A Laboratory Manual for

Basic Electronics

(3110016)

B.E. Semester___

Directorate of Technical Education, Gandhinagar, Gujarat

L. D. C.E. Ahmedabad

Certificate

This is to certify that Mr./Ms. ______________________________________ _________ Enrollment No. ________________ of B.E. Semester _____, Branch___________ of this Institute (GTU Code: 028) has satisfactorily completed the Practical work for the subject **Basic Electronics (3110016)** for the academic year ____________.

Place: ___________

Date: ___________

Name and Sign of Faculty member

Head of the Department

Preface

Main motto of any laboratory/practical/field work is for enhancing required skills as well as creating ability amongst students to solve real time problems by developing relevant competencies in the psychomotor domain. By keeping in view, GTU has designed competency focused outcome-based curriculum for engineering degree programs where sufficient weightage is given to practical work. It shows the importance of enhancement of skills amongst the students and it pays attention to utilize every second of time allotted for practical amongst students, instructors and faculty members to achieve relevant outcomes by performing the experiments rather than having merely study type experiments. It is must for effective implementation of competency focused outcome-based curriculum that every practical is keenly designed to serve as a tool to develop and enhance relevant competency required by the various industries among every student. These psychomotor skills are very difficult to develop through traditional chalk and board content delivery methods in the classroom. Accordingly, this lab manual is designed to focus on the industry-defined relevant outcomes, rather than old practice of conducting practical to prove concept and theory.

By using this lab manual students can go through the relevant theory and procedure in advance before the actual performance which creates an interest and students can have basic idea prior to performance. This in turn enhances pre-determined outcomes amongst students. Each experiment in this manual begins with competency, industry relevant skills, course outcomes as well as practical outcomes (objectives). The students will also achieve safety and necessary precautions to be taken while performing practical.

This manual also provides guidelines to faculty members to facilitate student centric lab activities through each experiment by arranging and managing necessary resources in order that the students follow the procedures with required safety and necessary precautions to achieve the outcomes. It also gives an idea that how students will be assessed by providing rubrics.

Basic Electronics is the fundamental course which deals with various components and circuits for particular applications. It provides a platform for students to learn basic components used in different circuits of all electronics as well communication circuitry. Students also learnt all Fundamental instruments used for different measurements of the circuits.

Utmost care has been taken while preparing this lab manual however always there is chances of improvement. Therefore, we welcome constructive suggestions for improvement and removal of errors if any.

Note : It is possible that the instruments, components , equipmenst available at the institute may have slightly different circuits and methodology presented here in the materials. Faculties are requested to make proper corrections according to available resources. Virtual Lab is also an effective alternative can be used as an extension to these practicals.

Practical – Course Outcome matrix

Course Outcomes (COs):

CO-1 : Analyze the general – and special-Purpose diode circuits

CO-2 : Design biasing circuits for BJT

CO-3 : Analyze BJT circuits in small signal domain

CO-4 : Analyze basic FET circuits

CO-5 : Verify the functionalities of basic digital Gates and Logic families

CO-6 : Construct and test circuit using basic electronic devices in a group

Sr. No.	**Objective(s) of Experiment**	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
1	To measure various parameters using different Instruments (Regulated power supply, Multimeter, function generator, C.R.O.) (A) To measure DC voltage and current, AC voltage and current with a multimeter. (B) To observe waveforms on an oscilloscope, measure basic parameters amplitude and frequency of sine wave, square wave and triangular wave.						
2	To obtain V-I characteristics of P-N junction diode and zener diode.	√					
3	To observe waveform at the output of half wave rectifier with and without filter capacitor. To measure DC voltage, DC current, ripple factor with and without filter capacitor	√					

4	To observe waveform at the output of full wave rectifier with and without filter capacitor. To measure DC voltage, DC current, ripple factor with and without filter capacitor	√					
5	To observe waveform at the output of bridge rectifier with and without filter capacitor. To measure DC voltage, DC current, ripple factor with and without filter capacitor	√					
6	To construct clamper circuits on breadboard and To observe waveforms at the output of clamper circuits	√					
7	To construct clipper circuits on breadboard and To observe waveforms at the output of clipper circuits	√					
8	Verify truth table of basic digital logic gates OR, AND, NOT, NAND, NOR, EX-OR, EX-NOR					√	
9	To obtain common emitter characteristics of NPN transistor		√	√			
10	To obtain common base characteristics of NPN transistor		√	√			
11	To obtain common collector characteristics of NPN transistor		√	√			
12	To design common emitter amplifier and construct circuit on breadboard. Measure gain at different frequencies and plot frequency response		√	√			
13	To understand working of transistor as a switch. To draw DC load line for given circuit.		√	√			

14	To obtain characteristics of field effect transistor (FET)				√		
15	To test individual circuit prepared by the student (Get circuit from the faculty, build it, draw circuit diagram and test it in the laboratory. Write test results in this practical) SUGGESTED: 1) V-I characteristics of LED and Photo diode 2) Construct AND gate & OR gate with help of diode and verify truth table 3) To observe input-output waveforms of common collector (CC) amplifier. To measure gain of amplifier at different frequencies and plot frequency response 4) To measure gain of FET common source (CS) amplifier						√

Industry Relevant Skills

The following industry relevant competencies are expected to be developed in the student by undertaking the practical work of this laboratory.

1. Analog Design & Product analog circuit understanding and design .
2. Support Hardware testing and Design validation.
3. Design the Product/POC/Prototype & Construct and test circuit using basic electronic devices

Guidelines for Faculty members

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain basic concepts/theory related to the experiment to the students before starting of each practical
3. Involve all the students in the performance of each experiment.
4. Teachers are expected to share the skills and competencies to be developed in the students and ensure that the respective skills and competencies are developed in the students after the completion of the experimentation.
5. Teachers should give opportunities to students for hands-on experience after the demonstration.

6. Teachers may provide additional knowledge and skills to the students even though not covered in the manual but are expected from the students by the concerned industry.
7. Give practical assignments and assess the performance of students based on tasks assigned to check whether it is as per the instructions or not.
8. Teacher is expected to refer to the complete curriculum of the course and follow the guidelines for implementation.

Instructions for Students

1. Students are expected to carefully listen to all the theory classes delivered by the faculty members and understand the COs, content of the course, teaching and examination scheme, skill set to be developed etc.
2. Students shall organize the work in the group and make a record of all observations.
3. Students shall develop maintenance skills as expected by industries.
4. Students shall attempt to develop related hand-on skills and build confidence.
5. Students shall develop the habits of evolving more ideas, innovations, skills etc. apart from those included in scope of manual.
6. Students shall refer to technical magazines and data books.
7. Student should develop a habit of submitting the experimentation work as per the schedule and s/he should be well prepared for the same.

Common Safety Instructions

1. Students must obey the safety instructions during laboratory sessions.
1. Keep the working area neat and clean to access the instruments.
2. Students should follow the instructions given by Lab assistant / Lab technicians and Faculty while performing practical.
3. Be careful while operating on equipments it is expected that more than one students or , lab assistant or faculty should remain present at the time of practicals
4. Always make circuit connections or changes after switching off the supply for the circuits/Kits.
5. Keep the resources in their designated space after the completion of practical

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(Progressive Assessment Sheet)

Sr. No.	Objective(s) of Experiment	Page No.	Date of perfor-mance	Date of submission	Assessment Marks	Sign. of Teacher with date	Remarks
0	Mission & Vision						
1	To measure various parameters using different Instruments (Regulated power supply, Multimeter, function generator, C.R.O.) (A) To measure DC voltage and current, AC voltage and current with a multimeter. (B) To observe waveforms on an oscilloscope, measure basic parameters amplitude and frequency of sine wave, square wave and triangular wave.						
2	To obtain V-I characteristics of P-N junction diode and zener diode.						
3	To observe waveform at the output of half wave rectifier with and without filter capacitor. To measure DC voltage, DC current, ripple factor with and without filter capacitor						
4	To observe waveform at the output of full wave rectifier with and without filter capacitor. To measure DC voltage, DC current, ripple factor with and without filter capacitor						
5	To observe waveform at the output of bridge rectifier with and without filter capacitor. To measure DC voltage,						

	DC current, ripple factor with and without filter capacitor						
6	To construct clamper circuits on breadboard and To observe waveforms at the output of clamper circuits						
7	To construct clipper circuits on breadboard and To observe waveforms at the output of clipper circuits						
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13	To understand working of transistor as a switch. To draw DC load line for given circuit.						
14	To obtain characteristics of field effect transistor (FET)						
15	To test individual circuit prepared by the student (Get circuit from the faculty, build it, draw circuit diagram and test it in the laboratory.						

	Write test results in this practical) SUGGESTED: 1) V-I characteristics of LED and Photodiode 2) Construct AND gate & OR gate with help of diode and verify truth table 3) To observe input-output waveforms of common collector (CC) amplifier. To measure gain of amplifier at different frequencies and plot frequency response 4) To measure gain of FET common source (CS) amplifier						
	Total						

Rubric wise marks obtained:

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)
Clarity of concepts and record book	1)The student understands the practical but struggles to identify the equipment and 2)clumsy while working on practicality.	1)The students can identify the equipment and connect the circuits properly. 2)Struggle to take proper reading.	1)The students can identify the equipment properly and 2)connect the circuits properly and arrange the equipment. 3)Take near accurate reading and can make calculations.	1)The students can clearly identify components , understand the procedures , and neatly arranges practical setup. 2)Takes proper reading, prepare graphs and calculate the needed parameters.
Knowledge and Understanding	1)Demonstrates limited knowledge and understanding of basic electronic concepts and principles. 2)Struggles to identify and explain key components and functions of electronic circuits.	1)Demonstrates some knowledge and understanding of basic electronic concepts and principles. 2)Can identify and explain key components and functions of	1)Demonstrates a solid knowledge and understanding of basic electronic concepts and principles. 2)Can identify and explain key components and functions of	1)Demonstrates a deep knowledge and understanding of basic electronic concepts and principles. 2)Can identify and explain complex components and functions of electronic circuits independently.

	3)Shows little familiarity with laboratory equipment and procedures.	electronic circuits with some guidance. 3)Shows some familiarity with laboratory equipment and procedures.	electronic circuits independently. 3)Shows a good level of familiarity with laboratory equipment and procedures.	3)Shows a high level of familiarity with laboratory equipment and procedures.
Practical Skills	1)Struggles to complete basic laboratory tasks. 2)Requires extensive guidance and assistance to use laboratory equipment. 3)Has difficulty interpreting experimental results and making conclusions.	1)Can complete basic laboratory tasks with some guidance. 2)Requires some guidance and assistance to use laboratory equipment. 3)Can interpret experimental results with some accuracy, but has difficulty making conclusions.	1)Can complete laboratory tasks independently and efficiently. 2)Has a good level of proficiency in using laboratory equipment. 3)Can interpret experimental results accurately and make well-supported conclusions.	1)Can complete complex laboratory tasks independently and efficiently. 2)Has a high level of proficiency in using laboratory equipment. 3)Can analyze experimental results and draw sophisticated conclusions.

Experiment No: 0

Vision and Mission of DTE:

Vision and Mission of Institute:

Vision and Mission of Department:

Program Objectives:

Program Outcome (PO)

Engineering Graduates will be able to:

PO1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics,natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes:

1) Graduates will apply knowledge in the area of Analog Electronics, Digital Electronics, Communication Engineering.

2) Graduates will demonstrate an ability to design, formulate and solve the implementation aspects problems with the electronics systems and products.

3) Graduate will demonstrate viable project involving analysis, design, and implementation and testing of substantial hardware, software or any combination thereof in the various applications, with emerging technologies

Program Educational Objectives:

Course Outcomes:

CO-1 : Analyze the general – and special-Purpose diode circuits

CO-2 : Design biasing circuits for BJT

CO-3 : Analyze BJT circuits in small signal domain

CO-4 : Analyze basic FET circuits

CO-5 : Verify the functionalities of basic digital Gates and Logic families

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Experiment No: 01

Study of Multimeter & CRO and Measurement of Voltage & current, Amplitude & Frequency

Date:

Competency and Practical Skills: After this practical students are expected to develop following competencies and skills,

1) Proper understanding of Multimeter and CRO and Measurements as these are the most basic set of measurement instruments
2) Knowledge of Working of Multimeter and CRO, various available functionalities how to use it in measurements
3) Practical hands of Multimeter and CRO and Troubleshooting skills in case of not getting the desired results.

Relevant CO: CO-1: Analyze the general – and Special-Purpose diode circuits

Objectives:

1) To achieve mentioned competency and have hands on of the Multimeter and CRO
2) To be able to measure AC and DC voltage and current in the circuitry.
3) To be able to calculate frequency, Amplitude and various shifts from the CRO which will enable them to understand and use DSO effectively.
4) Troubleshoot the instrument in case of not getting desired results.
5) Study of CRO and to find the Amplitude and Frequency using CRO.
6) To measure the Unknown Frequency & Phase difference using CRO.

Equipment/Instruments: Digital Multimeter, Cathode-ray oscilloscope, Function Generator, Regulated Power supply, Decade Resistance Box (DRB), CRO Probes and Bread Board.

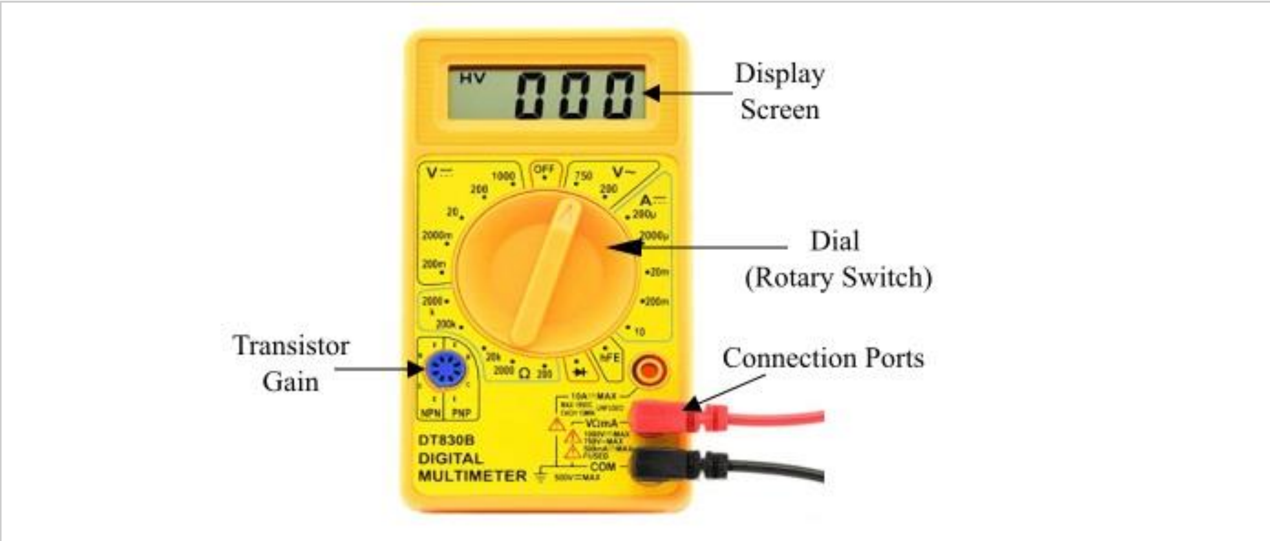
[A] MULTIMETER:

Theory:

A digital multimeter (DMM) is a measuring instrument used to measure various electrical quantities. The standard measurements that are performed by a DMM are current, voltage and resistance. Apart from these, a digital multimeter can also measure temperature, frequency, capacitance, continuity, transistor gains etc.

DMM Controls and Connection Ports

A typical DMM has a rotary switch, digital display and connecting jacks for the probes. Let’s



see the various parts of DMM in somewhat details −

Display − The DMM has an illuminated display screen for better visualization. Most DMM have four digit display, the first of which can only be either a 0 or 1 and a + / - indication as well. There may also be some more indicators like AC / DC etc.

Connection Ports − There are three or four ports available on the front of the DMM. However, only two are needed at a time. Typical ports of the DMM are −Common − It is used with all measurements. The negative (black) probe is connected to this.

VΩmA Port − This port is used for the most measurements and positive (red)probe is connected to it.

10A Port − It is used to measure the large currents in the circuits.

Dial (Selection Knob) − There is a rotary switch to select the types of measurement to be made and range that is needed.

Additional Connections − There are some additional connections in DMM for other measurements like temperature, transistor gains etc.

Additional Buttons and switches − There are a few additional buttons are present in a DMM. The main one is ON/OFF button.

Measurements using Digital Multimeter:

Measuring Current:

To measure current, the circuit must be broken at the point where we want that current to be measured, and the ammeter inserted at that point. In other words, an ammeter must be connected in series with the load under test. It is very important that the insertion of the ammeter into a circuit has little effect the circuit ‘s existing resistance and, thus, alter the current normally flowing in the circuit, ammeters are manufactured with very low values of internal resistance. Because ammeters have a very low internal resistance, it is vitally important that they are never inadvertently connected in parallel with any circuit component —and especially with the supply. Failure to do so will result in a short-circuit current flowing through the instrument which may damage the ammeter (although most ammeters are fused) or even result in personal injury.

Measuring Voltage:

To measure potential-difference, or voltage, a voltmeter must be connected between two points at different potentials. In other words, a voltmeter must always be connected in parallel with the part of the circuit under test. In order to operate, a voltmeter must, of course, draw some current from the circuit under test, and this can lead to inaccurate results because it can interfere with the normal condition of the circuit. We call this the ‗loading effect ‘and, to minimize this ‗loading effect ‘(and, therefore, improve the accuracy of a reading), this operating current must be as small as possible and, for this reason, voltmeters are manufactured with a very high value of internal resistance —usually many megohms

<u>Procedure:</u>

1. Turn the meter ON.
2. Insert the probes into the correct connecting ports.
3. Set the dial (rotary switch) to the correct measurement type and range for the measurement to be made. While selecting the range, ensure that the maximum range is above than that is expected. Optimize the range for the best reading. If possible enable all the leading digits to not read zero, in this way the greatest number of significant digits can be read.

4. Once the measurement is completed, it is a wise precaution to place the probes into the voltage measurement ports and turn the range to maximum voltage. So that if the meter probes are accidentally connected across a high voltage point, there is a little chance of damage to the DMM.

Circuit Diagram: Teacher can give any basic circuit for basic voltage and current measurement

Obsevations:

[B] CRO:

Theory: An outline explanation of how an oscilloscope works can be given using the block diagram shown below.

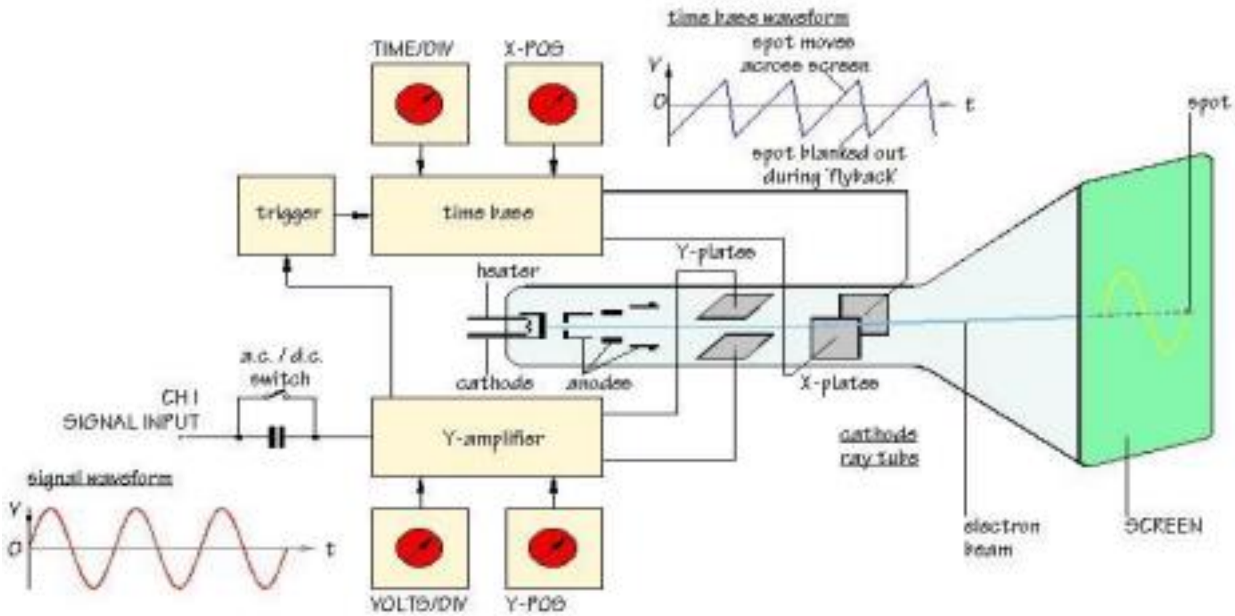


Fig. 1: Cathode Ray Oscilloscope

Like a television screen, the screen of an oscilloscope consists of a Cathode Ray Tube. Although the size and shape are different, the operating principle is the same. Inside the tube is a vacuum. The electron beam emitted by the heated cathode at the rear end of the tube is accelerated and focused by one or more anodes, and strikes the front of the tube, producing a bright spot on the phosphorescent screen.

The electron beam is bent, or deflected, by voltages applied to two sets of plates fixed in the tube. The horizontal deflection plates or X-plates produce side to side movement. As you can see, they are linked to a system block called the time base. This produces a saw tooth waveform. During the rising phase of the saw tooth, the spot is driven at a uniform rate from left to right across the front of the screen. During the falling phase, the electron beam returns rapidly from right ot left, but the spot is 'blanked out' so that nothing appears on the screen. In this way, the time base generates the X-axis of the V/t graph.

The slope of the rising phase varies with the frequency of the saw tooth and can be adjusted, using the TIME/DIV control, to change the scale of the X-axis. Dividing the oscilloscope screen into squares allows the horizontal scale to be expressed in seconds, milliseconds or microseconds per division (s/DIV, ms/DIV, µs/DIV). Alternatively, if the squares are 1 cm apart, the scale may be given as s/cm, ms/cm or µs/cm.

The signal to be displayed is connected to the **input**. The AC/DC switch is usually kept in the DC position (switch closed) so that there is a direct connection to the **Y-amplifier**. In the AC position (switch open) a capacitor is placed in the signal path. The capacitor blocks DC signals but allows AC signals to pass.

The Y-amplifier is linked in turn to a pair of Y-plates so that it provides the Y-axis of the the V/t graph. The overall gain of the Y-amplifier can be adjusted, using the VOLTS/DIV control, so that the resulting display is neither too small nor too large, but fits the screen and can be seen clearly. The vertical scale is usually given in V/DIV or mV/DIV.

Changing the scales of the X-axis and Y-axis allows many different signals to be displayed. Sometimes, it is also useful to be able to change the positions of the axes. This is possible using the X-POS and Y-POS controls. For example, with no signal applied, the normal trace is a straight line across the centre of the screen. Adjusting Y-POS allows the zero level on the Y-axis to be changed, moving the whole trace up or down on the screen to give an effective display of signals like pulse waveforms which do not alternate between positive and negative values.

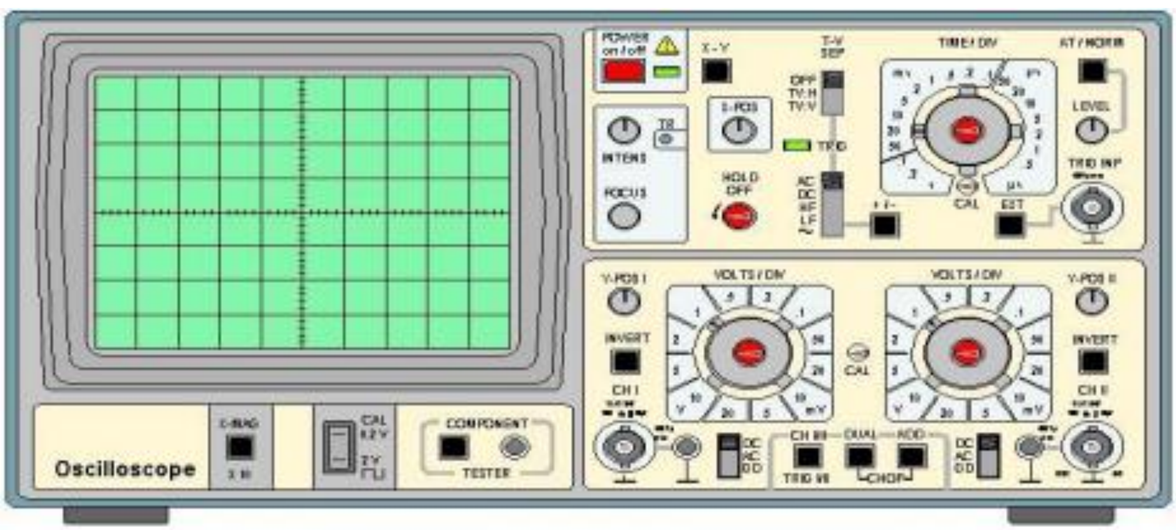


Fig. 2: Front View of Oscilloscope

Screen: Usually displays a *V*/*t* graph, with voltage *V* on the vertical axis and time *t* on the horizontal axis. The scales of both axes can be changed to display a huge variety of signals.

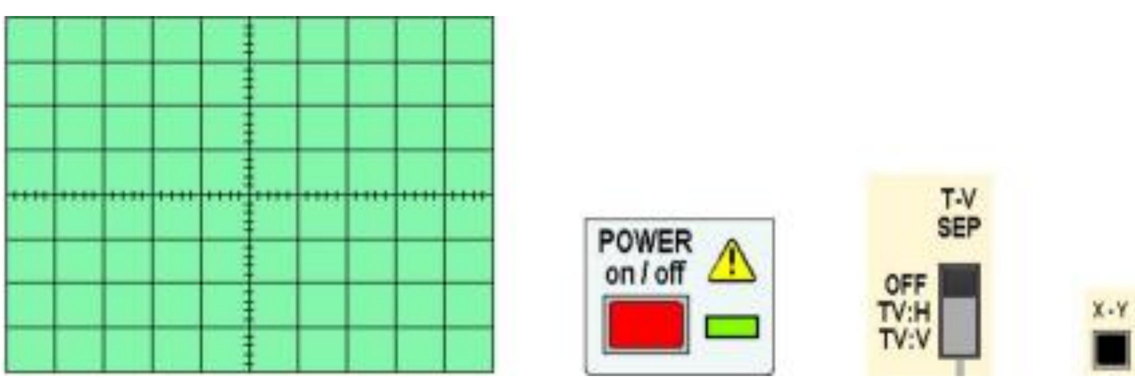


Fig. 3: Screen display of Oscilloscope

On/Off Switch: Pushed in to switch the oscilloscope on. The green LED illuminates.

X-Y Control: Normally in the OUT position.

When the X-Y button is pressed IN, the oscilloscope does not display a *V*/*t* graph. Instead, the vertical axis is controlled by the input signal to CH II. This allows the oscilloscope to be used to display a *V*/*V* voltage/voltage graph.

The X-Y control is used when you want to display component characteristic curves, or Lissajous figures. (Links to these topics will be added later.)

TV-Separation: Oscilloscopes are often used to investigate waveforms inside television systems. This control allows the display to be synchronized with the television system so that the signals from different points can be compared.

Time / Div: Allows the horizontal scale of the *V*/*t* graph to be changed.

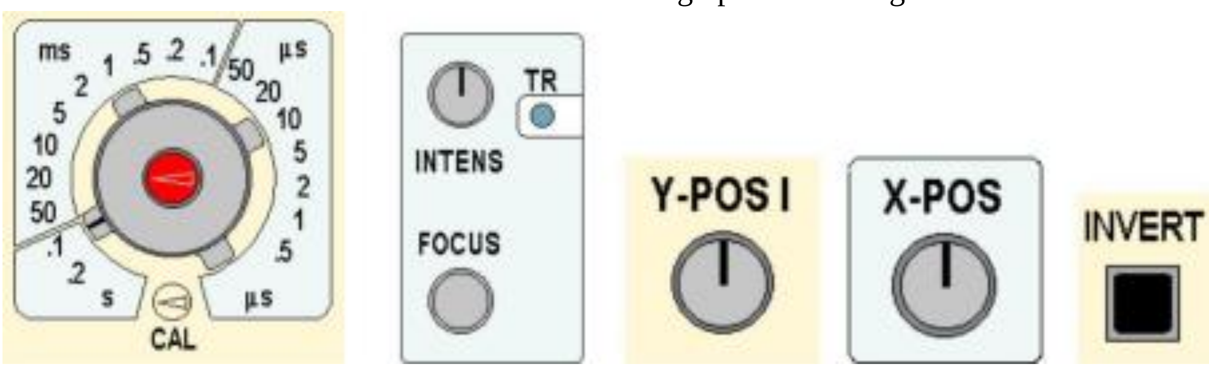


Fig. 4: Time division, Intensity, focus, X-Y mode knobs

With more experience of using the oscilloscope, you will develop a clear understanding of the functions of the important trigger controls and be able to use them effectively.

Intensity and Focus: Adjusting the INTENSITY control changes the brightness of the oscilloscope display. The FOCUS should be set to produce a bright clear trace.

If required, TR can be adjusted using a small screwdriver so that the oscilloscope trace is exactly horizontal when no signal is connected.

Volts / Div: Adjust the vertical scale of the *V*/*t* graph. The vertical scales for CH I and CH II can be adjusted independently.

DC/AC/GND Slide Switches: In the DC position, the signal input is connected directly to the Y-amplifier of the corresponding channel, CH I or CH II. In the AC position, a capacitor is connected into the signal pathway so that DC voltages are blocked and only changing AC signals are displayed.

In the GND position, the input of the Y-amplifier is connected to 0 V. This allows you to check the position of 0 V on the oscilloscope screen. The DC position of these switches is correct for most signals.

Measurement of Amplitude & Frequency:

Model waveforms:

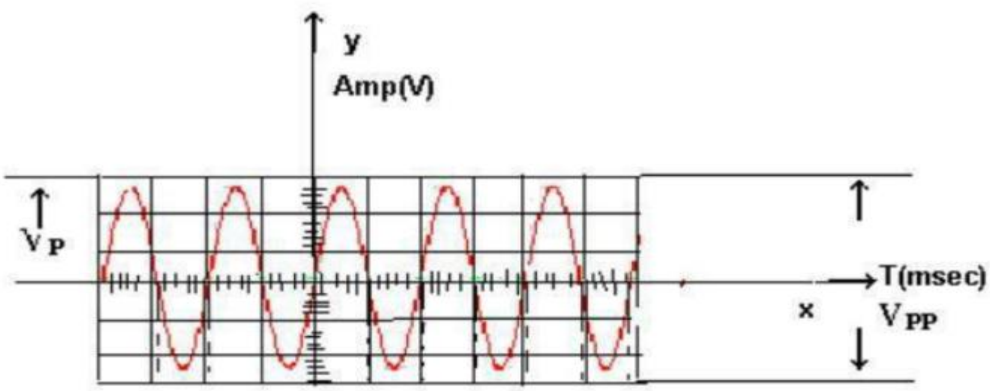


Fig. 7: Sinusoidal waveform

A) Measurement of Amplitude:

Procedure:

1. Make the connections as per the diagram shown above.
2. Put the CRO on a single channel mode and bring the CRO into operation by adjusting the trace of the beam to a normal brightness and into a thin line.
3. Now apply the sinusoidal wave of different amplitudes by using the LEVEL and COARSE buttons of the function generator.
4. Note on the vertical scale the peak to peak amplitude (Vpp).

Observations:

S. No.	No. of Vertical Divisions (X)	Volts/Division (Y)	Vp-p=X*Y	Measured Vm=Vp-p/2 using CRO	Input Vm from Function Generator

B) Measurement of Frequency:

Procedure:

1. Make the connections as per the diagram shown above.
2. Put the CRO on a single channel mode and bring the CRO into operation by adjusting the trace of the beam to a normal brightness and into a thin line.
3. Now apply the sinusoidal wave of different frequencies by using the LEVEL and COARSE buttons of the function generator.
4. Note down the horizontal scale period (T) in second by observing the difference between the two successive peaks of the waveform.

Observations:

S. No.	No. of Horizontal Divisions(X)	Time/Division (Y)	T=X*Y	Measured f=1/T using CRO	Input f from Function Generator

Result:

Conclusion:

Quiz:

1) List out the functions of the multimeter.

2) Draw a simple circuit diagram by placing voltmeter and ammeter to measure voltage and current respectively.

3) Which parameters of signal can be measured using CRO?

4) Give the max range of voltage and frequency that your CRO can measure.

Suggested Reference:

https://www.tutorialspoint.com/electronic_measuring_instruments/measuring_instruments.htm

References used by the students:

Insert the marks according to observations ;

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No: 2

Obtain V-I characteristic of P-N junction Diode and Zener Diode .

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills ,

1) Proper understanding of Diode functioning
2) Knowledge of V-I characteristics of Diode
3) Practical hands and observation of diode voltages and current.

Relevant CO: CO-1 : Analyze the general – and special-Purpose diode circuits

Objectives: 1) To perform an Experiment to Study forward bias and reverse bias characteristics of P-N Junction Diode and zener diode.

2) Observe and calculate diode voltages and current

Equipment/Instruments: Trainer kit, Power supply, Patch cords, Digital Multimeters, PN junction Diode ,Zener Diode, Resistors , bread board, Connectors

[A] PN Junction Diode:

<u>Theory:</u>

Donor impurities (pentavalent) are introduced into one-side and acceptor impurities into the other side of a single crystal of an intrinsic semiconductor to form a p-n diode with a junction called depletion region (this region is depleted off the charge carriers). This region gives rise to a potential barrier called Cut-in Voltage. This is the voltage across the diode at which it starts conducting. The P-N junction can conduct beyond this potential.

Forward bias :

The P-N junction supports uni-directional current flow. If +ve terminal of the input supply is connected to anode (P-side) and –ve terminal of the input supply is connected the cathode. Then diode is said to be forward biased. In this condition the height of the potential barrier at the junction is lowered by an amount equal to given forward biasing voltage. Both the holes from p-side and electrons from n-side cross the junction simultaneously and constitute a forward current from n-side (injected minority current – due to holes crossing the junction and entering P- side of the diode). Assuming current flowing through the diode to be very large, the diode can be approximated as short- circuited switch.

Reverse bias:

If –ve terminal of the input supply is connected to anode (p-side) and +ve terminal of the input supply is connected to cathode (n-side) then the diode is said to be **reverse biased**. In this condition an amount equal to reverse biasing voltage increases the height of the potential barrier at the junction. Both the holes on P-side and electrons on N-side tend to move away from the junction there by increasing the depleted region. However the process cannot continue indefinitely, thus a small current called reverse saturation current continues to flow in the diode. This current is negligible hence the diode can be approximated as an open circuited switch.

Circuit diagram:

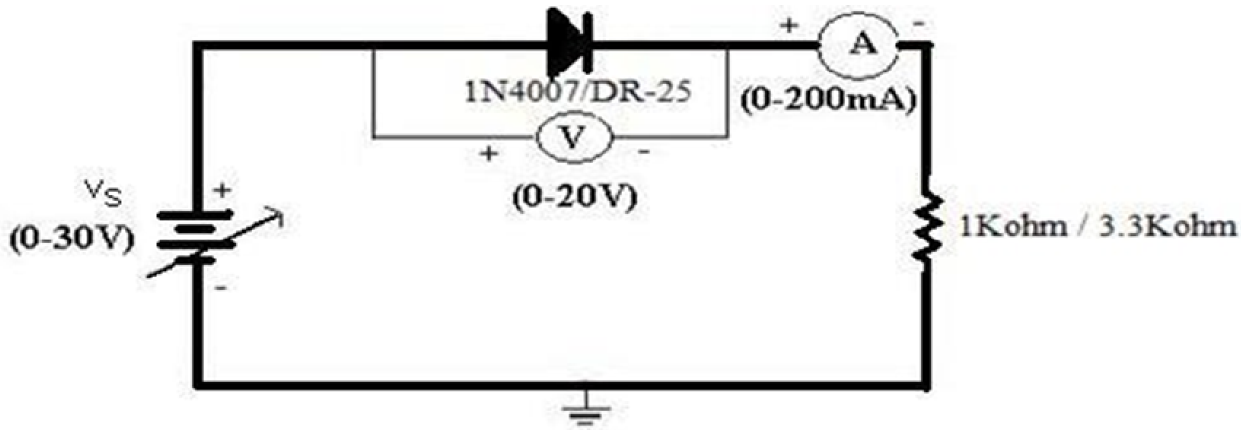


Fig. 1: Forward Bias Condition

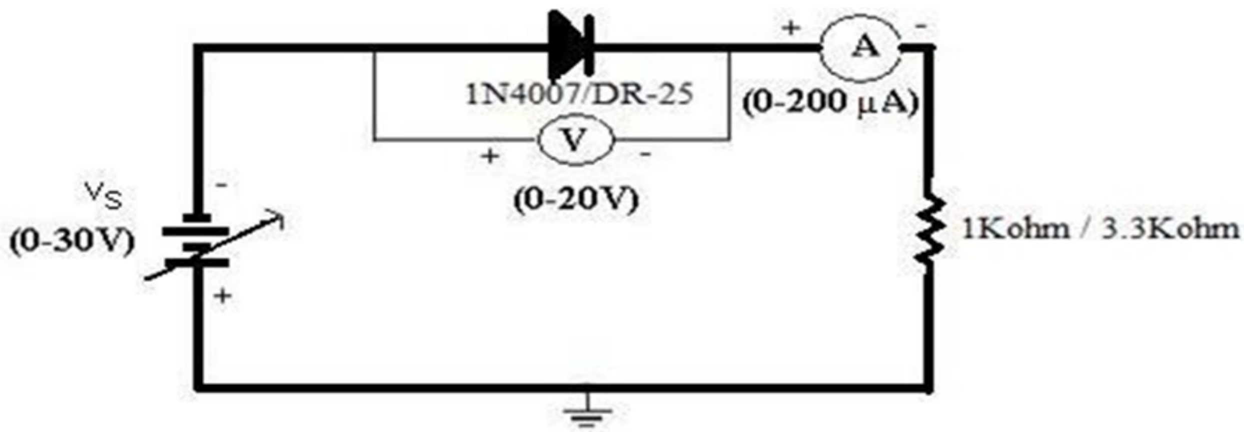


Fig. 2: Reverse Bias Condition

Safety and necessary Precautions:

1. While doing the experiment do not exceed the readings of the diode. This may lead to damaging of the diode.

2. Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.

3. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure:

Forward Bias Condition:

1. Connect the components as shown in the Fig.1.

2. Vary the supply voltage such that the voltage across the Silicon diode varies from 0 to 0.6 V in steps of 0.1 V and in steps of 0.02 V from 0.6 to 0.76 V. In each step record the current flowing through the diode as Id and Voltage across diode Vd.

3.Repeat the above steps for Germanium diode too but with the exception that the voltage across the diode should be varied in steps of 0.01 V from 0.1 to 0.3 V in step-2.

Reverse Bias Condition:

1. Connect the diode in the reverse bias as shown in the Fig.2.

2.Vary the supply voltage such that the voltage across the diode varies from 0 to 10V in steps of 1V. Record the current flowing through the diode Id and Voltage across diode Vd in each step.

3. Repeat the above steps for Germanium diode too and record the current in each step.

4. Now plot a graph between the voltage across the diode and the current flowing through the diode in forward and reverse bias, for Silicon and Germanium diodes on separate graph sheets. This graph is called the V-I characteristics of the diodes.

5. Calculate the static and dynamic resistance of each diode in forward and reverse bias using the following formulae.

Static resistance, $R = V/I$

Dynamic resistance, $r = \Delta V/\Delta I$

Graph:

1. Take a graph sheet and divide it into 4 equal parts. Mark origin at the center of the graph sheet.

2. Now mark +ve X-axis as VF, -ve X-axis as VR, +ve Y-axis as IF and –ve Y-axis as IR.

3. Mark the readings tabulated for forward biased condition in first Quadrant and reverse biased condition in third Quadrant.

Observations:

Forward Bias:

Sr. No.	Input voltage V_i (volt)	Forward Voltage V_D (volt)	Forward Current I_D (mA)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			

Reverse Bias:

Sr. No.	Input voltage Vi (volt)	Reverse Voltage V_R (volt)	Reverse Current I_R (A)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

Calculation:

Results:

Cut in Voltage = ________________V

Reverse Breakdown Voltage = ______________V

Static Forward Resistance = _______________Ω

Dynamic Forward Resistance = ______________Ω

Static Reverse Resistance = _______________Ω

Dynamic Reverse Resistance = ______________Ω

[B] Zener Diode:

Theory:

Zener diode is a heavily doped Silicon diode. An ideal P-N junction diode does not conduct in reverse biased condition. A Zener diode conducts excellently even in reverse biased condition. These diodes operate at a precise value of voltage called break down voltage. A Zener diode when forward biased behaves like an ordinary P-N junction diode. A Zener diode when reverse biased can undergo avalanche break down or zener break down.

Avalanche Break down:

If both p-side and n-side of the diode are lightly doped, depletion region at the junction widens. Application of a very large electric field at the junction increases the kinetic energy of the charge carriers which collides with the adjacent atoms and generates charge carriers by breaking the bond, they in-turn collides with other atoms by creating new charge carriers, this process is cumulative which results in the generation of large current resulting in Avalanche Breakdown.

Zener Break down:

If both p-side and n-side of the diode are heavily doped, depletion region at the junction reduces, it leads to the development of strong electric field and application of even a small voltage at the junction may rupture covalent bond and generate large number of charge carriers. Such sudden increase in the number of charge carriers results in Zener break down.

Circuit Diagram:

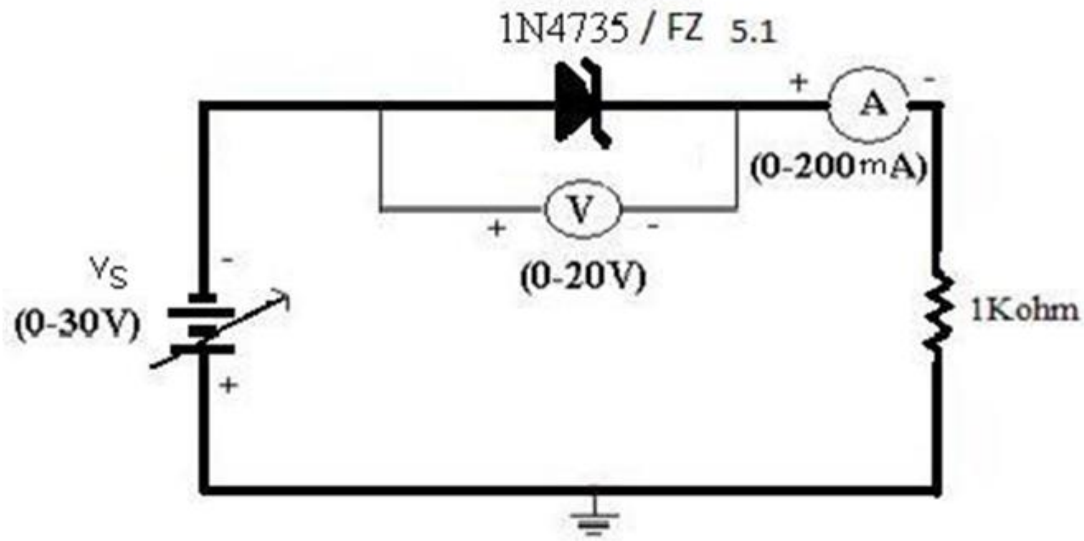


Fig. 3 : Forward Bias Condition

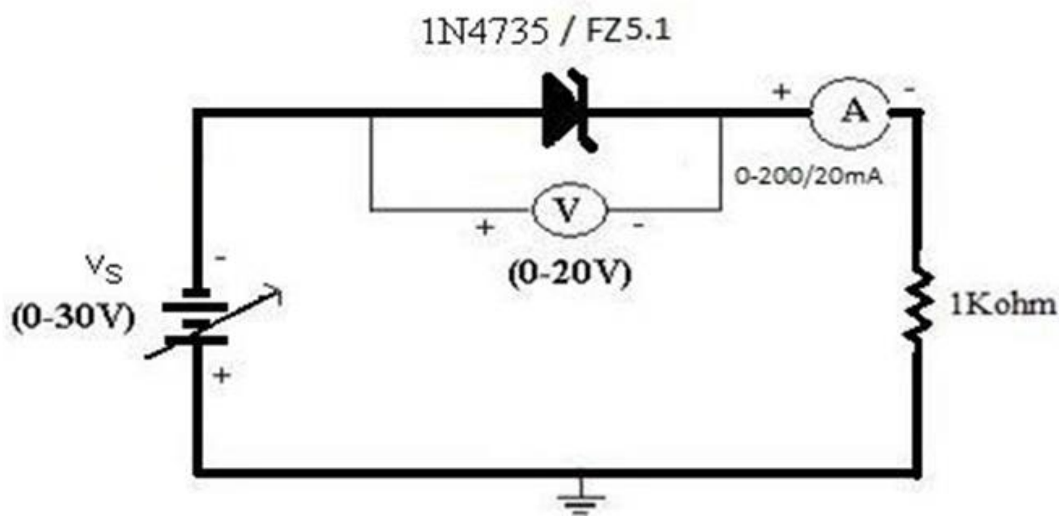


Fig. 4: Reverse Bias Condition

Safety and necessary Precautions:

1. While doing the experiment do not exceed the readings of the diode. This may lead to damaging of the diode.

2. Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.

3. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure:

Forward Bias Condition:

1. Connect the circuit as shown in fig.3.

2. Vary VF gradually from 0 to 0.6 V in steps of 0.1 V and In each step record the current flowing through the diode as IF.

3. Tabulate different forward currents obtained for different forward voltages.

Reverse Bias Condition:

1. Connect the Zener diode in reverse bias as shown in the fig.4. Vary the voltage across the diode in steps of 1V from 0 V to 6 V and in steps 0.1 V till its breakdown voltage is reached. In each step note the current flowing through the diode

2. Plot a graph between V and I. This graph will be called the V-I characteristics of Zener diode. From the graph find out the breakdown voltage for the diode.

Graph:

1. Take a graph sheet and divide it into 4 equal parts. Mark origin at the center of the graph sheet.

2. Now mark +ve X-axis as VF, -ve X-axis as VR, +ve Y-axis as IF and –ve Y-axis as IR.

3. Mark the readings tabulated for forward biased condition in first Quadrant and reverse biased condition in third Quadrant.

Observations:

Forward Bias:

Sr. No.	Input voltage V_i (volt)	Forward Voltage V_D (volt)	Forward Current I_D (mA)
1.			
2.			
3.			
4.			
5.			
6.			
7.			

8.			
9.			
10.			
11.			
12.			
13.			
14.			

Reverse Bias:

Sr. No.	**Input voltage Vi (volt)**	**Reverse Voltage V_R (volt)**	**Reverse Current I_R (□A)**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			

12.			
13.			
14.			

Calculation:

Results:

Cut in Voltage = ________________V

Reverse Breakdown Voltage = ______________V

Static Forward Resistance = _______________Ω

Dynamic Forward Resistance = ______________Ω

Static Reverse Resistance = _______________Ω

Dynamic Reverse Resistance = ______________Ω

Conclusion:

BASIC ELECTRONICS (3110016)

Quiz:

1) Give applications of P-N junction diode.

2) Give applications of zener diode.

3) Define Forward breakdown voltage.

4) Differentiate zener breakdown & Avalanche breakdown voltage.

5) Define PIV

Suggested Reference:

1) David A. Bell, “Electronic Devices and Circuits”, Oxford University Press, Fifth edition
2) Albert Malvino & David, “Electronic Principles”, Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations ;

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:3

Half Wave Rectifier with and without Filter

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills ,

1) Proper understanding of Half Wave Rectifier circuit.
2) Knowledge of rectification and filtration phenomena of circuit.
3) Knowledge of Ripple factor & rectification efficiency.

Relevant CO: CO-1: Analyze the general – and Special-Purpose diode circuits

Objectives: 1) To perform an Experiment to Study rectification by one diode.

2) Observe input output waveforms for given circuits

3) Measure output voltage, frequency, ripple factor and efficiency of the circuits.

Equipment/Instruments: Trainer kit / (PN junction Diode, Resistors, bread board) , function generator, C.R.O., Patch cords, Digital Multimeters

Theory:

A rectifier is a circuit that converts a pure AC signal into a pulsating DC signal or a signal that is a combination of AC and DC components.

A half wave rectifier makes use of single diode to carry out this conversion. It is named so as the conversion occurs for half input signal cycle. During the positive half cycle, the diode is forward biased and it conducts and hence a current flow through the load resistor. During the negative half cycle, the diode is reverse biased and it is equivalent to an open circuit, hence the current through the load resistance is zero. Thus the diode conducts only for one half cycle and results in a half wave rectified output.

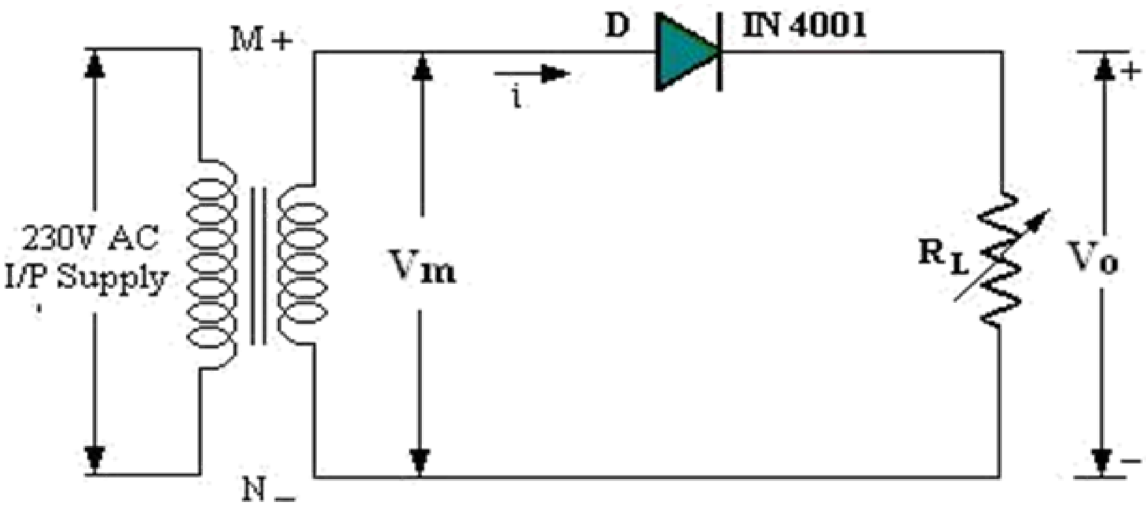
A rectifier is a circuit that converts a pure AC signal into a pulsating DC signal or a signal that is a combination of AC and DC components. In DC supplies, a rectifier is often followed by a filter circuit which converts the pulsating DC signal into pure DC signal by removing the AC component. An L-section filter consists of an inductor and a capacitor connected in the form of an inverted L. A - section filter consists of two capacitors and one induction in the form symbol pi.

In this practical we will use **Capacitor Filter.**

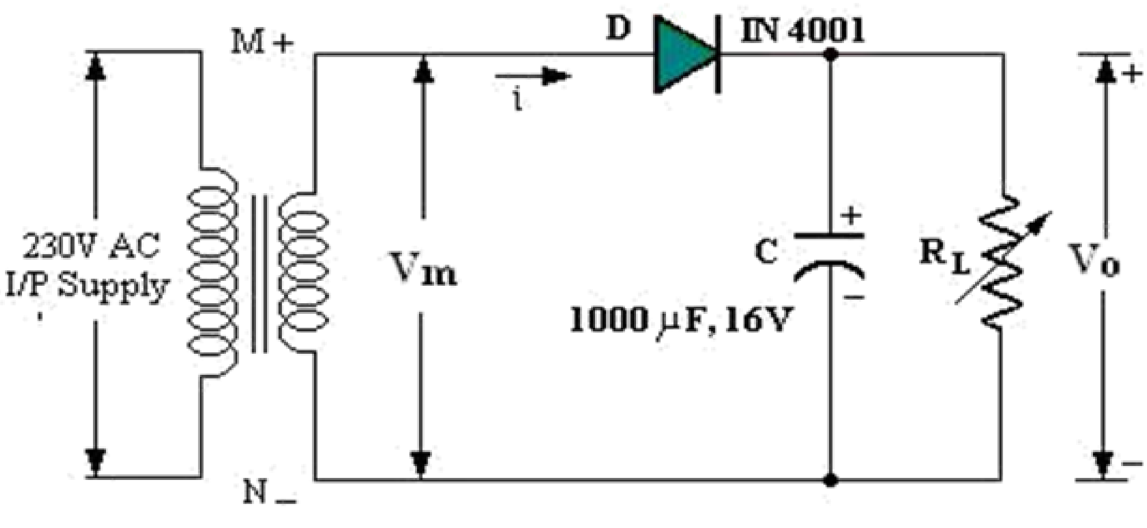
Ripple Factor: Ripple factor is defined as the ratio of the effective value of AC components to the average DC value. It is denoted by the symbol 'γ'.

Rectification Factor: The ratio of output DC power to input AC power is defined as efficiency. It is denoted by the symbol 'η'

Circuit Diagram:

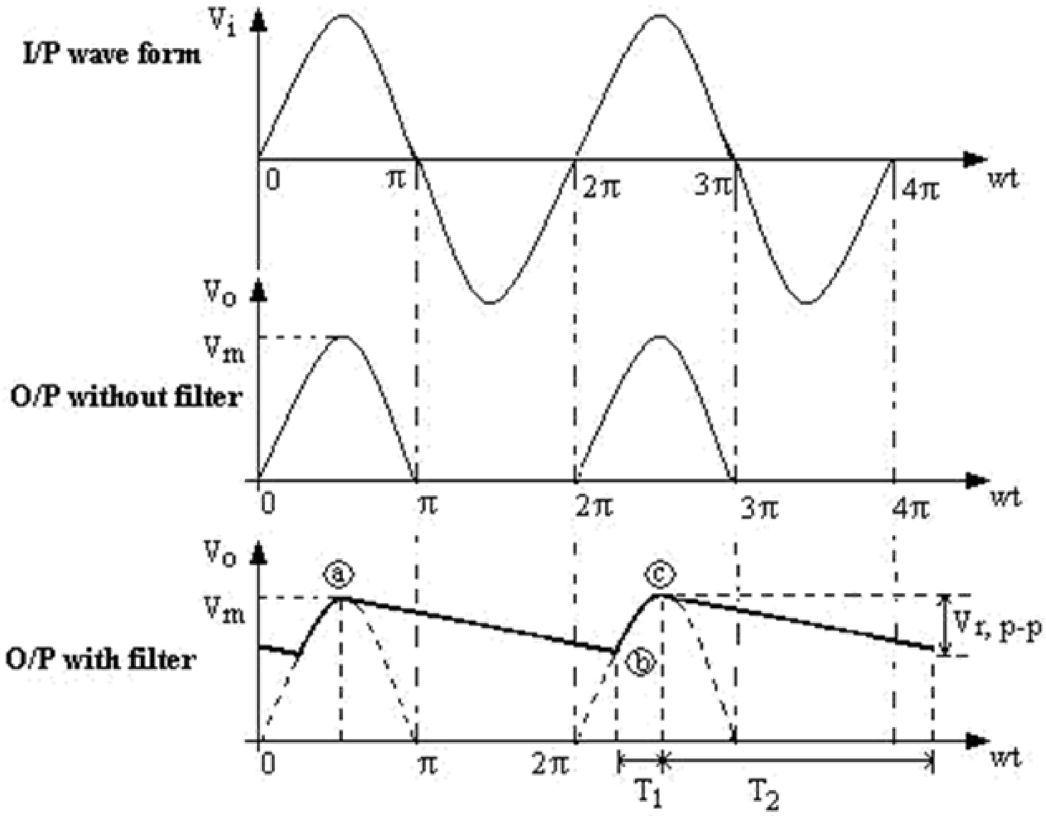


Half-wave Rectifier without filter



Half-wave Rectifier with capacitor filter

Waveforms:



Half-wave Rectifier with capacitor filter wave form

Safety and necessary Precautions:

1) Always keep power off while making connections.

2) Necessary care should be taken while working with ammeters , voltmeters and multimeters.

3) Before applying a signal to the C.R.O., make sure all the push buttons of control panel should be in depressed condition.

Procedure:

1.Connect the circuit as shown in the fig.

2. Connect the multimeter across the 1kΩ load.

3. Measure the AC and DC voltages by setting multimeter to ac and dc mode respectively.

4.Calculate the ripple factor using the following formula.

Ripple factor (γ) = *VAC/ VDC*

5. Calculate the rectification efficiency using the following formula.

rectification efficiency (η) = *VDC/ VAC * 100 %*

6. Connect the CRO channel-1 across input and channel-2 across output i.e load and Observe the input and output Waveforms. Now calculate the peak voltage of input and output waveforms and also the frequency

Observations:

Half wave rectifier without filter

Load Resistance (RL)	Multimeter		Ripple Factor	Input Signal		Output Signal	
	V_{AC}(V)	V_{DC}(V)		Vp-p(V)	Freq(Hz)	Vp-p(V)	Freq(Hz)

Half wave rectifier with Capacitor filter

Load Resistance (RL)	Multimeter		Ripple Factor	Input Signal		Output Signal	
	V_{AC}(V)	V_{DC}(V)		Vp-p(V)	Freq(Hz)	Vp-p(V)	Freq(Hz)

Calculations:

1) Ripple Factor (With and without filter) :

2) Rectification Efficiency (With and without filter) :

Results:

1) Ripple Factor without filter =____________ and with capacitor filter =_______
2) Rectification Efficiency without filter =____________ and with capacitor filter=_______

Conclusion:

Quiz:

1) Write the limitations of half wave rectifier.
2) Derive the value of ripple factor for half wave rectifier circuit.
3) Draw the circuit for negative half wave rectifier.

Suggested Reference:

1) David A. Bell, "Electronic Devices and Circuits", Oxford University Press, Fifth edition
2) Albert Malvino & David, "Electronic Principles", Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations ;

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:4

Full Wave Rectifier with and without Filter

Date:

Competency and Practical Skills:

After this practical student are expected to develop following competencies and skills,

1) Proper understanding of Full wave Rectifier circuit.
2) Knowledge of rectification and filtration phenomena of circuit.
3) Knowledge of Ripple factor & rectification efficiency.

Relevant CO: CO-1: Analyze the general – and Special-Purpose diode circuits

Objectives: 1) To perform an Experiment to Study rectification by two diodes.

2) Observe input output waveforms for given circuits

3) Measure output voltage, frequency, ripple factor and efficiency of the circuits.

Equipment/Instruments: Trainer kit / (PN junction Diodes, Resistors, bread board), function generator, C.R.O., Patch cords, Digital Multimeters

Theory:

A rectifier is a circuit that converts a pure AC signal into a pulsating DC signal or a signal that is a combination of AC and DC components.

A full wave rectifier makes use of a two diodes to carry out this conversion. It is named so as the conversion occurs for complete input signal cycle. The full-wave rectifier consists of a center-tap transformer, which results in equal voltages above and below the center-tap. During the positive half cycle, a positive voltage appears at the anode of D1 while a negative voltage appears at the anode of D2. Due to this diode D1 is forward biased it results in a current Id1 through the load R. During the negative half cycle, a positive voltage appears at the anode of D2 and hence it is forward biased. Resulting in a current Id2 through the load at the same instant a negative voltage appears at the anode of D1 thus reverse biasing it and hence it doesn’t conduct.

A rectifier is a circuit that converts a pure AC signal into a pulsating DC signal or a signal that is a combination of AC and DC components. In DC supplies, a rectifier is often followed by a filter circuit which converts the pulsating DC signal into pure DC signal by removing the AC component. An L-section filter consists of an inductor and a capacitor connected in the form of an inverted L. A - section filter consists of two capacitors and one induction in the form symbol pi.

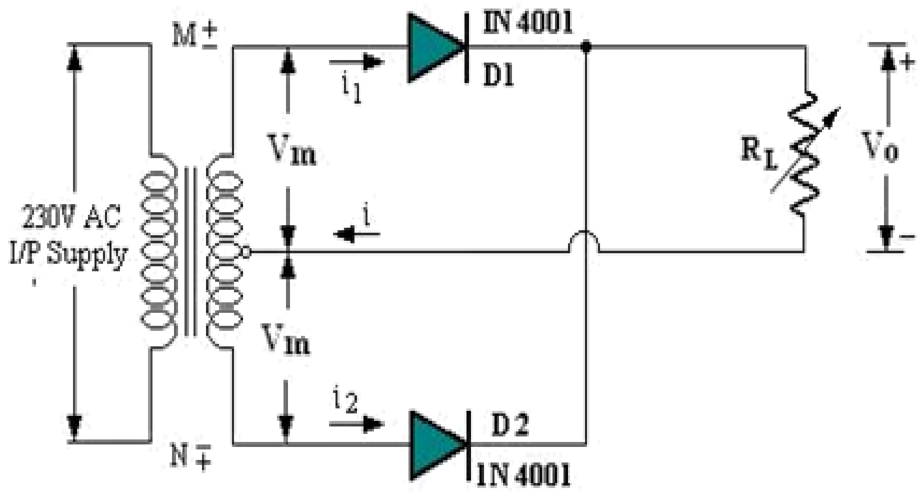
In this practical we will use **Capacitor Filter.**

Ripple Factor: Ripple factor is defined as the ratio of the effective value of AC components to the average DC value. It is denoted by the symbol ‘γ’.

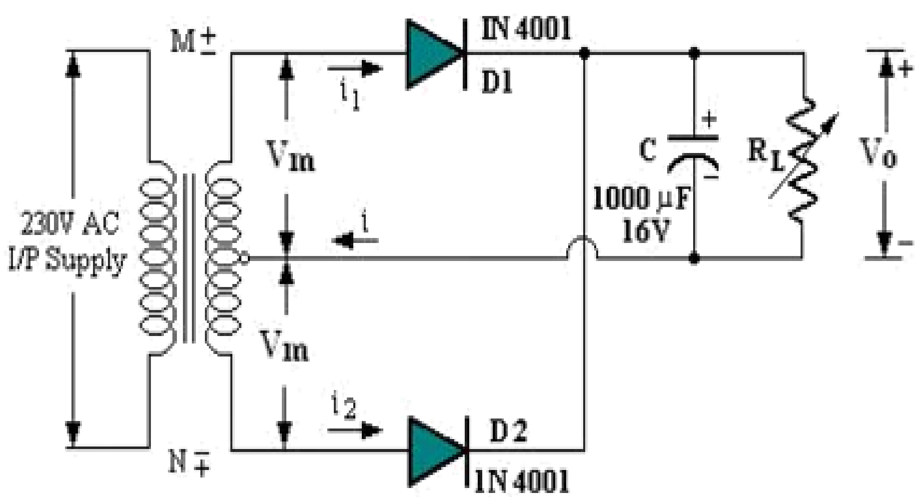
Rectification Factor: The ratio of output DC power to input AC power is defined as efficiency.

It is denoted by the symbol ‘η’

Circuit Diagram:

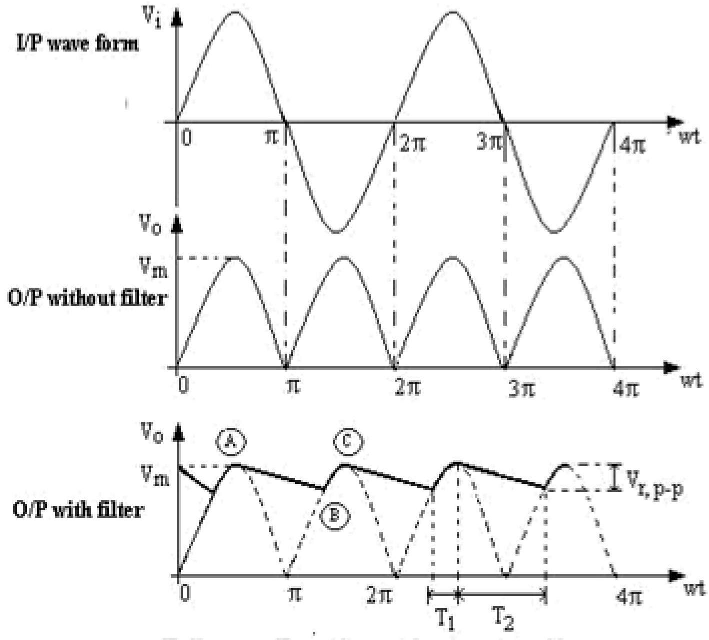


Full-wave Rectifier without filter



Full-wave Rectifier with capacitor filter

Waveforms:



Full-wave Rectifier with capacitor filter wave form

Safety and necessary Precautions:

1) Always keep power off while making connections.

2) Necessary care should be taken while working with ammeters, voltmeters and multimeters.

3) Before applying a signal to the C.R.O., make sure all the push buttons of control panel should be in depressed condition.

Procedure:

1. Connect the circuit as shown in the fig.
2. Connect the multimeter across the 1kΩ load.
3. Measure the AC and DC voltages by setting multimeter to ac and dc mode respectively.
4. Calculate the ripple factor using the following formula.

   Ripple factor (γ) = *VAC/ VDC*

5. Calculate the rectification efficiency using the following formula.

   rectification efficiency (η) = *VDC/ VAC * 100 %*

6. Connect the CRO channel-1 across input and channel-2 across output i.e load and Observe the input and output Waveforms. Now calculate the peak voltage of input and output waveforms and also the frequency

Observations:

Full wave rectifier without filter

Load Resistance (RL)	Multimeter		Ripple Factor	Input Signal		Output Signal	
	V_{AC}(V)	V_{DC}(V)		Vp-p(V)	Freq(Hz)	Vp-p(V)	Freq(Hz)

Full wave rectifier with capacitor filter

Load Resistance(RL)	Multimeter		Ripple Factor	Input Signal		Output Signal	
	V_{AC}(V)	V_{DC}(V)		Vp-p(V)	Freq(Hz)	Vp-p(V)	Freq(Hz)

Calculations:

1) Ripple Factor (With and without filter):

2) Rectification Efficiency (With and without filter):

Results:

1) Ripple Factor without filter =____________ and with capacitor filter =_______
2) Rectification Efficiency without filter =____________ and with capacitor filter=_______

Conclusion:

Quiz:

1) Write the limitations of Full wave rectifier.

2) Derive the value of ripple factor for full wave rectifier circuit.

3) Draw the circuit for negative full wave rectifier.

Suggested Reference:

3) David A. Bell, “Electronic Devices and Circuits”, Oxford University Press, Fifth edition
4) Albert Malvino & David, “Electronic Principles”, Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations;

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:5

Bridge Rectifier with and without Filter

Date:

Competency and Practical Skills:

After this practical student are expected to develop following competencies and skills,

1) Proper understanding of Bridge Rectifier circuit.
2) Knowledge of rectification and filtration phenomena of circuit.
3) Knowledge of Ripple factor & rectification efficiency.

Relevant CO: CO-1 : Analyze the general – and special-Purpose diode circuits

Objectives: 1) To perform an Experiment to Study rectification by four diodes.

2) Observe input output waveforms for given circuits

3) Measure output voltage, frequency, ripple factor and efficiency of the circuits.

Equipment/Instruments: Trainer kit / (PN junction Diodes, Resistors , bread board) , function generator, C.R.O., Patch cords, Digital Multimeters

Theory:

Another type of circuit that produces the same output as a full-wave rectifier is that of the Bridge Rectifier. This type of single phase rectifier uses 4 individual rectifying diodes connected in a "bridged" configuration to produce the desired output but does not require a special centre tapped transformer, thereby reducing its size and cost. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown in figure. The 4 diodes labeled D1 to D4 are arranged in "series pairs" with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes D1 and D2 conduct in Fig. 1: Full-wave Bridge Rectifier series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below (Fig. 2). During the negative half cycle of the supply, diodes D3 and D4 conduct in series, but diodes D1 and D2 switch of as they are now reverse biased. The current flowing through the load is the same direction as before.

A rectifier is a circuit that converts a pure AC signal into a pulsating DC signal or a signal that is a combination of AC and DC components. In DC supplies, a rectifier is often followed by a filter circuit which converts the pulsating DC signal into pure DC signal by removing the AC component.

An L-section filter consists of an inductor and a capacitor connected in the form of an inverted L. A -section filter consists of two capacitors and one induction in the form symbol pi.

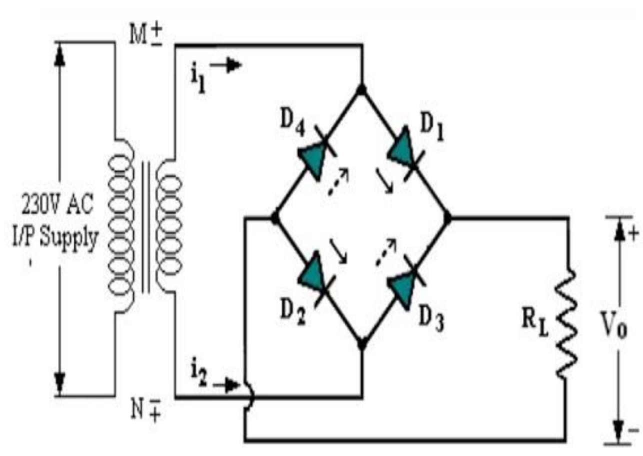
In this practical we will use **Capacitor Filter.**

Ripple Factor: Ripple factor is defined as the ratio of the effective value of AC components to the average DC value. It is denoted by the symbol ‘γ’.

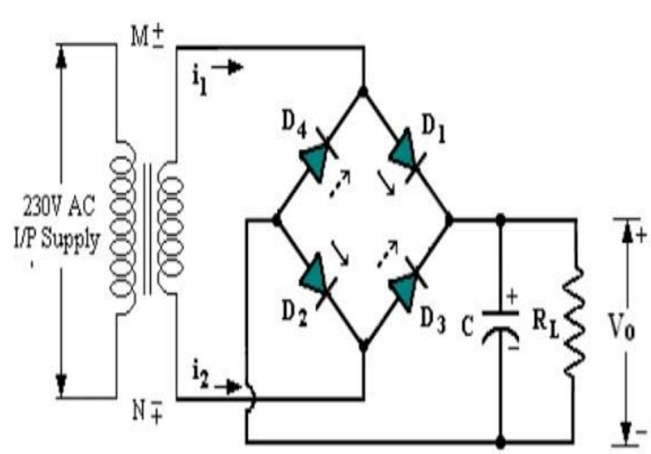
Rectification Factor: The ratio of output DC power to input AC power is defined as efficiency.

It is denoted by the symbol ‘η’

<u>Circuit Diagram:</u>

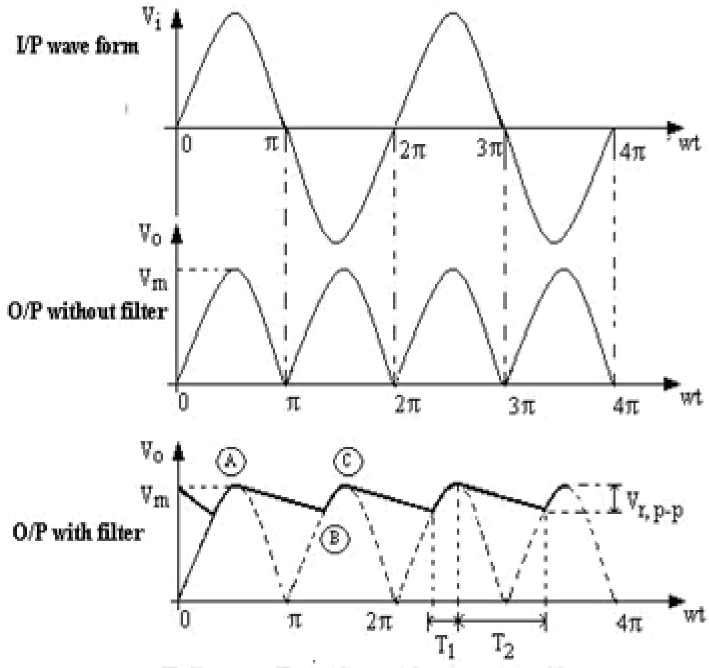


Bridge Rectifier without filter



Bridge Rectifier with capacitor filter

Waveforms:



Safety and necessary Precautions:

1) Always keep power off while making connections.

2) Necessary care should be taken while working with ammeters, voltmeters and multimeters.

3) Before applying a signal to the C.R.O., make sure all the push buttons of control panel should be in depressed condition.

Procedure:

1.Connect the circuit as shown in the fig.

2. Connect the multimeter across the 1kΩ load.

3. Measure the AC and DC voltages by setting multimeter to ac and dc mode respectively.

4.Calculate the ripple factor using the following formula.

Ripple factor (γ) = *VAC/ VDC*

5. Calculate the rectification efficiency using the following formula.

rectification efficiency (η) = *VDC/ VAC * 100 %*

6. Connect the CRO channel-1 across input and channel-2 across output i.e load and Observe the input and output Waveforms. Now calculate the peak voltage of input and output waveforms and also the frequency

Observations:

Bridge rectifier without filter

Load Resistance (RL)	Multimeter		Ripple Factor	Input Signal		Output Signal	
	V_{AC}(V)	V_{DC}(V)		Vp-p(V)	Freq(Hz)	Vp-p(V)	Freq(Hz)

Bridge rectifier with capacitor filter

Load Resistance (RL)	Multimeter		Ripple Factor	Input Signal		Output Signal	
	V_{AC}(V)	V_{DC}(V)		Vp-p(V)	Freq(Hz)	Vp-p(V)	Freq(Hz)

Calculations:

1) Ripple Factor (With and without filter):

2) Rectification Efficiency (With and without filter):

Results:

1) Ripple Factor without filter =____________ and with capacitor filter =_______
2) Rectification Efficiency without filter =____________ and with capacitor filter=_______

Conclusion:

Quiz:

1) Compare Full wave rectifier and Bridge rectifier.

2) Give the reason why bridge rectifier is used than full wave rectifier?

Suggested Reference:

1) David A. Bell, “Electronic Devices and Circuits”, Oxford University Press, Fifth edition
2) Albert Malvino & David, “Electronic Principles”, Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations:

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:6
Clamper Circuits

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills,

1) Proper understanding of the Clamper circuit.
2) Knowledge of positive and negative clamping.

Relevant CO: CO-1: Analyze the general – and Special-Purpose diode circuits

Objectives: 1) To perform positive and negative clamper circuits.

2) Observe input output waveforms for given circuits

Equipment/Instruments: Trainer kit / (PN junction Diode, Resistor, Capacitor, bread board), function generator, C.R.O., Patch cords.

Theory:

A Clamper Circuit is a circuit that adds a DC level to an AC signal. Actually, the positive and negative peaks of the signals can be placed at desired levels using the clamping circuits. As the DC level gets shifted, a clamper circuit is called as a Level Shifter.

Clamper circuits consist of energy storage elements like capacitors. A simple clamper circuit comprises of a capacitor, a diode, a resistor and a dc battery if required.

Clamper Circuit

A Clamper circuit can be defined as the circuit that consists of a diode, a resistor and a capacitor that shifts the waveform to a desired DC level without changing the actual appearance of the applied signal.

In order to maintain the time period of the wave form, the tau(τ) must be greater than, half the time period ($\tau > T/2$)

$$\tau = RC$$

Where, R is the resistance of the resistor employed

C is the capacitance of the capacitor used

The time constant of charge and discharge of the capacitor determines the output of a clamper circuit.

In a clamper circuit, a vertical shift of upward or downward takes place in the output waveform with respect to the input signal.

The load resistor and the capacitor affect the waveform. So, the discharging time of the capacitor should be large enough.

Discharging time of the capacitor should be slow.

Positive Clamper Circuit

A Clamping circuit restores the DC level. When a negative peak of the signal is raised A Positive Clamper circuit is one that consists of a diode, a resistor and a capacitor and that shifts the output signal to the positive portion of the input signal.

Initially when the input is given, the capacitor is not yet charged and the diode is reverse biased. The output is not considered at this point of time. During the negative half cycle, at the peak value, the capacitor gets charged with negative on one plate and positive on the other. The capacitor is now charged to its peak value Vm. The diode is forward biased and conducts heavily.

During the next positive half cycle, the capacitor is charged to positive Vm while the diode gets reverse biased and gets open circuited. The output of the circuit at this moment will be

Vo = Vi + Vm

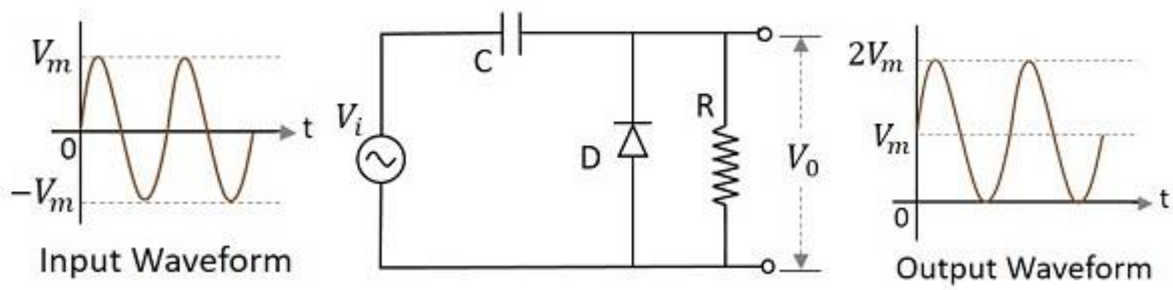
Negative Clamper Circuit

A Negative Clamper circuit is one that consists of a diode, a resistor and a capacitor and that shifts the output signal to the negative portion of the input signal.

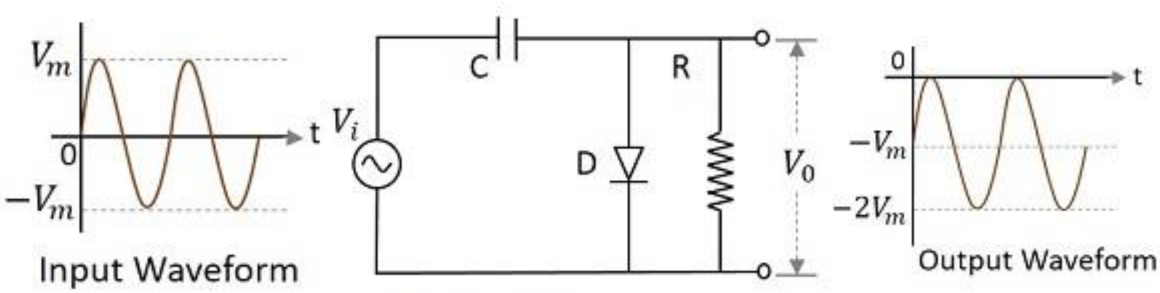
During the positive half cycle, the capacitor gets charged to its peak value vm. The diode is forward biased and conducts. During the negative half cycle, the diode gets reverse biased and gets open circuited. The output of the circuit at this moment will be

Vo = Vi + Vm

<u>Circuit Diagram with Waveforms:</u>



Positive Clamper circuit



Negative Clamper circuit

Safety and necessary Precautions:

1) Always keep power off while making connections.

2) Necessary care should be taken while working with ammeters, voltmeters and multimeters.

3) Before applying a signal to the C.R.O., make sure all the push buttons of control panel should be in depressed condition.

Procedure:

1.Connect the circuit as shown in the fig.

2. Connect the function generator to the input of the circuit and give this signal to Ch. 1 of CRO .

3. Take the output from the load resistor and give this signal to Ch. l 2 of CRO.

4. Observe input output signals on CRO screen.

5. Draw the input output waveforms for both positive and negative clamper circuits.

Observations:

I/O waveforms of positive clamper   I/O waveforms of negative clamper

Conclusion:

Quiz:

1) Draw the circuits for positive biased positive clamping and negative biased positive clamping.

2) Draw the circuits for positive biased negative clamping and negative biased negative clamping.

Suggested Reference:

1) David A. Bell, “Electronic Devices and Circuits”, Oxford University Press, Fifth edition
2) Albert Malvino & David, “Electronic Principles”, Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations:

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:7
Clipper Circuits

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills ,

1) Proper understanding of Clipper circuit.
2) Knowledge of positive and negative clipping.

Relevant CO: CO-1: Analyze the general – and special-Purpose diode circuits

Objectives: 1) To perform positive and negative clipper circuits.
2) Observe input output waveforms for given circuits

Equipment/Instruments: Trainer kit / (PN junction Diode, Resistor, bread board), function generator, regulated power supply, C.R.O., Patch cords.

Theory:

A Clipper circuit is a circuit that rejects the part of the input wave specified while allowing the remaining portion. The portion of the wave above or below the cut off voltage determined is clipped off or cut off.

The clipping circuits consist of linear and non-linear elements like resistors and diodes but not energy storage elements like capacitors.

Positive Clipper:

The Clipper circuit that is intended to attenuate positive portions of the input signal can be termed as a Positive Clipper.

1) **Positive Series Clipper**

A Clipper circuit in which the diode is connected in series to the input signal and that attenuates the positive portions of the waveform, is termed as Positive Series Clipper. The following figure represents the circuit diagram for positive series clipper.

Positive Cycle of the Input − When the input voltage is applied, the positive cycle of the input makes the point A in the circuit positive with respect to the point B. This makes the diode reverse biased and hence it behaves like an open switch. Thus the voltage across the load resistor becomes zero as no current flows through it and hence V0 will be zero.

Negative Cycle of the Input − The negative cycle of the input makes the point A in the circuit negative with respect to the point B. This makes the diode forward biased and hence it conducts like a closed switch. Thus the voltage across the load resistor will be equal to the applied input voltage as it completely appears at the output V0

2) **Positive Shunt Clipper**

A Clipper circuit in which the diode is connected in shunt to the input signal and that attenuates the positive portions of the waveform, is termed as Positive Shunt Clipper. The following figure represents the circuit diagram for positive shunt clipper.

Positive Cycle of the Input − When the input voltage is applied, the positive cycle of the input makes the point A in the circuit positive with respect to the point B. This makes the diode forward biased and hence it conducts like a closed switch. Thus the voltage across the load resistor becomes zero as no current flows through it and hence V0 will be zero.

Negative Cycle of the Input − The negative cycle of the input makes the point A in the circuit negative with respect to the point B. This makes the diode reverse biased and hence it behaves like an open switch. Thus the voltage across the load resistor will be equal to the applied input voltage as it completely appears at the output V0.

Negative Clipper:

The Clipper circuit that is intended to attenuate negative portions of the input signal can be termed as a Negative Clipper.

1) **Negative Series Clipper**

A Clipper circuit in which the diode is connected in series to the input signal and that attenuates the negative portions of the waveform, is termed as Negative Series Clipper. The following figure represents the circuit diagram for negative series clipper.

Positive Cycle of the Input − When the input voltage is applied, the positive cycle of the input makes the point A in the circuit positive with respect to the point B. This makes the diode forward biased and hence it acts like a closed switch. Thus the input voltage completely appears across the load resistor to produce the output V0.

Negative Cycle of the Input − The negative cycle of the input makes the point A in the circuit negative with respect to the point B. This makes the diode reverse biased and hence it acts like an open switch. Thus the voltage across the load resistor will be zero making V0 zero.

2) **Negative Shunt Clipper**

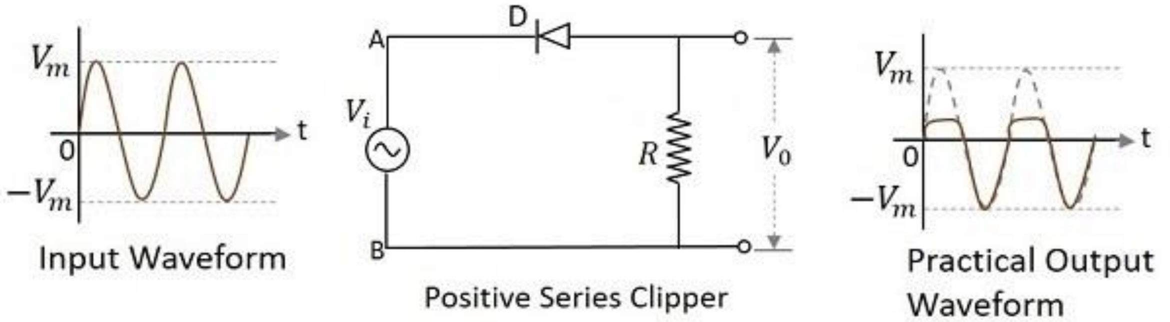
A Clipper circuit in which the diode is connected in shunt to the input signal and that attenuates the negative portions of the waveform, is termed as Negative Shunt Clipper. The following figure represents the circuit diagram for negative shunt clipper.

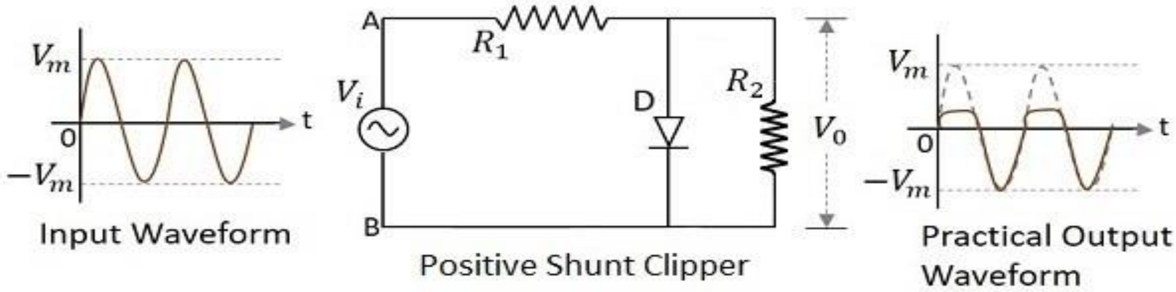
Positive Cycle of the Input − When the input voltage is applied, the positive cycle of the input makes the point A in the circuit positive with respect to the point B. This makes the diode reverse biased and hence it behaves like an open switch. Thus the voltage across the load resistor equals the applied input voltage as it completely appears at the output V0 is 0

Negative Cycle of the Input − The negative cycle of the input makes the point A in the circuit negative with respect to the point B. This makes the diode forward biased and hence it conducts like a closed switch. Thus the voltage across the load resistor becomes zero as no current flows through it.

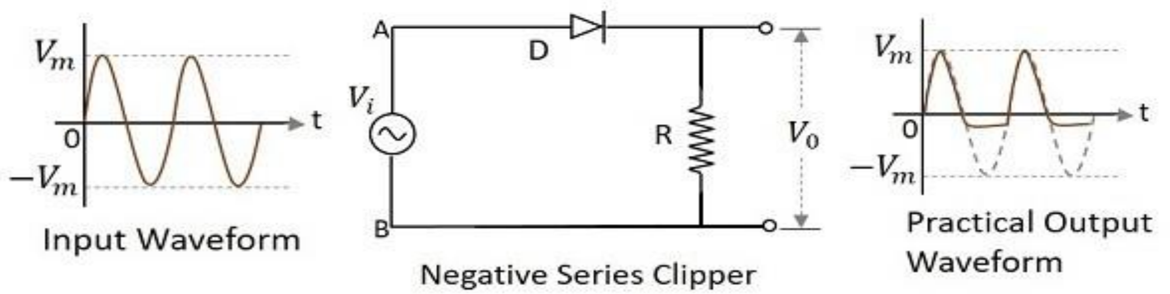
<u>Circuit Diagram with Waveforms:</u>

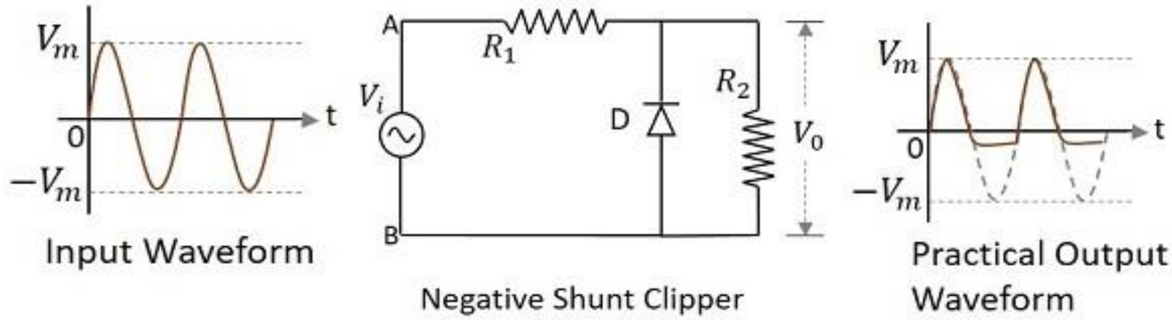
Positive Clipper:





Negative Clipper:





Safety and necessary Precautions:

1) Always keep power off while making connections

2) Necessary care should be taken while working with ammeters, voltmeters and multimeters.

3) Before applying a signal to the C.R.O., make sure all the push buttons of control panel should be in depressed condition.

Procedure:

1. Connect the circuit as shown in the fig.
2. Connect the function generator to the input of the circuit and give this signal to Ch. 1 of CRO.
3. Take the output from the load resistor and give this signal to Ch.l 2 of CRO.
4. Observe input output signals on CRO screen.
5. Draw the input output waveforms for both positive and negative (series and shunt) clipper circuits.

Observations:

I/O waveforms of positive clipper
(Series and shunt)

I/O waveforms of negative clipper
(Series and shunt)

Conclusion:

Quiz:

1) Draw the circuits for biased (positive & negative) series positive clipping.

2) Draw the circuits for biased (positive & negative) shunt positive clipping.

3) Draw the circuits for biased (positive & negative) series negative clipping.

4) Draw the circuits for biased (positive & negative) shunt negative clipping.

Suggested Reference:

1) David A. Bell, "Electronic Devices and Circuits", Oxford University Press, Fifth edition
2) Albert Malvino & David, "Electronic Principles", Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations ;

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:8

Logic Gates

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills,

1) Proper understanding of operation of all the logic Gates.

2) Knowledge of connections of input-output pins and supply-ground connection of every IC used as logic Gate.

Relevant CO: CO-5: Verify the functionalities of basic digital Gates and Logic families

Objectives: 1) To verify truth table of each logic Gate.

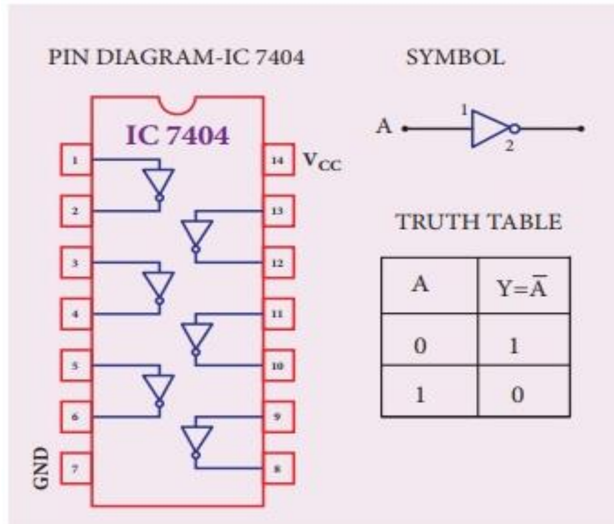
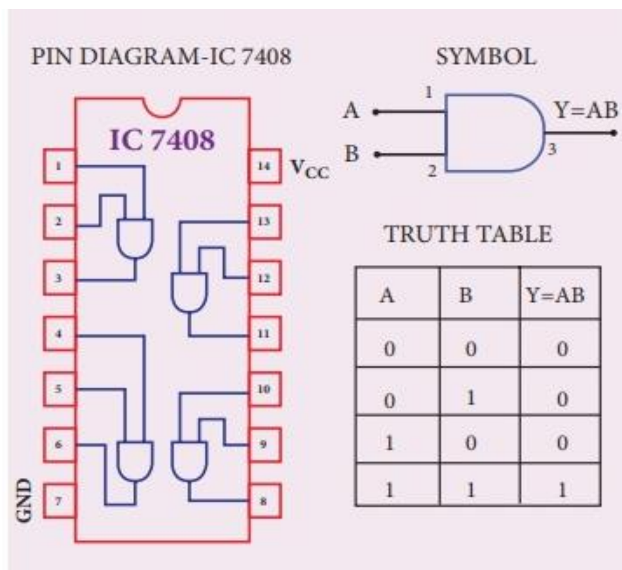
3) To have the knowledge of IC usage as logic Gate.

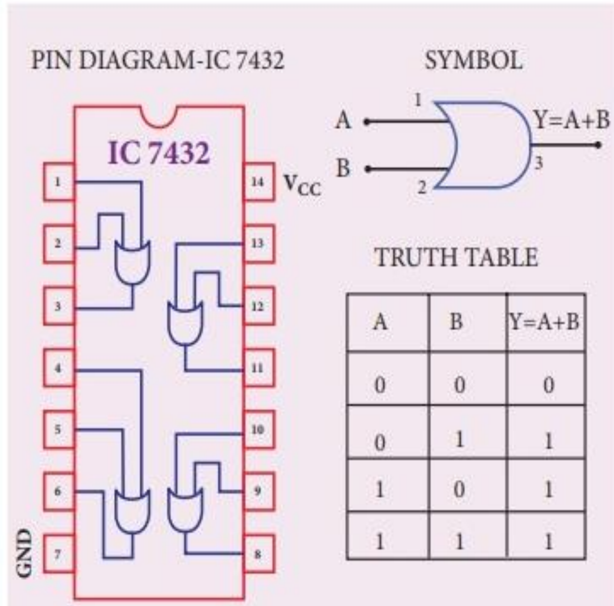
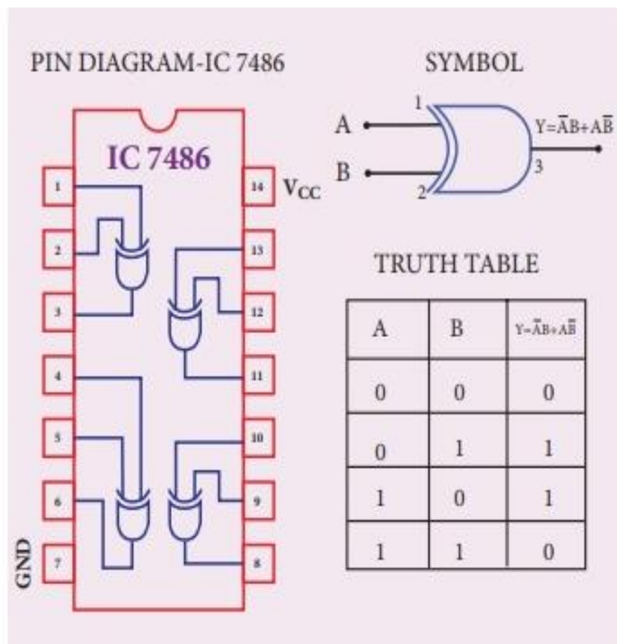
Equipment/Instruments: Digital IC Trainer kit / bread board, regulated power supply, IC's (7400, 7402, 7404, 7408, 7432, 7486 & 747266), connecting wires.

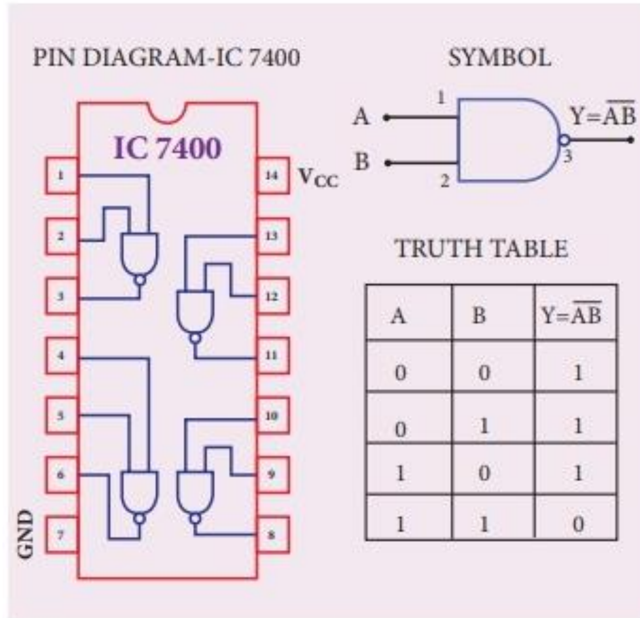
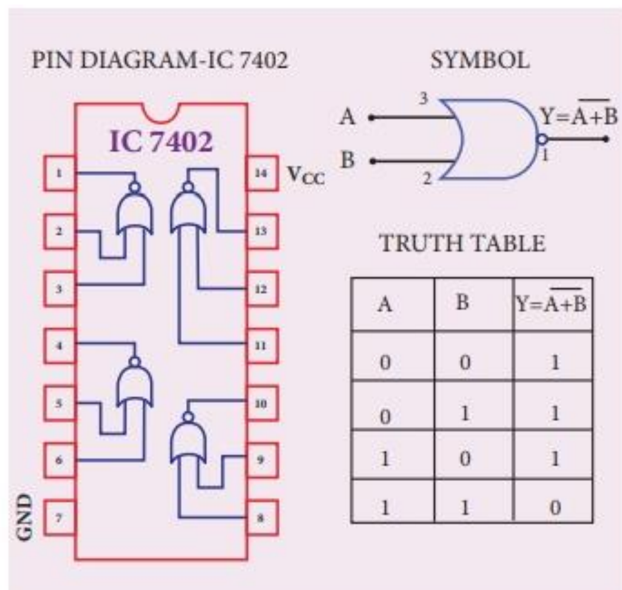
<u>Theory:</u>

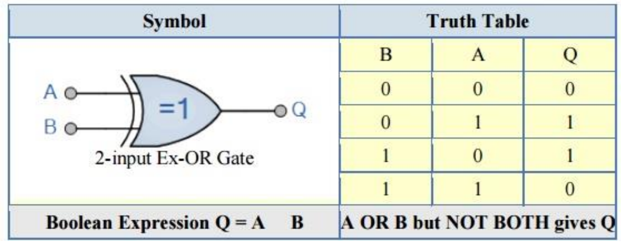
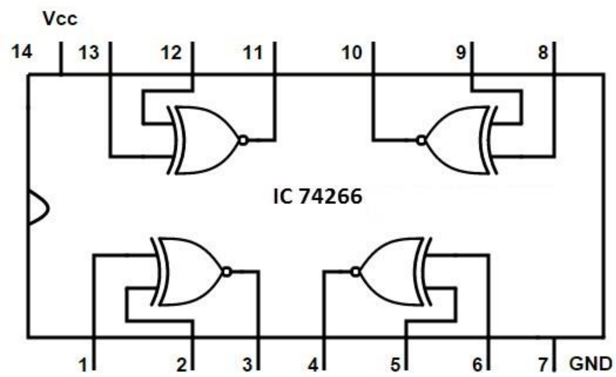
Logic gates are the basic building blocks of any digital system. It is an electronic circuit having one or more than one input and only one output. The relationship between the input and the output is based on a certain logic. Based on this, logic gates are named as AND gate, OR gate, NOT gate, NAND gate, NOR gate, XOR gate, XNOR gate etc.

AND, OR and NOT gates are called basic logic gates while NAND, NOR (the complements of AND, OR gates respectively) are the universal gates as any logic can be implemented using only NAND or only NOR gate.

<table>
<tr><th>Name of Gate</th><th>Description</th><th>Symbol, pin diagram, Truth table</th></tr>
<tr><td>NOT Gate</td><td>NOT gate complements the input.</td><td>
</td></tr>
<tr><td>AND Gate</td><td>AND gate gives logic 1 as output only if all of its inputs are at logic 1.</td><td>
</td></tr>
</table>

OR Gate	OR gate gives logic 0 as output only if all of its inputs are at logic 0.	
EXOR Gate	Ex-OR gate gives logic 1 output if the two inputs are dissimilar.	

NAND Gate	NAND gate gives logic 0 as output only if all of its inputs are at logic 1.	
NOR Gate	NOR gate gives logic 1 as output only if all of its inputs are at logic 0	

<table>
<tr>
<td>EX NOR Gate</td>
<td>Ex-NOR gate gives logic 1 output if the two inputs are similar.</td>
<td>

<table>
<tr><th>Symbol</th><th colspan="3">Truth Table</th></tr>
<tr><td rowspan="5"></td><td>B</td><td>A</td><td>Q</td></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>0</td></tr>
<tr><td>Boolean Expression Q = A B</td><td colspan="3">A OR B but NOT BOTH gives Q</td></tr>
</table>


</td>
</tr>
</table>

Safety and necessary Precautions:

Always keep power off while making connections.

Procedure:

1. Connect the IC's on the trainer kit
2. Connect Vcc = 5V o pin 14 & GND to pin 7 respectively.
3. Apply inputs to the logic gates from switches block of the trainer kit.
4. Verify output of the logic gates at LED indicators of the trainer kit.
5. Repeat the steps 3 & 4 for all the gates present in the IC.

Conclusion:

BASIC ELECTRONICS (3110016)

Quiz:

1) Draw symbols of all 7 Logic gates.

2) Mention IC nos. For all 7 logic gates.

3) Write characteristics of each gate in one sentence.

Suggested Reference:

David A. Bell, "Electronic Devices and Circuits", Oxford University Press, Fifth edition

Albert Malvino & David, "Electronic Principles", Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations ;

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:9

Common Emitter BJT Characteristics

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills,

1) Proper understanding of CE configuration of BJT circuits.
2) Knowledge of biasing of CE configuration for both NPN and PNP transistors.
3) Knowledge of Ideal input output characteristics for CE configuration of transistor circuit.

Relevant CO: CO-2: Design biasing circuits for BJT

Objectives:

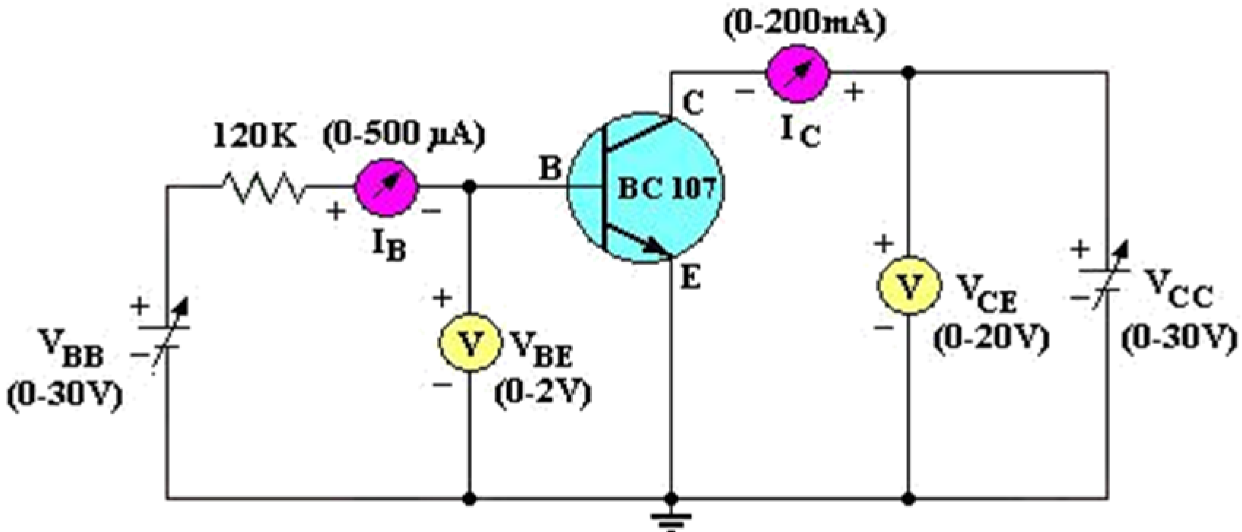
1) To perform an Experiment to Study Input Output characteristic of Common Emitter transistor configuration.
2) Observe change in input parameters (V and I) by keeping output parameter constant.
3) Observe change in output parameters (V and I) by keeping input parameter constant.

Equipment/Instruments: Trainer kit / (BJT (BC 107), Resistors, bread board), Regulated power supply, Patch cords, Digital Multimeters

<u>Theory:</u>

The configuration in which the emitter is connected between the collector and base is known as a common emitter configuration. The variation of Base current(I_B) with Base-Emitter voltage(V_{BE}) keeping Collector Emitter voltage(V_{CE}) constant gives input characteristics and variation of collector current(I_C) with Emitter-collector voltage(V_{CE}), keeping Base current(I_B) constant gives output characteristics

Circuit Diagram:

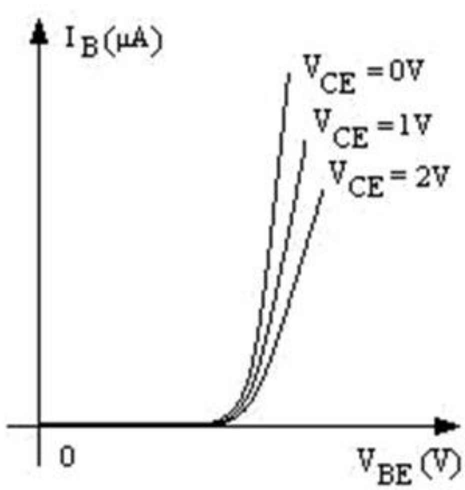


Common Emitter Transistor Characteristics

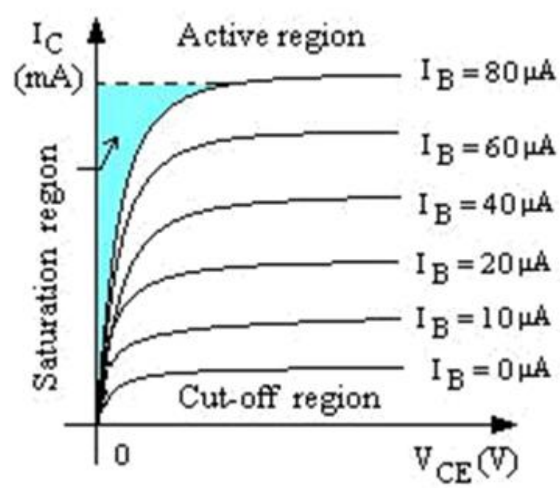
Model graph:

1. Plot the Input characteristics by taking I_B on y-axis and V_{BE} on x-axis.
2. Plot the Output characteristics by taking I_C on the y-axis and V_{CE} on x-axis.

INPUT CHARACTERISTICS: **OUTPUT CHARACTERISTICS:**



CE I/P Characteristics



CE O/P Characteristics

Safety and necessary Precautions:

1) Always keep power off while making connections.

2) Necessary care should be taken while working with ammeters, voltmeters and multimeters.

Procedure:

TO FIND THE INPUT CHARACTERISTICS:

1. Connect the circuit as in the circuit diagram.
2. Keep V_{BB} and V_{CC} in zero volts before giving the supply
3. Set V_{CE} = 1 volt by varying V_{CC} and vary the V_{BB} smoothly with fine control such that base current I_B varies in steps of 5µA from zero upto 200µA, and note down the corresponding voltage V_{BE} for each step in the tabular form.
4. Repeat the experiment for V_{CE} =2 volts and 3 volts.
5. Draw a graph between V_{BE} Vs I_B against V_{CE} = Constant.

TO FIND THE OUTPUT CHARACTERISTICS:

1. Start V_{BB} and V_{CC} from zero Volts.
2. Set the I_B = 20µA by using V_{BB} such that, V_{CE} changes in steps of 0.2 volts from zero upto 10 volts, note down the corresponding collector current I_C for each step in the tabular form.
3. Repeat the experiment for I_B = 40µA and I_B = 60µA, tabulate the readings.
4. Draw a graph between V_{CE} Vs I_C against I_B = Constant.

Observations:

INPUT CHARACTERISTICS;

Sr. No.	V_{CE}=______V		V_{CE}=______V		V_{CE}=______V	
	V_{BE} (V)	I_B (μA)	V_{BE} (V)	I_B (μA)	V_{BE} (V)	I_B (μA)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

OUTPUT CHARACTERISTICS;

Sr. No.	I_B = ______μA		I_B = ______μA		I_B = ______μA	
	V_{CE} (V)	Ic (mA)	V_{CE} (V)	Ic (mA)	V_{CE} (V)	Ic (mA)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Graph:

Draw the graph for both input and output characteristics on separate graph paper.

Results:

1) Input Rsistance ri = $\Delta V_{BE} / \Delta I_B$ = ___________Ω
2) Output Rsistance ro = $\Delta V_{CE} / \Delta I_C$ =___________Ω
3) Current amplification factor $\beta = \Delta Ic / \Delta Ib$ = _______

Conclusion:

Quiz:

1) Enlist the input output terminals for Common Emitter configuration of BJT.

2) Which parameters should keep constant while measuring input characteristics in CE configuration?

3) Which parameters should keep constant while measuring output characteristics in CE configuration?

4) What will be the biasing condition for Cut-off, Active and Saturation region of BJT.

5) What is the range of β?

Suggested Reference:

1) David A. Bell, "Electronic Devices and Circuits", Oxford University Press, Fifth edition
2) Albert Malvino & David, "Electronic Principles", Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations ;

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:10

Common Base BJT Characteristics

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills,

1) Proper understanding of CB configuration of BJT circuit.
2) Knowledge of biasing of CB configuration for both NPN and PNP transistor.
3) Knowledge of Ideal input output characteristics for CB configuration of transistor circuit.

Relevant CO: CO-2: Design biasing circuits for BJT

Objectives:

1) To perform an Experiment to Study Input Output characteristic of Common Base transistor configuration.

2) Observe change in input parameters (V and I) by keeping output parameter constant.

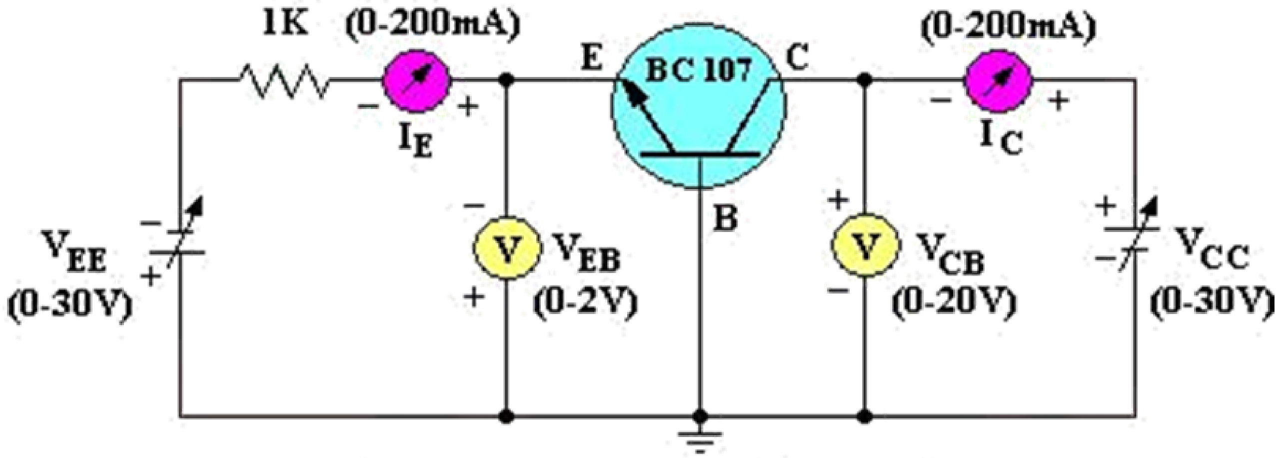
3) Observe change in output parameters (V and I) by keeping input parameter constant.

Equipment/Instruments: Trainer kit / (BJT (BC 107), Resistors, bread board), Regulated power supply, Patch cords, Digital Multimeters

<u>Theory:</u>

In CB Configuration, the base terminal of the transistor will be connected common between the output and the input terminals. The variation of emitter current(I_E) with Base-Emitter voltage(V_{BE}), keeping Collector Base voltage(V_{CB}) constant gives input characteristics and variation of collector current(I_C) with Base-Collector voltage(V_{CB}), keeping emitter current(I_E) constant gives output characteristics

Circuit Diagram:

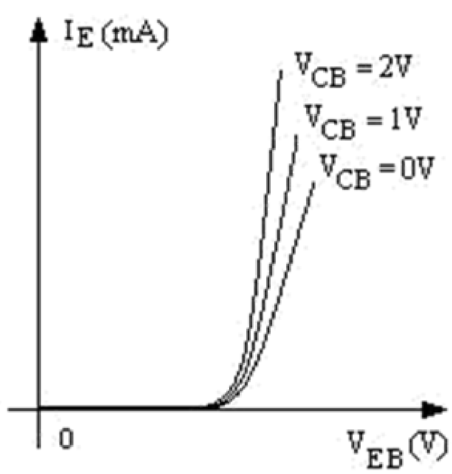


Common Base Transistor Characteristics

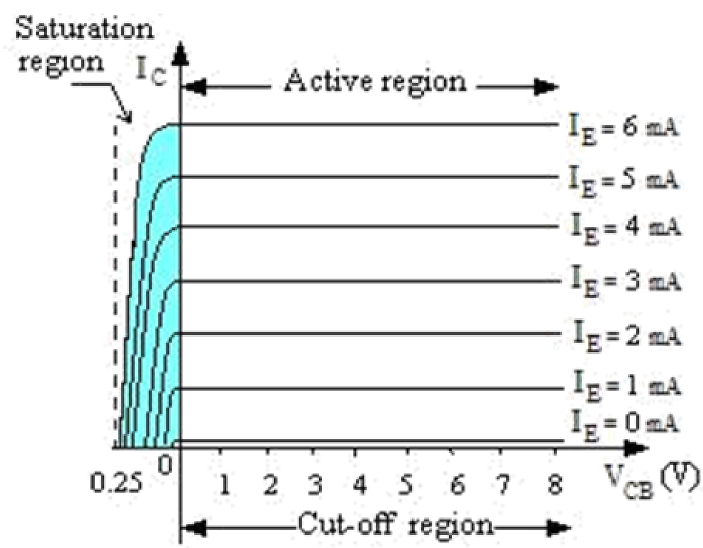
Model graph :

1) Plot the Input characteristics by taking I_E on y–axis and V_{EB} on x–axis.
2) Plot the Output characteristics by taking I_C on y–axis and V_{CB} on x–axis.

INPUT CHARACTERISTICS: **OUTPUT CHARACTERISTICS:**



CB I/P Characteristics



CB O/P Characteristics

Safety and necessary Precautions:

1) Always keep power off while making connections.

2) Necessary care should be taken while working with ammeters, voltmeters and multimeters.

Procedure:

TO FIND THE INPUT CHARACTERISTICS:

1. Connect the circuit as in the circuit diagram.
2. Keep V_{EE} and V_{CC} in zero volts before giving the supply
3. Set V_{CB} = 1 volt by varying V_{CC}. and vary the V_{EE} smoothly with fine control such that emitter current I_E varies in steps of 0.2mA from zero upto 20mA, and note down the corresponding voltage V_{EB} for each step in the tabular form.
4. Repeat the experiment for V_{CB} =2 volts and 3 volts.
5. Draw a graph between V_{EB} Vs I_E against V_{CB} = Constant.

TO FIND THE OUTPUT CHARACTERISTICS:

1. Start V_{EE} and V_{CC} from zero Volts.
2. Set the I_E = 1mA by using V_{EE} such that, V_{CB} changes in steps of 1.0 volts from zero upto 20 volts, note down the corresponding collector current I_C for each step in the tabular form.
3. Repeat the experiment for I_E = 3mA and I_E = 5mA, tabulate the readings.
4. Draw a graph between V_{CB} Vs I_C against I_E = Constant.

Observations:

INPUT CHARACTERISTICS;

Sr. No.	V_{CB}=______V		V_{CB}=______V		V_{CB}=______V	
	V_{EB} (V)	I_E (mA)	V_{EB} (V)	I_E (mA)	V_{EB} (V)	I_E (mA)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

OUTPUT CHARACTERISTICS;

Sr. No.	I_E = ______mA		I_E = ______mA		I_E = ______mA	
	V_{CB} (V)	Ic (mA)	V_{CB} (V)	Ic (mA)	V_{CB} (V)	Ic (mA)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Graph:

Draw the graph for both input and output characteristics on separate graph paper.

Results:

1) Input Rsistance ri = $\Delta V_{EB} / \Delta I_E$ = ___________Ω
2) Output Rsistance ro = $\Delta V_{CB} / \Delta I_C$ =___________Ω
3) Current amplification factor $\alpha = \Delta Ic / \Delta Ie$ = _______

Conclusion:

Quiz:

1) Enlist the input output terminals for Common Base configuration of BJT.

2) Which parameters should keep constant while measuring input characteristics in CB configuration?

3) Which parameters should keep constant while measuring output characteristics in CB configuration?

4) What is the value of α?

5) Derive relation between α and β.

Suggested Reference:

1) David A. Bell, “Electronic Devices and Circuits”, Oxford University Press, Fifth edition

2) Albert Malvino & David, “Electronic Principles”, Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations:

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:11
Common Collector BJT Characteristics

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills,

1) Proper understanding of CC configuration of BJT circuit.
2) Knowledge of biasing of CC configuration for both NPN and PNP transistor.
3) Knowledge of Ideal input output characteristics for CC configuration of transistor circuit.

Relevant CO: CO-2: Design biasing circuits for BJT

Objectives:

1) To perform an Experiment to Study Input Output characteristic of Common Collector transistor configuration.

2) Observe change in input parameters (V and I) by keeping output parameter constant.

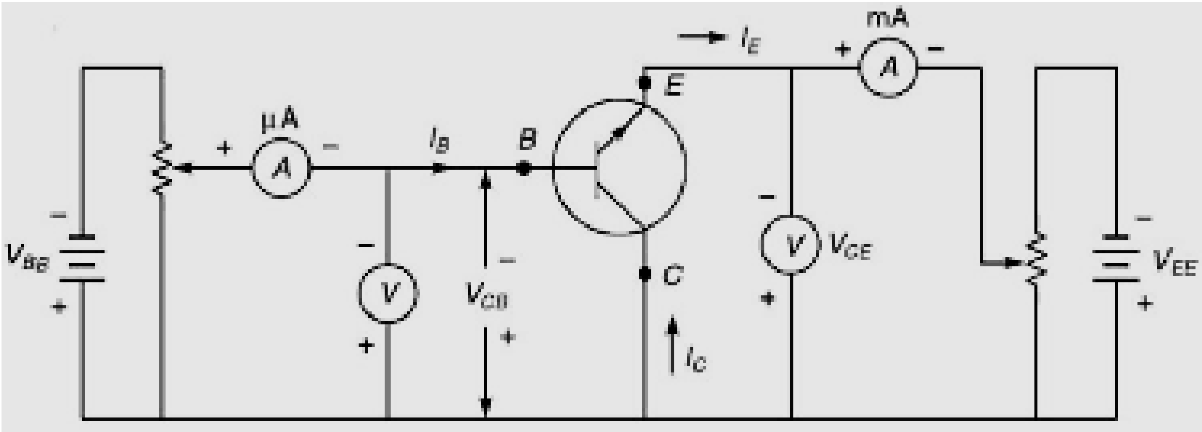
3) Observe change in output parameters (V and I) by keeping input parameter constant.

Equipment/Instruments: Trainer kit / (BJT (BC 107), Resistors, bread board), Regulated power supply, Patch cords, Digital Multimeters

<u>Theory:</u>

In CC Configuration, the Collector terminal of the transistor will be connected common between the output and the input terminals. The variation of Base current(I_B) with Collector-Base voltage(V_{CB}), keeping Collector Emitter voltage(V_{CE}) constant gives input characteristics and variation of emitter current(I_E) with Collector-Emitter voltage(V_{CE}), keeping Base current(I_B) constant gives output characteristics.

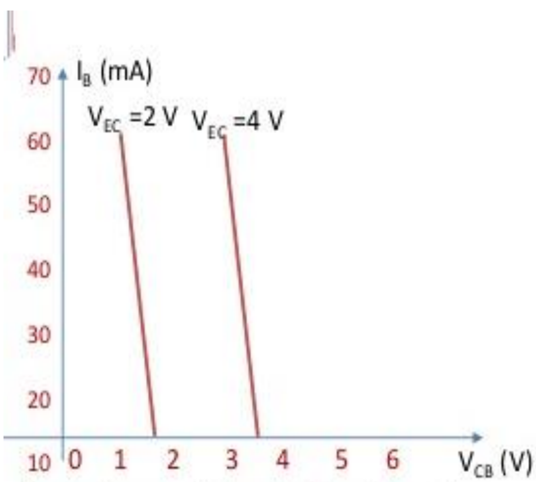
Circuit Diagram:



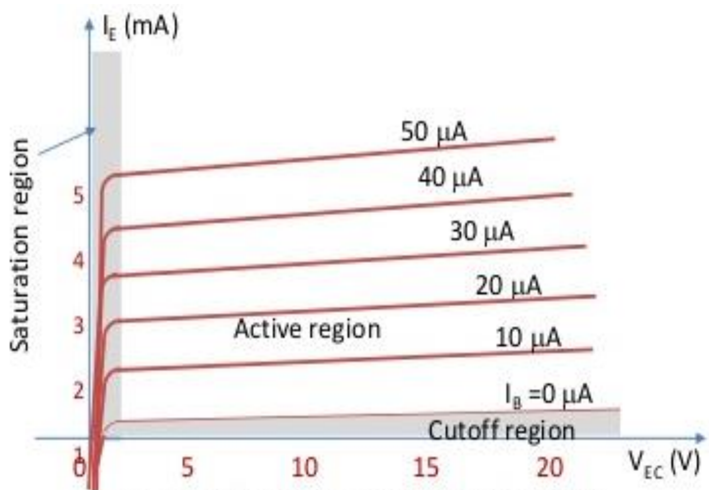
Model graph :

1. Plot the Input characteristics by taking I_B on y-axis and V_{CB} on x-axis.
2. Plot the Output characteristics by taking I_E on the y-axis and V_{CE} on x-axis.

INPUT CHARACTERISTICS: **OUTPUT CHARACTERISTICS:**



Input characteristics of CC configuration



Output characteristics of CC configuration

Safety and necessary Precautions:

1) Always keep power off while making connections.

2) Necessary care should be taken while working with ammeters, voltmeters and multimeters.

Procedure:

TO FIND THE INPUT CHARACTERISTICS:

1. Connect the circuit as in the circuit diagram.
2. Keep V_{BB} and V_{EE} in zero volts before giving the supply
3. Set V_{CE} = 1 volt by varying V_{CC} and vary the V_{BB} smoothly with fine control such that base current I_B varies in steps of 5µA from zero upto 200µA, and note down the corresponding voltage V_{CB} for each step in the tabular form.
4. Repeat the experiment for V_{CE} =2 volts and 3 volts.
5. Draw a graph between V_{CB} Vs I_B against V_{CE} = Constant.

TO FIND THE OUTPUT CHARACTERISTICS:

1. Start V_{EE} and V_{CC} from zero Volts.
2. Set the I_B = 20µA by using V_{BB} such that, V_{CE} changes in steps of 0.2 volts from zero upto 10 volts, note down the corresponding Emitter current I_E for each step in the tabular form.
3. Repeat the experiment for I_B = 40µA and I_B = 60µA, tabulate the readings.
4. Draw a graph between V_{CE} Vs I_E against I_B = Constant.

Observations:

INPUT CHARACTERISTICS;

Sr. No.	**V_{CE}=______V**		**V_{CE}=______V**		**V_{CE}=______V**	
	V_{CB} (V)	**I_B (μA)**	**V_{CB} (V)**	**I_B (μA)**	**V_{CB} (V)**	**I_B (μA)**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

OUTPUT CHARACTERISTICS;

Sr. No.	**I_B = ______μA**		**I_B = ______μA**		**I_B = ______μA**	
	V_{CE} (V)	**I_E(mA)**	**V_{CE} (V)**	**I_E(mA)**	**V_{CE} (V)**	**I_E(mA)**
1						
2						
3						
4						
5						
6						
7						
8						
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10						
11						
12						
13						
14						
15						

Graph:

Draw the graph for both input and output characteristics on separate graph paper.

Results:

1) Input Rsistance ri = $\Delta V_{CB} / \Delta I_B$ = ____________Ω
2) Output Rsistance ro = $\Delta V_{CE} / \Delta I_E$ =____________Ω
3) Current amplification factor = $\Delta I_E / \Delta I_B$ = ________

Conclusion:

Quiz:

1) Enlist the input output terminals for Common Emitter configuration of BJT.

2) Which parameters should keep constant while measuring input characteristics in CE configuration?

3) Which parameters should keep constant while measuring output characteristics in CE configuration?

4) What is the value of γ?

5) Derive relation between α and β and γ.

Suggested Reference:

1) David A. Bell, “Electronic Devices and Circuits”, Oxford University Press, Fifth edition
2) Albert Malvino & David, “Electronic Principles”, Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations:

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:12

Common Emitter Amplifier

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills,

1) Proper understanding Amplifier circuit.
2) Knowledge of biasing of CE configuration Amplifier.
3) Knowledge of Frequency response, Bandwidth and gain of amplifier circuit.

Relevant CO: CO-2: Design biasing circuits for BJT

CO-3: Analyze BJT circuits in small signal domain

Objectives:

1) To plot the frequency response of a Common Emitter BJT amplifier.
2) To find the cut off frequencies, Bandwidth and calculate its gain.

Equipment/Instruments: Trainer kit / (BJT (BC 547) , Resistors , Capacitors, bread board) ,Regulated power supply, Digital Multimeters, Function generator, C.R.O.,Patch cords, Connectors

Theory:

An amplifier is an electronic circuit that can increase the strength of a weak input signal without distorting its shape. The common emitter configuration is widely used as a basic amplifier as it has both voltage and current amplification with 1800 phase shift.

The factor by which the input signal gets multiplied after passing through the amplifier circuit is called the gain of the amplifier. It is given by the ratio of the output and input signals.

Gain = output signal / input signal

A self bias circuit is used in the amplifier circuit because it provides highest Q-point stability among all the biasing circuits. Resistors R1 and R2 forms a voltage divider across the base of the transistor. The function of this network is to provide necessary bias condition and ensure that emitter-base junction is operating in the proper region.

In order to operate transistor as an amplifier, the biasing is done in such a way that the operating point should be in the active region. For an amplifier the Q-point is placed so that the load line is bisected. Therefore, in practical design it is always set to Vcc/2. This will confirm that the Q-point always swings within the active region. Output is produced without any clipping or distortion for the maximum input signal. If not reduce the input signal magnitude.

The Bypass Capacitor:

The emitter resistor is required to obtain the DC quiescent stability. However, the inclusion of it in the circuit causes a decrease in amplification. In order to avoid such a condition, it is bypassed by capacitor so that it acts as a short circuit for AC and contributes stability for DC quiescent condition. Hence capacitor is connected in parallel with emitter resistance which increases the A.C gain.

The Coupling capacitor:

An amplifier amplifies the given AC signal. In order to have noiseless transmission of a signal (without DC), it is necessary to block DC i.e. the direct current should not enter the amplifier or load. This is usually accomplished by inserting a coupling capacitor between two stages.

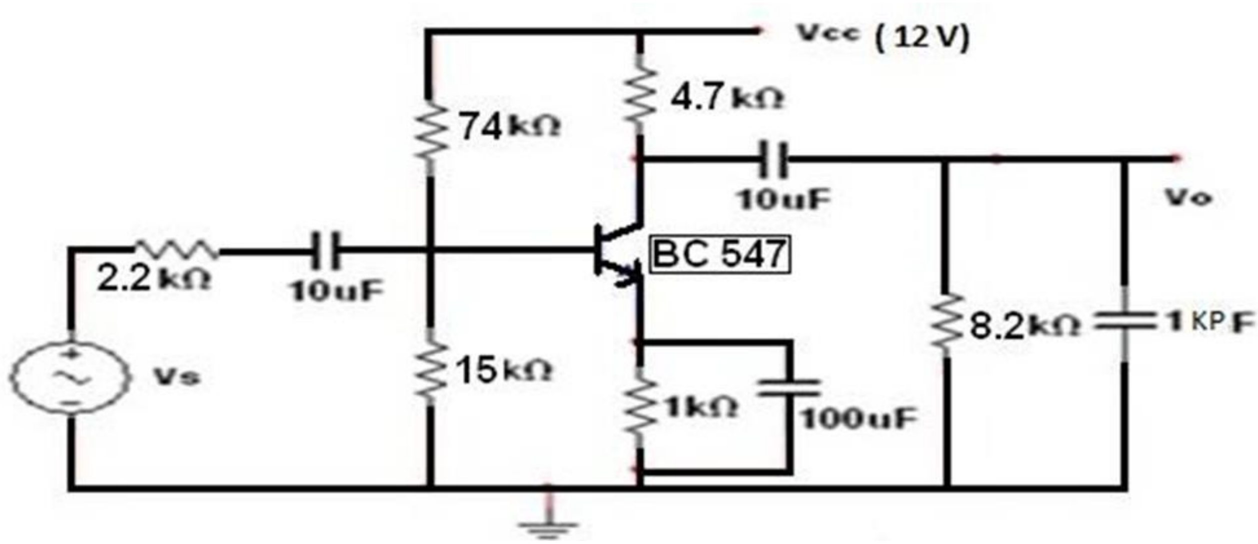
Frequency response:

The plot of gain versus frequency is called as frequency response. The coupling and bypass capacitors causes the gain to fall at low frequency region and internal parasitic capacitance and shunt capacitor causes the gain to fall at high frequency region. In the mid frequency range large capacitors are effectively short circuits and the stray capacitors are open circuits, so that no capacitance appear in the mid frequency range. Hence the mid band frequency gain is maximum. Hence we get a Band Pass frequency response

Characteristics of CE Amplifier:

- Large current gain.
- Large voltage gain.
- Large power gain.
- Current and voltage phase shift of 180°.
- Moderate output resistance.

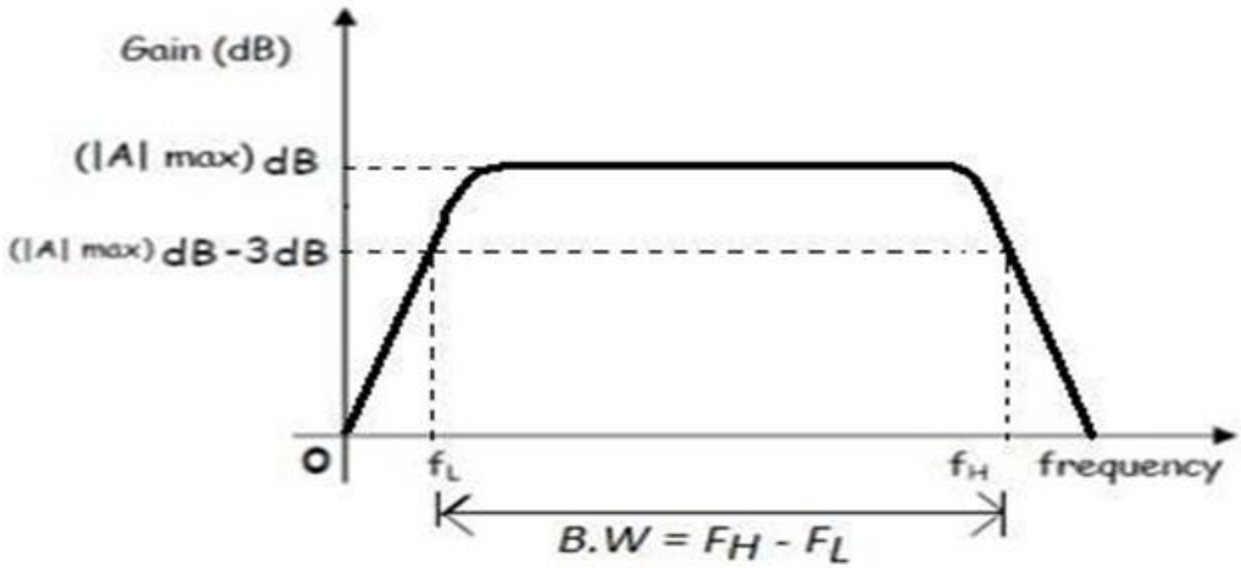
Circuit Diagram:



CE BJT AMPLIFIER

Model graph :

In the usual application, mid band frequency range is defined as those frequencies at which the response has fallen to 3dB below the maximum gain (|A| max). These are shown as f_L, f_H and are called as the 3dB frequencies or simply the lower and higher cut off frequencies respectively. The difference between the higher cut off and lower cut off frequency is referred to as the bandwidth (f_H - f_L).



Frequency Response Curve of RC coupled BJT CE Amplifier

Safety and necessary Precautions:

1) Always keep power off while making connections.

2) Necessary care should be taken while working with ammeters, voltmeters and multimeters.

3) While performing the experiment do not exceed the ratings of the transistor. This may lead to damage the transistor.

4) Connect signal generator in correct polarities as shown in the circuit diagram.

5) Before applying a signal to the C.R.O., make sure all the push buttons of control panel should be in depressed condition.

Procedure:

1. Connect the circuit as shown in fig, Set source voltage as 50mV P-P at 1 KHz frequency using the function generator.

2. Keeping the input voltage as constant, vary the frequency from 50 Hz to 1 MHz in regular steps and note down the corresponding output P-P voltage.
3. Plot the graph for gain in (dB) verses Frequency on a semi log graph sheet.
4. Calculate the bandwidth from the graph.

Observations:

Frequency	**Vs (Volts)**	**Vo (Volts)**	**Gain = Vo / Vs**	**Gain(dB) = 20 log(Vo/Vs)**

Graph:

Draw the graph for frequency on X-axis and Gain (dB) on Y- axis on a semilog paper.

Results:

1. Lower cutoff frequency, f_L = …………….
2. Higher cutoff frequency, f_H = ……………
3. Bandwidth = $f_H - f_L$ = ……………………

Conclusion:

Quiz:

1) What is cut off frequency?

2) What is Bandwidth for amplifier?

3) What are the applications of CE amplifier?

Suggested Reference:

1) David A. Bell, "Electronic Devices and Circuits", Oxford University Press, Fifth edition

2) Albert Malvino & David, "Electronic Principles", Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations ;

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:13

Transistor as a Switch

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills,

1) Proper understanding BJT circuit working.
2) Knowledge of biasing of BJT circuit .

Relevant CO: CO-2: Design biasing circuits for BJT

CO-3: Analyze BJT circuits in small signal domain

Objectives:

1) To make the load ON or OFF as per the switching effect of BJT.
2) To observe the required current to drive any application load.

Equipment/Instruments: BJT (Q2N3904), Resistors, Switch, LED, bread board, Regulated power supply, Digital Multimeters, Connectors

<u>Theory:</u>

A transistor is a semiconductor device has three terminals emitter-base and collector. There are many uses of this electronic component but most common is it used as switch and amplifier. Here, we will have discuss use of tra nsistor or BJT as Switch, application, circuits and different parameters related to it.

BJT as Switch

In the below figure the circuit shown explains the operation of BJT as a switch.

In the first circuit, the transistor is in the cutoff region because the emitter-base junction is not forward biased condition. In this state, there is no connection between emitter and collector of a transistor as shown like an open switch.

In the second circuit, a transistor is in a saturation state as both base-collector and the base-emitter junction is in forward biased state. The value of base current is such large that it makes collector current such level that transistor is in saturation state. In a saturation state, there is a short circuit between emitter and collector as it is shown in a circuit like closes switch configuration.

In real, a minor voltage loss across the transistor of up to some 10th of a volt usually exits, that is the saturation voltage, V_{CE}(sat).

Transistor Cutoff Mode

The state where both junctions of transistor base-emitter and base-collector are in reverses biased condition called a cutoff mode of a diode. In this case voltage across the base-emitter is less that does not allow current to flow from collector to emitter. In this state, VCE is equal to the VCC.

$$V_{CE}(cutoff) = V_{CC}$$

Transistor saturation Mode

In this mode of operation, their base-emitter junction is in forward biased condition due to that base current generated that results in the production of collector current.

The expression for saturation collector current is given here.

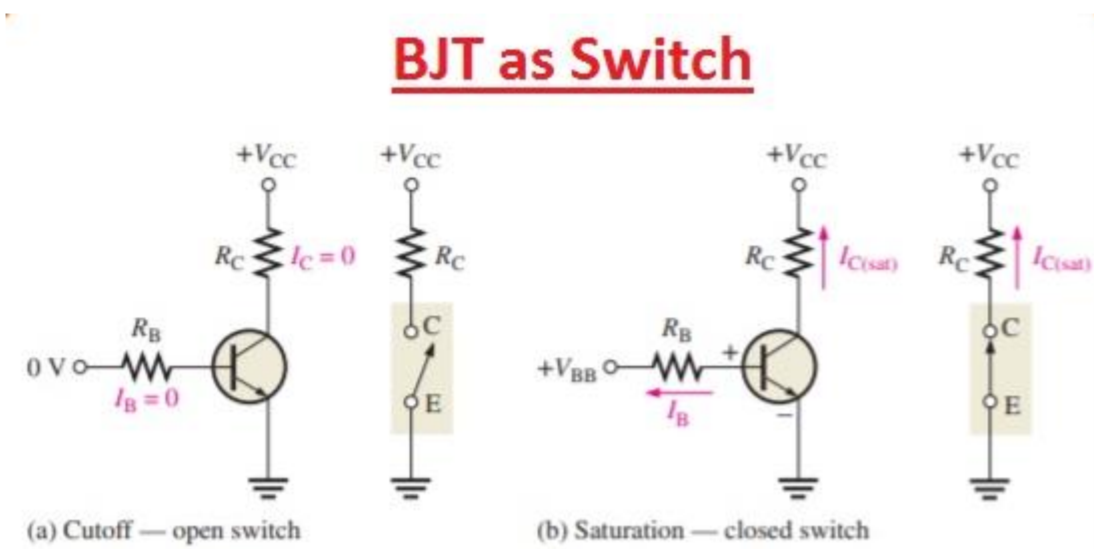
$$I_C(sat)=V_{CC}-V_{CE(sat)}/RC$$

As the value of VCE(sat) is less as compare to the VCC so it can be ignored.

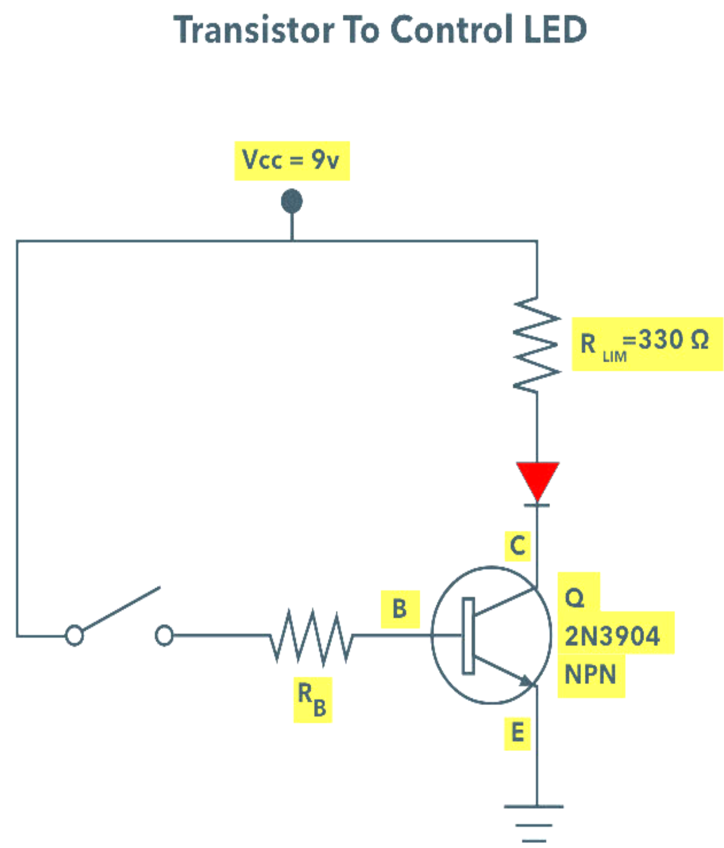
The minimum value of the base current required to generated saturation is given here.

$$I_{B(min)}= I_{C(sat)}/ \beta_{DC}$$

Usually, IB must be significantly larger than $I_{B(min)}$ to confirm that the transistor is saturated.



Circuit Diagram:



Safety and necessary Precautions:

1) Always keep power off while making connections.

2) Necessary care should be taken while working with ammeters, voltmeters and multimeters.

3) While performing the experiment do not exceed the ratings of the transistor. This may lead to damage the transistor.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Connect current meter between Switch and RB.
3. When the switch at the base terminal is open, no current flows through the base so the transistor is in the cutoff state. Therefore, the transistor acts as an open-circuit and the LED becomes OFF. So current meter deflection will be zero.
4. When the switch is closed, base current starts flowing through the transistor and then drives into saturation, which results in LED to turn ON.
5. Note down the reading of current meter.
6. Resistors are placed to limit the currents through the base and LED. It is also possible to vary the intensity of LED by varying the resistance in the base current path.

Observations:

Switch position	**I_B (mA)**	**I_C (mA)**	**LED On/OFF?**
ON			
OFF			

Results:

1. Minimum Current I_B required to ON the LED is _______________ mA

Conclusion:

Quiz:

1) Derive the equation for the output loop to find the output/ load current for NPN transistor.

2) Draw the circuit for transistor working as a switch to ON-OFF another device (except LED)

Suggested Reference:

1) David A. Bell, “Electronic Devices and Circuits”, Oxford University Press, Fifth edition

2) Albert Malvino & David, “Electronic Principles”, Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations:

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:14
Characteristics of FET

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills ,

1) Proper understanding FET terminals.
2) Knowledge of biasing of CS configuration FET .
3) Knowledge of Drain Resistance, Trans-conductance and Amplification factor of FET circuit.

Relevant CO: CO-4: Analyze basic FET circuits

Objectives:

1) To plot the transfer characteristics and Drain characteristics of CS FET configuration.
2) To find Drain Resistance, Trans-conductance and Amplification factor of FET circuit.

Equipment/Instruments: Trainer kit / (JFET BFW11, Resistors, bread board) Regulated power supply, Digital Multimeters, Connectors

Theory:

A JFET is called as Junction Field effect transistor. It is a unipolar device because the flow of current through it is due to one type of carriers i.e., majority carriers where as a BJT is a Bi - Polar device, It has 3 terminals Gate, Source and Drain. A JFET can be used in any of the three configurations viz, Common Source, Common Gate and Common Drain. The input gate to source junction should always be operated in reverse bias, hence input resistance $R_i = \infty$, $I_G \approx 0$.

Pinch off voltage V_P is defined as the gate to source reverse bias voltage at which the output drain current becomes zero.

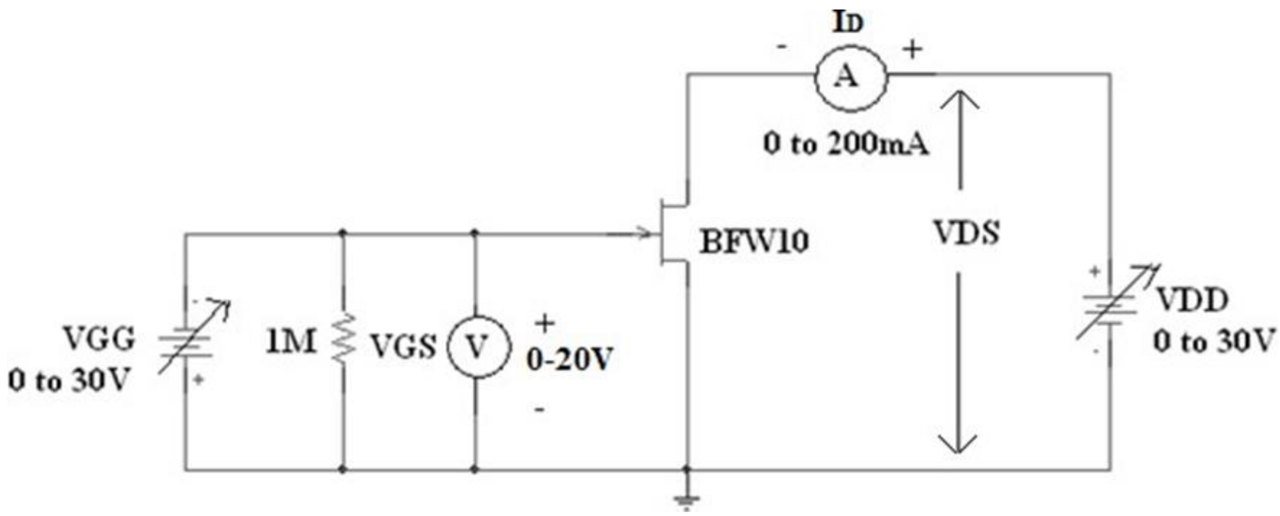
In CS configuration Gate is used as input node and Drain as the output node. A JFET in CS configuration is used widely as an amplifier. A JFET amplifier is preferred over a BJT amplifier when the demand is for smaller gain, high input resistance and low output resistance. Any FET operation is governed by the following equation.

The drain current equation and trans-conductance is given as

$I_D = I_{DSS} [1- V_{GS}/V_P]^2$ $g_m = \Delta I_{out}/\Delta V_{in} = I_D / V_{GS}$

Where □□□□ is called as Drain to Source Saturation current & V_p is called as the Pinch off voltage

Circuit Diagram:



Characteristics of FET in Common Source

Safety and necessary Precautions:

1) While performing the experiment do not exceed the ratings of the FET. This may lead to damage the FET.
2) Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.
3) Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
4) Make sure while selecting the Source, Drain and Gate terminals of the transistor.

Procedure:

Transfer Characteristics:

1) Connect the circuit as shown. All the knobs of the power supply must be at the minimum position before the supply is switched on.
2) Adjust the output voltage V_{DS} to 4V by adjusting the supply V_{DD}.
3) Vary the supply voltage V_{GG} so that the voltage V_{GS} varies in steps of -0.25 V from 0 V onwards. In each step note the drain current I_D. This should be continued till I_D becomes zero.
4) Repeat above step for V_{DS} = 8 V.
5) Plot a graph between the input voltage V_{GS} and output current I_D for output voltage V_{DS} in the second quadrant. This curve is called the transfer characteristics.

Drain Characteristics:

1) Connect the circuit as shown in figure. Adjust all the knobs of the power supply to their minimum positions before switching the supply on.
2) Adjust the input voltage V_{GS} to 0 V by adjusting the supply V_{GG}
3) Vary the supply voltage V_{DD} so that V_{DS} varies in steps of 0.5 V from 0 to 4 V and then in steps of 1 V from 4 to 10 V. In each step note the value of drain current I_D.
4) Adjust V_{GS} to -1 and -2 V and repeat step-3 for each value of V_{GS}.
5) Plot a graph between V_{DS} and I_D for different values of V_{GS}. These curves are called drain characteristics.
6) Mark the various regions in the drain characteristics graph and calculate the drain resistance.

Observations:

Transfer Characteristics:

V_{DS} = 4V		V_{DS} = 6V	
V_{GS}(V)	I_D(mA)	V_{GS}(V)	I_D(mA)

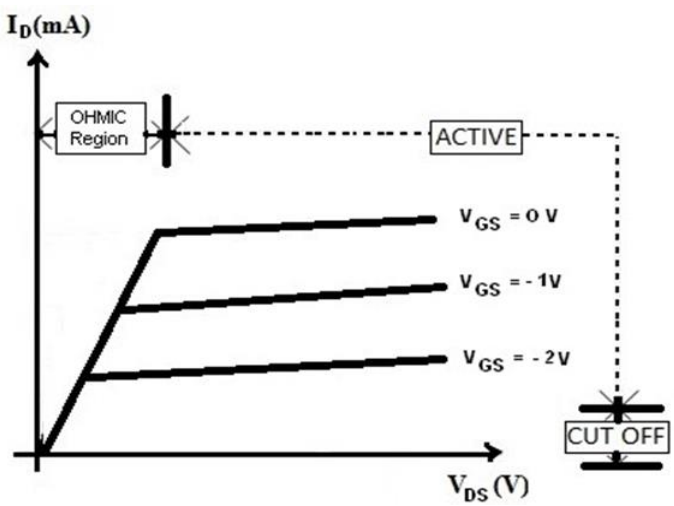
Drain Characteristics:

V_{GS} = 0V		V_{GS} = -1V		V_{GS} = -2V	
V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)

Graph:

1. Plot the drain characteristics by taking V_{DS} on X-axis and I_D on Y-axis at a constant V_{GS}.
2. Plot the transfer characteristics by taking V_{GS} on X-axis and taking I_D on Y-axis at constant V_{DS}.

Model graph:



Transfer Characteristics **Drain Characteristics**

Calculations from Graph:

1. Drain Resistance (r_d): It is given by the relation of small change in drain to source voltage (V_{DS}) to the corresponding change in Drain Current (I_D) for a constant gate to source voltage (V_{GS}), when the JFET is operating in pinch-off region.

2. Trans Conductance (gm): Ratio of small change in drain current (I_D) to the corresponding change in gate to source voltage (V_{GS}) for a constant V_{DS}.

$g_m = \dfrac{\Delta I_D}{\Delta V_{GS}}$ at constant V_{DS} (from transfer characteristics). The value of gm is expressed in mho's ( ) or Siemens (s).

3. Amplification factor (µ): It is given by the ratio of small change in drain to source voltage (V_{DS}) to the corresponding change in gate to source voltage (V_{GS}) for a constant drain current (I_D).

Results:

1. Drain Resistance rd=_____________
2. Transconductance gm = ___________
3. Amplification Factor µ = _____________

Conclusion:

Quiz:

1) What are the advantages of FET?

2) What are the disadvantages of FET?

3) What is transconductance?

4) Relation between μ, g_m and r_d?

Suggested Reference:

1) David A. Bell, "Electronic Devices and Circuits", Oxford University Press, Fifth edition
2) Albert Malvino & David, "Electronic Principles", Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations:

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					

Experiment No:15

Individual Circuit as Project

Date:

Competency and Practical Skills:

After this practical students are expected to develop following competencies and skills,

1) Proper understanding of theory of given circuit.

2) Knowledge of required terminology, biasing and connections etc. for the components and instruments used in the given circuit.

3) Knowledge of the parameters and results that are required to find after executing given circuit.

Relevant CO: CO-6: Construct and test circuit using basic electronic devices in a group

Objectives:

1)To provide opportunities to students to showcase their learnings by implementing circuits on the breadboard/ General purpose PCB and test.

2) To trouble shoot, measure the parameters and understand the findings.

Equipment/Instruments: breadboards, resistors, capacitors, potentiometers, led, General purpose PCB , Multimeters, Soldering iron , Soldering wire ,Single core wires, Jumper cables etc.

Suggested circuits: The faculties can decide which circuits to be given.

1) V-I characteristics of LED and Photodiode

2) Construct AND gate & OR gate with help of diode and verify truth table

3) To observe input-output waveforms of common collector (CC) amplifier. To measure gain of amplifier at different frequencies and plot frequency response

4) To measure gain of FET common source (CS) amplifier

Circuit Diagram:

Observations:

Results:

Conclusion:

Suggested Reference:

1)David A. Bell, “Electronic Devices and Circuits”, Oxford University Press, Fifth edition

2)Albert Malvino & David, “Electronic Principles”, Tata McGraw-Hill, Seventh edition

References used by the students:

Insert the marks according to observations ;

Category	Novice (2)	Developing (3)	Proficient (4)	Expert (5)	Score
Clarity of concepts and record book					
Knowledge and Understanding					
Practical Skills					