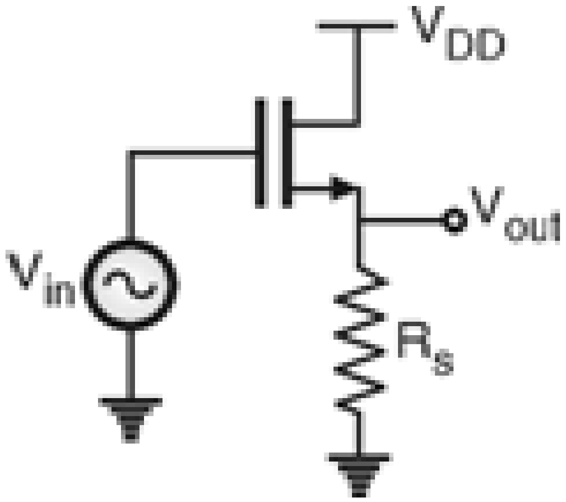
A field-effect transistor (FET) is a type of transistor commonly used for weak-signal amplification (for example, for amplifying wireless (signals). The device can amplify analog or digital signals. It can also switch DC or function as an oscillator. In the FET, current flows along a semiconductor path called the channel. At one end of the channel, there is an electrode called the source. At the other end of the channel, there is an electrode called the drain. The physical diameter of the channel is fixed, but its effective electrical diameter can be varied by the application of a voltage to a control electrode called the gate. Field-effect transistors exist in two major classifications. These are known as the junction FET (JFET) and the metal-oxide-semiconductor FET (MOSFET).

The junction FET has a channel consisting of N-type semiconductor (N- channel) or P-type semiconductor (P-channel) material; the gate is made of the opposite semiconductor type. In P-type material, electric charges are carried mainly in the form of electron deficiencies called holes. In N-type material, the charge carriers are primarily electrons. In a JFET, the junction is the boundary between the channel and the gate. Normally, this P-N junction is reverse-biased (a DC voltage is applied to it) so that no current flows between the channel and the gate. However, under some conditions there is a small current through the junction during part of the input signal cycle.

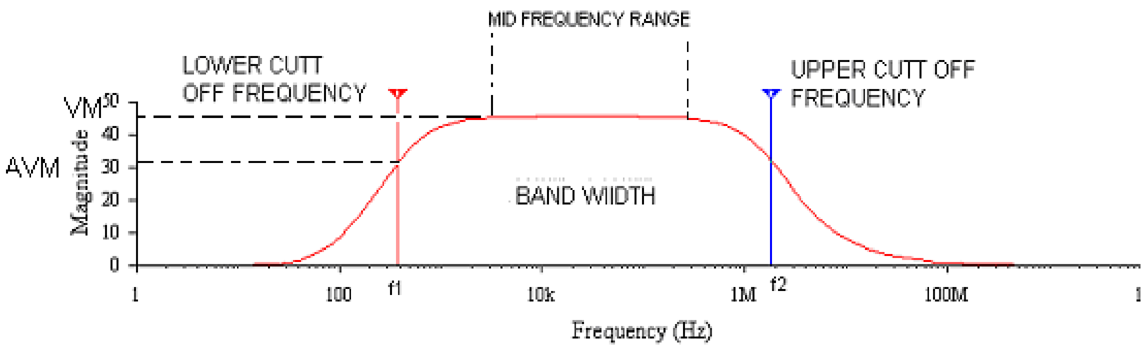
The FET has some advantages and some disadvantages relative to the bipolar transistor. Field-effect transistors are preferred for weak-signal work, for example in wireless, communications and broadcast receivers. They are also preferred in circuits and systems requiring high impedance. The FET is not, in general, used for high-power amplification, such as is required in large wireless communications and broadcast transmitters. Field-effect transistors are fabricated onto silicon integrated circuit (IC) chips. A single IC can contain many thousands of

FETs, along with other components such as resistors, capacitors, and diodes.A common source amplifier FET amplifier has high input impedance and a moderate voltage gain. Also, the input and output voltages are 180 degrees out of Phase.

15.4 CIRCUIT DIAGRAM:



15.5 FREQUENCY RESPONSE PLOT:



15.6 OBSERVATIONS:

INPUT VOLTAGE (V_i) =50mv

Frequency (in Hz)	Output Voltage (V_o)	Gain $A_v=V_o/V_i$	Gain (in dB) = $20\log_{10}(V_o/V_i)$
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40			
80			
100			
500			
1000			
5000			
10K			
50K			
100K			
200K			
400K			
600K			
800K			

15.7 PROCEDURE:

1. Connections are made as per the circuit diagram.
2. A signal of 1 KHz frequency and 20mV peak-to-peak is applied at the Input of amplifier.
3. Output is taken at drain and gain is calculated by using the expression,

$$A_V=V_0/V_i$$

4. Voltage gain in dB is calculated by using the expression,

$$A_V=20\log 10(V_0/V_i)$$

5. .Repeat the above steps for various input voltages.

15.8 PRECAUTIONS:

1. All the connections should be tight.
2. Transistor terminals must be identified properly

15.9 RESULT:

15.6 VIVA QUESTIONS:

- What is the difference between FET and BJT?
- FET is unipolar or bipolar?
- Draw the symbol of FET?
- What are the applications of FET?

BEYOND THE SYLLABUS

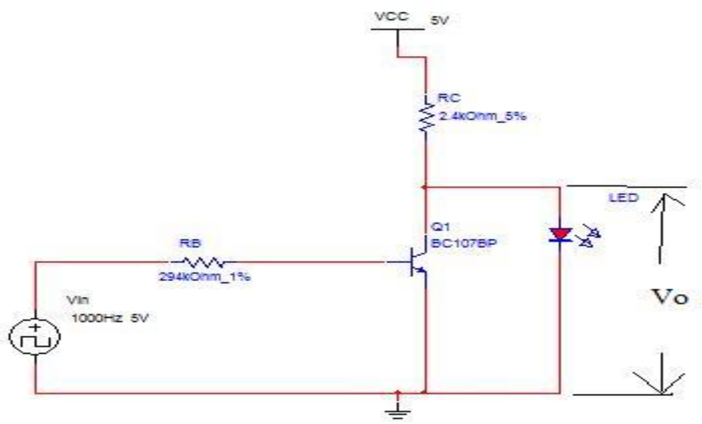
1. TRANSISTOR AS A SWITCH

1.1 **AIM:** Design a switch using BJT to switch LED, and observe the waveform, note down Vce, Vbe ON & Voff values.

1.2 **EQUIPMENT/COMPONENTS REQUIRED**

S.No	Name of the component	Specification	Quantity
1.	Resistors		1
		2.4kΩ	1
2.	Transistor	BC 107	1
3.	Bread board		1
4.	Connecting wires		1 Bunch
5.	Function generator		1
6.	CRO		1
7.	Dual Regulated Power supply	(0-30) V DC	1
8.	LED		1

1.3 **CIRCUIT DIAGRAM**



1.4 **PROCEDURE**

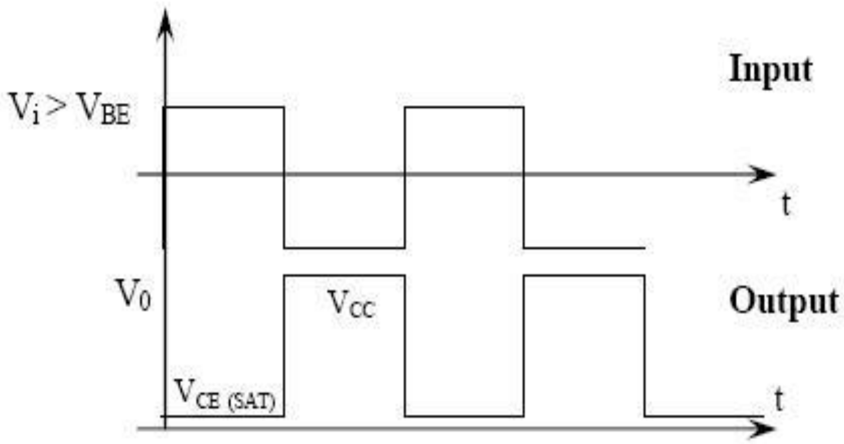
1. Connect the circuit as shown in the figure 1.
2. Connect 5V power supply to *VCC* and 0V to the input terminals.
3. Measure the voltage (a) across collector – to – emitter terminals, (b) across collector – to – base terminals and (c) Base – to – emitter terminals.
4. Connect 5V to the input terminals.
5. Measure the voltage (a) across collector – to – emitter terminals, (b) across collector – to – base terminals and (c) Base – to – emitter terminals.
6. Observe that the LED glows when the input terminals are supplied with 0 volts. The LED will NOT glow when the input voltage is 5V.
7. Remove the load (1kΩand LED) and DC power supply (connected between
8. RB and Gnd.). Now connect a function generator to the input terminals.
9. Apply Square wave of 1 KHz, V (p-p) is 5V

10. Observe the waveforms at the input terminals and across collector and ground.
11. Plot the waveform on a graph sheet. Note the inversion of the signal from input to output.

1.5 OBSERVATIONS

	V_{BE} (Volts)	V_{CE} (Volts)	V_{CB} (Volts)
When Transistor is ON			
When Transistor is OFF			

1.6 MODEL WAVEFORMS



1.7 PRE LAB QUESTIONS

What are the different switching times of a transistor?
Define ON time of a transistor?
Define OFF time of a transistor?

1.8 LAB ASSIGNMENT

Design common base amplifier.

1.9 POST LAB QUESTIONS

1. Explain how transistor acts as a switch?
2. Define delay time (td), raise time (tr), saturation time (ts) and fall time (tf) of a transistor?

1.10 RESULT

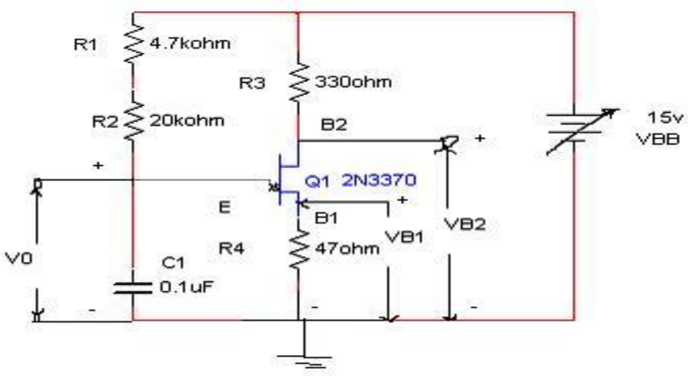
2. UJT RELAXATION OSCILLATOR

2.1 AIM: Design UJT relaxation oscillator at 200Hz, verify response and plot waveforms.

2.2 COMPONENTS / EQUIPMENTS REQUIRED

S.No	Name of the component	Specification	Quantity
1	Resistors	4.7KΩ, 470Ω, 330Ω, 20K Ω	1
2	UJT	2N3370	1
3	DRB		1
4	Capacitors	0.1 µF	1
5	RPS	0-30V	1
6	Bread board trainer		1
7	Connectibg qires		1 bunch

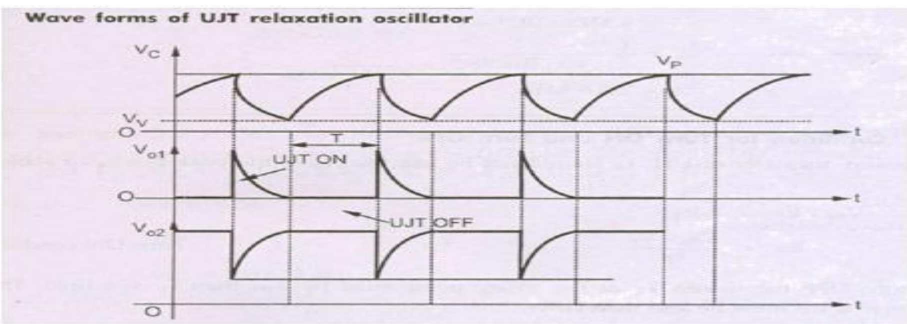
2.3 CIRCUIT DIAGRAM



2.4 PROCEDURE

1. Connections are made as per the circuit diagram.
2. The Output V_o is noted, time period is also noted.
3. The theoretical time period should be calculated.
4. $T=R_TC_T \ln(1/1-n)$
5. The Output at base 1 and base 2 should note.
6. Graph should be plotted and waveforms are drawn for V_0, V_{B1},V_{B2}.

2.5 MODEL WAVE FORMS



2.6 THEORITICAL CALCULATIONS

$T = R_T C_T \ln(1/(1-n))$ $n = (V_P - V_D)/V_{BB}$

Let η=0.56 ,R_T=24.7Kohm ,C_T=0.1microfarad Then T=

2.7 PRE LAB QUESTIONS

1. Draw the circuit symbol of double sided diode?
2. Define intrinsic-standoff ratio?

2.8 LAB ASSIGNMENT

If a 100nF capacitor is used to generate the timing pulses, calculate the timing resistor required to produce an oscillation frequency of 100Hz. (**η** = 0.65).

2.9 POST LAB QUESTIONS

1. Define peak voltage?
2. Define valley voltage?
3. Mention the names for negative resistances devices?

2.10 RESULT