SCHEME : K

Name : _____

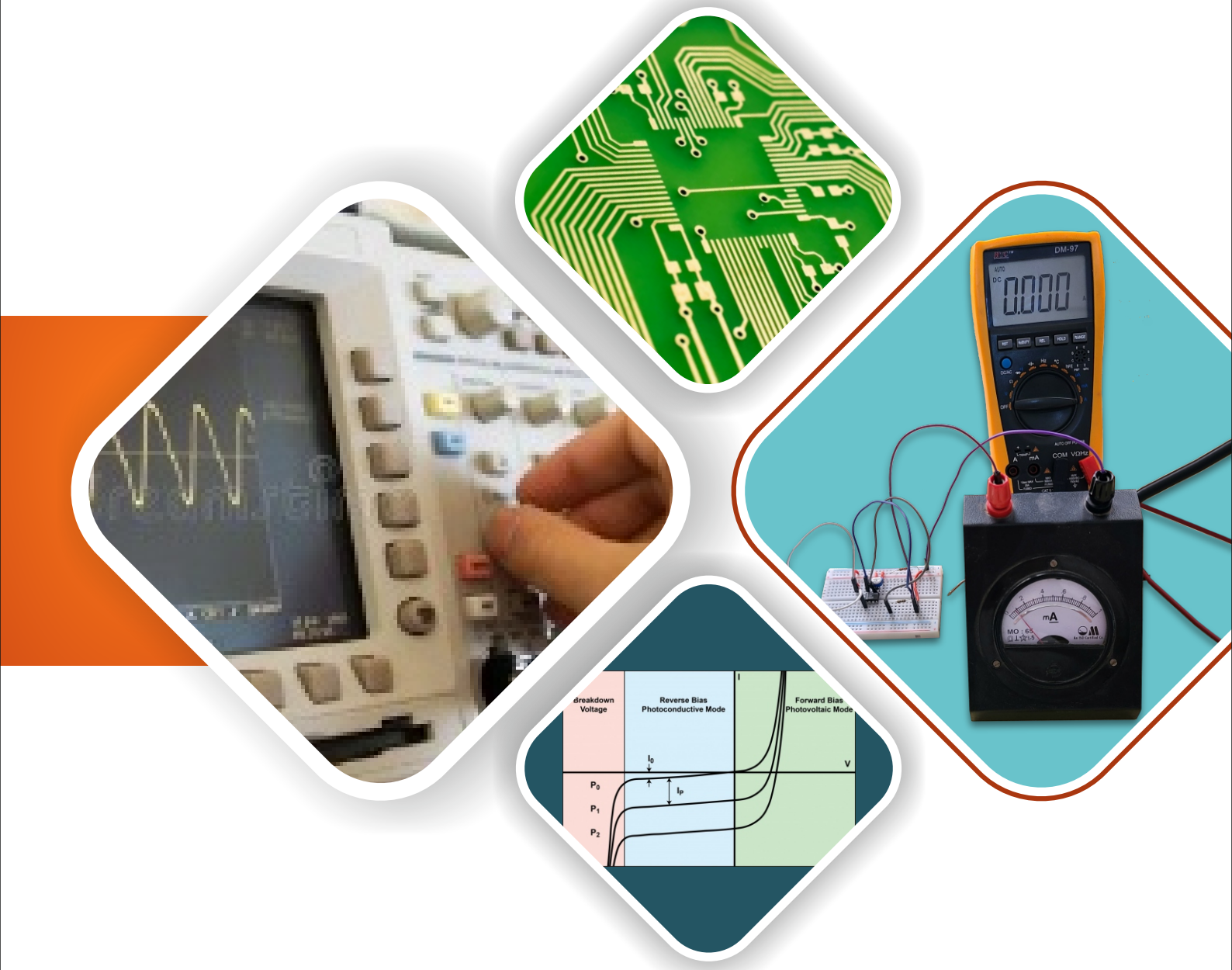
Roll No. : _____ Year : 20___ 20___

Exam Seat No. : _____

LABORATORY MANUAL FOR

BASIC ELECTRONICS

(312314)



ELECTRONICS ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001: 2015) (ISO/IEC 27001:2013)

A Laboratory Manual for

Basic Electronics

(312314)

Semester-II

(EJ/EX/EN/ET/EQ/DE/IS/IC/IE)

MAHARASHTRA STATE

BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr. / Ms . …….

Roll No. .....' of second Semester of Diploma in.....

..... of Institute, …….....

..... (Code: .....) has completed the term work satisfactorily in

Subject **Basic Electronics (312314)** for the academic year 20_____- 20_____

as prescribed in the curriculum.

Place:..... Enrollment No:.....

Date ……. Exam. Seat No: .....

Subject Teacher **Head of the Department** **Principal**

Preface

The primary focus of any engineering laboratory/field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programs with outcome-based education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practical to ***focus*** on the ***outcomes,*** rather than the traditional age old practice of conducting practical to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Basic Electronics course provides a platform for students to understand working of active devices such as Diode, BJT, MOSFET, JFET and circuits like rectifier regulators and wave shaping circuit. It is one of the foundation course, which is required for students to understand working of complex electronic circuits and systems. It also gives information about rectifiers, filters, different wave shaping circuits and voltage regulator with their applications for effective functioning in the field of electronic service industry.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual

Program Outcomes (POs) to be achieved through Practical of this Course

Following programme outcomes are expected to be achieved through the practical of the course

PO1 Basic and Discipline knowledge: Apply knowledge of basic mathematics, science and basic engineering to solve the broad-based Electronics related problems.

P02. Problem Analysis: Electronics and Telecommunication engineering knowledge To solve broad-based Electronics and Telecommunications engineering related problems

P03. Design Development and Solution: Plan to design experiments and develop to use the results to solve broad-based Electronics related problems.

P04. Engineering tools: Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

PO5. Engineering Practices for Society, Sustainability and Environment: Assess social, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of Electronics. Apply Electronics and Telecommunication engineering solutions also for sustainable development practices in social and environmental contexts**:**

P06. Project Management : Function effectively as a leader and team member in the diverse/ multidisciplinary teams. Apply ethical principles for commitment to professional ethics, Responsibilities and norms of the practice also in the field of Electronics and Telecommunication engineering

PO7. Life-long learning: Engage in independent and life-long learning activities in the context of technological changes also in the Electronics and Telecommunication engineering and allied industry.

List of Industry Relevant Skills

The following industry relevant skills of the competency "Maintain electronic circuits comprising of discrete electronic components" are expected to be developed in the student by undertaking the practical of this laboratory manual.

1. Identify the electronic component.
2. Test electronic component
3. Select the electronic component of proper value as per the requirement.
4. Mount the electronic component on breadboard as per circuit diagram.
5. Test the circuit for the given application.
6. Compare the observed output with the expected output.
7. Find faults and trouble shoot the given circuit.

Guidelines to Teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each practical
3. Involve students in performance of each experiment.
4. Teacher should ensure that the respective skills and competencies are developed in the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
8. Finally give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.
9. If practical is in two parts -Part I and Part II it should be conducted in two weeks.
10. Teacher is expected to refer complete curriculum document and follow guide lines for implementation

Instructions for Students

1. Listen carefully the lecture given by teacher about course, curriculum, learning structure, skills to be developed.
2. Organize the work in the group and make record of all observations.
3. Students shall develop maintenance skill as expected by industries.
4. Student shall attempt to develop related hand-on skills and gain confidence.
5. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
6. Student shall refer technical magazines, IS codes and data books.
7. Student should develop habit to submit the practical on date and time.
8. Student should well prepare while submitting write-up of exercise.

COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Use relevant diode in electronics circuits.

CO2 - Use BJT in electronics circuits.

CO3 - Use of BJT as amplifier and switch..

CO4 - Use FET and MOSFET in electronics circuits.

. CO5 - Maintain DC regulated power supply.

Content Page

List of Practical's and Progressive Assessment Sheet

S. No	Practical Outcome	Page No.	Date of performance	Date of submission	Assessment marks (25)	Dated sign. of teacher	Remarks (if any)
1.	Test the performance of PN junction diode.						
2.	Test the performance of zener diode.						
3.	Test the performance of photo diode by varying the light intensity as well as distance of the light source.						
4.	Construct and test half wave rectifier on breadboard.						
5.	Build and test the half wave rectifier with LC filter/ π filter						
6.	Prepare and test the full wave rectifier using two diodes.						
7.	Build and test the full wave Bridge Rectifier on bread board using two diodes.						
8.	Use LC/ π filter with full wave rectifier to measure ripple factor						
9.	Construct and test the full wave rectifier on bread board using IC KBU 808 with filter.						
10.	Build and Test the performance parameters of 7 Segment LED display FND 507/508.						
11.	Identify and select transistors using datasheets						
12.	Build and Test the performance of BJT working in CB mode.						
13	Prepare and Test the performance of BJT working in CE mode						
14.	Build and Test the BJT voltage divider bias circuit for given input						
15.	Construct and Test the performance parameters of BJT as Switch.						

S. No	Practical Outcome	Page No.	Date of performance	Date of submission	Assessment marks (25)	Dated sign. of teacher	Remarks (if any)
16	Build and Test the performance of single stage Low Power Common emitter amplifier						
17	Simulate and Test output waveform and frequency response of single stage common emitter (CE) amplifier using simulation software (like SPICE / Multisim)						
18	Build and Test the performance of RC coupled two stage amplifier.						
19	Test the performance of FET drain characteristics						
20	Check the performance of FET transfer characteristics and calculate transconductance						
21	Build and Test the performance of common source FET amplifier						
22	Test the various blocks of regulated dc power supply.						
23	Find out faults at different stages of regulated dc power supply.						
24	Trouble shoot given DC regulated power supply.						
25	Construct and test the performance of Zener voltage regulator for given voltage.						
26	Build and Test the performance of Positive voltage regulator using 78XX , three terminal IC for given voltage.						
27	Build and Test the performance of Negative voltage regulator using 79XX, three terminal IC for given voltage.						
28	Construct and test the performance of Dual voltage regulator using 78XX and 79XX ,three terminal IC for given voltage						
29	* Build and Test the performance of LOW voltage regulator using IC LM723 for given voltage.(2 V-7V)						
30	Build and Test the performance of HIGH voltage regulator using IC LM723 for given voltage.(7V-30V)						

Practical No.1: Test the Performance of PN Junction Diode.

I Practical Significance:

PN Junction diode is used in industries as well as in domestic applications such as detector circuits, wave shaping circuits and in rectifier of DC Power Supplies. For these applications diode selection plays a vital role. In this practical, students will draw V-1 characteristics of the given diode to understand diode behavior with respect to change in voltage.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

1. Component identification skills.
2. Component mounting skills.
3. Use DC Power supply to give different voltages.
4. Use Digital multimeter to measure the voltages and currents.

III Course Level Learning Outcomes

- Use relevant diode in Electronics circuits.

IV Laboratory Learning Outcome

Test V-1 characteristics of PN Junction diode to:

- LLO 1.1 Test PN junction Diode in forward bias.
- LLO 1.2 Plot the V-I characteristics of PN junction diode and determine cut in voltage.
- LLO 1.3 Calculate static and Dynamic resistance of diode.

V Relevant Affective domain related Outcome(s)

- Handle components and equipment carefully.
- Follow safety precautions.

VI Minimum Theoretical Background

A PN Junction Diode is one of the simplest semiconductor devices, and it has the characteristic of passing current in one direction only. If a suitable positive voltage (forward bias) is applied between the two ends of the PN junction, it can supply free electrons and holes with the extra energy they require to cross the junction, as the width of the depletion layer around the PN junction is decreased.

Static resistance (Rstatic) of a PN junction diode is a ratio of forward voltage (VF) to the forward current (IF).

$$\mathbf{R_{static} = VF / IF}$$

Dynamic resistance (Rdynarnic) of a PN junction diode is a ratio of small change m forward voltage (δVF) to small change in forward current (δIF).

$$R_{dynamic} = \boldsymbol{\delta VF / \delta IF}$$

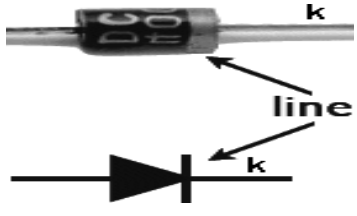


Figure 1: Diode and its symbol

Courtesy: (https://www.google.co.in/search?q=image+of++1n4007+diode&)

VII Practical Circuit Diagram:

a) Sample

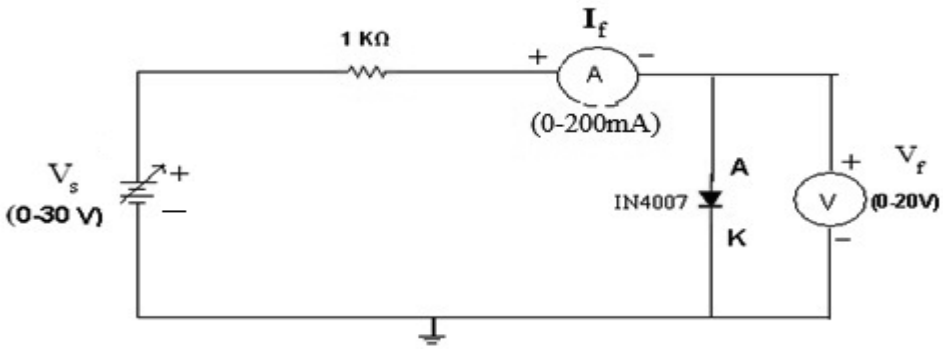


Figure 2: Circuit diagram of diode in forward bias

b) Actual Circuit used in laboratory

c) Actual Experimental set up used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	2	1. Digital Multi meter with diode testing facilities will be preferred. 2. In place of Digital Multimeter, DC Voltmeter and DC ammeter can be used.
2.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	**1**	
3.	Voltmeter	0-20 V	**1**	
4.	Ammeter	0 - 200 mA, 0 - 200 µA	1	
5.	Bread board	5.5 CMX 17CM	**1**	
6.	Diode	IN4001 (or any another equivalent diode)	**1**	
7.	Resistor	1KQ (0.5watts/0.25watts)	**1**	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

IX Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode.
3. Connect voltmeter and ammeter with correct polarities as shown in the circuit diagram.

X Procedure

1. Connect the electrical circuit as in figure 2.
2. Switch ON the power supply.
3. Increase the input voltage in step of0.l V
4. Record the voltage VF and current h in the observation table
5. Repeat steps 4 to 5 till **1** V is reached.
6. Plot the graph for the forward bias characteristics of diode by taking VF on X-axis and IF on Y- axis.
7. Calculate the static resistance at a particular point, on the characteristics.
8. Considering two points on the plotted graph, calculate dynamic resistance.

XI Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Table 1: Measurement of VF and IF

S.No.	VF(volts)	IF(mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Calculations:

Calculate static resistance at particular point

$$R_{static} = V_F / I_{FO}$$

Calculate dynamic resistance:

$$R_{ctynamic} = V_F / I_{FO}$$

XV Results

1. Static resistance of given diode= Ω
2. Dynamic Resistance of given diode = Ω
3. Knee Voltage of given diode= V

XVI Interpretation of results

XVII Conclusions


Scale
X-axis -
Y-axis -

XVIII Practical related Questions

Repeat the above experiment for germanium diode and find its knee voltage.

[Space for answers]

XIX References / Suggestions for further Reading

1. https://www.youtube.com/watch?v= vKeaPHXF9U
2. https://www.youtube.com/watch?v=7U8NzRAvy-I
3. https://www.youtube.com/watch?v=UqJ258EPTkI
4. https://www.youtube.com/watch?v=Coy-WRCfems
5. http://www.mouser.com/ds/2/149/1N4007-888322.pdf

XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	**100%**

Names of Student Team Members

6. .....
7. .....
8. .....
9. .....

Marks Obtained			Dated Signature of Teacher
Process Related(15)	**Product Related(l0)**	**Total (25)**	

Practical No. 2: Test the Performance of Zener Diode.

I Practical Significance:

In industries, Zener diodes are widely used as voltage references and as shunt regulators to regulate the voltage across circuits. Zener diodes are also used in over voltage protection circuits and switching applications. Zener diodes are suitable for surge suppression circuits, for device protection, for clipping, clamping circuits and especially as peak clippers.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

5. Component identification skills.
6. Component mounting skills.
7. Use DC Power supply to give different voltages.
8. Use Digital multimeter to measure the voltages and currents.

III Course Level Learning Outcomes

- Use relevant diode in Electronics circuits.

IV Laboratory Learning Outcome

Test V-1 characteristics of Zener diode to:

- LLO 2.1 Test Zener Diode in reverse bias.
- LLO 2.2 Plot V-I characteristics of Zener Diode in reverse bias.

V Relevant Affective domain related Outcome(s)

- Handle components and equipment carefully.
- Follow safety precautions.

VI Minimum Theoretical Background

Zener diode is formed by combining highly doped P and N semiconductor materials. It works on the principle of Zener breakdown and is normally operated in reverse breakdown region. In reverse breakdown region, high current flow through the diode leading to high power dissipation.

The Zener breakdown occurs when the electric field across the junction produced due to the reverse voltage is sufficiently high, this breaks covalent bonds. Thus a large numbers of carriers are generated which causes a more current to flow. This mechanism is called as Zener breakdown. After Zener breakdown the reverse current increases sharply.

Zener resistance of a Zener diode is a ratio of reverse Zener voltage to the reverse Zener current.

Figure 1: Symbol of Zener diode

VII Practical Circuit Diagram:

d) Sample

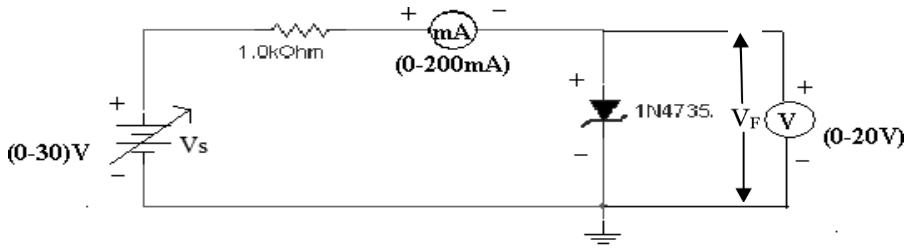


Figure 2: Circuit diagram of diode in forward bias

e) Actual Circuit used in laboratory

f) Actual Experimental set up used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	2	3. Digital Multi meter with diode testing facilities will be preferred. 4. In place of Digital Multimeter, DC Voltmeter and DC ammeter can be used.
2.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	**1**	
3.	Voltmeter	0-20 V	**1**	
4.	Ammeter	0 - 200 mA, 0 - 200 µA	1	
5.	Bread board	5.5 CMX 17CM	**1**	
6.	Diode	IN4735(or any other equivalent diode)	**1**	
7.	Resistor	1KΩ (0.5watts/0.25watts)	**1**	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

IX Precautions

4. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
5. While doing the experiment do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode.
6. Connect voltmeter and ammeter with correct polarities as shown in the circuit diagram.

X Procedure

1. Connect the circuit as shown in figure 2.
2. Switch ON the power supply.
3. Record the voltage VF and current IF in the observation table no1.
4. Increase the input voltage in step of 0.1 V
5. Record the voltage VF and current IF in the observation table no1.
6. Repeat steps 4 to 5 till 1 Vis reached.
7. Plot the graph for the forward bias characteristics of Zener diode by taking VF on X- axis and hon Y-axis.

8. Connect the circuit as shown in figure 3.
9. Vary input voltage gradually in steps of 1V up to 12V.
10. Record the corresponding readings of VR and IR.in the observation table no2.
11. Plot the graph for the reverse bias characteristics of Zener diode by taking VR on X- axis and IR on Y-axis.

XI Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Table 1: Measurement of VF and IF

S.No.	VF(volts)	IF(mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Table 2: Measurement of VR and IR

S.No.	VR(V)	IR(mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Calculations:

$R_Z = V_F / I_F \Omega$

$R_Z = V_R / I_R \quad \Omega$

XV Results

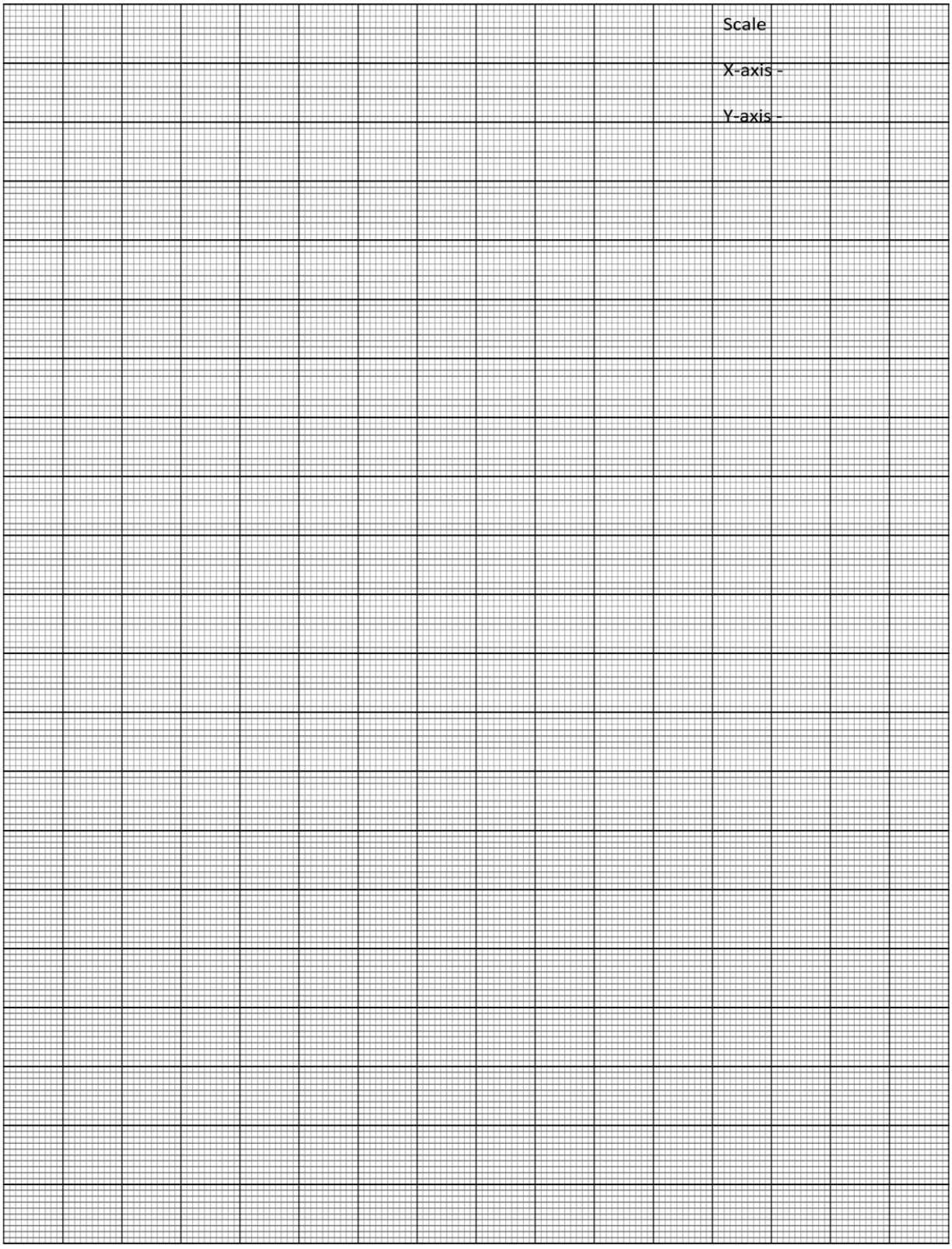
1. Zener breakdown voltage = V
2. Forward resistance of zener diode= Ω

XVI Interpretation of results

XVII Conclusions

XIX Practical related Questions

1. What is the value of zener voltage for given zener diode?
2. What is the maximum value of reverse current for given zener diode.
3. What is the effect on voltage across zener diode and current flowing through it, when reverse voltage across it is more than breakdown voltage?
4. What portion of zener diode characteristics is most useful for voltage regulator applications?


Scale
X-axis -
Y-axis -

XIX References / Suggestions for further Reading

https://www.youtube.com/watch?v=izPT3UbClI

XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	**100%**

Names of Student Team Members

10. .....
11. .....
12. .....
13. .....

Marks Obtained			Dated Signature of Teacher
Process Related(15)	**Product Related(l0)**	**Total (25)**	

Practical No. 3: Check the Performance of Photo Diode by Varying the Light Intensity as Well as Distance of the Light source.

I Practical Significance:

In industry and domestic applications, photodiodes are used in applications of photo detectors like charge-coupled devices, photoconductors, and photomultiplier tubes. These diodes are used in consumer electronics applications like smoke detectors, compact disc players, and televisions remote controls. Photodiodes are frequently used for exact measurement of the intensity of light in scientific and industry applications. Generally, they have an enhanced, more linear response than photoconductors. These diodes are much faster and more complex than normal PN junction diodes and hence are frequently used for lighting regulation and in optical communications.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: **'Maintain electronic circuits comprising of discrete electronic components.'**

9. Component identification skills.
10. Component mounting skills.
11. Use DC Power supply to give different voltages.
12. Use Digital multimeter to measure the voltages and currents.

III Course Level Learning Outcomes

- Use relevant diode in Electronics circuits.

IV Laboratory Learning Outcome

Test V-1 characteristics of Zener diode to:

- LLO 3.1 Build the circuit for Photo Diode .
- LLO 3.2 Observe the change in current with change in light intensity of the source.
- LLO 3.3 Plot distance VS Photo diode Currentiode in reverse bias.

V Relevant Affective domain related Outcome(s)

a. Handle components and equipment carefully.
i. Follow safety precautions.

VI Minimum Theoretical Background

A photodiode is a two terminal PN-junction diode that is operated by first reverse biasing the junction and then illuminating it by light energy to produce electric current. It is also called as photo-detector/light detector/photo-sensor. These diodes are designed to work in **reverse bias** condition, it means that the P-side of the photodiode is connected with the negative terminal of the battery and N-side is connected to the positive terminal of the battery. This diode is very sensitive to light, so when light falls on the diode it changes light into electric current.

Figure 1: Symbol of Photo Diode

Figure 2: Photo Diode

Photo Current (l1.): It is the reverse current produced due to tthermally generated electron-hole pairs in depletion region due to incident light. photo current is proportional to light intensity, as light intensity increases photo current increases.

Dark Current: A reverse current flows when no light is incident on the devices

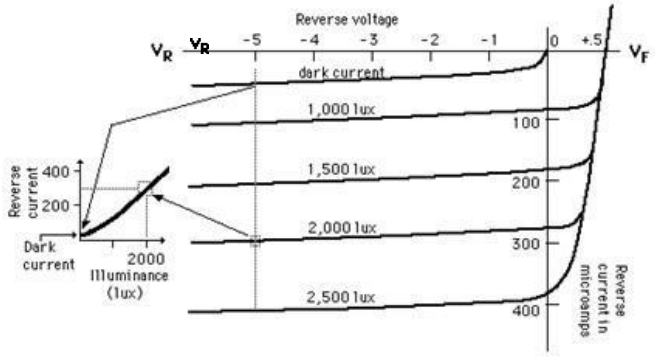


Figure 3: Plot of Reverse bias VI characteristics of Photo diode

VII Practical Circuit Diagram:

g) Sample

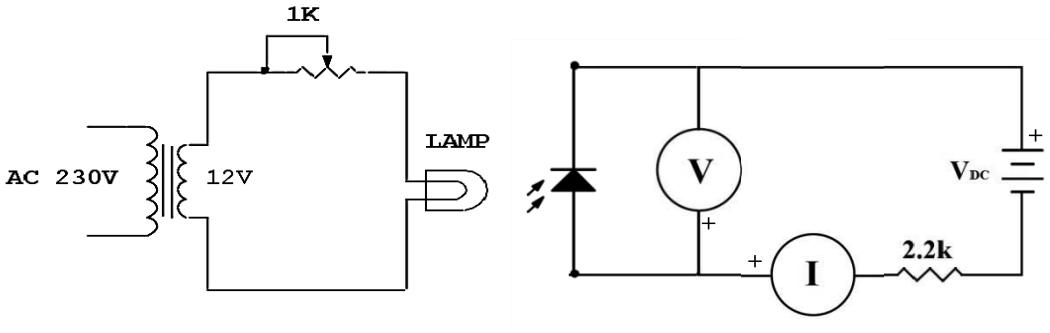


Figure 4: Experimental setup

h) Actual Circuit used in laboratory

i) Actual Experimental set up used in laboratory

Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Experimental kit/ breadboard	840 -1000 contact points: Positive and Negative power rails on opposite side of the board 5.5 CM X 17CM	1	
2.	Photo diode	BPW 34 or equivalent any other photodiode	1	
3.	Connecting wires	Single strand Teflon coating(0.6mm diameter)		
4.	Resistor	2.2KQ, 0.5Watt	1	
5.	Digital Multimeter	3 1/2 digit display, 9999 counts digital multimeter measures: Vac, Vdc (1000V max), Ade, Aac (10 amp max), Resistance (0 - 100 MQ),	1	Voltmeter (0-25) V, Ammeter (0-10μ) A
6.	DC Power supply	0-30V,2A,SC protection, display for voltage and current	1	
7.	Lux meter/Optical power meter,	3000 Lumen, Battery operated hand held type	1	
8.	Light source.	Portable Lamp mounted on stand	1	

VIII Precautions

7. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
8. While doing the experiment do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode.
9. Connect voltmeter and ammeter with correct polarities as shown in the circuit diagram.

IX Procedure

Test performance of photo diode by varying the light intensity.

1. Select the component as per circuit diagram.
2. Make the connections as per circuit diagram.
3. Apply the reverse voltage, and measure the current when light is not incident.
4. Increase the reverse voltage and light intensity in step and note down the photocurrent.
5. Change the light intensity and repeat the steps.
6. Plot the graph of reverse voltage (negative X-Axis) Vs reverse photo current (negative Y-Axis) for various light intensity.

Test performance of photo diode by varying distance of the light source.

1. Select the component as per circuit diagram.
2. Make the connections as per circuit diagram.
3. Apply the reverse voltage, and measure the current when light is not incident.
4. Keep the input voltage constant at which we get sufficient light intensity and vary the distance of light source from photo diode in step and note down the photocurrent.
5. Plot the graph of reverse voltage (negative X-Axis) Vs reverse photo current (negative Y-Axis) for various light intensity.

X Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XI Actual procedure followed

XII Precautions followed

XIII Observations and Calculations:

Table 1: Measurement of Photodiode current when light intensity is varied

Light Intensity	**No light Condition (Lux meter reading - ---)**		**Low Light Condition (Lux meter reading -)**		**High Light Condition (Lux meter reading - ---)**	
SR No.	**VR Volts**	**Ip (µA)**	**VR Volts**	**Ip (µA)**	**VR Volts**	**Ip (µA)**
1	2					
2	4					
3	6					
4	8					
5	10					
6	12					
7	14					
8	16					

Table 2 : **Measurement of Photodiode current when distance is varied**

Light Intensity	**Position** I **No light condition (Distance of light source in cm** ---)		**Position** II **(Distance of light source in cm)**		**Position** III **(Distance of light source in cm** ----)	
SR No.	**VR Volts**	**Ip (µA)**	**VR Volts**	**Ip (µA)**	**VR Volts**	**Ip (µA)**
1	2					
2	4					
3	6					
4	8					
5	10					
6	12					
7	14					
8	16					

Calculations:

XIV Results

Dark Current: .....

XV Interpretation of results

XVI Conclusion

XVIII Practical related Questions

1. Write specification of photodiode used in above performance.

[Space for answers]


Scale
X-axis -
Y-axis -

XIX. References / Suggestions for further Reading

1. https://www.youtube.com/watch?v=SFc673lEyQA
2. https://www.youtube.com/watch?v=yMmXHgOhRok
3. https://www.youtube.com/watch?v=BtQ7qY-uqs8
4. https://www.electronics-notes.com/articles/electroniccomponents/diode/photodiode-detector-technology.php
5. http://silas.psfc.mit.edu/22.07lj/photodiode.pdf
6. http://www.osioptoelectronics.com/ application-notes/an-photodiode-parameters-characteristics.pdf

XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	**100%**

Names of Student Team Members

14. .....
15. .....
16. .....
17. .....

Marks Obtained			Dated Signature of Teacher
Process Related(15)	**Product Related(l0)**	**Total (25)**	

Practical No. 4: Construct and Test Half Wave Rectifier on Breadboard.

I Practical Significance:

AC power is more efficiently and economically transmitted. The majority of electronic equipment, devices work on DC power. It becomes necessary to convert AC power into DC power. In half wave rectifier single diode is used. The current flows in only one direction through diode. So it is unidirectional device.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

1. Component identification skills.
2. Component mounting skills.
3. Use DC Power supply to give different voltages.
4. Use Digital multimeter to measure the voltages and currents.

III Relevant Course Outcomes

Use relevant diode in different electronics circuits.

IV Laboratory Learning Outcome

Test half wave rectifier on Breadboard:

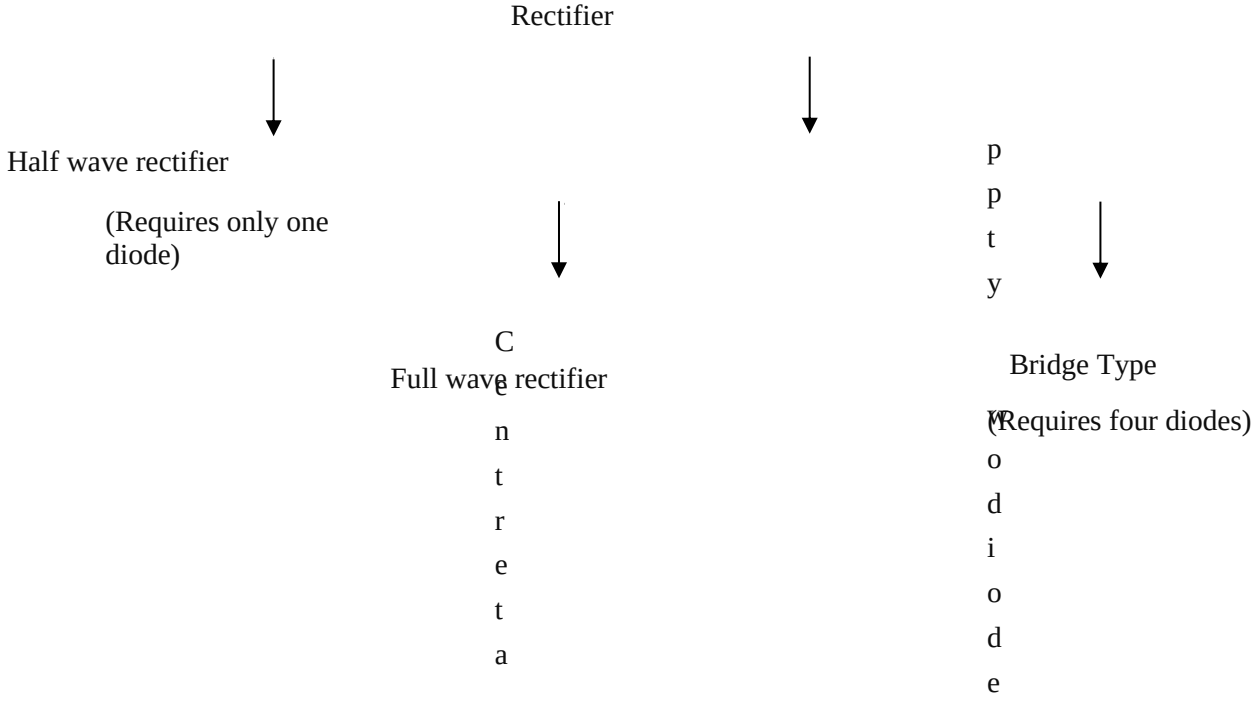
- LLO 4.1 Construct the circuit for Half Wave Rectifier using PN junction Diode on.
- LLO 4.2 Plot Output Waveform for sinusoidal input

V Relevant Affective domain related Outcome(s)

- Handle components and equipment carefully.
- Follow all safety precautions.

VI Minimum Theoretical Background

Rectifier: - It is a circuit, which converts AC supply into the Pulsating DC supply.



Half wave Rectifier: DC or average output voltage of half wave rectifier is Vmhr as the output current flows only for half the cycle of input signal.

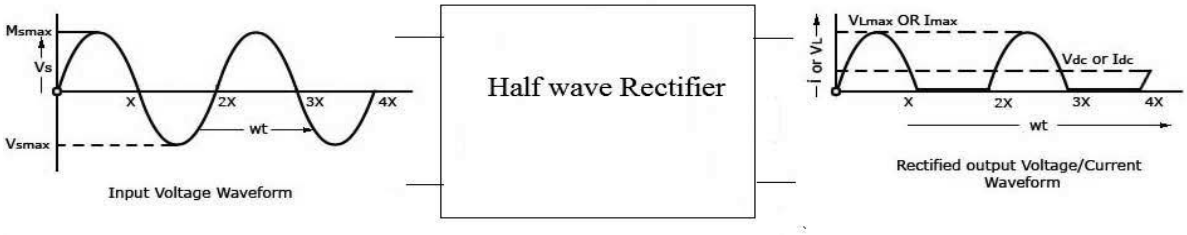


Figure 1: Half Wave rectifier.

Courtesy: *(www.Circuit.Today.com)*

VII Practical Circuit Diagram :

a. Sample

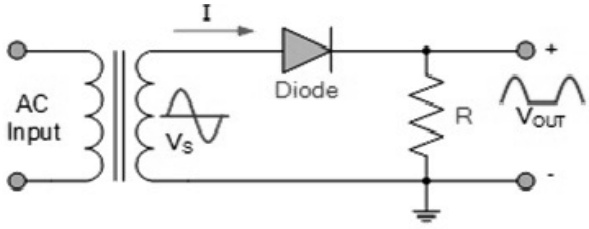


Figure 2: Circuit diagram of Half Wave rectifier.

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Transformer	Step down 9-0-9 V 500mA	**1**	
2.	Digital Multimeter	Digital Multimeter: 3 1/2-digit display.	2	Digital Multimeter with diode testing facilities will be preferred.
3.	CRO	25 MHz, dual scope	**1**	
4.	Bread board	5.5 CMX 17CM	**1**	
5.	Diode	IN4007 (or any other equivalent diode)	**1**	
6.	Resistor	1KQ/10KΩ(0.5watts/0.25watts)	**1**	
7.	Connecting wires	Single strand Teflon coating(0.6mm diameter)	L.S.	

IX Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode.

X Procedure

1. Make the connection as per the circuit diagram shown in figure2.
2. Connect the CRO probe across the Secondary and measure the Vp-p appearing across the diodes.
3. Now connect the CRO probes across the resistance RLand measure the peak value of output voltage (Vm).
4. Observe the waveform on CRO and draw it on graph paper.
5. From the measured peak value of output voltage (Vm), calculate the average or de value of output voltage (Yctc)-
6. Connect the DMM across the RL and measure the de voltage.
7. Compare the value calculated in step 5 with the value measured in step 6.
8. Tabulate the readings in Table1.

XI Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Table 1

Type of rectifier	Rectifier Output on CRO (Vm)	V_{dc} Calculated (using Formula $V_{de}= (Vm/\pi)$	V_{de} Measured (usingDMM)	Comment

Calculations: Calculate V_{dc} using Formula:

$$V_{dc} = (V_m /\pi)$$

XV Results

DC output voltage of Half wave rectifier

1. Calculated V_{dc} (CRO)= V
2. Measured V_{dc} (DMM)= V

XVI Interpretation of results

XVII Conclusions

XVIII Practical related Questions

1. Repeat the above experiment for silicon diode of different specification.

[Space for answers]


Scale
X-axis -
Y-axis -

XIX References / Suggestions for further Reading

1. https://www.youtube.com/watch?v= vKeaPHXF9U
2. https://www.youtube.com/watch?v=7U8NzRAvy
3. https://www.youtube.com/watch?v=UqJ258EPTkI
4. https://www.youtube.com/watch?v=Coy-WRCfems
5. http://www.mouser.com/ds/2/ l 49/l N4007-888322.pdf

XX Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks:

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculation of theoretical values	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

1. .....
2.
3.
4.

Marks Obtained			Dated signature of Teacher
Process Related(l5)	**Product Related(l0)**	**Total (25)**	

Practical No. 5: Build and Test Half Wave Rectifier on Breadboard with Filter (LC filter / π Filter)

I Practical Significance

Electric power is usually transmitted in AC form. However certain applications need DC power supply such as electronic appliances. Hence, AC mains need to be rectified using rectifier when DC power is required.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

1. Component identification skills.
2. Component mounting skills.
3. Use Digital multimeter to measure the voltages.

III Relevant Course Outcome(s)

Use relevant diode in electronics circuits.

IV Laboratory Learning Outcome

Convert AC signal into DC signal using Half wave rectifier:

- LLO 5.1 Build the circuit for Half Wave Rectifier with LC filter/ Pi filter using PN junction Diode.
- LLO 5.2 Observe and draw input & output waveforms for sinusoidal wave.

V Relevant Affective domain related Outcome(s)

- Handle components and equipment carefully.
- Follow safety precautions.

VI Minimum Theoretical Background

Rectifier is an electronic circuit used for converting AC into Pulsating DC and this process is known as **Rectification.** In half wave rectifier, during the positive half cycles of the input wave, the diode will be forward biased and during the negative half cycles of input wave, the diode will be reverse biased. The rectifier conducts current during positive half Cycle of A.C. input and no current through it during negative half cycle of AC input. This is called **half wave rectification.**

Rectifier performance is based on efficient DC output. The pulsating Direct Current (DC) is not constant. It fluctuates with respect to time. When this fluctuating Direct Current (DC) is applied to any electronic device, the device may not work properly. Sometimes the device may also be damaged. So, the fluctuating Direct Current (DC) is not useful in most of the applications. Therefore, it needs a Direct Current (DC) that does not fluctuate with respect to time. The only solution for this is smoothing the fluctuating Direct Current (DC). This can be achieved by using a circuit called filter. The filter is made up of a combination of components such as capacitors, resistors, and inductors. The capacitor allows the AC component and blocks the DC component. The inductor allows the DC component and blocks the AC component.

VII Circuit diagram:

a. Sample

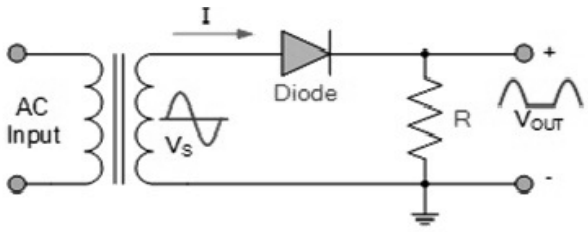
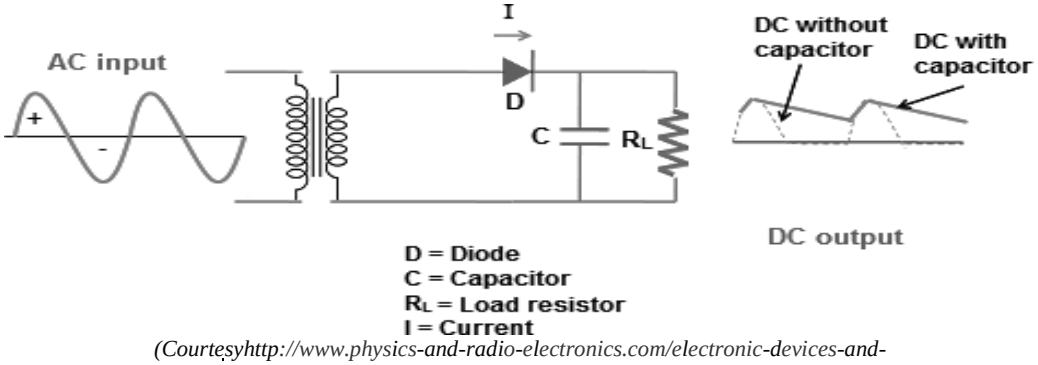


Figure 1. Half wave rectifier without filter.



(Courtesyhttp://www.physics-and-radio-electronics.com/electronic-devices-and-circuits/rect!flerlhalfivaverect!flerwithjilter.html)

Figure 2. Half wave rectifier with filter

b. Actual Circuit used in laboratory

c. Actual Experimental set up used in laboratory

VIII Resources required

S. No.	Instrument /Object	Specification	Quantity
1.	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	2
2.	Voltmeter	0-20 V	1
3.	CRO	25MHz	1
4.	Ammeter	(0 - 200 mA, 0 - 200 µA)	**1**
5.	Bread board	5.5 CMX 17CM	1
6.	Transformer	12-0-12 V AC, 500 mA	1
7.	Diode	IN4001 (or any other equivalent diode)	**1**
8.	Resistor	1KO (0.5watts/0.25watts)	1
9.	Capacitor	l0µf/ 24 V	1
10.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

IX Precautions to be Followed

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode.

X Procedure

1. Connect the Electronic circuit for half wave rectifier with Capacitor filter on breadboard as shown in Figure 2.
2. Connect the primary side of the transformer to AC mains. Connect the CRO probe across the secondary and measure the Vsp-p appearing across diode. Now connect the probes across the resistance RL.
3. Measure the peak value of output voltage (Vm) using CRO. From measured peak value of output voltage (Vm) calculate the average or DC value of output voltage.
4. Draw the input/output waveforms of rectifier on graph paper.
5. Using a DMM measure the DC voltage across the load resistance.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XII Actual Procedure Followed

XIII Precautions Followed

XIV Observations and Calculations

Table 1

S.No.	Rectified output (Vm)	Vdc (V) measured without filter on CRO	Vdc (V) measured without filter on DMM	Vdc (V) measured With filter on CRO	Vdc (V) measured with filter on DMM
1					

Calculations:

$$V_{dc}=V_m/\pi$$

XV Results

V_{dc} calculated= V

XVI Interpretation of results

XVII Conclusions

XVIII Practical related Questions

1. State the effect on output voltage if we replace the filter capacitor of different specification.

2. Attach the data sheet of capacitor used in Q1 of XIX . Refer second website given in XIX.

[Space for answers]

XIX References / Suggestions for further Reading

1. http://npteLac.in/courses/117103063/4
2. http://eecs.oregonstate.edu/education/docs/datasheets/XC-600178.pdf

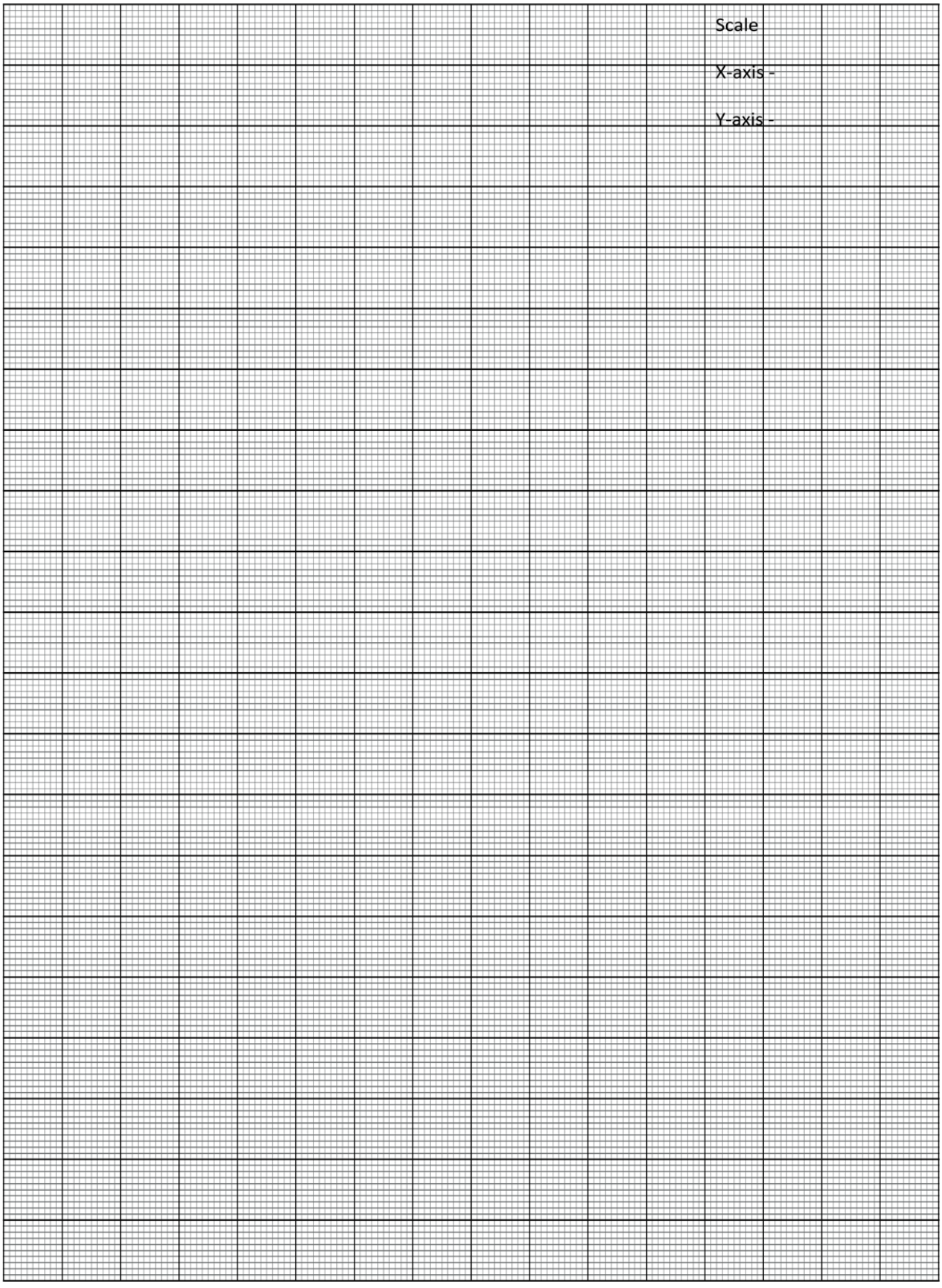
XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(l0)**	**Total (25)**	


Scale
X-axis -
Y-axis -

1N4001 - 1N4007

1.0A RECTIFIER

Please click here to visit our online spice models database.

Features

- Diffused Junction
- High Current Capability and Low Forward Voltage Drop
- Surge Overload Rating to 30A Peak
- Low Reverse Leakage Current
- **Lead Free Finish, RoHS Compliant (Note 3)**

Mechanical Data

- Case: DO-41
- Case Material: Molded Plastic. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020D
- Terminals: Finish - Bright Tin. Plated Leads Solderable per MIL-STD-202, Method 208
- Polarity: Cathode Band
- Mounting Position: Any
- Ordering Information: See Page 2
- Marking: Type Number
- Weight: 0.30 grams (approximate)

Dim	DO-41 Plastic	
	Min	Max
A	25.40	–
B	4.06	5.21
C	0.71	0.864
D	2.00	2.72
All Dimensions in mm		

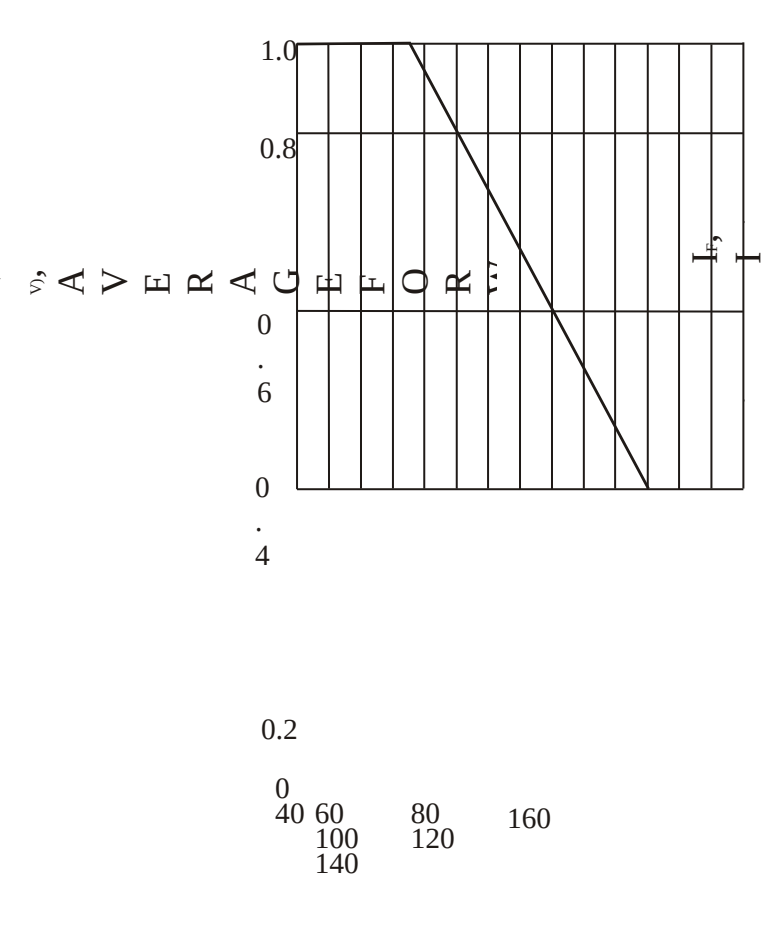
Maximum Ratings and Electrical Characteristics @T_A = 25°C unless otherwise specified

Single phase, half wave, 60Hz, resistive or inductive load.

For capacitive load, derate current by 20%.

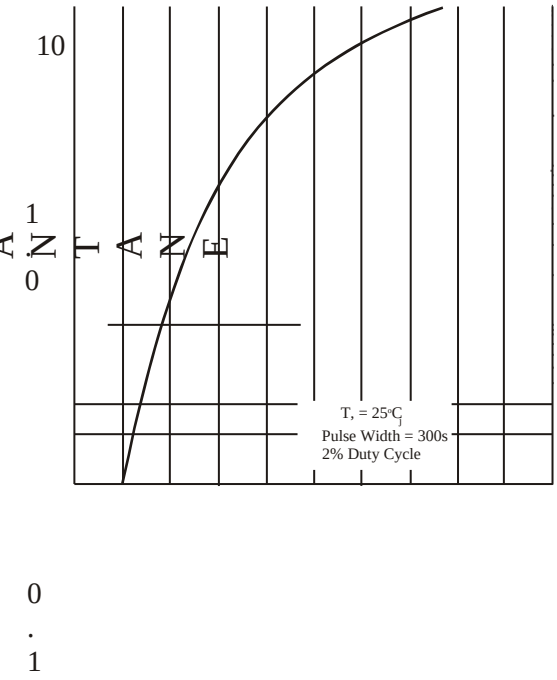
Characteristic	Symbol	1N4001	1N4002	1N4003	1N4004	1N4005	1N4006	1N4007	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	V
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	V
Average Rectified Output Current (Note 1) @ T_A = 75°C	I_O	1.0							A
Non-Repetitive Peak Forward Surge Current 8.3ms single half sine-wave superimposed on rated load	I_{FSM}	30							A
Forward Voltage @ I_F = 1.0A	V_{FM}	1.0							V
Peak Reverse Current @T_A = 25°C at Rated DC Blocking Voltage @ T_A = 100°C	I_{RM}	5.0 50							⌠A
Typical Junction Capacitance (Note 2)	C_j	15				8			pF
Typical Thermal Resistance Junction to Ambient	$R_{\theta JA}$	100							K/W
Maximum DC Blocking Voltage Temperature	T_A	+150							°C
Operating and Storage Temperature Range	T_J, T_{STG}	-65 to +150							°C

Notes:
1. Leads maintained at ambient temperature at a distance of 9.5mm from the case.
2. Measured at 1.0 MHz and applied reverse voltage of 4.0V DC.
3. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied, see EU Directive 2002/95/EC Annex Notes.



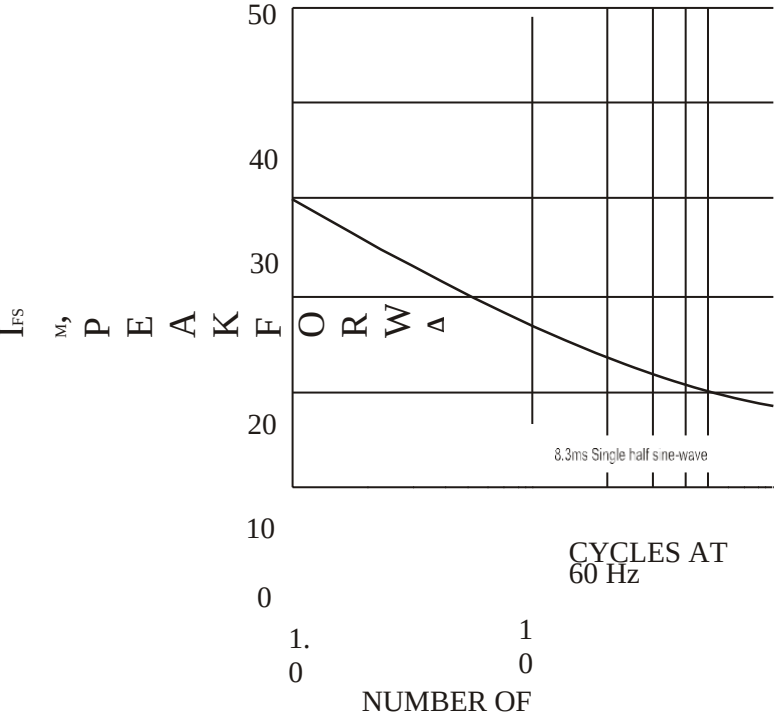
TA, AMBIENT TEMPERATURE (ºC)

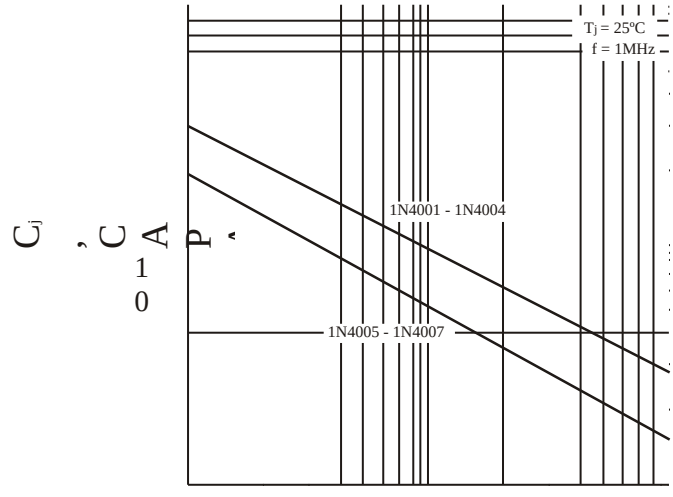
Fig. 1 Forward Current Derating Curve



VF, INSTANTANEOUS FORWARD VOLTAGE (V)

Fig. 2 Typical Forward Characteristics





100

Fig. 3 Max Non-Repetitive Peak Fwd Surge Current

Fig. 4 Typical Junction Capacitance

Ordering Information (Note 4)

Device	Packaging	Shipping
1N4001-B	DO-41 Plastic	1K/Bulk
1N4001-T	DO-41 Plastic	5K/Tape & Reel, 13-inch
1N4002-B	DO-41 Plastic	1K/Bulk
1N4002-T	DO-41 Plastic	5K/Tape & Reel, 13-inch
1N4003-B	DO-41 Plastic	1K/Bulk
1N4003-T	DO-41 Plastic	5K/Tape & Reel, 13-inch
1N4004-B	DO-41 Plastic	1K/Bulk
1N4004-T	DO-41 Plastic	5K/Tape & Reel, 13-inch
1N4005-B	DO-41 Plastic	1K/Bulk
1N4005-T	DO-41 Plastic	5K/Tape & Reel, 13-inch
1N4006-B	DO-41 Plastic	1K/Bulk
1N4006-T	DO-41 Plastic	5K/Tape & Reel, 13-inch
1N4007-B	DO-41 Plastic	1K/Bulk
1N4007-T	DO-41 Plastic	5K/Tape & Reel, 13-inch

Notes: 4. For packaging details, visit our website at http://www.diodes.com/datasheets/ap02008.pdf.

Practical No.6: Prepare and Test the full wave rectifier using two diodes.

I. Practical Significance:

Electric power is usually transmitted in AC form. However certain applications needs DC power supply such as electronic appliances. Hence, AC mains need to be rectified using rectifier when DC power is required.

II. Industry /Employer Expected outcome(s)

The aim of this course is to attend following industry identified competency through various teaching learning experiences: • Maintain electronic equipment/systems comprising of discrete electronic components

III. Course Level Learning Outcome Students will be able to achieve & demonstrate the use of relevant diode in electronics circuits

IV. Laboratory learning outcome(s) prepare the circuit for Full Wave Centre Tapped Rectifier using PN junction Diode.

V Relevant Affective domain related Outcome(s)

Handle components and equipment carefully.
Follow all safety precautions.

VI. Relevant Theoretical Background

Rectifier is an electronic device used for converting AC into pulsating DC and this process is known as Rectification. Like the half wave circuit, a full wave rectifier circuit produces an output voltage or current which is pulsating DC. Full wave rectifier utilizes both the cycle of input AC voltage. Two diodes are used in full wave centre tapped rectifier. Center Tapped Full wave rectifier using two diodes is shown in the figure no.

1. Center tapped transformer is used in this full wave rectifier. During the positive cycle diode Dl conducts and D2 remains OFF. During negative cycle diode Dl remains OFF but diode D2 is ON. Note that direction of current in the load resistance is same during both the cycles hence output consists of only positive cycles.

VII: Actual circuit diagram used in Laboratory with equipment specifications

a. Sample

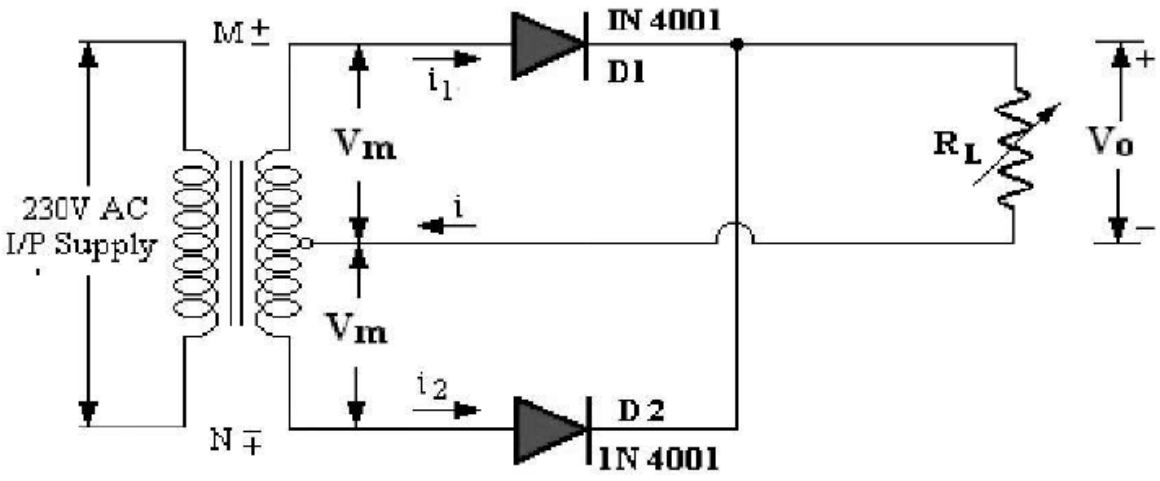


Figure 6.1 : full wave rectifier with two diodes.

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VII. Resources required

VIII Precautions to be Followed

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode.

S. No.	Instrument /Object	Specification	Quantity
1	Transformer (center tapped)	12-0-12 V AC, 500 mA	1
2	Resistor	l0K Q,0.5 Watt	1
3	Diode	Silicon 1N4001	2
4	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	1
5	Bread board	5.5 CM X 17CM	1
6	CRO	25 MHz Dual trace	1
7	Connecting wires	Single strand Teflon Coating (0.6mm diameter)	1

IX Procedure

1. Connect the circuit for Center Tapped Full wave rectifier on breadboard as shown in Figure 1.
2. Connect the primary side of the transformer to AC mains. Connect the CRO probe across the secondary and measure the VSp-p appearing across diode.
3. Measure the peak value of output voltage (Vm) across the resistance RL.
4. Draw input and output waveforms of full wave rectifier.
5. Calculate the average or de value of output voltage.
6. Using DMM measure the DC voltage at the load resistance RL.
7. Compare the value calculated in step 5 with the value measured in step 6.
8. Tabulate the readings in Table

X Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XI Actual Procedure Followed

XII Precautions Followed

XIII Observations and Calculations

Table 1.

Type of rectifier	Rectifier Output on CRO (Vm)	V_{de} Calculated (using Formula Vde=(2Vmtn)	V_{de} Measured (using DMM)	Comment

Calculations:

Yctc=2Vm/rc

XIV Results

V_{de} calculated = V

XV Interpretation of results

XVI Conclusions

XVII Practical related Questions

1. Calculate frequency of waveform obtained at the output of full wave rectifier.
2. Compare half wave and Full wave rectifier based on output waveforms obtained in Laboratory.

[Space for answers]

XVIII References / Suggestions for further Reading

1. http://nptel.ac.in/courses/
2. www.electronics-tutorials.ws > Diodes

XIX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(l0)**	**Total (25)**	

1N4001 - 1N40D7
Genera.I-Purpose Re,ctifiers

Feamres,

- Low Fomand'ltdltage-[)rop
- **1-JWi** Surge Ourrenl Gapabilily

00-411

cm.al:11,1,NillZDDTC::I

Order1Ing lnfonn11tion

Part Ni.nrbe.-	TopMilf"k	Package	Paclcing Melhod
1N4001	1N4001	00-204-Al (00-41)	Tape **.and** Reel
1N4002	1N4002	00-204-Al (00-41)	Tape **.and** Reel
1N4003	1N4003	00-204-Al (00-41)	Tape **.and** Reel
1N4D04	1N4004	00-204-Al (00-41)	Tape **.and** Reel
1N4005	1N4005	00-204-Al (00-41)	Tape **.and** Reel
1N4006	1N4006	00-204-Al (00-41)	Tape **.and** Reel
1N4007	1N4007	00-204-Al (00-41)	Tape **.and** Reel

Absolute **Maximmn** Ratililgs

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Symbol	P:aramefN	Yialue							Unit
		1N Silt	1N 4002	1N .40113	1N 4011:t	1N ,4Dll!'i	1N 40(16	tN .,Wll7	
"IRRM	pea>; Re;petilive- erse- Voltage	50	100	200	400	e□o	mo	moo	V
IF.:.Wl	"""erage Rectified Forwarn Curent .:375" lead Length at T,,,= 75'<C	1.0							A
lrnt.1	Non-Repetitive Peak Forward Sg-ge Corent B.3 ms **Smgle**- Hslf..Sine,.Waue	30,							A
121	**Ratmg** fur Fusing {! « 8-..3 ms)	3.7							AZsec
T m,	**Slorage TEfl1P£!raha"e** R:ang:e-	-65to•175							•C
TJ	Operating Junction Temperatune	-65to •175							•G

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Symbol	P:ar.1111..ter,	Value	Unit
	Power Dissipation	3 □	W

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Values ane a! T_,,= 251'C unless otherwi5e noled.

Symbol	Parameter	Conditions	WIIJe	Unit
	f;orwanl Vdtage	11,=1.0A	u	V
,.,.	Maunum F.. Load Revei;se Ou1JeDt. Full Cycle	T,. =75"C	3□	µA
	Reverse Current at Rated V_R	T,. =25"C	!ii.	µA
		T,. = 100"C	□	pF
			50	
			15	
C,.	Tot.al Gapaatmce	V_R = 4.0 V, f = 1.0 MHz		

Practical No.7 Build and Test the full wave Bridge rectifier on breadboard using four diodes.

I **Practical Significance**

A bridge rectifier is an arrangement of four diodes in a bridge configuration, which provides the same output polarity for either input polarity. It is used for converting an alternating current (AC) input into a direct current (DC) output. Bridge rectifier is widely used in power supply circuit.

II. Industry /Employer Expected outcomes:

- **Discipline knowledge:** Apply Electronics and Telecommunications engineering knowledge to solve broad-based Electronics engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunications engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III. Course Level Learning Outcomes: Students will be able to achieve & demonstrate the use of relevant diode in electronics circuits.

IV. Laboratory Learning Outcomes:

1. Build the circuit for Full Wave Bridge Rectifier using PN junction Diode.
2. Observe and draw input & output waveform for sinusoidal wave.

V. Relevant Affective domain related Outcome(s)

- Handle components and equipment carefully.
- Follow all safety precautions.

VI. Relevant Theoretical Background

The circuit diagram of the full wave bridge rectifier is shown in figure 1. During positive half cycle diode D1 and D4 becomes forward bias and diode D2 and D3 becomes Reverse bias. Currents starts flowing through D1 and D4 which produces output voltage across Load Resistor **R.**

During negative half cycle diode D2 and D3 becomes forward bias and diode D1 and D4 becomes Reverse bias. Currents starts flowing through D2 and D3 which produces output voltage across Load Resistor **R.**

VII. Circuit diagram:

(a) Sample

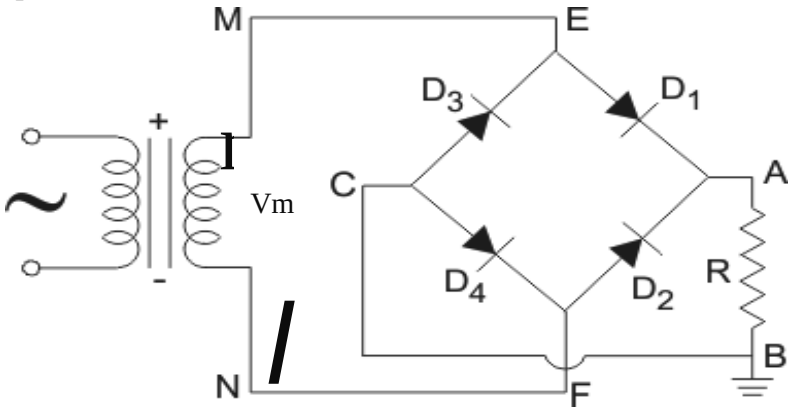


Figure 7.1 Full wave bridge rectifier

(b) Actual Circuit used in laboratory

(c) Actual Experimental set up used in laboratory

VIII. Resources required

Table 7.1

S.No.	Instrument /Object	Specification	Quantity
1.	Transformer	9-0-9VAC, 500 mA	1
2.	Resistor	l0KQ 0.5 Watt	1
3.	Diode	Silicon 1N4007	4
4.	CRO	25MHz	1
5.	Bread board	5.5 CMX 17CM	
6.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	L.S

IX. Precautions to be Followed

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the practical do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode

X. Procedure

1. Connect the circuit for full wave bridge rectifier on bread board as shown in circuit diagram.
2. Connect the primary side of the transformer to AC mains and the secondary side to rectifier input.
3. Before switching ON power supply, check the connections.
4. Switch ON the power supply and connect the CRO to the load resistor.
5. Measure the peak voltage V_m (peak voltage) across load resistor.

XI. Resources Used

Table 7.2

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII. Actual Procedure Followed

XIII. Precautions Followed

XIV. Observations and Calculations

Table 7.3

S. No.	Rectified output across R (Vm)
1	

Calculations: NA

XV. Results

XVI Interpretation of results

XVII Conclusions

XIX Practical related Questions

Sketch DC output voltage of Half wave, Centre tapped Full wave Rectifier and Full wave Bridge rectifier for the same AC input and comment on it.

[Space for answers]

XX References / Suggestions for further Reading

1. **http://npteLac.in/courses/**
2. **http://www.circuitstoday.com/full-wave-bridge-rectifier.**
3. **https://www.electrical4u.com/bridge-rectifiers/**

Performance indicators	Weightage
Process related (15 Marks)	**60%**
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of
Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical No.8: Use LC Filter with Full Wave Rectifier to Measure Ripple Factor.

I. Practical Significance

The filter converts the pulsating DC into pure DC. The electronic reactive elements like capacitor and inductors are used for filtering.

II. **Industry /Employer Expected outcomes:**

a. **Discipline knowledge:** Apply Electronics and Telecommunications engineering knowledge to solve broad-based Electronics engineering related problems.

b. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunications engineering problems.

c. **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III. **Course Level Learning Outcomes:** Students will be able to achieve & demonstrate the use of relevant diode in electronics circuits.

IV. **Laboratory Learning Outcomes:**

Build the circuit for Full Wave Rectifier using PN junction Diode with LC/Pi filter.

Calculate ripple factor for given setup.

V. **Relevant Affective domain related Outcome(s)**

- Handle components and equipment carefully.
- Follow all safety precautions.

VI. Theoretical Background

The capacitor used in "C" filter reduces the ripple voltage, but causes the diode current to increase .This large current may damage the diode and will further cause heating problem and decrease the efficiency of the filter. On the other hand, a simple series inductor reduces both the peak and effective values of the output current and output voltage. So the combination of both the filter (Land C), forms a new filter called the L-C filter which will have a good efficiency, with controlled diode current and enough ripple removal factor. The voltage stabilizing action of shunt capacitor and the current smoothing action of series inductor filter can be combined to form a perfect practical filter circuit

VII. Circuit diagram:

a. sample

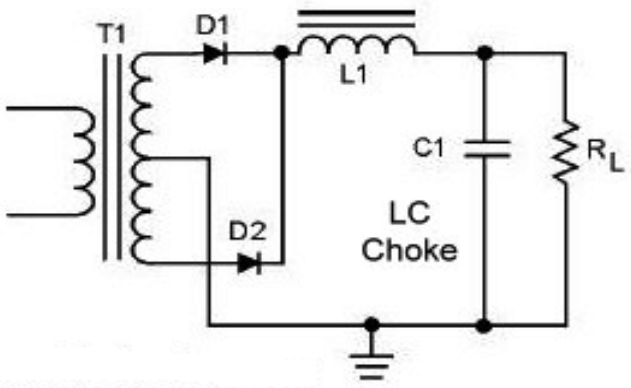


Figure 8.1:Full wave rectifier with LC filter.

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VIII. Resources required: Table 8.1

S.No.	Instrument /Object	Specification	Quantity
1.	Transformer (center tapped)	12-0-12 V AC, 500 mA	1
2.	Resistor	**IOK n,** 0.5 Watt.	1
3.	Diode	Silicon 1N4007	2
4.	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	1
5.	Capacitor, Inductor	Suitable rating	1
6.	C.R.O.	25MHz	1
7.	Bread board	5.5 CMX 17CM	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

IX. Precautions to be Followed

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the practical do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode.

X. Procedure

1. Connect the circuit of rectifier with LC Filter on bread board as shown in Figure 1.
2. Connect the primary side of the transformer to AC mains and the secondary side to rectifier input.
3. Before switching ON power supply, check the connection.
4. Record peak voltage across load resistor using CRO.
5. Calculate the DC output voltage and peak to peak ripple voltage.
6. Calculate the ripple factor.
7. Observe and draw the waveforms across LC filter on graph paper.

XI. Resources Used : Table 8.2

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XII. Actual Procedure Followed

XIII. Precautions Followed

XIV. Observations and Calculations: Table 8.3

Type of Rectifier	Peak Voltage Vm (volts)	Vdc= 2Vm/π (volts)	Peak to peak ripple voltage Vr(volts)	Ripple factor= Vr/Vdc
Full wave rectifier				

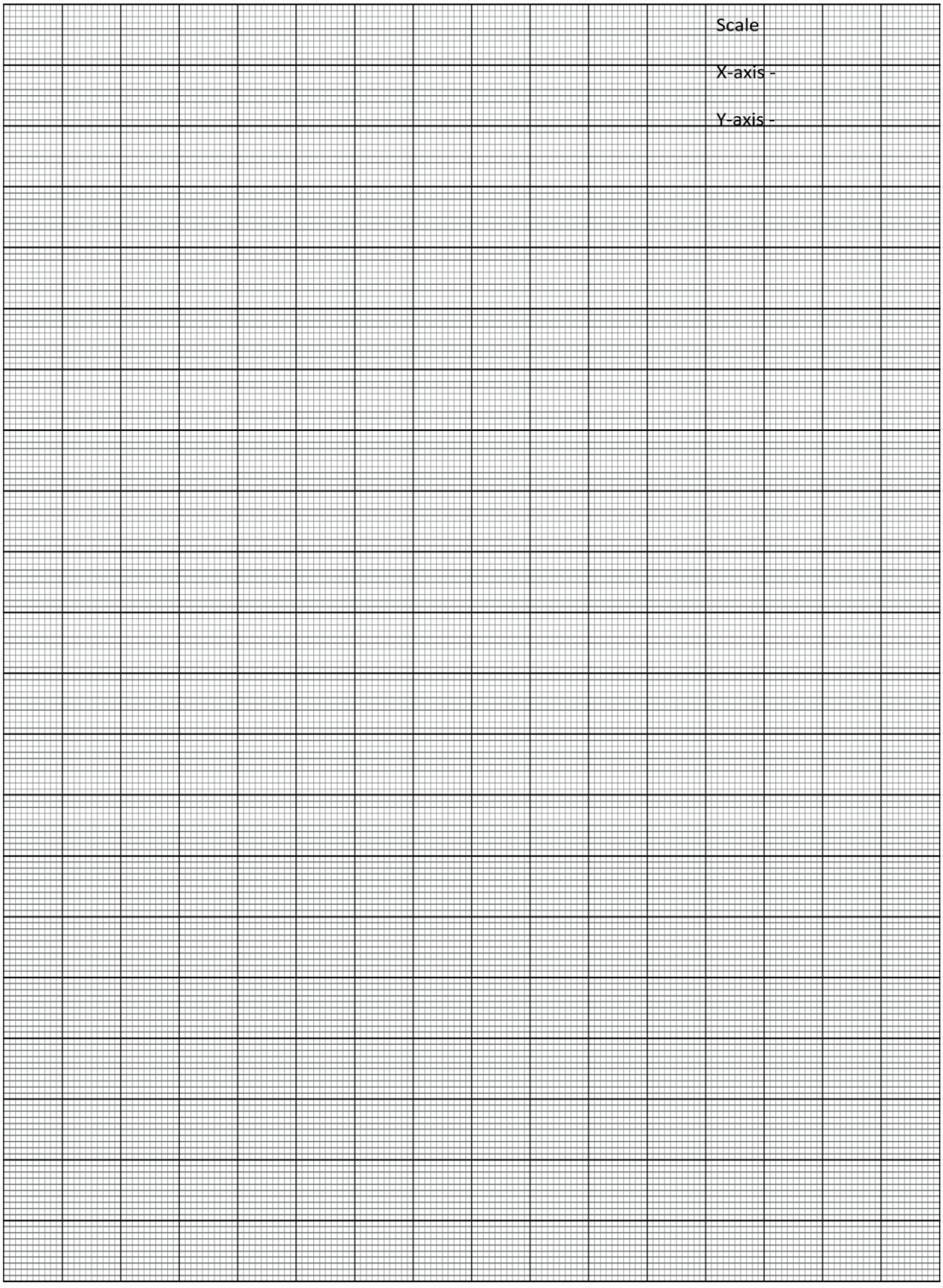
XV. Results

XVI. Interpretation of results

XVII. Conclusions

XVIII. Practical related Questions

1. Repeat the above experiment using C filter and comment on ripple factor.


Scale
X-axis -
Y-axis -

XIX. References / Suggestions for further Reading

1. http://www. physics-and-radio-electronics.com/electronic-devices-and-circuits/rectifier/halfwaverectifierwithfilter.htmlhttp://nptel.ac .in/courses/117103063/4
2. https://www.elprocus.com/half-wave-rectifier-circuit-working-principle-and- characteri stics-2/
3. http://www. physics-and-radio-electronics.com/electronic-devices-and-circuits/rectifier/halfwaverectifierwi thfilter.html

indicators	Weightage
Process related (15 Marks)	**60%**
1 H**Performance** andling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical No. 09: Construct and Test the full wave rectifier on bread board using IC KBU 808 with filter

I. Practical Significance

The filter converts the pulsating DC into pure DC. The electronic reactive elements like capacitor and inductors are used for filtering

II. Industry/Employer Expected outcomes

Discipline knowledge: Apply Electronics and Telecommunications engineering knowledge to solve broad-based Electronics engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunications engineering problems.

Engineering tools: Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III. **Course level learning outcomes:** Students will be able to achieve & demonstrate the following COs on completion of course based learning the use of relevant diode in electronics circuits.

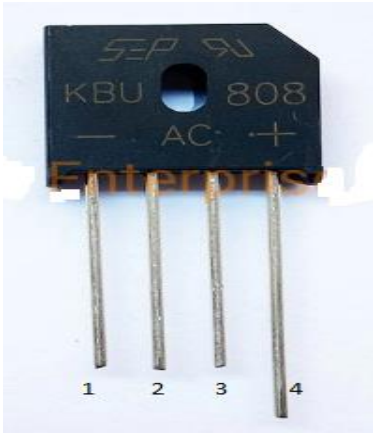
IV. Laboratory learning outcomes

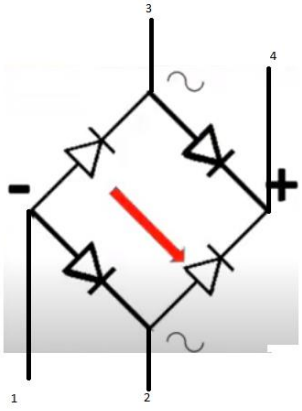
Construct the circuit for full wave rectifier using IC KBU 808 with filter.
Observe and draw input & output waveform for sinusoidal wave

V. **Relevant affective domain related outcomes.** Use KBU rectifier IC with filter to remove the ripples at the output of bridge rectifier:
Observe the waveform at output of KBU rectifier IC with filter

VI. Relevant theoretical Background: The KBU808 is a bridge rectifier integrated circuit that is commonly used in power supply applications to convert alternating current (AC) into direct current(DC)

VII. Actual circuit diagram used in Laboratory with equipment specifications.





VIII. Required resources /apparatus/equipment with specifications

S. No.	Instrument /Object	Specification	Quantity
1	IC KBU 808	IF=8A,VF=1V	1
2	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	1

IX. Precautions to be followed

While doing the practical do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode

X. Procedure

1. Keep DMM on diode test mode.
2. Connect the positive terminal of DMM to pin no.4 and the negative terminal of DMM to pin no.3 of IC 808 observe the drop on DMM of IC 808 observe the drop on DMM.
3. Connect the negative terminal of DMM to pin no.4 of IC 808 DMM and connect the positive terminal of DMM to pin no.3 of IC 808 observe OL(no drop) on DMM
4. Repeat above steps for pin no.1 and Pin no.2 of IC 808 note down the drop and no drop on DMM.
5. Connect the positive terminal of DMM to pin no.4 of IC and connect negative terminal of DMM to pin no.1 of IC note down the double diode drop on DMM

XI. Observation table

SR.NO.	Pin connection	Output on DMM
1	Drop between pin no.3 and 4	
2	Reverse drop between pin no.4 and pin no.3	
3	Drop between pin no.2 and pin no.1	
4	Reverse drop between pin no.1 and pin no.2	
5	Drop between pin no.1 and 4	
6	Reverse drop between pin no.4 and pin no.1	

XII. Results.

XIII. Interpretation of results.

XIV. Conclusion and recommendations

XV. Practical related questions

Repeat above experiment for Schottky diode and comment on voltage drop.

XVI. References/suggestions for further readings

Assessment Scheme

Performance indicators	Weightage
Process related (15 Marks)	**60%**
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....
5.

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical No. 10: Build and Test the performance parameters of 7 Segment LED display FND 507/508.

I. **Practical Significance** Most often seven-segment displays are used to display the digits in digital watches, calculators, clocks, measuring instruments and digital counters, etc. Generally, LCD and LED segments provide the display output of numerical numbers and characters. Each LED has two connecting pins, one called the "Anode" and the other called the "Cathode", there are therefore two types of LED 7-segment display called: **Common Cathode** (CC) and **Common Anode** (CA).

II. Industry/Employer Expected outcomes

Discipline knowledge: Apply Electronics and Telecommunications engineering knowledge to solve broad-based Electronics engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunications engineering problems.

Engineering tools: Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III. **Course level learning outcomes (cos):** Students will be able to achieve & demonstrate the use of relevant diode in electronics circuits.

IV. Laboratory learning outcomes:

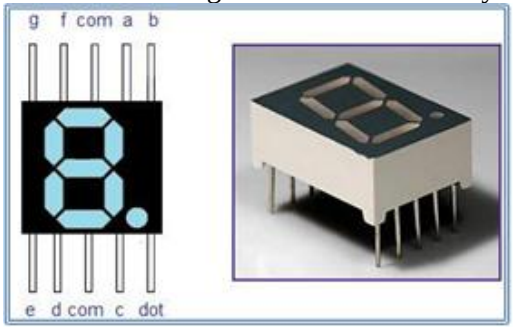
- Build the circuit for 7 Segment LED display FND 507/508.
- Observe numeric output for 0-9

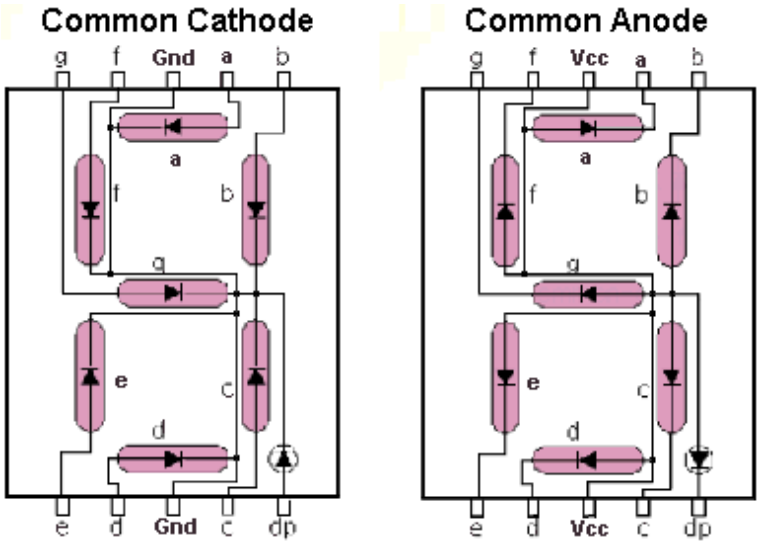
V. **Relevant affective domain related outcomes**. To know working of 7 segment display. To Use FND 507/508 display IC in both common anode and common cathode mode.

To Use of LED segments to provide the display output of numerical numbers and characters.

VI. Relevant theoretical Background. An LED or Light Emitting Diode, is a solid state optical pn-junction diode which emits light energy in the form of photons. The emission of these photons occurs when the diode junction is forward biased by an external voltage allowing current to flow across its junction, this property is called electroluminescence.

VII. Actual circuit diagram used in Laboratory with equipment specifications.





VIII. Required resources /apparatus/equipment with specifications

S. No.	Instrument /Object	Specification	Quantity
1	7 Segment LED display FND 507/508 IC	Current consumption : 30mA / segment Peak current : 70	1
2	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	1

IX. Precautions to be followed

While doing the practical do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode

X. Procedure

1. Put your millimeter's black lead on pin 3 or 8. Both are common pin as they are internally connected.
2. Now put your meter's red lead on any other pin such as 1 or 5.
3. If any of the display's segments glow then the display is common cathode.
4. If none of the segment glows than interchange the leads of multi-meter.
5. Connect your meter's red lead to pin 3 or pin 8.
6. Now put the black lead of the multimeter on other remaining pin. If any of the segment glow than the display is common anode, as in common anode the positive pin is common and the rest are connected to a negative supply.

7. Check all segments of both common cathode and anode to ensure the display is working properly.
8. If no segment glows, this 7 segment is faulty.

XI. Observation table.

Sr no	Pin connections	DMM ouput	Remark
1	Pin no. 1 (e) and pin no. 3		
2	Pin no.2 (d) and pin no 3		
3	Pin no.4 (c) and pin no.3		
4	Pin no.5 (dp) and pin no.3		

XII. Results.

XIII. Interpretation of results.

XIV. Conclusion and recommendations

XV. Practical related questions

Repeat the same practical for common cathode.

XVI. References/suggestions for further readings
https://youtu.be/ulKdgSJq_08

Assessment Scheme

Performance indicators	Weightage
Process related (15 Marks)	**60%**
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical No. 11: Identify and select transistors using datasheets.

I Practical Significance:

In industries as well as in domestic appliances transistor is used in amplifier circuits, oscillator circuits and in DC Power Supplies. For these applications transistor selection plays vital role. In this practical students will find specifications of the given transistor to understand transistor selection with respect to change in applications.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

1. Component selection skills.
2. Specification reading skills.
3. Use Data Book to find compatible /equivalent transistor.
4. Use specifications to calculate biasing circuit components values.

III Relevant Course Outcomes

- Use BJT in electronics circuits

IV Practical Outcome

Identify and select transistors using datasheets

- LLO 11.1 Identify the terminals of the PNP and NPN transistor for TO-5, TO220, TO-66
- LLO 11.2 Select of transistor for different max. voltage, current and switching speed for particular application.

V Relevant Affective domain related Outcomes

- Handle and interpret data book specification carefully.

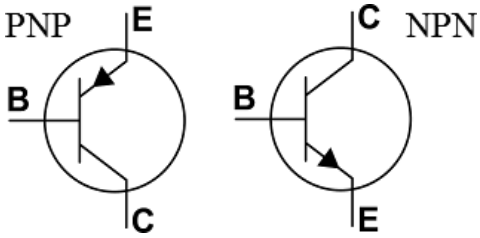
VI Minimum Theoretical Background

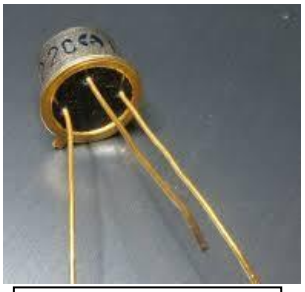
A BJT is a most used semiconductor device, and which has variety of applications. It is suitable for amplifier circuits, oscillator circuits and in DC regulated power supplies. Transistor selection depends on its specification and application. Transistor requires biasing circuit. Rating of biasing circuit components are calculated using specification of transistor.

Data sheet consists of transistor package diagram to know lead position, absolute maximum rating, thermal data, electrical characteristics and mechanical data. Data sheet also provide compatible transistor part numbers.

VII Practical Circuit Diagram :

a. Sample





TO-5 package

TO-220 package

TO-66 package

Figure 1: Transistors and its symbol

b. Actual Circuit used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Transistor	2N2222. 2N3055 SLl00 BC147 2N2055 (or any other equivalent transistor)	lNo. each	
2.	Data book	Transistor data book Tower's International transistor selection data book (or any other equivalent data book)	1 No.	Datasheets may be referred using web site

IX Precautions

Hold the transistor in proper position so that its leads will not break.

X Procedure

1. Read out given transistor number on its casing.
2. Find out this number in data book.
3. Record the transistor package terminals.
4. Record absolute maximum rating of transistor.
5. Record the electrical characteristics.
6. Record thermal data.
7. Calculate the rating ofrequired collector resistor, Base resistors for biasing circuit.
8. Repeat the procedure for another transistor.

XI Resources used (with major specifications)

S. No.	Data book /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Table 1: Absolute maximum rating of BJTl ( )

S.No.	Specifications	Value
1		
2		
3		
4		
5		
6		

Calculations:

Calculate required collector resistance

$$Re = V_{CC}/I_{C(max)}\ \Omega$$

Calculate Base resistance

R_{B1} = Ω

R_{B2} = Ω

XV Results

1. BJT 1 is a NPN / PNP Si / Ge transistor
2. For BJTl Collector resistors= .....
3. For BJT 1 $R_{s\,1}$ = ...
4. ForBJT 1 R_{82} = ...

XVI Interpretation of results

XVII Conclusion(s)

XVIII Practical related Questions

a. Repeat the above experiment for BJT 2.

b. Identify the legs of given transistor

[Space for answers]

XIX References / Suggestions for further Reading

- http://www.onsemi.com/pub/Collateral/P2N2222A-D.PDF
- http://www.alldatasheet.com/view datasheet.jsp?Searchword=BC147

XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

a. .....
b. .....
c. .....
d. .....

Marks Obtained			Dated signature of Teacher
Process Related(l5)	**Product Related(l0)**	**Total (25)**	

Practical No. 12: Build and Test the Performance of BJT Working in CB Mode

I Practical Significance:

Transistor is a basic building block of modem electronic circuits. A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. In electronics, a common-base (also known as grounded-base) amplifier is one of three basic single-stage bipolar junction transistor (BJT) amplifier topologies, typically used as a voltage amplifier.
In Common base mode configuration the emitter terminal of the transistor serves as the input, the collector as the output, and the base is connected to ground.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

1. Component identification skills.
2. Component mounting skills.
3. Use DC Power supply to give different voltages.
4. Use Digital multimeter to measure the voltage and current.

III Relevant Course Outcomes

- Use BJT in electronics circuits

IV Practical Outcome

Test input/output characteristics of NPN Transistor in CB Mode:

- LLO 12.1 Build the circuit for BJT in common base configuration.
- LLO 12.2 Plot input and output characteristics of common base configuration.

V Relevant Affective domain related Outcomes

- Handle components and equipment carefully.
- Follow safety precautions.

VI Minimum Theoretical Background

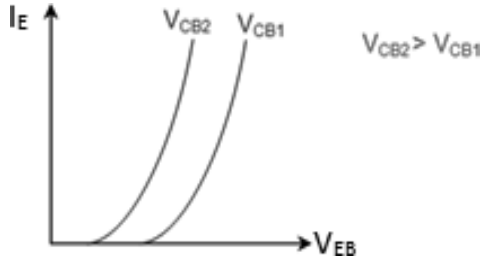


Figure 1: Input Characteristics for CB

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Input Characteristics for CB configuration:

The curve given in figure 1 gives the relationship between input current (IE) and input voltage (VEB) for constant output voltage (VCB)- By varying VEB for constant VCB it may be noted that below knee voltage current is very small. Beyond knee voltage, the Emitter current (IE) increases with small increase in emitter to base voltage VEB for constant V_{CB}. As the collector to Base voltage is increased above **1**V, the curve shifts upwards.

Input characteristics may be used to determine the value of common base transistor A.C. input resistance Ri. It is the ratio of change in emitter to base voltage (VEB) to resulting change in emitter current (IE) at a constant collector to base voltage (VCB)

$$R_{i=} \frac{\Delta V_{EB}}{\Delta I_E}$$

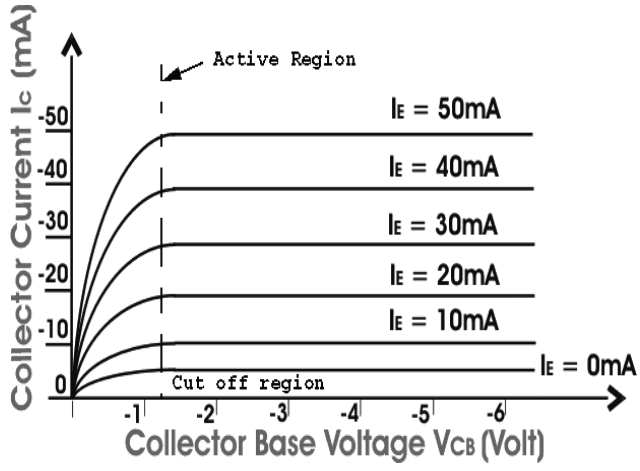


Figure 2: Output Characteristics for CB configuration

Output Characteristics for CB configuration:

This curve gives the relationship between output current (le) and output voltage (VCB) for a constant emitter current (IE)-

The output characteristics are divided into three regions:

Cut off region: Transistor act as OFF switch

Saturation Region: Transistor act as ON switch

Active Region: Transistor acts as amplifier.

Output characteristics may be used to determine the value of common base transistor Output resistance Ro. It is the ratio of change in collector to base voltage (VCB) to resulting change in Collector current (le) at a constant emitter current (IE)-

$$R_o = \frac{\Delta V_{CB}}{\Delta I_C}$$

VII Practical Circuit Diagram :

a. Sample

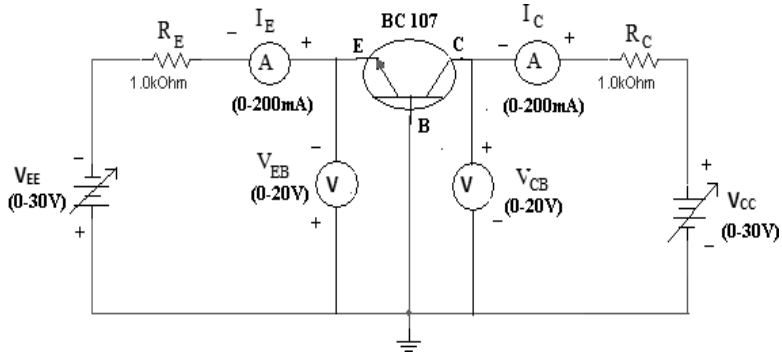


Figure 3: Circuit diagram of BJT in CB mode

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2	1. Digital Multimeter with transistor testing facilities will be preferred. 2. In place of Digital Multimeter, Voltmeter and ammeter can be used.
2.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1	
3.	Voltmeter	(0-20 V), (0-2 V),	1	
4.	Ammeter	(0 - 200 mA, (0 - 200 µA)	1	
5.	Transistor	BC107 or any other equivalent	1	
6.	Resistor	1KQ(0.5watts/0.25watts)	1	
7.	Bread board	5.5 CMX 17CM	1	
8.	Connecting wires	Single strand Teflon coating (0.6mm)	As per requirement	

IX Precautions

1. Care should be taken while handling terminals of components.
2. Select proper range of ammeter and voltmeter.
3. Connect wires tightly while building circuit.

X Procedure

Part I
Input characteristics:

1. Connect the circuit as shown in figure 3.
2. Keep output voltage VCB= 0V by varying Vcc-
3. Vary VEB in step of 0.1V from 0 to 1Vand note down the corresponding emitter current IE.
4. Repeat above procedure (step 3) for VCB= 4V.

Part II

Output characteristics:

1. Connect the circuit as shown in figure 3.
2. Keep input current IE = 0 mA by varying VEE·
3. Vary V_{CB} in step of **1**V from **1** to 10 V and note down the corresponding collector current le.
4. Repeat above procedure (step 3) for IE= 10mA

XI Resources used (with major specifications)

S. No.	Data book /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Table 1: Input Characteristics

S. No.	VEB=OV		VCB =4V	
	VEB (V)	I_E(mA)	VEB (V)	I_E(mA)
1				
2				
3				
4				
5				
6				

Table 2: Output Characteristics

S. No.	IE(mA)=0		IE(mA)=10	
	VCB(Volts)	**lc(mA)**	**VCB (Volts)**	**le (mA)**
1				
2				
3				
4				
5				
6				

Calculations (from graph)

1. Input resistance Ri:
2. Output resistance Ro:
3. Current amplification factor α:

XV Results

1. Input resistance Ri:

2. Output resistance Ro:

3. Current amplification factor α:

XVI Interpretation of results

XVII Conclusions

XVIII Practical related Questions

a. Repeat the same experiment using PNP transistor.

[Space for answers]

XIX References / Suggestions for further Reading

a. https://www.electrical4u.com/transistor-characteristics/
b. http://nptel.ac.in/courses/117107095/11

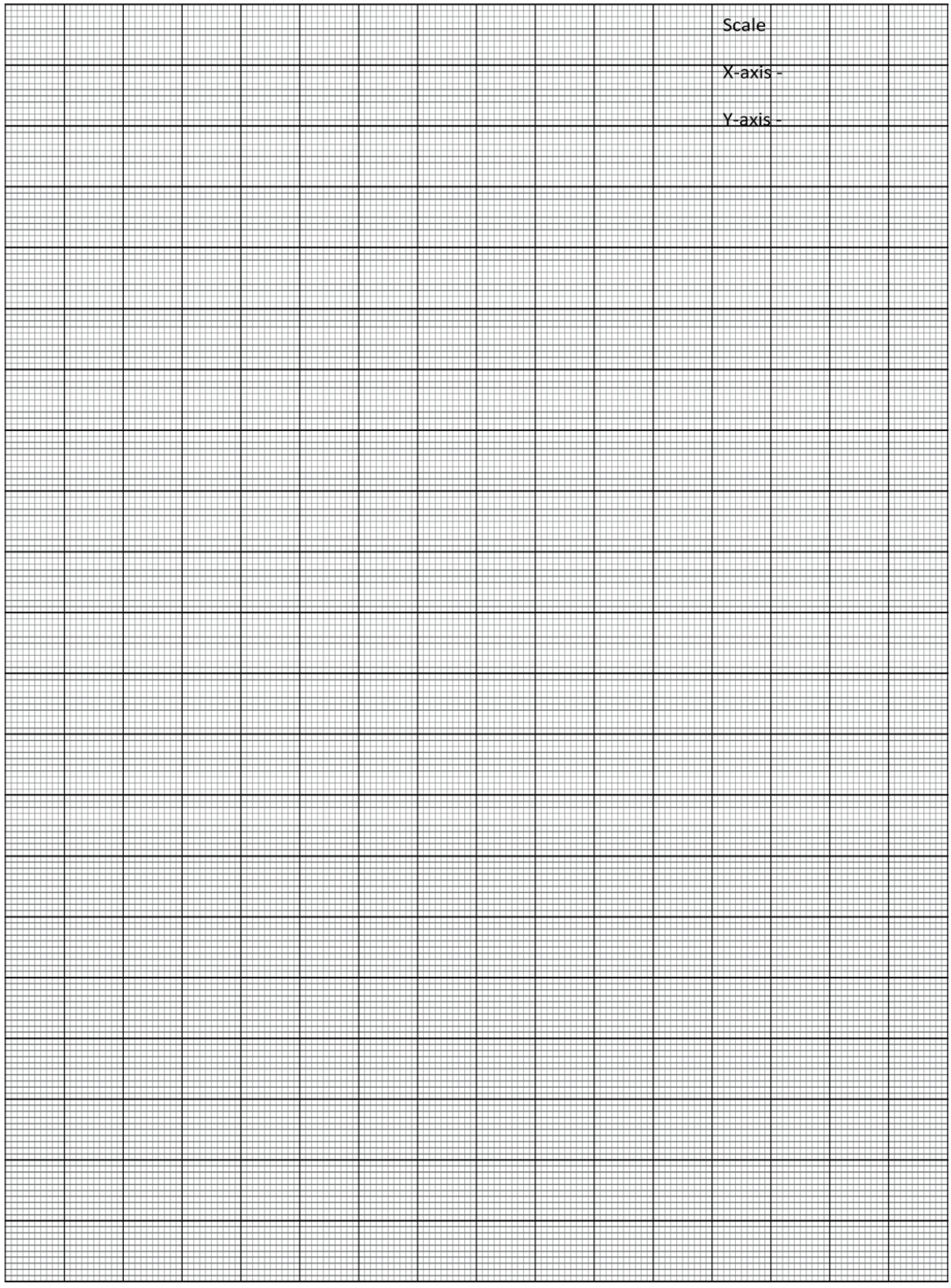
XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

a. .....
b. .....
c. .....
d. .....

Marks Obtained			Dated signature of Teacher
Process Related(l5)	**Product Related(l0)**	**Total (25)**	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X-axis -
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Practical No. 13: Build and Test the Performance of BJT Working in CE Mode

I Practical Significance:

A BJT is commonly used as an amplifier. Common Emitter (CE) mode is the universal mode of operation for a BJT. All types of amplifications can be performed using CE mode with suitable biasing. Common-emitter amplifiers are also used in radio frequency circuits.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

5. Component selection skills.
6. Specification reading skills.
7. Use Data Book to find compatible /equivalent transistor.
8. Use specifications to calculate biasing circuit components values.

III Relevant Course Outcomes

- Use BJT in electronics circuits

IV Practical Outcome

Identify and select transistors using datasheets

- LLO 13.1 Select the specific transistor for different max. voltage, current and switching speed
- LLO 13.2 Prepare the circuit for BJT in common emitter configuration.

V Relevant Affective domain related Outcomes

- Handle components and equipment carefully.
- Follow safety precautions.

VI Minimum Theoretical Background

CE is the most frequently used configuration in practical amplifier circuits, since it provides good voltage, current, and power gain. The input is applied across the base-emitter circuit and the output is taken from the collector-emitter circuit, making the emitter "common" to both input and output. CE configuration provides a phase reversal between input and output signals

Input Characteristics for CB configuration:

The curve plotted between base current IB and the base-emitter voltage VEB is called Input characteristics curve. For drawing the input characteristic the reading of base currents is taken through the ammeter on emitter voltage VBE at constant collector-emitter current. The curve for different value of collector-base current is shown in the figure below.

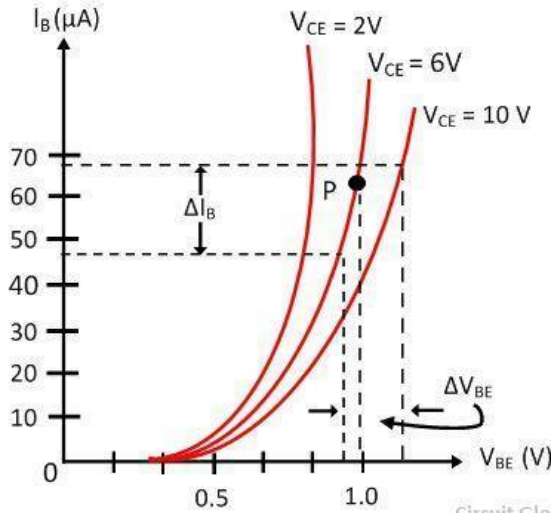


Figure 13.1: Input Characteristics for CE

The curve for common base configuration is similar to a forward diode characteristic. The base current IB increases with the increases in the emitter-base voltage VBE. Thus the input resistance of the CE configuration is comparatively higher that of CB configuration.

The effect of CE does not cause large deviation on the curves, and hence the effect of a change in VCE on the input characteristic is ignored.

Input Resistance: The ratio of change in base-emitter voltage VBE to the change in base current ΔIB at constant collector-emitter voltage VCE is known as input resistance, i.e.,

$$r_i = \frac{\Delta V_{BE}}{\Delta I_B} \text{ at constant } V_{CE}$$

Output Characteristics for CB configuration:

In CE configuration the curve draws between collector current IC and collector-emitter voltage VCE at a constant base current IB is called output characteristic. The characteristic curve for the typical NPN transistor in CE configuration is shown in the figure below.

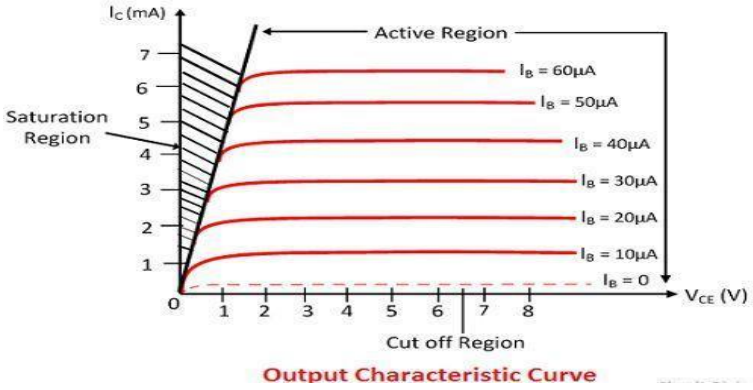


Figure 13.2: Output Characteristics for CE

In the active region, the collector current increases slightly as collector-emitter VCE current increases. The slope of the curve is quite more than the output characteristic of CB configuration. The output resistance of the common base connection is more than that of CE connection.

The value of the collector current IC increases with the increase in VCE at constant voltage IB, the value β of also increases.

When the VCE falls, the IC also decreases rapidly. The collector-base junction of the transistor always in forward bias and work saturate. In the saturation region, the collector current becomes independent and free from the input current IB

In the active region IC = βIB, a small current IC is not zero, and it is equal to reverse leakage current ICEO.

$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

Output Resistance: The ratio of the variation in collector-emitter voltage to the collector-emitter current is known at collector currents at a constant base current IB is called output resistance ro.

$$r_o = \frac{\Delta V_{CE}}{\Delta I_C} \; at \; constant \; I_B$$

VII Practical Circuit Diagram :

a. Sample

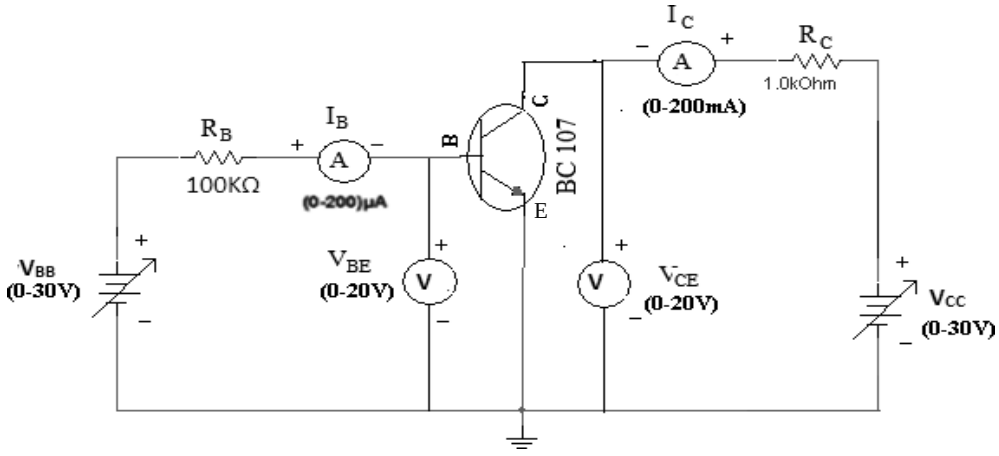


Figure 13.3: Circuit diagram of BJT in CE mode

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2	Digital Multimeter with transistor testing facilities will be preferred. In place of Digital Multimeter, Voltmeter and ammeter can be used.
2.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1	
3.	Voltmeter	(0-20 V), (0-2 V),	1	
4.	Ammeter	(0 - 200 mA, (0 - 200 µA)	1	
5.	Transistor	BC107 or any other equivalent	1	
6.	Resistor	1KΩ(0.5watts/0.25watts)	1	
7.	Bread board	5.5 CMX 17CM	1	
8.	Connecting wires	Single strand Teflon coating (0.6mm)	As per requirement	

IX Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment do not exceed the input voltage of the transistor beyond its rated voltage. This may lead to damaging of the transistor.
3. Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.

X Procedure

PartI

Input characteristics:

1. Connect the circuit as shown in Figure 1.
2. Set VCE at constant voltage (2V) by varying Vcc.
3. Vary the input voltage VBE in steps of 0.1V from 0V up to 1V and record the corresponding value of IB in observation table.
4. Repeat the above steps 2 and 3 by keeping VCEat 5V, and l0V.
5. Sketch the characteristics from the recorded readings.
6. At suitable operating point calculate input resistance (Ri)-

Part II

Output characteristics:

1. Connect the circuit as shown in Figure **1.**
2. Set IB constant at l0µA by varying VBB.
3. Vary the output voltage Vcc in steps of 1V from 0V upto **1**0V and record the corresponding value of VCE and IE in observation table.
4. Repeat the above steps 2 and 3 by keeping IB at 20µA and 30µA.
5. Sketch the characteristics from the recorded readings.
6. At suitable operating point calculate output resistance (Ro).

XI Resources used (with major specifications)

S. No.	Data book /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Table 1: Input Characteristics

S.No.	VCE=2V		V_{CE}=5V		V_{CE}=10V	
	V_{BE} (V)	I_B(μA)	V_{BE} (V)	I_B(μA)	VBE (V)	I_B(μA)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Table 2: Output Characteristics

S.No.	IB=lOμA		IB=20μA		IB=30μA	
	VcE(V)	Ic(mA)	VCE(V)	Ic(mA)	VCE(V)	Ic(mA)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Calculations(from graph)

1. Input resistance Ri:

2. Output resistance Ro:

3. Current amplification factor β:

XV Results

1. Input resistance Ri =Q
2. Output resistance Ro =Q
3. Current amplification factor β =.....

XVI Interpretation of results

XVII Conclusions

XVIII Practical related Questions

Repeat the same experiment using PNP transistor.

[Space for answers]

XIX References / Suggestions for further Reading

1. https://www.electrical4u.com/transistor-characteristics/
2. http://nptel.ac.in/courses/117107095/11

XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

a. .....
b. .....
c. .....
d. .....

Marks Obtained			Dated signature of Teacher
Process Related (l5)	**Product Related(l0)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No. 14: Build and Test the BJT voltage divider bias circuit for given input

I Practical Significance:

Wherever there is need to reduce the voltage, voltage dividers are used. The voltage divider bias configuration is considered the simplest method that gives a very stable and predictable bias current. Voltage dividers are useful for setting the output voltage of linear regulators, dividing down a higher voltage to the input range of an *AID* inside a microcontroller

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

5. Component identification skills.
6. Component mounting skills.
7. Use DC Power supply to give different voltages.
8. Use Digital multimeter to measure the voltage and current.

III Relevant Course Outcomes

- Use BJT in electronics circuits

IV Practical Outcome

Build and Test the BJT voltage divider bias circuit for given input:

- LLO 14.1 Build the circuit for BJT voltage divider bias circuit.
- LLO 14.2 Locate Q point on Load line.

V Relevant Affective domain related Outcomes

- Handle components and equipment carefully.
- Follow safety precautions.

VI Minimum Theoretical Background

The voltage divider configuration achieves the correct voltages by the use of resistors in certain patterns. By selecting the proper resistor values, stable current levels can be achieved that vary only little over temperature and with transistor properties.

Transistors used in amplifier circuits must be biased with constant (direct) levels of collector, base and emitter current and constant terminal voltages. The levels of Ie and V_{CE} define the transistor de operating point, or quiescent point. The circuit that provides this state is known as a bias circuit. Ideally, the current and voltage levels in bias circuits should remain constant. In practical circuits these quantities are affected by the transistor current gain and by temperature changes.

Figure 14.1 shows voltage divider bias , biasing is provided by three resistors R1, R2 and RE. The resistors R1& R2 act as a potential divider giving a fixed voltage to base. If collector current increases due to change in temperature or change in β, emitter current IE also increases and voltage drop across RE increases thus reducing the voltage difference between base and emitter. Due to reduction in base emitter voltage, base current and collector current reduces.

So we can say that negative feedback exists in emitter bias circuit. This reduction in collector current compensates for the original change in IC.

VII Practical Circuit Diagram :

a. Sample

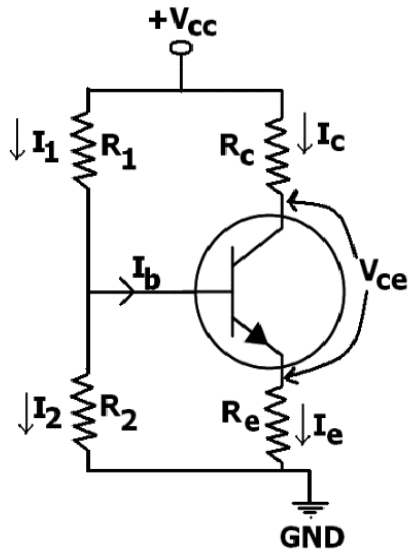


Figure 14.1: Voltage divider biasing

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2	3. Digital Multimeter with transistor testing facilities will be preferred. 4. In place of Digital Multimeter, Voltmeter and ammeter can be used.
2.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1	
3.	Voltmeter	(0-20 V), (0-2 V),	1	
4.	Ammeter	(0 - 200 mA, (0 - 200 µA)	1	
5.	Transistor	BC107 or any other equivalent	1	
6.	Resistor	Suitable as per voltage division	1	
7.	Bread board	5.5 CMX 17CM	1	
8.	Connecting wires	Single strand Teflon coating (0.6mm)	As per requirement	

IX Precautions

4. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
5. While doing the experiment do not exceed the input voltage of the transistor beyond its rated voltage. This may lead to damaging of the transistor.
6. Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.

X Procedure

1. Connect the electrical circuit as in Figure 1.
2. Switch on the power supply.
3. Measure the voltage VE and Vc at emitter and collector terminal respectively.
4. Measure VcE means the difference between Vc and VE-
5. Calculate the collector current Ic=(Vcc-Vc)/Rc.
6. Compare the measured values with the designed values.

XI Resources used (with major specifications)

S. No.	Data book /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

$V_{CE}=V_c-V_E$

$I_c=(V_{cc}-V_c)/R_c$

Calculations

XV Results

XVI Interpretation of results

XVII Conclusions

XVIII Practical related Questions

- Change value of R1 and find change in voltages.

[Space for answers]


Scale
X-axis -
Y-axis -

XIX References / Suggestions for further Reading

a. http://www.srmuniv.ac.in/downloads/biasing.pdfhttp://www.srmuniv.ac.in/downloa ds/biasing.pdf
b. https://www.youtube.com/watch?v=9trNaY6C7bQ
c. https://www.youtube.com/watch?v=wGDi3zZhtqc
d. https://en.wikipedia.org/wiki/Voltage_divider

XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

a. .....
b. .....
c. .....
d. .....

Marks Obtained			Dated signature of Teacher
Process Related(l5)	**Product Related(l0)**	**Total (25)**	

Practical No. 15: Construct and Test the performance parameters of BJT as Switch.

I Practical Significance:

Switching and Amplification are the two areas of applications of Transistors. A transistor is used for switching operation either for the opening or closing of the circuit. Transistor as a Switch is the basis for many digital circuits. Solid state switches are one of the main applications for the use of transistor to switch a DC output “ON” or “OFF”.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

9. Component identification skills.
10. Component mounting skills.
11. Use DC Power supply to give different voltages.
12. Use Digital multimeter to measure the voltage and current.

III Relevant Course Outcomes

- Use of BJT as amplifier and switch

IV Practical Outcome

Construct and Test the performance parameters of BJT as Switch.:

- LLO 15.1 Test the performance parameters of BJT as Switch
- LLO 15.2 Identify Cutoff and saturation regions.

V Relevant Affective domain related Outcomes

- Handle components and equipment carefully.
- Follow safety precautions.

VI Minimum Theoretical Background

If either the circuit uses the BJT transistor as a switch, then the biasing of the transistor, NPN or PNP is arranged to operate the transistor at the both sides of the I-V characteristics curves shown below. A transistor can be operated in three modes, active region, saturation region and cut-off region: In the active region, transistor works as an amplifier. The two operating regions of transistor Saturation Region (fully ON) and the Cut-off Region (fully OFF) were used to operate a transistor switch

. **Operating Regions:** We can observe from the above characteristics, the pink shaded area at the bottom of the curves represents the Cut-off region and the blue area to the left represent the Saturation region of the transistor. These transistor regions are defined as

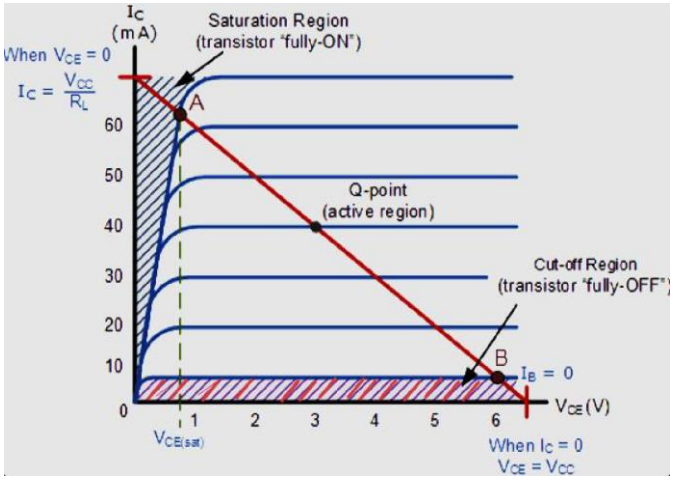


Figure15.1 : Operating regions of Transistor.

- **Cut-off Region:** The operating conditions of the transistor are zero input base current (IB=0), zero output collector current(Ic=0), and maximum collector voltage (VCE) which results in a large depletion layer and no current flowing through the device. Therefore, the transistor is switched to "Fully-OFF". So we can define the cut-off region when using a bipolar transistor as a switch as being, both the junctions of NPN transistors are reverse biased, VB< 0.7v and Ic=0. Similarly, for PNP transistor, the emitter potential must be –ve with respect to the base of the transistor.

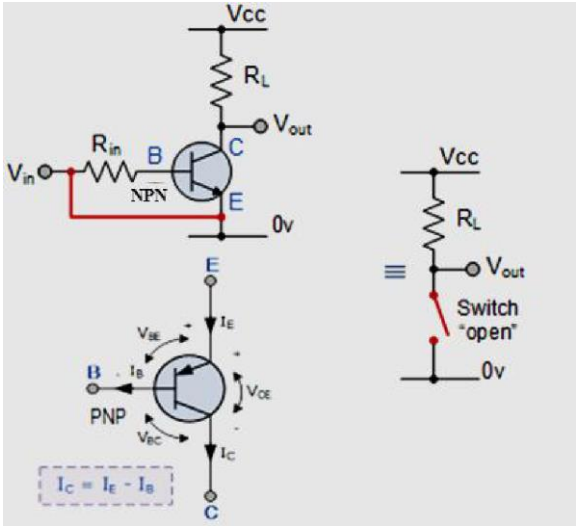


Figure15.2 : Cutoff region of Transistor.

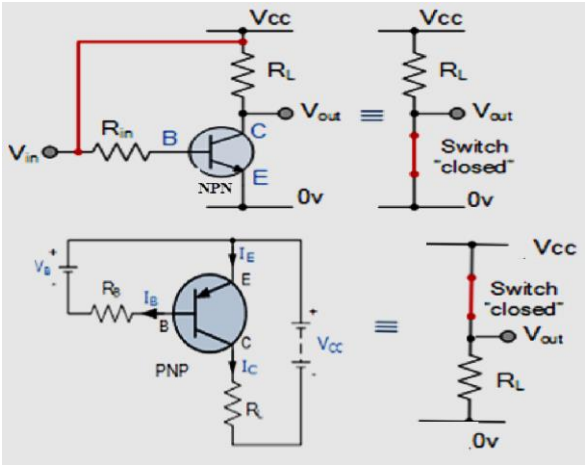


Figure 15.3 : Saturation region of Transistor.

- **Saturation Region:** In this region, the transistor will be biased so that the maximum amount of base current (IB) is applied, resulting in maximum collector current(IC=VCC/RL) and then resulting in the minimum collector-emitter voltage (VCE ~ 0) drop. At this condition, the depletion layer becomes as small as the possible and maximum current flowing through the transistor. Therefore, the transistor is switched "Fully-ON".

VII Practical Circuit Diagram :

a. Sample

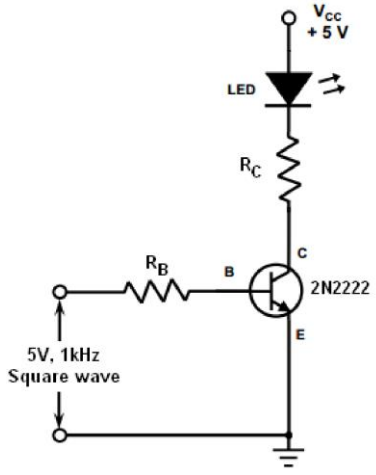


Figure 15.4: Voltage divider biasing

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2	5. Digital Multimeter with transistor testing facilities will be preferred. 6. In place of Digital Multimeter, Voltmeter and ammeter can be used.
2.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1	
3.	Voltmeter	(0-20 V), (0-2 V),	1	
4.	Ammeter	(0 - 200 mA, (0 - 200 µA)	1	
5.	Transistor	2N2222 or any other equivalent	1	
6.	Resistor	Suitable as per voltage division (RB= 6.8KΩ, RC= 1 KΩ)	1	
7.	Bread board	5.5 CMX 17CM	1	
8.	Connecting wires	Single strand Teflon coating (0.6mm)	As per requirement	

IX Precautions

7. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
8. While doing the experiment do not exceed the input voltage of the transistor beyond its rated voltage. This may lead to damaging of the transistor.
9. Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.

X Procedure

7. Connect the electrical circuit as in Figure .
8. Switch on the power supply.
9. Set the AC source (4V) and frequency (200 HZ) (Square wave) and draw it.
10. Set the oscilloscope (first terminal) at the common terminal of collector and resistance (RL) and (second terminal of OSC) to the emitter of transistor Observe the input and output waveforms simultaneously using oscilloscope.
11. Compare the measured values with the specification values.

XI Resources used (with major specifications)

S. No.	Data book /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Rise Time Tr =
Fall Time Tf=
On Time T-on =
Off Time T-off

Calculations

XV Results

XVI Interpretation of results

XVII Conclusions

XVIII Practical related Questions

a. From the 2N2222 datasheet, write down the parameters required to design the circuit.
b. From the design values, suggest a suitable transistor for switching action other than 2N2222. State reasons.

[Space for answers]

XIX References / Suggestions for further Reading

a. https://www.youtube.com/watch?v=_17m7eP6Uxs
b. https://www.youtube.com/watch?v=EQmND0UhFwQ
c. https://eeeforum.weebly.com/uploads/1/0/2/5/10254481/15e282_18_lab4_2.pdf
d. https://community.ibm.com/community/user/ai-datascience/discussion/what-is-the-difference-between-bc547-transistor-vs-2n2222-transistor#:~:text=The%20trigger%20terminal's%20maximum%20bias,the%202N2222%20transistor's%20transition%20frequency.

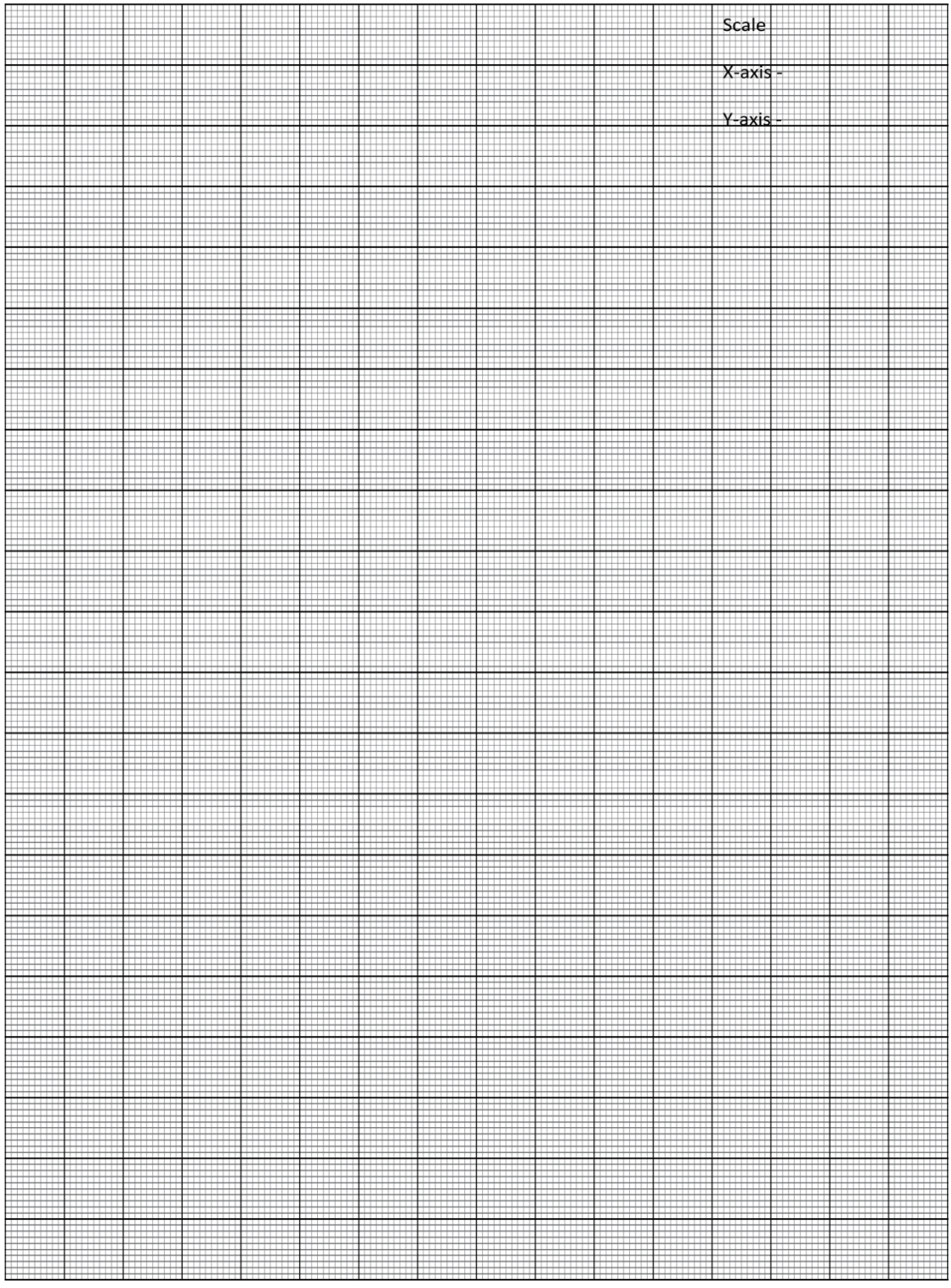
XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

a. .....
b. .....
c. .....
d. .....

Marks Obtained			Dated signature of Teacher
Process Related(l5)	**Product Related(l0)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.16: Build and Test the performance of Single Stage Common Emitter Amplifier

I **Practical Significance** Single stage low power amplifiers are generally used for small signal amplification in the electronic circuit. Low power amplifier is used in various electronic appliances and electronic communication. This practical will help the students to develop skills to build and test single stage low power common emitter amplifier

II **Industry/Employer Expected outcomes**

Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
Discipline knowledge: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems
.

III **course level learning outcomes (cos)** Students will be able to achieve & demonstrate the Use of BJT in electronics circuits

IV **Laboratory learning outcomes:** Build single stage Common emitter amplifier
Plot frequency response for Common emitter amplifier

V **Relevant affective domain related outcomes**.

- Follow safe practices.
- Follow ethical practices
- Demonstrate working as a leader/a team member

VI **Relevant theoretical Background.**

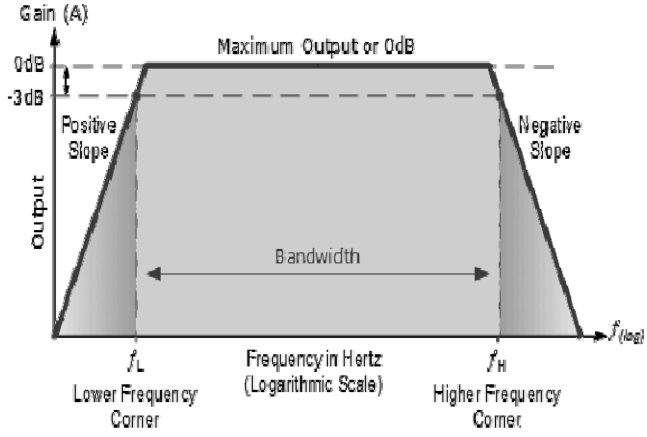
Low power amplifier is an electronic device that can increase the power of a signal. An amplifier uses electric power from a power supply to increase the amplitude of a signal by an amplifier but not all amplifiers are the same as they are classified according to their circuit configurations and methods of operation. The classification of an amplifier depends upon the size of the signal, large or small, its physical configuration and how it processes the input signal, which is the relationship between input signal and current flowing in the load.

There are three different kinds of amplifier gain which can be measured and these are: *Voltage Gain* (Av), *Current Gain* (Ai) and *Power Gain* (Ap) depending upon the quantity being measured.

Voltage Gain, Av= VoutlVin

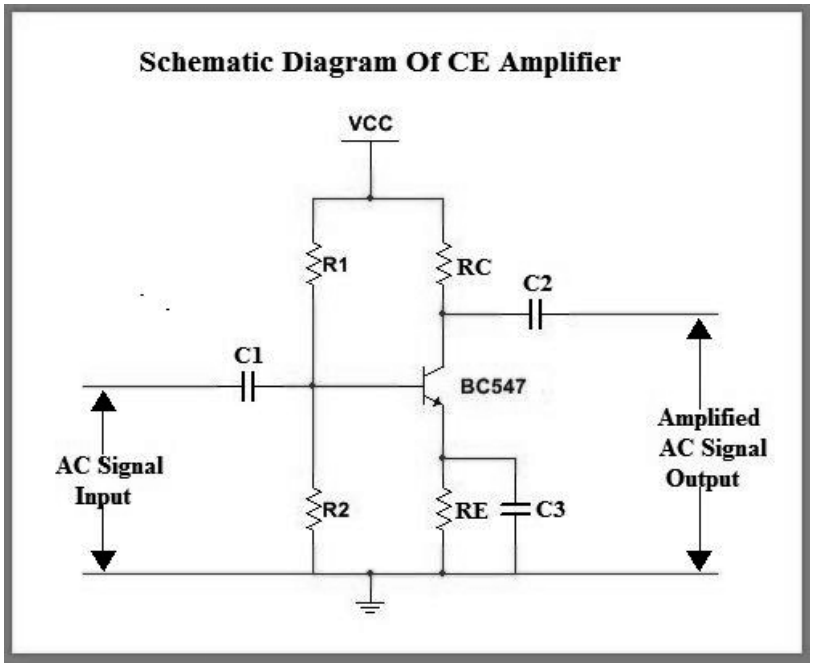
Current Gain, $A_i = I_{out}/I_{in}$

Power Gain, Ap= Av X Ai



VII Actual circuit diagram used in Laboratory with equipment specifications.

a. **sample**



b. Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

VIII Required resources /apparatus/equipment with specifications

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Oscilloscope (Analog Ray type)	20/30/100 MHz Frequency	1 No.	
2.	Function Generator	0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1 No.	
3.	Regulated DC Power Supply	0-30V, 2Amp SC protection	1 No.	
4.	Transistor	BC 547 or equivalent Transistor	1 No.	
5.	Resistors	R1=33KO,R2=3.3KO,RC=l.5KO, RE=470O	1 No.	
6.	Capacitors	Cl=0.lµf, C2=0.lµf C3=10 µf	1 No.	
7.	Breadboard	5.5 cmX 17 cm	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

IX Precautions to be followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off condition initially.
3. Ensure the use of proper settings of function generator and CRO.

X Procedure

1. Build circuit on breadboard as per circuit diagram.
2. Select appropriate amplitude (10 mV to 20 mV) and frequency (1 KHz) of sine wave input signal on function generator.
3. Connect function generator output to CRO and observe input sine wave signal on CRO.
4. Connect function generator at input terminals and CRO at output terminals of circuit.
5. Switch on DC Power Supply.
6. Observe output waveform on CRO.
7. Vary input frequency (100 Hz to 2 MHz) and note down output voltage from CRO.
8. Calculate Gain. Repeat step 7 for twenty readings.
9. Plot frequency response on semi-log paper.

XI Observation & Calculations

Table No: 1.1 Observation Table

Input Voltage in mV at 1 KHz (To be kept Constant), Vi = ---------

Sr. No.	Input Frequency(Hz)	Output Voltage,Vo (Volts)	Voltage Gain (A=VoNi)	Gain in dB 20 log(VoNi)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				

Calculations:

Voltage Gain: Vo/Vi

Gain in dB =20 log (Vo/Vi)

XII Results.

Bandwidth= (Hz/KHz/MHz)
Av(max)= …….dB

XIII Interpretation of results.

XIV Conclusion and recommendations

XV Practical related questions

1. Identify type of biasing used in circuit.
2. Suggest the changes required in circuit if PNP transistor is used.
3. Suggest equivalent transistor using datasheet.

XVI References/suggestions for further readings

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4. https://www.youtube.com/watch?v=NEiVSbPYWNE
5. https://www.sparkfun.com/datasheets/Components/BC546.pdf
6. https://www.google.co.in/search?q=semilog+paper+paper&dcr=0&tbm=isch&source=iu&ictx=1&fir=Moe ylTfJDjG41M%253A%252CduGhD8XXNMsn8M%252C_&usg=_ROLCPnZZraikY LlpkpZgKnGHtRY%3D&sa=X&ved=0ahUKEwiI35-XquPYAhVFsI8KHe3 EAIMQ9QEidDAR# imgrc= Moey 1TtJDjG41M:

Assessment Scheme

Performance indicators	Weightage
Process related (15 Marks)	60%
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	40%
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	100%

Names of Student Team Members

.....
…….....
.....
…….....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (l0)	Total (25)	

Practical No.17: Simulate and Test output waveform and frequency response of single stage common emitter (CE) amplifier using simulation software (like SPICE / Multisim)

I. Practical Significance

This practical will help the students to use EDA tools to build and test simple Electronics circuits such as single stage low power common emitter. Simulation of circuit is advantageous for Study the behavior of a system without building it, Results are accurate in general, compared to analytical model. Simulation modeling solves real-world problems safely and efficiently.

II. Industry/Employer Expected outcomes

Discipline knowledge: Apply Electronics and Telecommunications engineering knowledge to solve broad-based Electronics engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunications engineering problems.

Engineering tools: Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III. Course level learning outcomes (cos) Students will be able to achieve & demonstrate the use of BJT electronics circuits.

IV. Laboratory learning outcomes

- Build the circuit for BJT common emitter (CE) amplifier using simulation software (like SPICE/Multisim)
- Plot Output Waveform for sinusoidal input.
- Plot frequency response curve.

V. Relevant affective domain related outcomes.

a. Follow ethical practices.

b. Demonstrate working as a leader/a team member

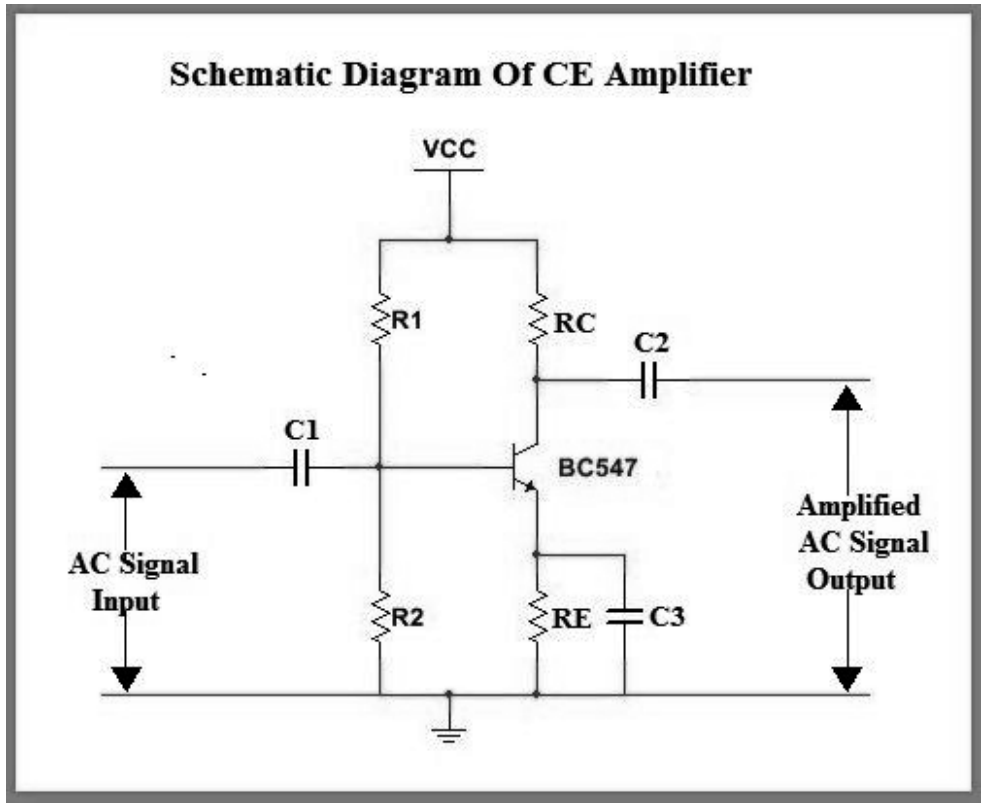
c. Use of computer.

VI Relevant theoretical Background.

Electronic Design Automation (EDA) is a powerful technology in the field of modem Electronics technology. It does not have only strong design capabilities, but also has the testing, analysis and management capabilities. According to the EDA service objects, EDA software is classified into four kinds depend on circuit design and analysis, digital circuit design, radio frequency circuit design and printed circuit board (PCB) design such as Pspice, Multisim, Quartus II and Protel. It contains many kinds of components, which can be chosen to use in experiments, in the component database. At the same time, the new component be designed to expand the component database. It provides all kinds of virtual instruments that include universal instruments (multimeter, function generator, wattmeter and oscilloscope) and special instruments (bode plotter, word generator, logic analyzer, distortion analyzer.

VII. Actual circuit diagram used in Laboratory with equipment

specifications.



VIII. Required resources /apparatus/equipment with specifications

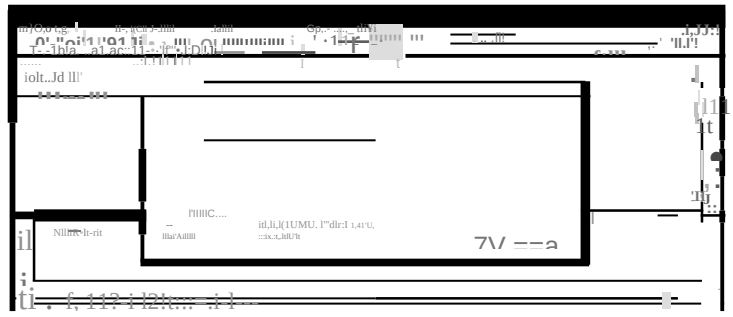
S. No.	Instrument /Components	Specification	Quantity	Remarks
1	Computer with advanced Configuration	Latest Processor	1 No.	
2.	Simulation software	LT Spice /Lab view/H Spice *IP* Spice /HS Spice / Multisim/ Proteus/Octave Or any other relevant open source software	1 No.	

IX. Precautions to be followed

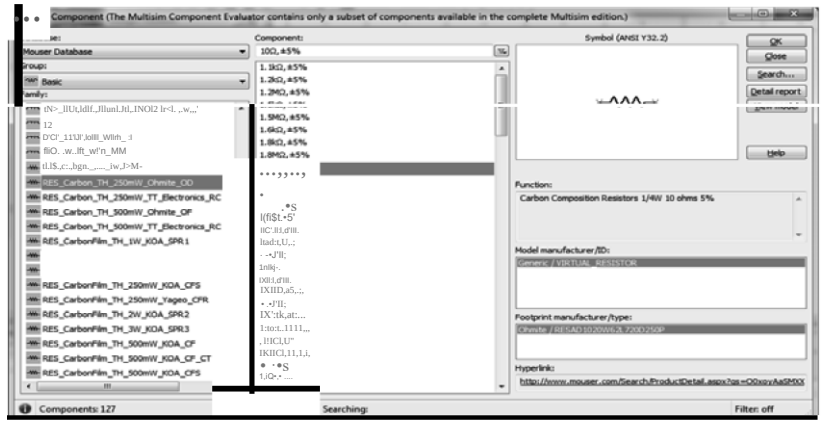
- Ensure proper earthing to the computer system.
- Ensure compatibility of computer system with software.
- Ensure proper installation of simulation software.

X. Procedure

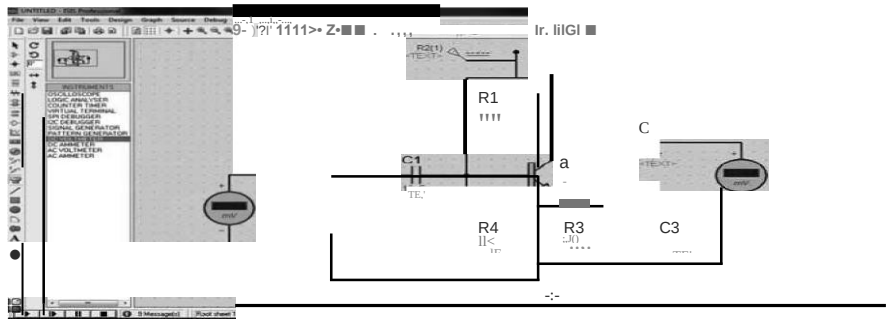
1. Perform step by step Installation process of simulation software.



2. Select relevant electronic components from software library.



3. Build the common emitter amplifier in simulation software as per diagram



4. Apply Input signal sine wave to the circuit.
5. Simulate /run the circuit.
6. Note down output voltage for input frequency (l00Hz to 1MHz).
7. Take printouts of simulated circuit and frequency response on A-4 Paper

XI Observation table Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 2.1 Observation Table

Input Voltage in mV (To be kept Constant),Vi = ---------

Sr. No.	**Input Frequency(Hz)**	**Output Voltage, Vo (Volts)**	**Voltage Gain (A=VoNi)**	**Gain in dB 20 log(Vo/Vi)**
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				

Calculations:

i. Voltage Gain: Vo/Vi

ii. Voltage Gain in dB : 20log (VoNi)

XII Results

1. Bandwidth (B.W) = (KHz/MHz)
2. Av (max) = dB

XIII Interpretation of Results (Give meaning of the above obtained results)

XIV Conclusions and Recommendation

(Actions/decisions to be taken based on the interpretation of results).

XV Practical Related Questions (Note: Teacher shall assign batch wise additional one or two questions related to practical)

1. Write down the procedure of installation of available Simulation Software.
2. Suggest the equivalent software to simulate single stage CE Amplifier circuit
3. Calculate input resistance and output resistance using software practically.

1. ..... .
2. .....

[Space for Answers]

Assessment Scheme

Performance indicators	Weightage
Process related (15 Marks)	**60%**
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical No. 18: Build and Test the performance of RC coupled two stage amplifiers.

I Practical Significance

An amplifier is the basic building block of most electronic systems. Just as one brick does not make a house, a single stage amplifier is not sufficient to build a practical electronic system. The gain of the single stage is not sufficient for practical applications. The voltage level of a signal can be raised to the desired level if we use more than one stage. When a number of amplifier stages are used in succession (one after the other) it is called a multistage amplifier or a cascade amplifier. Much higher gains can be obtained from the multi-stage amplifiers. This practical will help the students to use appropriate coupling of amplifiers.

II Industry/Employer Expected outcomes

a. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
Discipline knowledge: Apply Electronics and Telecommunication engmeermg knowledge to solve broad-based Electronics and Telecommunications engmeenng related problems.
Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Course Level Learning Outcomes:

- Use of BJT as amplifier and switch

IV Laboratory learning outcomes

- Build the circuit for BJT two stage RC coupled common emitter(CE) amplifier.
- Plot frequency response

V Relevant affective domain related outcomes.

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipment's

VI Relevant theoretical Background.

In a multi-stage amplifier, the output of one stage makes the input of the next stage. We must use a suitable coupling network between two stages so that a minimum loss of voltage occurs when the signal passes through this network to the next stage. Also, the de voltage at the output of one stage should not be permitted to go to the input of the next. If it does, the biasing conditions of the next stage are disturbed

Frequency response curve is a graph that indicates the relationship between voltage gain and function of frequency. The frequency response of a RC coupled amplifier is as shown in the following graph.

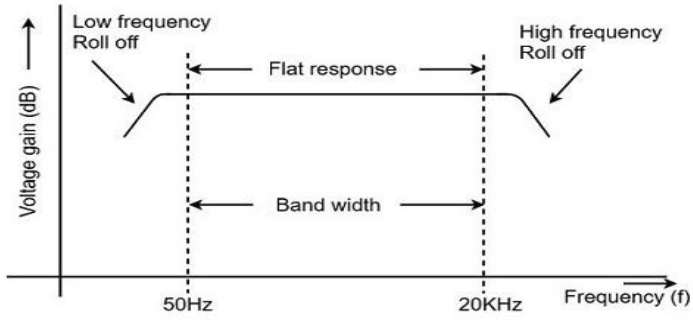


FIGURE 18.1 FREQUENCY RESPONSE OF AMPLIFIER

From the above graph, it is understood that the frequency decreases for the frequencies below 50Hz and for the frequencies above 20 KHz. whereas the voltage gain for the range of frequencies between 50Hz and 20 KHz is constant.

Actual circuit diagram used in Laboratory with equipment specifications.

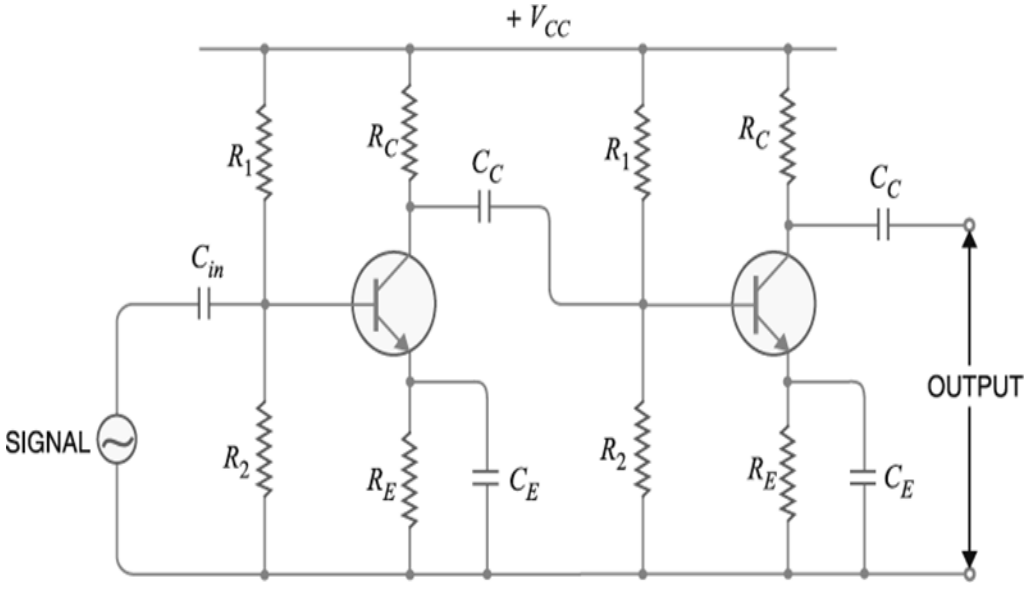


figure no.18.2 circuit diagram of 2 stage RC coupled amplifier

VII Actual Circuit used in laboratory/ Actual Experimental set up used in laboratory

VIII Required resources /apparatus/equipment with specifications

Sr. No.	Instrument/ Component	Specification	Quantity	Remark
1	Cathode Ray Oscilloscope type (Analog	20/30/100 MHz Frequency	**1** No.	
2	Function Generator	0-2 MHz with Sine, square and iangular output with variabl frequency and amplitude	**1** No.	
3	Regulated DC Power Supply	0-30V, 2Amp SC protection	**1** No.	
4	Transistor	BC 547 or equivalent Transistor	2No.	
5	Resistors	Rl =33Kn,R2=3.3KO,RC=1.5KO, RE=470O	2No.	
6	Capacitors	Cl=0.lµf, C2=0.lµfC3=10 µf	2No.	
7	Breadboard	5.5 cmX 17 cm	**1** No.	
8	Connecting wires	Single strand TTeflon coating(0.6 mm diameter)	As per equiremen	

IX Precautions to be followed

- Ensure proper connections are made to the equipment.
- Ensure the power switch is in 'off condition initially.
- Ensure the use of proper settings of function generator and CRO.

X Procedure

1. Make circuit connections as per diagram.
2. Connect function generator at input and CRO at the output terminals of circuit.
3. Set appropriate amplitude and frequency of sine wave signal on function generator.
4. Switch on DC Power Supply, function generator and CRO.
5. Vary input frequency and note down output voltage on CRO.
6. Observe output waveform of CRO
7. Calculate Gain. Repeat step 5 & 6.
8. Plot frequency response on semi log paper.

XI Observation table

use blank sheet provided if space not sufficient)

Table No: 5.1 Observation Table

Input Voltage in mV(To be kept Constant),Vi = ---------

Sr. No.	Input Frequency(Hz)	Output Voltage, Vo (Volts)	Voltage Gain (A= Vo/Vi)	Gain in dB 20 log(Vo/Vi)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				

Calculations :

i. Voltage Gain: Vo/Vi

ii. Voltage Gain in dB: 20 log (Vo/Vi)

iii. 3 dB Bandwidth (B.W) = FwFL

XII Results.

Bandwidth= (Hz/KHz/MHz)

Av(max) = dB

XIII Interpretation of results. (Give meaning of the above obtained results)

XIV Conclusion and recommendations: (Actions/decisions to be taken based on the interpretation of results).

XV Practical related questions

1. Identify type of coupling used in circuit.
2. Calculate gain of Two Stage Amplifier if gain of amplifier 1 is 100 & gain of amplifier 2 is 200?
3. Suggest equivalent Transistor for multistage amplifier using datasheet.

[Space for Answers]

XVI References/suggestions for further readings

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. https://www.youtube.com/watch?v=44UNkKddNdw
4. https://www.youtube.com/watch?v=7HxGCFMCNYE

Performance indicators	Weightage
Process related (15 Marks)	**60%**
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical No. 19: Test the Performance of FET Drain Characteristics.

I Practical Significance

The field-effect transistor (FET) is a transistor that uses an electric field to control the electrical behavior of the circuit. JFETs are known as unipolar transistors since they involve single-carrier-type operation. Field effect transistors have a very high input impedance at low frequencies. In this experiment students will plot Drain and Gate
/Transfer characteristics of JFET

II Industry/Employer Expected outcomes

Discipline knowledge: Apply Electronics and Telecommunications engineering knowledge to solve broad-based Electronics engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunications engineering problems.

Engineering tools: Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III Course level learning outcomes (cos) : Students will be able to achieve & demonstrate the Use of FET and MOSFET in electronics circuits.

IV Laboratory learning outcomes

1. Build the circuit for FET in common source configuration.
2. Plot characteristics for drain to source voltage VDS verses drain Current ID for different Values of VGS

V Relevant affective domain related outcomes.

- Handle equipment and component carefully.

VI Relevant theoretical Background.

Junction Field Effect Transistors are a type of FETs (high input impedance devices) which have three terminals namely Source (S), Gate (G) and Drain (D). These devices are also called voltage controlled devices as the voltage applied at the gate terminal determines the amount of current flowing in-between the drain and the source terminals.

N-channel JFET

N-channel JFET has its major portion made of n-type semiconductor. The mutually-opposite two faces of this bulk material form the source and the drain terminals. There are two relatively-small p-regions embedded into this substrate which are internally joined together to form the gate terminal. Thus, here, the source and the drain terminals are of n-type while the gate is ofp-type.

P-channel JFET

P-channel JFET has its major portion made of p-type semiconductor. The mutually-opposite two faces of this bulk material form the source and the drain terminals. There are two relatively-small-regions embedded into this substrate which are internally joined together to form the gate terminal. Thus, here, the source and the drain terminals are of p-type while the gate is of n-type.

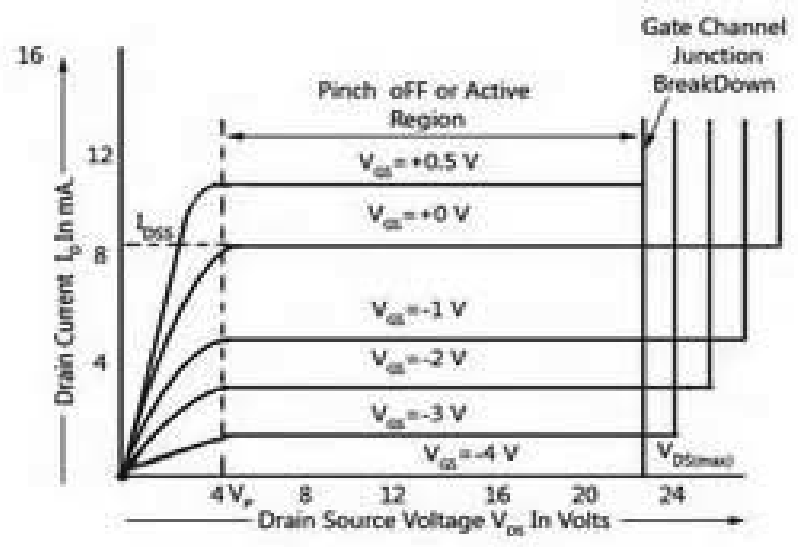


Figure 1: Drain characteristic

VII Actual circuit diagram used in Laboratory with equipment specifications.

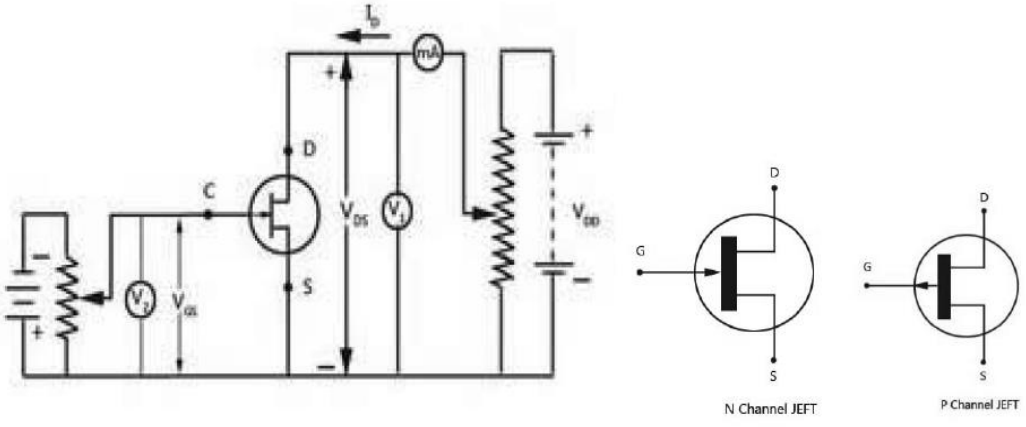


Figure 2: FET characteristic and its symbol

VIII Required resources /apparatus/equipment with specifications

S.No.	Name of Resource	Suggested Specification	Quantity
1.	Power Supply	0-30V 1 Amp	2No.
2.	Voltmeter	0-20V	1 No.
3.	Ammeter	(0-50 milliamps) (0-500µA)	1 No.
4.	JFET	BFWl0, BFW15 or equivalent JFET	1 No.
5.	Connecting wires/ probes	Single strand 0.6mm Teflon coating	As per requirement
6.	Bread Board	5.5 CMX 17CM	1

IX Precautions to be followed

1. Care should be taken while handling terminals of components.
2. Select proper range & mode of ammeter and voltmeter.
3. Connect wires tightly while building circuit.
4. Show the connections to concerned teacher and then switch ON the power supply

X Procedure

Drain characteristics:

1. Connect the electrical circuit as shown in fig 3.
2. Fix gate to source voltage (Vgs) at 0V.
3. Increase drain to source power supply and note down drain to source voltage (Vgs) and drain current (Id).
4. Increase gate to source de power supply so that voltmeter connected to gate and source terminal show 1V.
5. Now repeat above procedure and note down drain to source voltage and drain current by increasing drain power supply.
6. Take readings for 3 to 4 gate voltage values and tabulate it.
7. Plot a graph of Vds verses Id for various values of Vgs.

XI Observation table

S. No.	Vgs= V		Vgs= V		Vgs= V	
	Vds (V)	Id(mA)	Vgs(V)	Id(mA)	Vgs (V)	Id(mA)
I						
2						
3						
4						
5						
6						

Calculations:

Drain dynamic Resistance:

$$r_d = \frac{\Delta V_{DS}}{\Delta I_D}$$

Mutual Conductance:

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}}$$

XII Results.

1. Drain dynamic Resistance (Rd)= .....
2. Mutual Conductance (gm)=.....

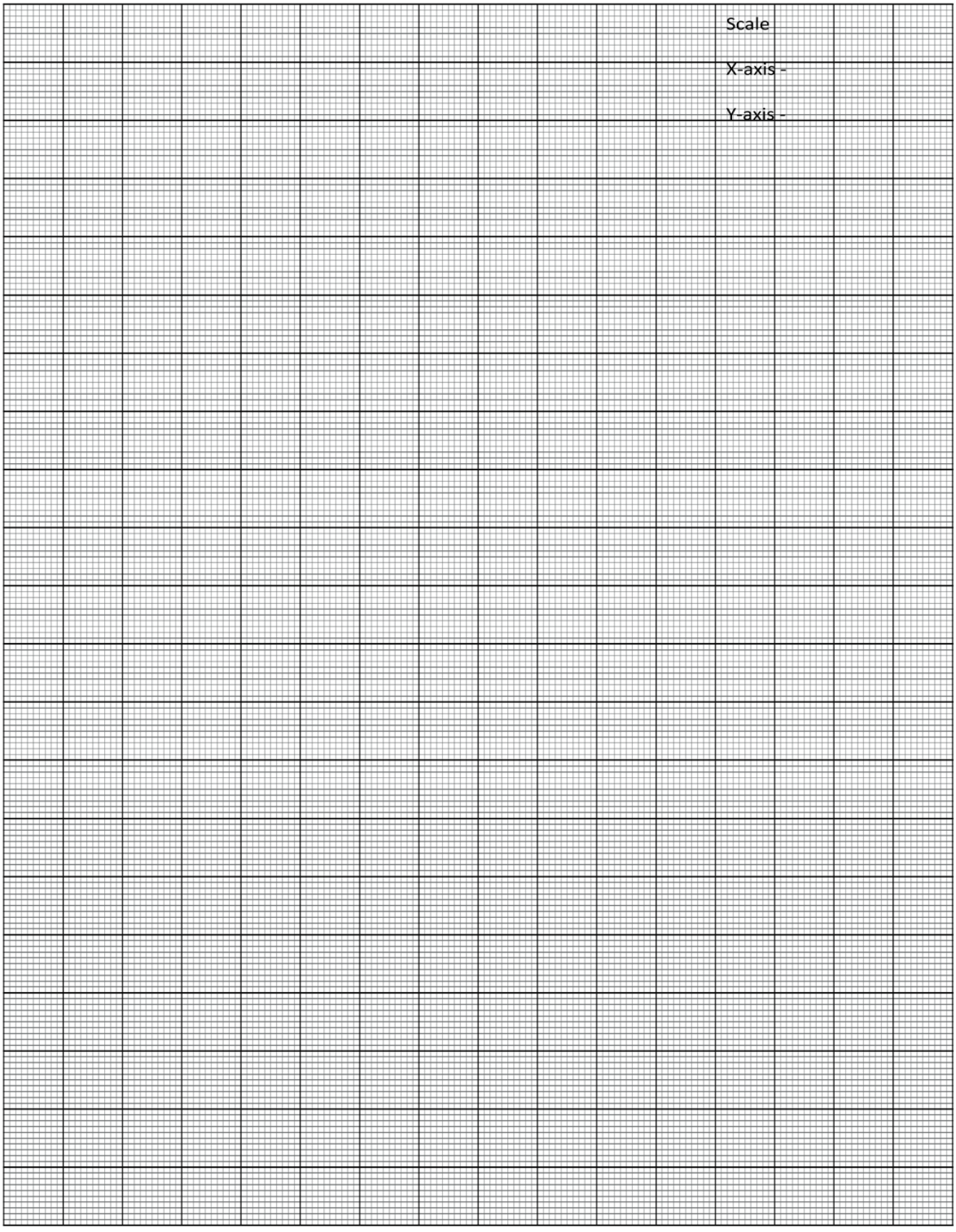
XIII Interpretation of results.

XIV Conclusion and recommendations

XV Practical related questions

1. Write the Part number and manufacturer of given JFET.
2. Write the steps to identify terminals of given JFET.

[Space for answer]


Scale
X-axis -
Y-axis -

XVI References/suggestions for further readings

http://www.electronics-tutorials.ws/transistor/tran 5.html
http://www.circuitstoday.com/characteristics-of-jfets
www.npteLac.in/courses/117107095/lecturers/lecture 36/lecture36 pagel.htm

Performance indicators	Weightage
Process related (15 Marks)	**60%**
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical no. 20: Check the performance of FET transfer characteristics and calculate transconductance.

I **Practical Significance**

The field-effect transistor (FET) is a transistor that uses an electric field to control the electrical behavior of the circuit. JFETs are known as unipolar transistors since they involve single-carrier-type operation. Field effect transistors have a very high input impedance at low frequencies. In this experiment students will plot Drain and Gate/Transfer characteristics of JFET

II. **Industry/Employer Expected outcomes**

Discipline knowledge: Apply Electronics and Telecommunications engineering knowledge to solve broad-based Electronics engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunications engineering problems.

Engineering tools: Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III. Course level learning outcomes (cos) :

Students will be able to achieve & demonstrate the Use of FET and MOSFET in electronics circuits.

IV. Laboratory learning outcomes

1. Build the circuit for FET in common source configuration.
2. Plot characteristics for Gate to source voltage VGS verses drain current ID
3. Calculate transconductance

V. Relevant affective domain related outcomes.

- Handle equipment and component carefully.

VI. Relevant theoretical Background.

Junction Field Effect Transistors are a type of FETs (high input impedance devices) which have three terminals namely Source (S), Gate (G) and Drain (D). These devices are also called voltage controlled devices as the voltage applied at the gate terminal determines the amount of current flowing in-between the drain and the source terminals.

Drain Characteristics:

The curve is divided into following regions:

Ohmic Region: In this region drain current increases linearly with the increase in drain to source voltage, obeying ohm's law.

Curve AB: In this region drain current increases at the inverse square law rate with the increase in drain to source voltage. It is because of fact that with increase in drain to source voltage, drain current increases. This in tum increases reverse bias voltage across gate to source junction. As a result width of depletion region increases reducing effective width of channel.

Pinch off Region: This is also called saturation region. In this region drain current remains almost constant and at its maximum value

Breakdown Region: In this region drain current increases rapidly as the drain to source voltage is also increased. It happens because of breakdown of gate to source junction due to avalanche effect.

Gate/ Transfer Characteristics.
It gives relationship between drain current (Id) and gate to source voltage for a constant value of drain to source voltage (Vds)

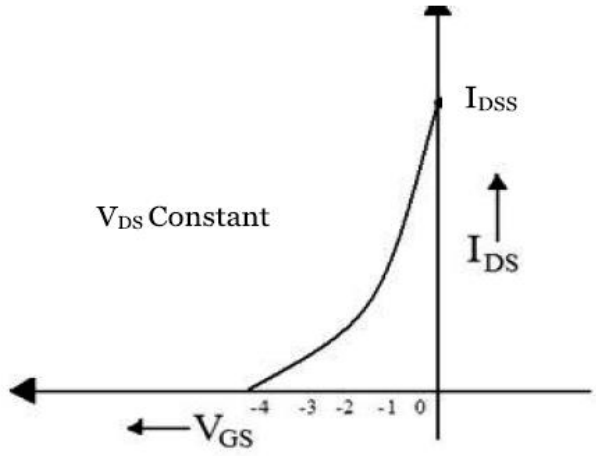


Figure 1: FET transfer characteristic

VII. Actual circuit diagram used in Laboratory with equipment specifications.

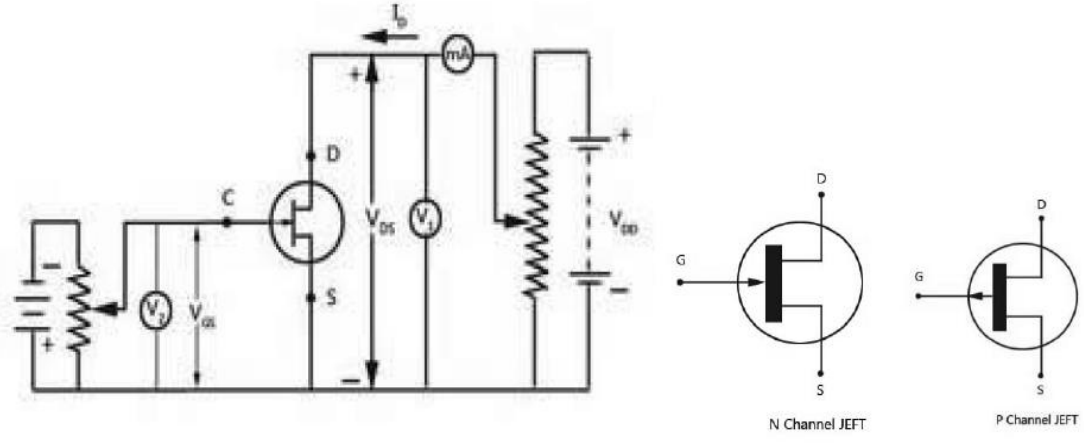


Figure 2: FET characteristic

VIII. Required resources /apparatus/equipment with specifications

S.No.	Name of Resource	Suggested Specification	Quantity
1.	Power Supply	0-30V 1 Amp	2No.
2.	Voltmeter	0-20V	1 No.
3.	Ammeter	(0-50milliamps) (0-500µA)	1 No.
4.	JFET	BFWl0, BFW15 or equivalent JFET	1 No.
5.	Connecting wires/ probes	Single strand 0.6mm Teflon coating	As per requirement
6.	Bread Board	5.5 CMX 17CM	1

IX. Precautions to be followed

5. Care should be taken while handling terminals of components.
6. Select proper range & mode of ammeter and voltmeter.
7. Connect wires tightly while building circuit.
8. Show the connections to concerned teacher and then switch ON the power supply.

X. Procedure

Transfer characteristics:

1. Connect the electrical circuit as shown in fig 3.
2. Set drain to source voltage to 1V, vary gate to source voltage in steps and note down corresponding drain current (In).
3. Repeat the procedure for different set values of drain voltage and keep the record of gate to source voltage and drain current.
4. Plot a graph of gate to source voltage verses drain current for different set values of drain to source voltage.
5. A graph will be in second quadrant as gate to source voltage is negative.

XI. Observation table

s. No.	Vds =OV		Vds = V		Vds = V	
	Vgs (V)	Id(mA)	Vgs(V)	Id(mA)	Vgs (V)	Id(mA)
I						
2						
3						
4						
s. No.	Vds =OV		Vds = V		Vds = V	
	Vgs (V)	Id(mA)	Vgs(V)	Id(mA)	Vgs(V)	Id(mA)
5						
6						

XII Results.

Amplification Factor:

$$\mu = \frac{\Delta V_{DS}}{\Delta V_{GS}}$$

XIII Interpretation of results.

Amplification Factor(μ)= .....

XIV Conclusion and recommendations

XV Practical related questions

3. Write the steps to identify terminals of given MOSFET.
4. Compare JFET and MOSFET

[Space for answer]

XVI References/suggestions for further readings

http://www.electronics-tutorials.ws/transistor/tran 5.html
http://www.circuitstoday.com/characteristics-of-jfets
www.npteLac.in/courses/117107095/lecturers/lecture 36/lecture36 pagel.htm

Performance indicators	Weightage
Process related (15 Marks)	**60%**
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical No. 21: Build and Test the performance of common source FET amplifier.

I Practical Significance:

The field-effect transistor (FET) is a transistor that uses an electric field to control the electrical behavior of the circuit. JFETs are known as unipolar transistors since they involve single-carrier-type operation. Field effect transistors have a very high input impedance at low frequencies. In this experiment students will plot Drain and Gate/Transfer characteristics of JFET

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.'**

1. Component identification skills.
2. Use Digital multimeter to measure the voltage at output of each block.
3. Fault finding skills.

III Relevant Course Outcomes

- Use of FET and MOSFET in electronics circuits.

.

IV Practical Outcome

Build and Test the performance of FET in common source configuration.

LLO 21.1 Plot characteristics for Gate to source voltage VGS verses drain current ID

V Relevant Affective domain related Outcomes

Handle components and equipment carefully.
Select instruments of required range.

VI Minimum Theoretical Background

FETs (high input impedance devices) which have three terminals namely Source (S), Gate (G) and Drain (D). These devices are also called voltage controlled devices as the voltage applied at the gate terminal determines the amount of current flowing in-between the drain and the source terminals.

Common Source (CS) Configuration

In the **Common Source** configuration (similar to common emitter), the input is applied to the Gate and its output is taken from the Drain as shown. This is the most common mode of operation of the FET due to its high input impedance and good voltage amplification and as such Common Source amplifiers are widely used.

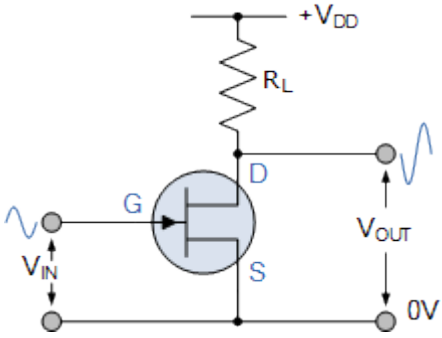
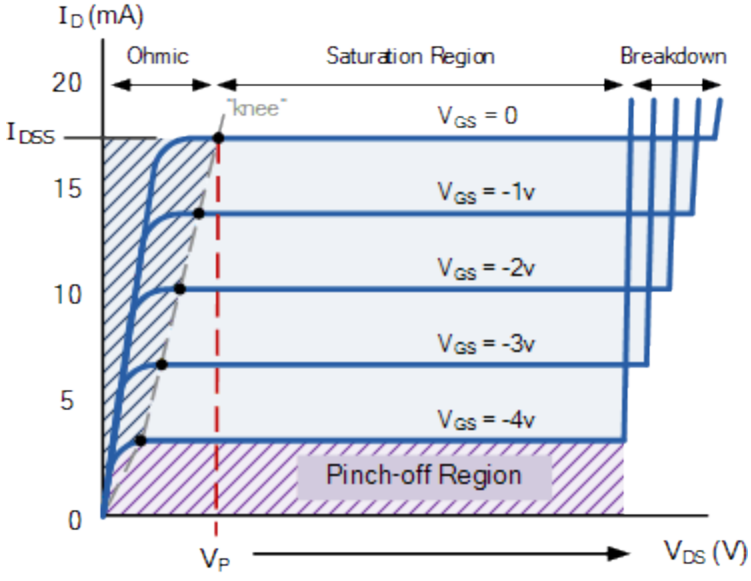


Figure 21.1 **Common Source** configuration

The common source mode of FET connection is generally used audio frequency amplifiers and in high input impedance pre-amps and stages. Being an amplifying circuit, the output signal is 180^{o} “out-of-phase” with the input.

Output characteristic V-I curves of a typical junction FET



FET Parameters

1. Drain Resistance (rd): It is given by the relation of small change in drain to source voltage (VDS) to the corresponding change in Drain Current (ID) for a constant gate to source voltage (VGS), when the JFET is operating in pinch-off region.

   $rd = \Delta VDS/\Delta ID$ at a constant VGS (from drain characteristics)

2. 2. Trans Conductance (gm): Ratio of small change in drain current (ID) to the corresponding change in gate to source voltage (VGS) for a constant VDS.

   $gm = \Delta ID/\ \Delta V$ at constant VDS (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 (VDS) to the corresponding change in gate to source voltage (VGS) for a constant drain current (ID).

   $\mu = (\Delta VDS/\ \Delta ID) \times (\Delta ID\ /\Delta VGS) = \Delta VDS\ \Delta VGS$ *ie.* $\mu = rd \times g$m

4. Drain current in the active region.

$$I_D = I_{DSS}\left[1-\frac{V_{GS}}{V_P}\right]^2$$

VII Circuit diagram:

a. Sample

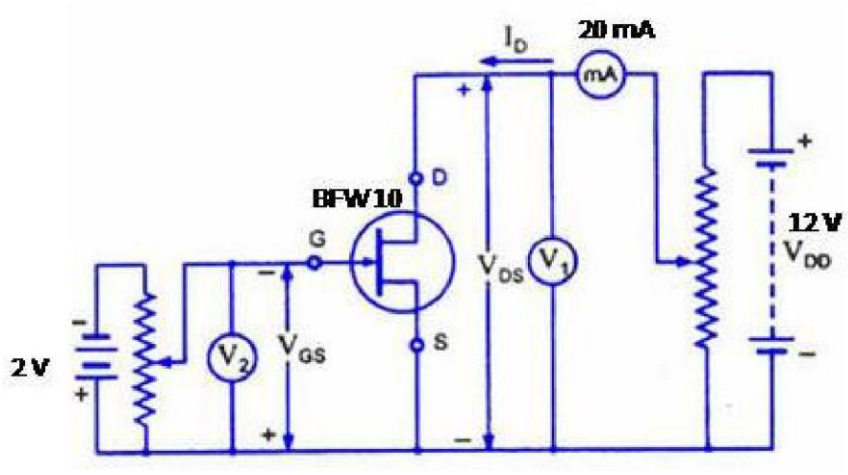


Figure21.2: Circuit Diagram for Common Source characteristics

Note: *This circuit* is *just a sample you can have any regulated power supply*

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VIII Resources required

s. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2	1. Digital Multimeter with diode testing facilities will be preferred. 2. In place of Digital Multimeter, Voltmeter and ammeter can be used.
2.	JFET	(BFW10),	1	
3.	Dual channel DC regulated Power supply.	0-12 V	2	
4.	Resistors	Variable (Potentiometers)	2	
5.	Connecting wires	Single Strand)	As per requirement	
6.	Bread board	5.5 CMX 17CM	1 No.	

IX Precautions

Before connecting the plug to the mains, check the insulation of wires.

X Procedure

Drain Characteristics:

1. Connect the circuit as shown in the figure1.
2. Keep V_{GS} **= 0V** by varying V_{GG}.
3. Varying V_{DD} gradually in steps of **1V** up to **10V** note down drain current I_D and drain to source voltage (V_{DS}).
4. Repeat above procedure for V_{GS} **= -0.4, -0.8, -1.2** and **-1.6 V**

Transfer Characteristics:

1. Connect the circuit as shown in the figure1.
2. Set voltage VDS = 4V/8V
3. Varying V_{DS} in steps of 0.5V until the current I_D reduces to minimum value.
4. Varying V_{GG} gradually, note down both drain current I_D and gate-source voltage (V_{GS}).
5. Repeat above procedure (step 3) for V_{DS} = 4V/ 8V

XI Resources used (with major specifications)

S. No.	Data book /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Table 1: Drain Characteristics.

S.N.	VGS= 0V		VGS= -0.4V		VGS= -0.8V		VGS= -1.2V	
	VDS(v)	ID(mA)	VDS(v)	ID(mA)	VDS(v)	ID(mA)	VDS(v)	ID(mA)
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								

Table 2: Transfer Characteristics.

S.N.	VDS = 4V		VDS = 8V	
	VGS(V)	ID(mA)	VGS(V)	ID(mA)
1.				
2.				
3.				
4.				
5.				

Calculations:

1. Drain Resistance (r_d):

$r_d = \Delta V_{DS}/\Delta I_D$ at a constant V_{GS} (from drain characteristics)

2. Trans Conductance (gm):

$gm = \Delta ID/\Delta VGS$ at constant V_{DS} (from transfer characteristics).

3. Amplification factor (μ):

$\boldsymbol{\mu} = (\Delta \boldsymbol{VDS}/\Delta \boldsymbol{ID}) \times (\Delta \boldsymbol{ID}/\Delta \boldsymbol{VGS}) = \Delta \boldsymbol{VDS}/\Delta \boldsymbol{VGS}$

ie. $\boldsymbol{\mu} = \boldsymbol{rd} \times \boldsymbol{gm}$

XV Results

$\boldsymbol{rd}$=

$\boldsymbol{gm}$=

$\boldsymbol{\mu}$=

XVI Interpretation of results

XVII Conclusions

XVIII Practical related Questions

a) Repeat the experiment with N- Channel FET.

[Space for answers]

XIX References / Suggestions for further Reading

1. https://commons.wikimedia.org/wiki/File:Practical Regulated Power Supply_Components.jpg#/media/File:Practical Regulated Power Supply_Components.jpg
2. https://www.electrical4u.com/regulated-power-supply/
3. http://www.circuitstoday.com/regulated-power-supply

XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

a. .....
b. .....
c. .....
d. .....

Marks Obtained			Dated signature of Teacher
Process Related(l5)	**Product Related(l0)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No. 22: Test the various blocks of regulated dc power supply.

I Practical Significance:

AC power is generated and transmitted from power plants. But the integrated circuits and electronic components used inside office automation equipment, factory automation equipment, and other electronics appliances cannot be operated with the AC voltage and they will be damaged by the high voltages. Stable DC voltage is required to operate these integrated circuits and electronic components. The device that converts commercial AC power to regulated DC power is called a regulated DC Power Supply.

A regulated power supply converts unregulated AC into a constant DC. With the help of a rectifier it converts AC supply into DC. The output from the regulated power supply may be constant or variable, but is always DC. (Direct Current). The testing of regulated DC power supply is carried out to check whether the expected output is obtained at the output stage, else this will conclude that there is fault at the particular stage.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

1. Component identification skills.
2. Use Digital multimeter to measure the voltage at output of each block.
3. Visual circuit inspection skill

III Relevant Course Outcomes

- Maintain DC regulated power supply

IV Practical Outcome

Test the various blocks of regulated dc power supply.

- LLO 22.1 Test the voltages and waveforms at various Test points of regulated dc power supply.

V Relevant Affective domain related Outcomes

- Handle components and equipment carefully.
- Select instruments of required range.

VI Minimum Theoretical Background

Testing of regulated DC power supply is used to troubleshoot the power supply. Testing is used to solve and eliminate the causes of fault. These faults cause voltage and current instability. Which can have a significant impact on equipment. The aim of a DC power supply is to provide the required level of DC power to the load using an AC supply at the input. The DC power supplies, consists of following major components /circuits :

- Input transformer: The input transformer 1s a step down transformer of required voltage and current rating.
- Rectifier: The rectifier converts AC to pulsating DC.
- Filter: It removes ripples.
- Voltage Regulator: It provides a constant output voltage irrespective of change in line voltage and load current.

VII Block Diagram :

c. Sample

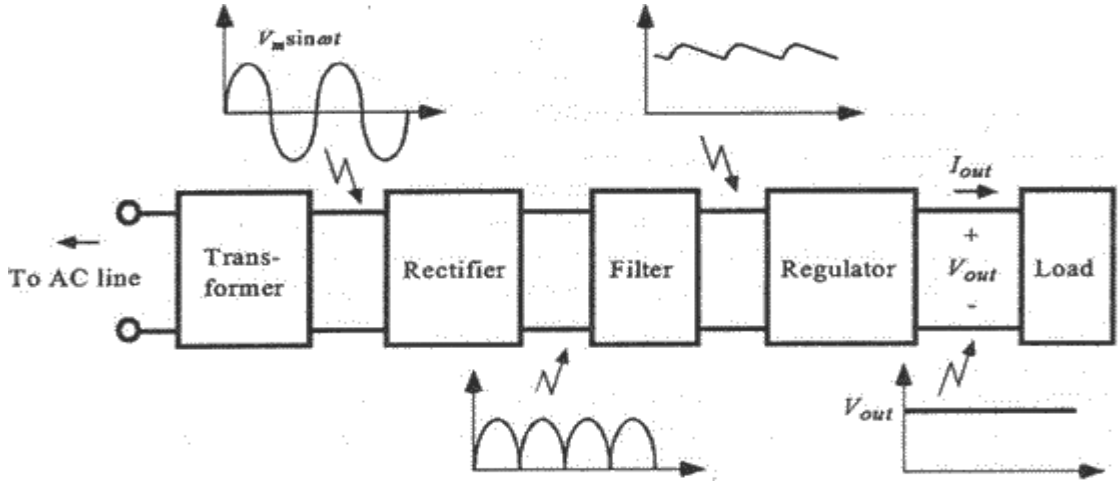


Figure l: Regulated power supply Block diagram

Courtesy: *(http:/lwww.circuitstoday.com/wp-content/uploads/2009/10/Regulated-Power-Suppley-Block-Digram.jpg*

d. Actual Circuit used in laboratory

VIII. Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2	1. Digital Multimeter with diode testing facilities will be preferred. 2. In place of Digital Multimeter, Voltmeter and ammeter can be used.
2.	CRO	25MHz Dual scope	**1**	
3.	DC regulated Power supply Trainer Kit		2	
4	Electric Tester		**1**	

IX. Precautions

Before connecting the plug to the mains check, check the wires insulation.

X. Procedure

1. Use trainer kit of regulated DC power supply.
2. ON the AC supply.
3. Check and Sketch the nature of waveform using CRO:
   - at primary of the Transformer on CRO
   - at secondary of the Transformer on CRO
   - at output of rectifier.
   - at output of filter .
   - at output of regulator.
4. Draw all waveforms nature in the observation table.
5. Draw all waveforms nature on graph paper.

Resources used (with major specifications)

S. No.	Data book /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XI. Actual procedure followed

XII. Precautions followed

XIII. Observations and Calculations:

Table 1: Output voltage and Output waveform.

S.No.	Stage	Output voltage (V)	Output waveform
1	Primary of Transformer		
2	Secondary of Transformer		
3	Output of Rectifier		
4	Output of Filter		
5	Output of Regulator		

XIV. Results

XVI Interpretation of results

XVII Conclusion(s)

XVIII Practical related Questions

Measure the voltages at different stages given in observation table using DMM.

[Space for answers]

XIX References / Suggestions for further Reading

1. https://commons.wikimedia.org/wiki/File:Practical Regulated Power Supply_Components.jpg#/media/File:Practical Regulated Power Supply_Components.jpg
2. https://www .electrical4u.com/regulated-power-supply/
3. http://www.circuitstoday.com/regulated-power-supply

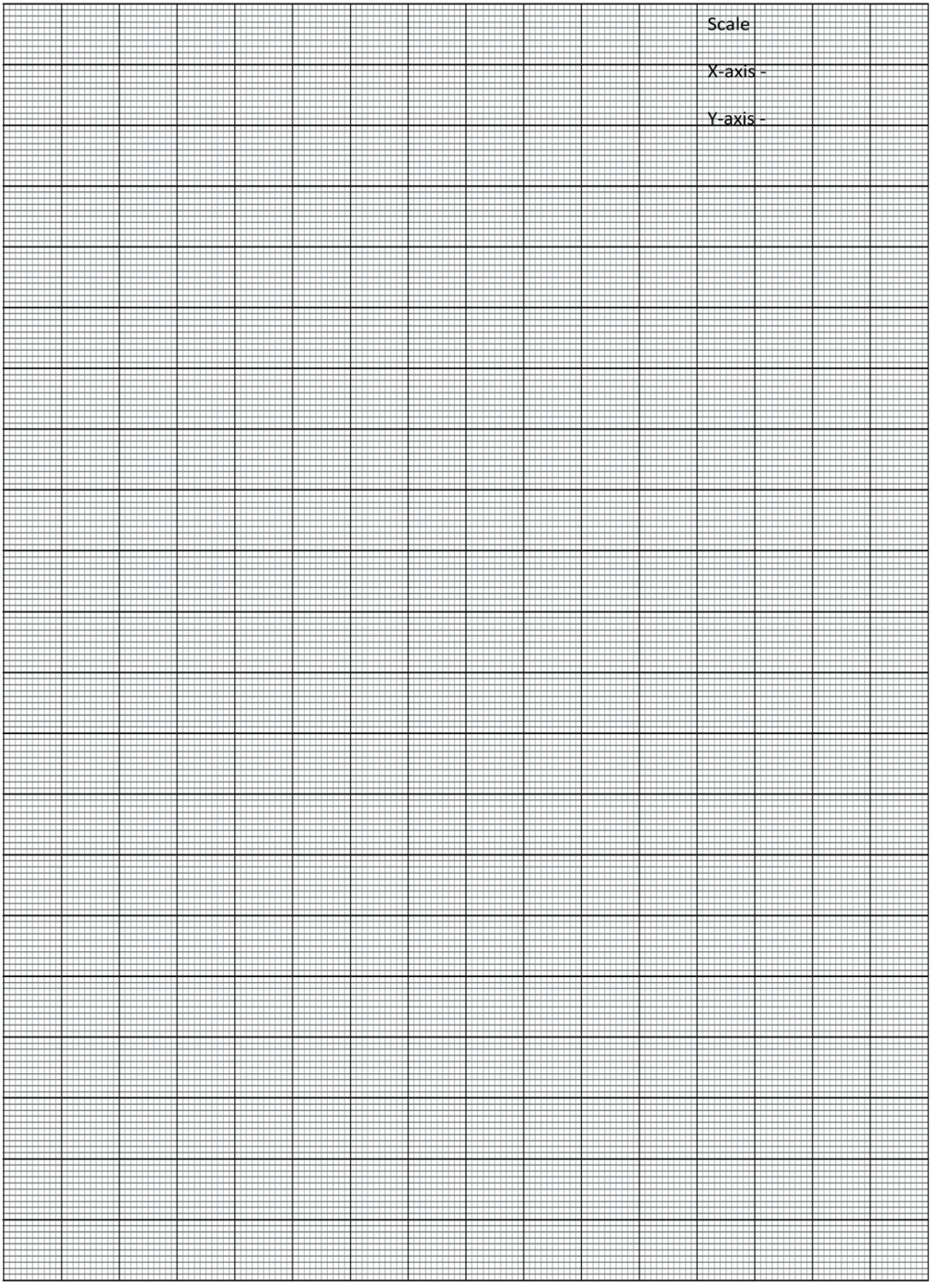
XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

a. .....
b. .....
c. .....
d. .....

Marks Obtained			Dated signature of Teacher
Process Related(l5)	**Product Related(l0)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No. 23: Find out faults at different stages of regulated dc power supply.

I Practical Significance:

AC power is generated and transmitted from power plants. AC power generation and transmission is easier and cheaper than DC supply transmission. But the integrated circuits and electronic components used inside office automation equipment, factory automation equipment, and other electronics appliances cannot be operated with the AC voltage and they will be damaged by the high voltages. Stable DC voltages are required to operate these integrated circuits and electronic components. The device that converts commercial AC power to regulated DC power is called a regulated DC Power Supply. A regulated power supply converts unregulated AC into a constant DC. With the help of a rectifier it converts AC supply into DC. The output from the regulated power supply may be constant or variable, but is always DC. (Direct Current). The testing of regulated DC power supply is carried out to check whether the expected output is obtained at the output stage, else this will conclude that there is fault at the particular stage.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

4. Component identification skills.
5. Use Digital multimeter to measure the voltage at output of each block.
6. Fault finding skills.

III Relevant Course Outcomes

Maintain DC regulated power supply.

IV Practical Outcome

Find out faults at different stages of regulated dc power supply.
:

- LLO 23.1 Identify the various faults in the Regulated DC power supply.

V Relevant Affective domain related Outcomes

- Handle components and equipment carefully.
- Follow safety precautions.
- Select instruments of required range.

VI Minimum Theoretical Background

Testing of regulated DC power supply is used to troubleshoot the power supply. Testing is used to solve and eliminate the causes of fault. These faults cause voltage and current instability. Which can have a significant impact on equipment. The aim of a DC

power supply is to provide the required level of DC power to the load using an AC supply at the input. The DC power supply consists of following major components/circuits:

- Input transformer: The input transformer is a step down transformer.
- Rectifier: The rectifier converts AC to pulsating DC.
- Filter: It removes ripples.

Voltage Regulator: It provides a constant output voltage irrespective ofchange m line and load voltage

VII Block diagram:

a. Sample

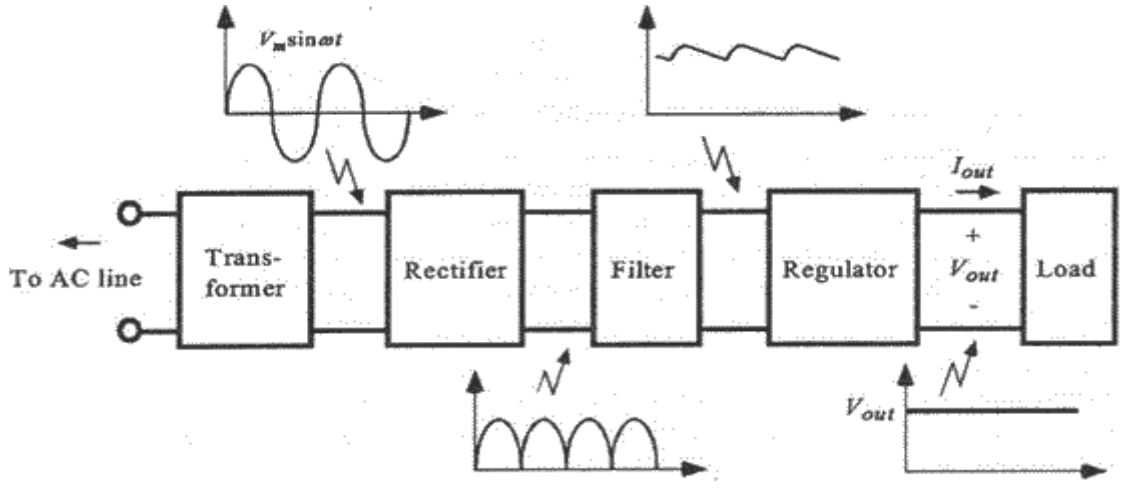


Figure 23.1 :Regulated power supply Block diagram

Courtesy: *(b_tto:l/www.circuitstodav.com/wo-conlentluoloads/2009/10/Regulated-Power-Suoplev-Block-Digram.iog)*

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2	3. Digital Multimeter with diode testing facilities will be preferred. 4. In place of Digital Multimeter, Voltmeter and ammeter can be used.
2.	CRO	25MHz Dual scope	1	
3.	DC regulated Power supply Trainer Kit		2	

IX Precautions

Before connecting the plug to the mains, check the insulation of wires.

X Procedure

1. Use trainer kit of regulated DC power supply.
2. ON the AC supply.
3. Create faults at different stages, compare the observed output voltage with the expected output voltage at each stage and comment on the values.

XI Resources used (with major specifications)

S. No.	Data book /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Table 1: Observe output voltage and fault..

S.No.	Create fault at Stage	Expected Output Voltage (V)	Observed Output Voltage (V)	Comment Related to Observed fault
1.				
2.				
3.				
4.				
5.				

Calculations: Not Applicable

XV Results

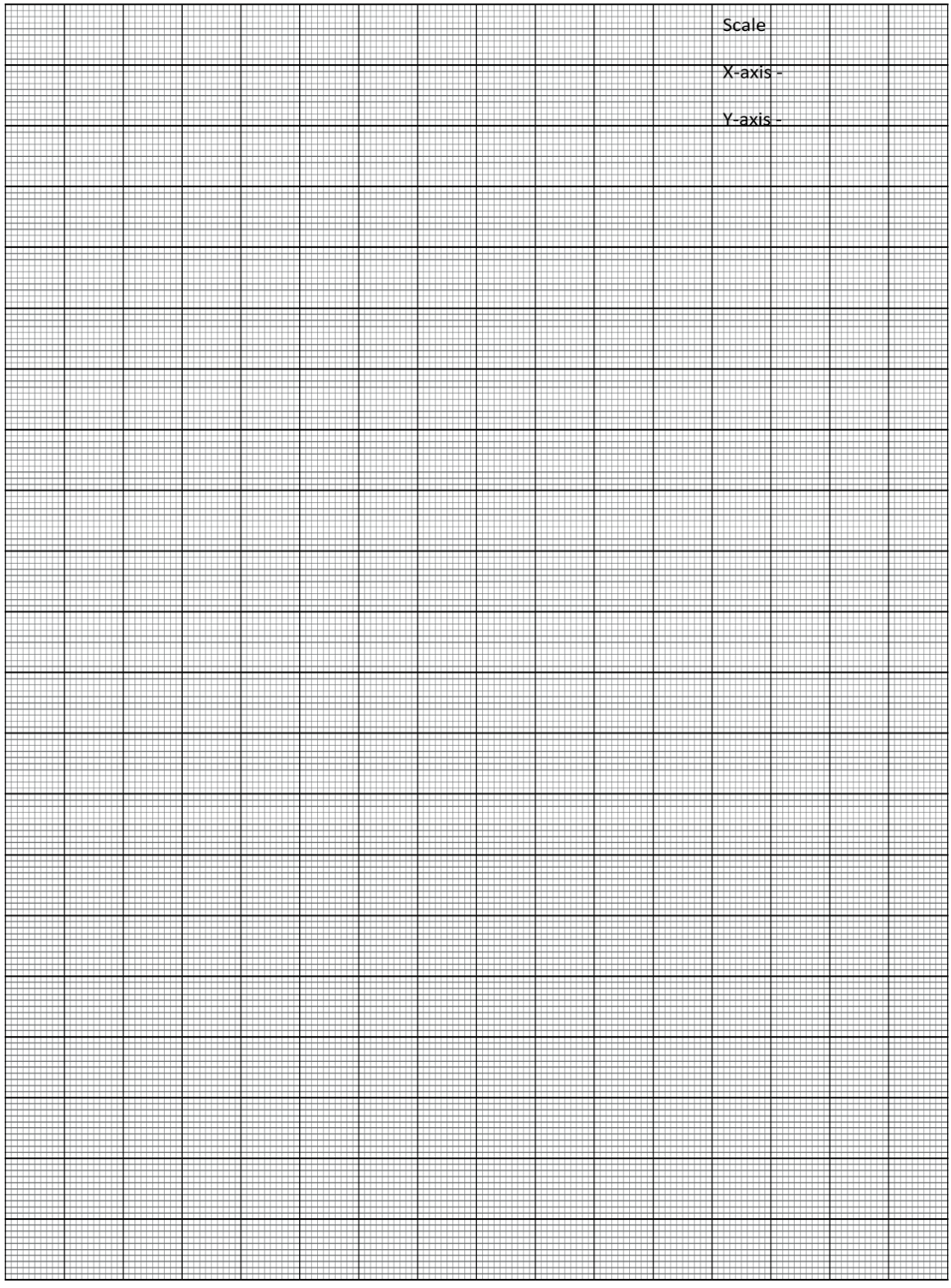
XVI Interpretation of results

XVII Conclusions

XVIII Practical related Questions

a. Measure the voltages at given different stages given in observation table using DMM.

[Space for answers]


Scale
X-axis -
Y-axis -

XIX References / Suggestions for further Reading

1. https://commons.wikimedia.org/wiki/File:Practical Regulated Power Supply_Components.jpg#/media/File:Practical Regulated Power Supply_Components.jpg.
2. https://www.e1ectrica14u.com/regu1ated-power-supp1y/
3. http://www.circuitstoday.com/regulated-power-supply.

XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

a......

b. .....

c. .....

d. .....

Marks Obtained			Dated signature of Teacher
Process Related(l5)	**Product Related(l0)**	**Total (25)**	

Practical No. 24: Construct and test the performance of Zener voltage regulator for given voltage.

I Practical Significance:

Troubleshooting of an electronic circuit is a process of having a special outlook on components that comes out with remedies to repair it. The unexpected behavior exhibited by the circuit is due to improper locating or soldering of components, component damage due to aging, faults, overheat, and so on.

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

7. Component identification skills.
8. Use Digital multimeter to measure the voltage at output of each block.
9. Fault finding skills.

III Relevant Course Outcomes

Maintain DC regulated power supply.

IV Practical Outcome

Find out faults at different stages of regulated dc power supply.

- LLO 24.1 Rectify the various faults in the Regulated DC power supply.

V Relevant Affective domain related Outcomes

- Handle components and equipment carefully.
- Select instruments of required range.

VI Minimum Theoretical Background

Troubleshooting is a form of problem solving, often applied to repair failed products or processes on a machine or a system. It is a logical, systematic search for the source of a problem in order to solve it, and make the product or process operational.

Troubleshooting approach consists of the following:

Step 1 -Physical Observation
(Locating different electronic components in different section)

Step 2 -Define Problem Area

Step 3 -Identify Possible Causes

Step 4 -Determine Most Probable Cause

Step5-Test and Repair

VII Block diagram:

a. Sample

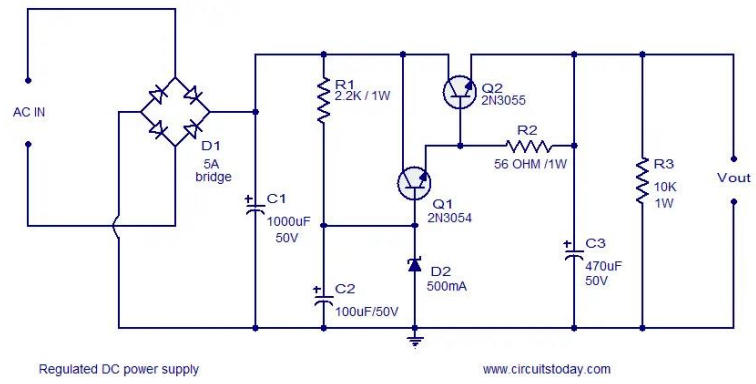


Figure24.1: Regulated power supply

Note: *This circuit* is *just a sample you can have any regulated power supply*

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2	5. Digital Multimeter with diode testing facilities will be preferred. 6. In place of Digital Multimeter, Voltmeter and ammeter can be used.
2.	CRO	25MHz Dual scope	1	
3.	DC regulated Power supply Trainer Kit		2	

IX Precautions

Before connecting the plug to the mains, check the insulation of wires.

X Procedure

Follow the given flow chart for troubling shooting the given power supply.

1. Do the physical observations of different sections of the given power supply.
2. Draw the circuit diagram of the given power supply and mark test point as per the flow chart.
3. Go on testing each section of given circuit from input side to output side and test output.
4. Record the voltage and sketch waveforms at all check points in the table.
5. Compare the voltage value at given point with expected value, check waveform at given point and then identify the fault in given supply.

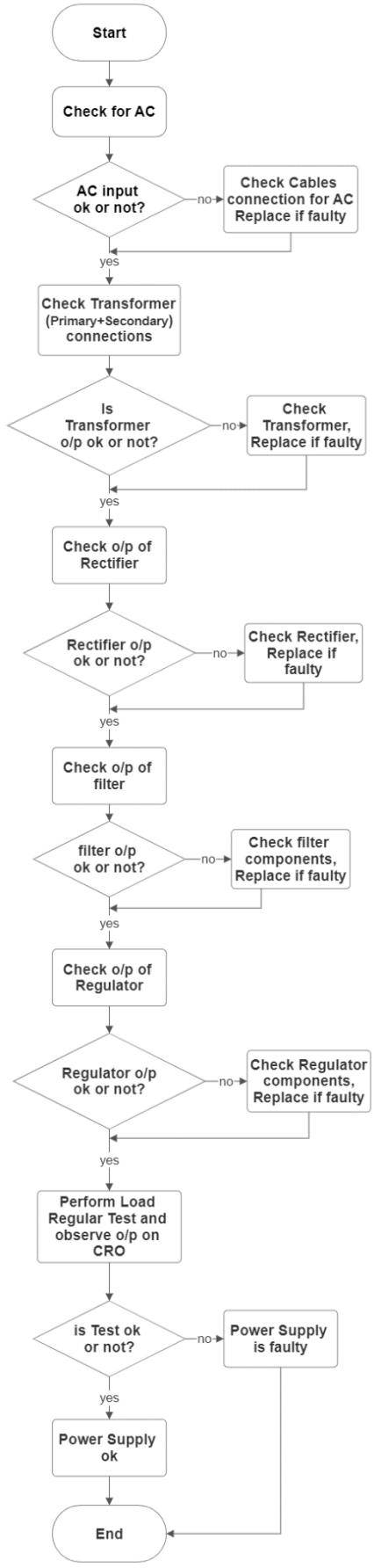


Figure 24.2 : flowchart for troubleshooting of DC regulated Power supply

XI Resources used (with major specifications)

S. No.	Data book /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Table 1: Observed waveforms.

S.No.	Test Points	Standard value	Measured value	Observed waveform
1.				
2.				
3.				
4.				
5.				

Calculations: Not Applicable

XV Results

XVI Interpretation of results

XVII Conclusions

XVIII Practical related Questions

b) Repeat the experiment with different faults.

[Space for answers]

XIX References / Suggestions for further Reading

XV. https://commons.wikimedia.org/wiki/File:Practical Regulated Power Supply_Components.jpg#/media/File:Practical Regulated Power Supply_Components.jpg
XVI. https://www.electrical4u.com/regulated-power-supply/
XVII. http://www.circuitstoday.com/regulated-power-supply

XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

a......
b. .....
c. .....
d. .....

Marks Obtained			Dated signature of Teacher
Process Related(l5)	**Product Related(l0)**	**Total (25)**	

Practical No. 25: Construct and test the performance of Zener voltage regulator for given voltage.

I Practical Significance:

The Zener diode is like a general-purpose PN junction diode. When biased in the forward direction it behaves just like a normal PN junction diode, but when a reverse voltage is applied to it, the voltage remains constant for a wide range of currents.

Zener Breakdown: There is a limit for the reverse biasing voltage. Reverse biasing voltage can increase until the diode breakdown voltage reaches. This reverse biased voltage is called Zener *Breakdown voltage.* At this stage, maximum current will flow through the Zener diode.

The fact that the voltage across the diode in the breakdown region is almost constant turns out to be an important application of the Zener diode as a voltage regulator

II Industry/Employer Expected Outcome

This practical is expected to develop the following skills for the industry-identified competency: '**Maintain electronic circuits comprising of discrete electronic components.**'

10. Component identification skills.
11. Use Digital multimeter to measure the voltage at output of each block.
12. Fault finding skills.

III Relevant Course Outcomes

Maintain DC regulated power supply.

IV Practical Outcome

Find out faults at different stages of regulated dc power supply.

- LLO 25.1 Construct Zener voltage regulator for given voltage.
- LLO 25.2 Calculate load and line regulation.

V Relevant Affective domain related Outcomes

- Handle components and equipment carefully.

VI Minimum Theoretical Background

a) Line Regulation

In line regulation, series resistance and load resistance are fixed, only input voltage is changing. Output voltage remains the same as long as the input voltage is maintained above a minimum value. Line regulation is the system's ability to maintain a constant output voltage regardless of the input voltage delivered to the regulator.

Percentage of line regulation can be calculated by = $\Delta Vo/\Delta Vin * 100$

where Vo is the output voltage and Vin is the output voltage for a particular change in input

b) Load Regulation

Load regulation is the system's ability to maintain a constant output voltage regardless of the size of the load. Percent voltage load regulation is defined as the ratio of the difference between an unloaded and fully loaded circuit over that of a fully loaded circuit.

Percentage of load regulation = $\frac{(VNL-VFL)}{VNL} * 100$

where V_{NL} is the no load resistor voltage (ie. remove the load resistance an the voltage across the Zener Diode) and V_{FL} is the full load voltage.

VII Practical Circuit Diagram:

a. Sample

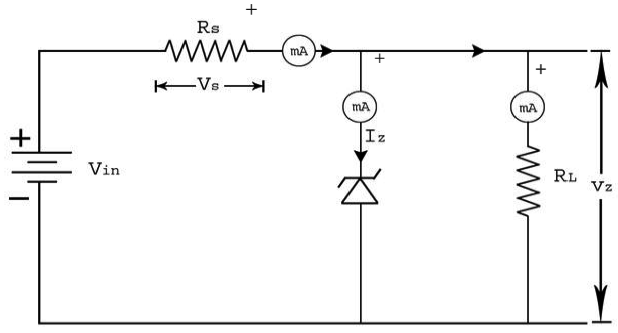


Figure24.1: Regulated power supply

Note: *This circuit* is *just a sample you can have any regulated power supply*

b. Actual Circuit used in laboratory

c. Actual Experimental Set up used in laboratory

VIII Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2 No.	1. Digital Multimeter with diode testing facilities will be preferred. 2. In place of Digital Multimeter, DC Voltmeter and DC ammeter can be used.
2.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1 No.	
3.	Voltmeter	0-20 V	1 No.	
4.	Ammeter	(0 - 200 mA, 0 - 200 µA)	2No.	
5.	Bread board	5.5 CMX 17CM	1 No.	
6.	Diode	**1N4733 (or any other equivalent Zener diode)**	1 No.	
7.	Variable Load Resistor		1 No.	
8.	Resistor	1KQ(0.5watts/0.25watts)	1 No.	

IX Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment do not exceed the input voltage of the diode beyond the rated voltage of diode. This may lead to damaging of the diode.
3. Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.

X Procedure

A) Line Regulation:

1. Connect the circuit as in figure 1.
2. Keep load resistance fixed value; vary DC input voltage from 5V to 15V.
3. Record the output voltage as a load voltage with high line voltage 'V HL' and as a load voltage with low line voltage 'Vu' in the observation table.

B) **Load Regulation:**

1. Keep input voltage constant say 1OV, vary load resistance value.
2. Record no load voltage 'VNL' for maximum load resistance value and full load voltage 'VpL' for minimum load resistance value.
3. Calculate load regulation as per formula.
4. Sketch the graph for recorded readings.

XI Resources used (with major specifications)

S. No.	Data book /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XII Actual procedure followed

XIII Precautions followed

XIV Observations and Calculations:

Table 1: Measurement of Vin and Vz

S.No.	Line Regulation (RLconstant) IL =lO(mA)		Load Regulation (Vinconstant) Vin=lO(V)	
	Input voltage Vin(VOLTS)	**Output voltage Vz(VOLTS)**	**Load current IL(mA)**	**Output voltage Vz(VOLTS)**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Calculations:

Percentage of line regulation=

Percentage of load regulation=

XV Results

Load Resistance	**Output voltage Vz(VOLTS)**	**Load current IL(mA)**
RLminimum		
RLmaximum		

XVI Interpretation of results

XVII Conclusions

XVIII Practical related Questions

Repeat the above experiment with Zener diode of different ratings.

[Space for answers]

XIX References / Suggestions for further Reading

1. https://www.youtube.com/watch?v=n5 6b6-j0r4
2. https://www.youtube.com/watch?v=jG2YAtTWxv
3. https://www.youtube.com/watch?v=mfGEODPzTmc

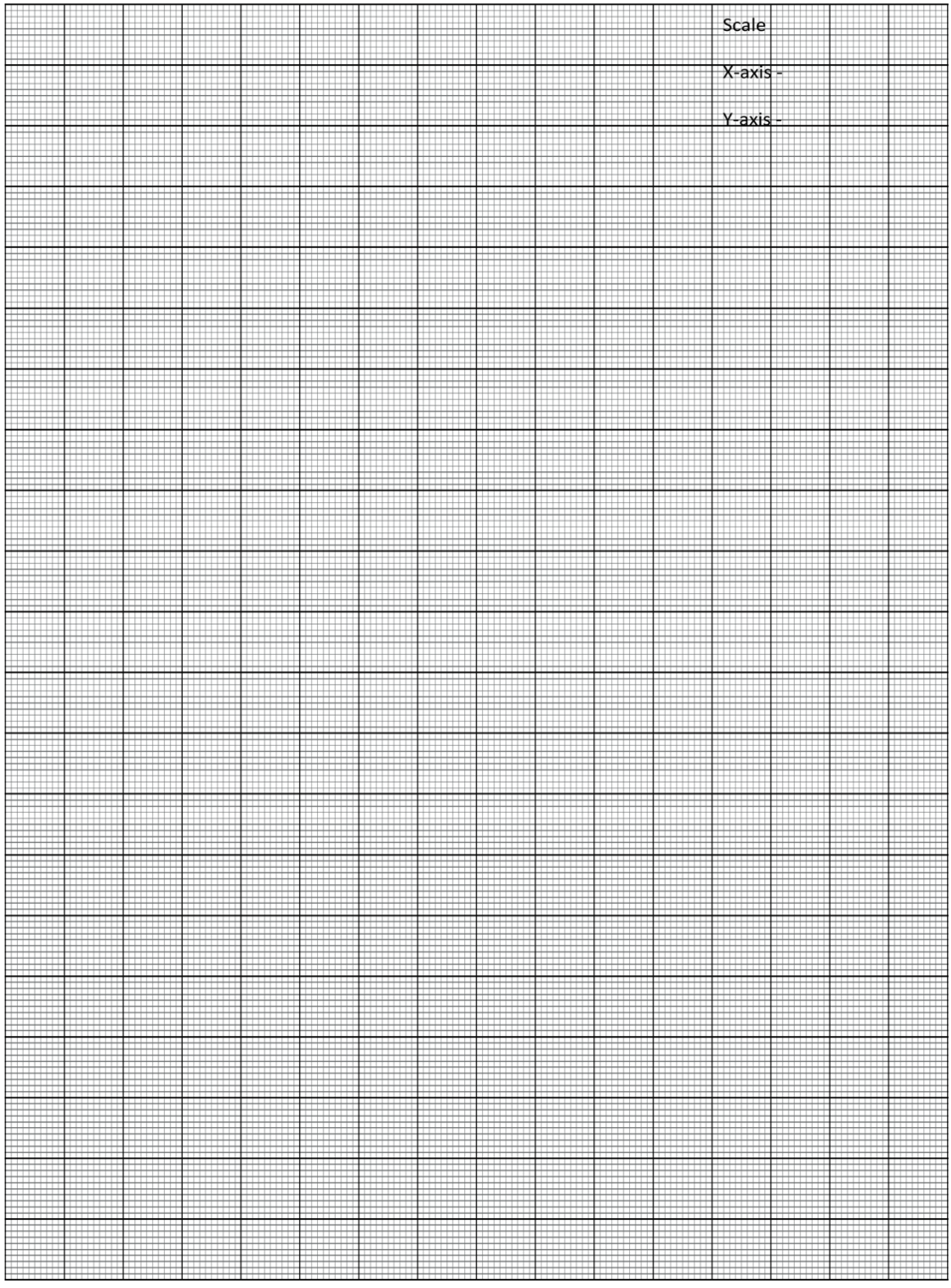
XX Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total (25 Marks)	100 %

Names of Student Team Members

a......
b. .....
c. .....
d. .....

Marks Obtained			Dated signature of Teacher
Process Related(l5)	**Product Related(l0)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical no.26: Build and Test the performance of Positive voltage regulator using 78XX , three terminal IC for given voltage.

I. Practical Significance

In the industry and home appliances three terminal regulators are used. They give fixed output voltages making them useful in a wide range of applications. Use of IC 78xx will help students to acquire necessary practical skills related to regulators. This practical will help the students to apply relevant Electronics technologies and EDA tools with an understanding of the limitations.

II. Industry/Employer Expected outcomes

Discipline knowledge: Apply Electronics and Telecommunications engineering knowledge to solve broad-based Electronics engineering related problems.

Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunications engineering problems.

Engineering tools: Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III. Course level learning outcomes (cos)

Maintain DC regulated power supply

IV. Laboratory learning outcomes

- Build the circuit for Negative voltage regulator using 78XX IC.
- Calculate load and line regulation.

V. Relevant affective domain related outcomes.

- This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***
- Maintain IC voltage regulator and SMPS.

VI. Relevant theoretical Background.

IC 78XX is positive series of regulators. For ICs within the 78xx family, the xx is replaced with two digits, indicating the output voltage for example; the 7805 has a 5-volt output, while the 7812 produces 12 volts. The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. The LM78XX series is available in an aluminum TO-3 package which will allow over l .0A load current if adequate heat sinking is provided.

Line Regulation: It is defined as percentage change in the output voltage for a change in the input voltage.

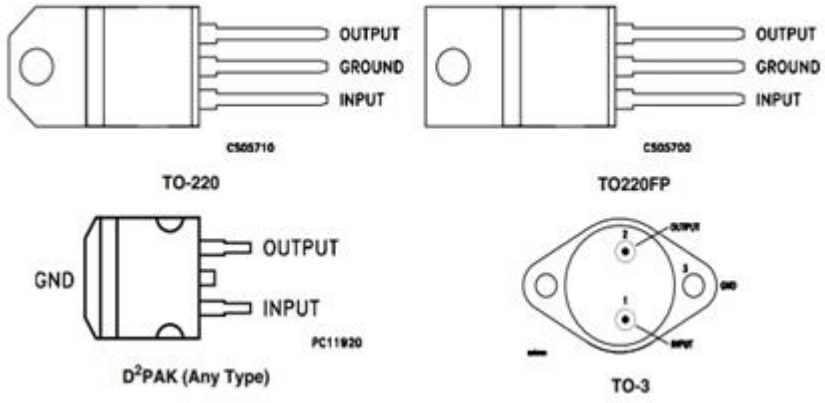


Figure 1 : voltage regulator 78XX family

VII. Practical circuit diagram

a. sample

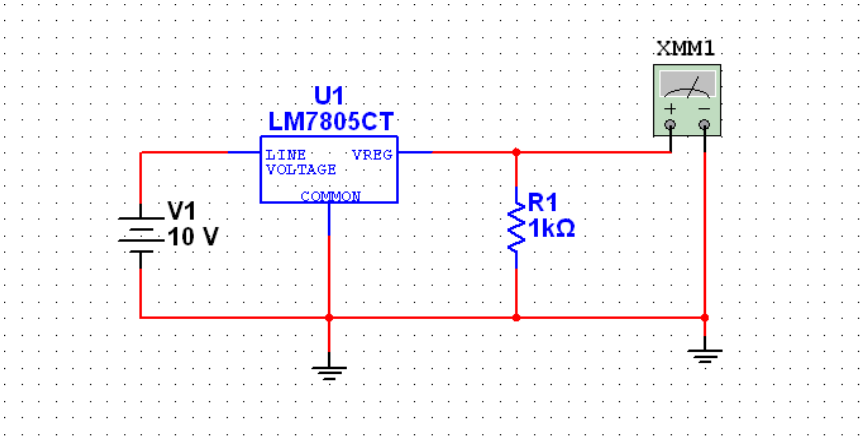


Figure 2 voltage regulator using 7805

b. Actual circuit diagram used in Laboratory with equipment specifications.

VIII. Required resources /apparatus/equipment with specifications

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2 No.	3. Digital Multimeter with diode testing facilities will be preferred. 4. In place of Digital Multimeter, DC Voltmeter and DC ammeter can be used.
2.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1 No.	
3.	Bread board	5.5 CMX 17CM	1 No.	
4.	Resistor	1K(0.5watts/0.25watts)	1 No.	
5.	IC7805	Thermal, short circuit and safe area protection, High ripple rejection, 1.5A output current, 4% tolerance on preset output voltage	1 No.	
6	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	Asper requirement	Connecting wires

IX. Precautions to be followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the polarity and appropriate range of multimeter

X. Procedure

a. Line Regulation:

1. Build circuit on breadboard as per circuit diagram.
2. Apply unregulated voltage to the circuit.
3. Measure input voltage with Digital Multimeter
4. Measure output voltage with Digital Multimeter
5. Note down the output voltages at different stages of regulated power supply

XI. Observation table

Sr no	Vin: input voltage (v)	Vo output voltage(v)
1	2	
2	4	
3	6	
4	8	
5	10	
6	12	
7	14	
8	16	
9	18	
10	20	

Calculation

$$\text{Line Regulation} = \frac{\Delta V_o}{\Delta V_i} \cdot 100\%$$

XII. Results.

Line regulation is ……

XIII. Interpretation of results.

XIV. Conclusion and recommendations

XV. Practical related questions

1. Refer the datasheet state the performance parameters of IC 7812 and 7912.
2. Compare fixed and variable regulators?

XVI. References/suggestions for further readings

1. Voltage regulator PCB for LM317 LM337 or 78xx 79xx IC by ebay.com
2. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
3. https:/lbw-server.com/voltage-regulators-stabi1izers-78xx-and-79xx
4. https://www.youtube.com/watch?v=mG9Jok1lTxU

Performance indicators	Weightage
Process related (15 Marks)	**60%**
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

PRACTICAL NO.27: Build and Test the performance of Negative voltage regulator using 79XX, three terminals IC for given voltage.

I. **Practical Significance:** In the industry and home appliances three terminal regulators are used. They give fixed output voltages making them useful in a wide range of applications. Use of IC 79xx will help students to acquire necessary practical skills related to regulators. This practical will help the students to apply relevant Electronics technologies and EDA tools with an understanding of the limitations.

II. Industry/Employer Expected outcomes

- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations
- **EDA Tools Usage:** Use EDA tools to develop simple Electronics and Telecommunication engineering related circuits

III. Course level learning outcomes (cos)

Maintain DC regulated power supply

IV. Laboratory learning outcomes

- Build the circuit for Negative voltage regulator using 78XX IC.
- Calculate load and line regulation.

V. Relevant affective domain related outcomes.

- This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators***
- Maintain IC voltage regulator and SMPS.

VI. Relevant theoretical Background.

IC 79XX is negative series of regulators. For ICs within the 79xx family, the xx is replaced with two digits, indicating the output voltage for example; the 7905
has a -5volt output, while the 7912 produces -12 volts. The LM79XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. The LM79XX series is available in an aluminum TO-3 package which will allow over l .0A load current if adequate heat sinking is provided.

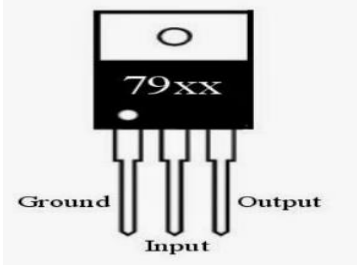
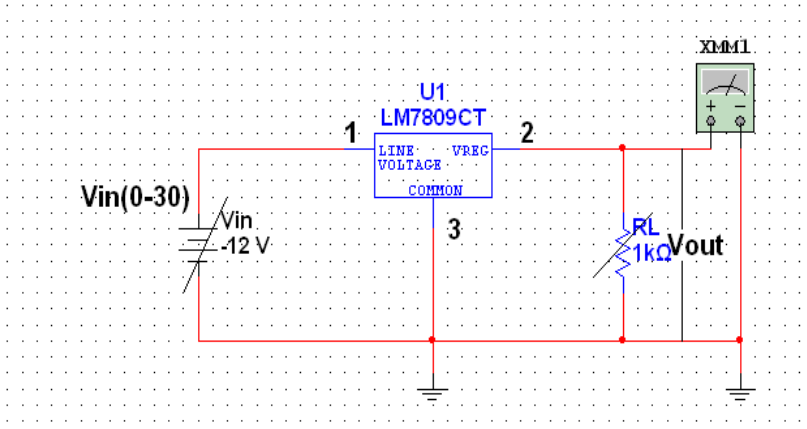


Figure 1 : negative voltage 79XX series IC

VII. Practical circuit diagram

c. Sample



d. Actual circuit diagram used in Laboratory with equipment specifications.

VIII. Required resources /apparatus/equipment with specifications.

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter : 3 1/2 digit display.	2 No.	5. Digital Multimeter with diode testing facilities will be preferred. 6. In place of Digital Multimeter, DC Voltmeter and DC ammeter can be used.
2.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1 No.	
3.	Bread board	5.5 CMX 17CM	1 No.	
4.	Resistor	1K(0.5watts/0.25watts)	1 No.	
5.	IC7905	Thermal, short circuit and safe area protection, High ripple rejection, 1.5A output current, 4% tolerance on preset output voltage	1 No.	
6	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	Connecting wires

IX. Precautions to be followed

4. Ensure proper connections are made to the equipment.
5. Ensure the power switch is in 'off' condition initially.
6. Ensure the polarity and appropriate range of multimeter

X. Procedure

1. Build circuit on breadboard as per circuit diagram.
2. Apply unregulated voltage to the circuit.
3. Measure input voltage with Digital Multimeter
4. Measure the negative output voltage with Digital Multimeter
5. Note down the output voltages at different stages of regulated power supply.

Sr no	Vin: input voltage (v)	Vo output voltage(v)
1	-1	
2	-2	
3	-3	
4	-4	
5	-5	
6	-6	
7	-7	
8	-8	
9	-9	
10	-10	

XI. Observation table.

XII. Results.

$$\text{Line Regulation} = \frac{\Delta V_o}{\Delta V_i} \cdot 100\%$$

Line regulation is ……

XIII. Interpretation of results.

XIV. Conclusion and recommendations

XV. Practical related questions

1. What is load regulation?
2. Repeat above practical for load regulation.

[Space for Answers]

XVI. References/suggestions for further readings

Voltage regulator PCB for LM317 LM337 or 78xx 79xx IC by ebay.com
Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
https:/lbw-server.com/voltage-regulators-stabi1izers-78xx-and-79xx
https://www.youtube.com/watch?v=mG9Jok1lTxU

Performance indicators	Weightage
Process related (15 Marks)	**60%**
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of Student Team Members

1. .....
2. .....
3. .....
4. .....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical no.28: Construct and test the performance of Dual voltage regulator using 78XX and 79XX, three terminals IC for given voltage.

I. Practical Significance

Three terminal voltage regulators i.e. 78xx and 79xx series ICs are most commonly used to build fixed voltage regulated power supply for various applications. 78xx and 79xx series ICs have built-in protection against a circuit drawing too much current. They have protection against overheating and short-circuits, making them robust in most applications. This practical will help the students to develop practical skills to build dual regulated power supply for appropriate output voltage

II Industry/Employer Expected outcomes

a. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
b. **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
c. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

Maintain electronic equipment/systems comprising of discrete electronic components.

III Course level learning outcomes (cos)

Maintain DC regulated power supply.

IV Laboratory learning outcomes.

Construct the circuit for Dual voltage regulator using 78XX and 79XX IC.
Calculate load and Line regulation.

V Relevant affective domain related outcomes.

d. Follow safe practices.
e. Demonstrate working as a leader/a team member.
f. Maintain tools and equipment

VI Relevant theoretical Background.

IC 78XX is series of positive voltage regulator and IC 79XX as a negative voltage regulator. Last two digits indicates the voltage value for example, the 7805 has a + 5-volt output, while the 7905 produces -5 volts. The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications.

The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation.

The LM79XX series of 3-terminal regulators is available with fixed output voltages of 5V, 8V, 12V, and 15V. These devices need only one external component, i.e. compensation capacitor at the output. The LM79XX series is packaged in the TO-220 power package and is capable of supplying 1.5A of output current

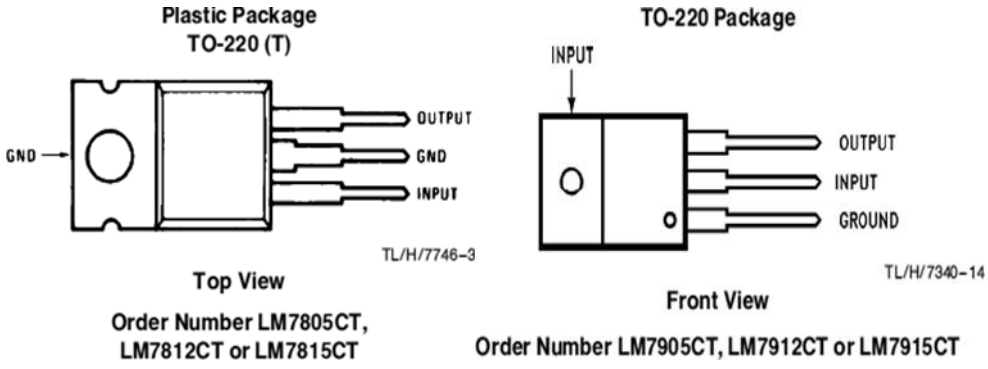


Figure 28.1 IC package

VII Practical circuit diagram

g. Sample

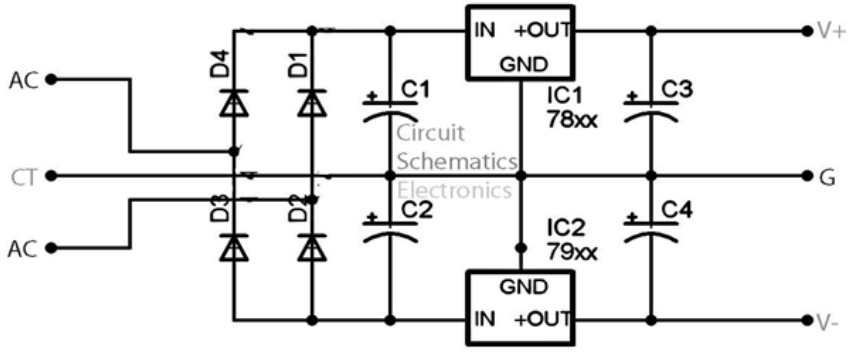


Figure 28.2 Dual Voltage Regulator

h. Actual circuit diagram used in Laboratory with equipment specifications.

VIII Required resources /apparatus/equipment with specifications

S. No.	Instrument/Component	Specification	Quantity	Remark
1.	IC 7805/ 7812/ 7815	Thermal, short circuit and safe area protection, High ripple rejection, 1.5A output current, 4% tolerance on preset output voltage	1 No.	
2.	IC 7905/ 7912/ 7915	Thermal, short circuit and safe area protection, High ripple rejection, 1.5A output current, 4% tolerance on preset output voltage	1 No.	
3.	Digital Multimeter	Digital Multimeter: 3 1/2 digit Display.	1 No.	
4.	PN junction Diode	1N4007or any other equivalent	4No.	
5.	Centre tapped Transformer	6-0-6 or 9-0-9 or l 2-0-12,	1 No.	
6.	Capacitors	lO00µF, 100 µF,	1 No.	
7.	Breadboard	5.5 cm X 17 cm	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

IX Precautions to be followed

- Ensure proper connections are made to the equipment.
- Ensure the power switch is in 'off' condition initially.
- Ensure the polarity and appropriate range of multimeter.

X Procedure

- Build circuit on breadboard as per circuit diagram.
- Apply unregulated voltage to the circuit.
- Measure input voltage with Digital Multimeter
- Measure output voltage with Digital Multimeter
- Note down the output voltages at different stages of dual regulated power supply.

XI Observation table

Table No: 28.1 Observation Table

Sr. No.	IC Used	Output DC Voltage
1.	7805	
2.	7905	

XII Results.

1. For 7805 the output DC voltage is …… (Positive/negative).
2. For 7905 the output DC voltage is …… (Positive/negative).

XIII Interpretation of results. (Give meaning of the above obtained results)

XIV Conclusion and recommendations (Actions/decisions to be taken based on the interpretation of results).

XV Practical related questions.

(**Note: Teacher shall assign batch wise additional one or two questions related to practical**)

1. Sketch the circuit of dual regulated power supply using IC 78XX and 79XX that will give output equals to+/- 20V
2. Refer the datasheet state the performance parameters ofIC 7812 and 7912.
3. Compare fixed and variable regulators?

[Space for Answers]

XVI References/suggestions for further readings

Voltage regulator PCB for LM317 LM337 or 78xx 79xx IC by ebay.com
Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
https:/lbw-server.com/voltage-regulators-stabi1izers-78xx-and-79xx
https://www.youtube.com/watch?v=mG9Jok1lTxU

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product related (10 Marks)		**40%**
5	Calculate theoretical values of given component	10%
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100%**

Names of Student Team Members

.

1. .....
2. .....
3. .....

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical no.29: Build and Test the performance of LOW voltage regulator using IC LM723 for given voltage.(2 V-7V).

I Practical Significance

Voltage regulators are used to compensate for voltage fluctuations in main power as well as load current variation .Voltage regulators are used in industries as well as in domestic applications such as Air Conditioners, TV Receivers and Refrigerators in order to protect them from fluctuating input voltage. In this practical students will able to sketch line and load regulation characteristics of given IC 723.

II Industry/Employer Expected outcomes

- Maintain electronic equipment/systems comprising of discrete electronic components

III Course level learning outcomes (cos)

- Maintain DC regulated power supply.

IV Laboratory learning outcomes

- Build LOW voltage regulator circuit using IC LM723 (2V- 7V).
- Calculate load and line regulation.

V Relevant affective domain related outcomes.

i. Follow safe practices.
j. Demonstrate working as a leader/a team member
k. Maintain tools and equipment.

VI Relevant theoretical Background.

IC 723 voltage regulator is commonly used for series voltage regulator applications. It can be used as low and high voltage regulator. The output voltage can be set to any desired positive voltage between 2 volt to 37volt. It is available in both Dual-In-Line and Metal Can packages.

Features of 723 Voltage Regulator

- 150 mA output current without external pass transistor
- Output currents of 10A is possible by adding external transistors
- Input voltage ranges from 9.5 to 40V.
- Output voltage adjustable from 2V to 37V

- 150 mA output current without external pass transistor
- Output currents of 10A is possible by adding external transistors
- Input voltage ranges from 9.5 to 40V.
- Output voltage adjustable from 2V to 37V

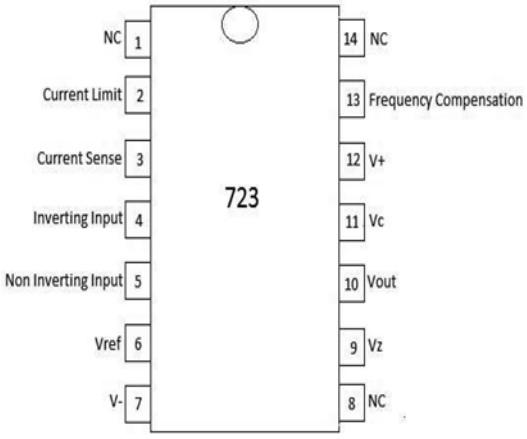


Figure: 29.1 Pin configuration of IC LM723

Block diagram of IC 723.

Includes, voltage reference source, error amplifier, a series pass transistor and a current limit transistor all are included in 14 pin DIP package. It has temperature compensated 6.2 V Zener, which is biased with constant current source. A reference voltage amplifier generates the precise reference voltage in between 6.8 to 7.5 V.

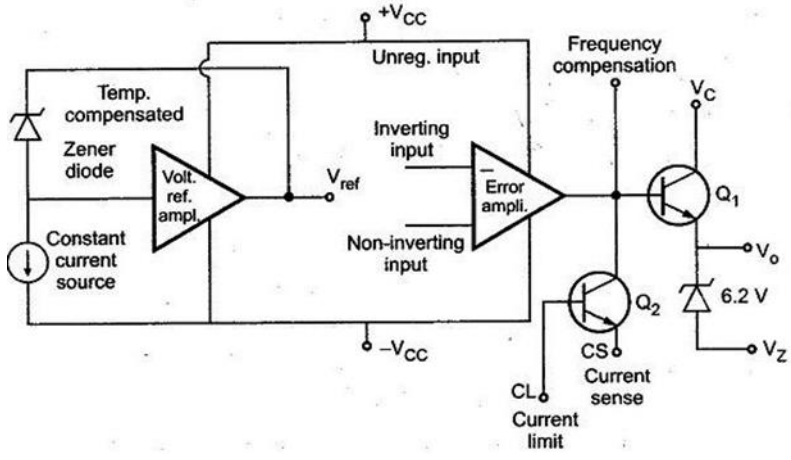


Figure 29.2: Block diagram of IC LM723

VII Practical Circuit diagram :

a. Sample

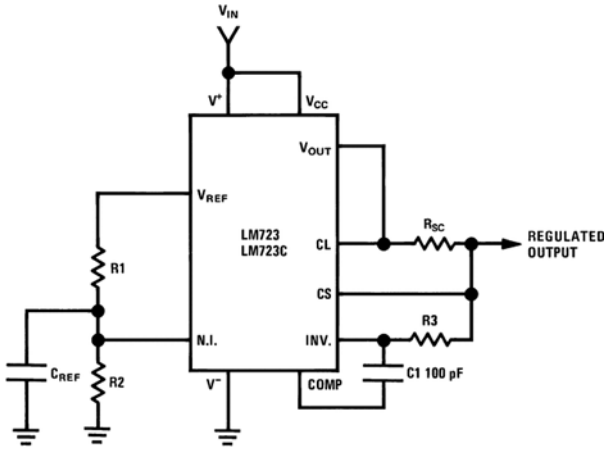


Figure 29.3: Circuit diagram of IC LM723

b. Actual circuit diagram used in Laboratory with equipment specifications.

VIII Required resources /apparatus/equipment with specifications.

S. No.	Instrument/Component	Specification	Quantity	Remark
1.	Digital Multimeter	Digital Multimeter: 3 1/2 digit Display.	1 No.	
2.	DC Power Supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current. Or output of rectifier -filter circuit	1 No.	
3.	Regulator IC	LM723	1 No.	
4.	Resistor	1.2K.Q, 560.Q, 3.9 K.Q,15 K.Q ,0.15.Q/5W,10K.Qvariable resistor	1 No. each	
5.	Capacitor	100 pF,100 Nf,	1 No. each	
6.	Breadboard	5.5 cm X 17 cm	1 No.	
7.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	Asper requirement	

IX. Precautions to be followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the polarity and appropriate range of multimeter.

X. Procedure

1. Build circuit on breadboard as per circuit diagram.
2. To find out line regulations vary the input voltage in steps keeping load constant.
3. Measure the output voltage.
4. To find out Load regulations vary the load in steps keeping input voltage constant.
5. Measure Output voltage.

XI. Observation table

Table 29.1: Measurement of V in and Vo for Line Regulation

RL = (to be kept constant)

Sr. No.	Input Voltage (Vin)	Output Voltage (Vo)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Table 29.2: Measurement of IL and Vo for Load Regulation

Vin= (to be kept constant)

Sr. No.	Load Current (IL)in mA	Output Voltage (Vo) in Volts
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Calculations:

i. Line Regulation = Vout/ Vin

ii. Load Regulation =

$$\% \text{ Regulation} = \frac{V_{no\text{-}load} - V_{full\text{-}load}}{V_{full\text{-}load}} \times 100$$

Where

$V_{no\text{-}load}$ is the no-load voltage and

$V_{full\text{-}load}$ is the full-load voltage.

XII. Results.

1. %Line Regulation =.....
2. %Load Regulation= .....

XIII. Interpretation of results. (Actions/decisions to be taken based on the interpretation of results).

XIV. Conclusion and recommendations

XV. Practical related questions

1. State the difference between low voltage and high voltage regulator?
2. List out various protection circuits used in regulator
3. State the significance of lead temperature rating of IC 723

[Space for Answers]

XVI. References/suggestions for further readings.

1. Voltage Regulator Circuit Manual by Robert J. Traister ,Publisher : Academic Presss
2. http://www.ti.com/lit/ds/symlink/lm723.pdf
3. https://www.youtube.com/watch?v=veXShWaCliA
4. https://www .youtube.com/watch?v=tNqT7vCDswk
5. https://www.youtube.com/watch?v=mG9Jok1lTxU

Performance indicators	Weightage
Process related (15 Marks)	**60%**
1 Handling of the components	10%
2 Identification of component	20%
3 Measuring value using suitable instrument	20%
4 Working in team	10%
Product related (10 Marks)	**40%**
5 Calculate theoretical values of given component	10%
6 Interpretation of result	05 %
7 Conclusions	05 %
8 Practical related questions	15 %
9 Submitting the journal in time	05%
Total (25 Marks)	**100%**

Names of Student Team Members

1. .....
2. .....
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	

Practical no. 30: Build and Test the performance of HIGH voltage regulator using IC LM723 for given voltage.(7V-30V)

I. Practical Significance

The LM723/LM723C is a voltage regulator designed primarily for series regulator applications. By itself, it will supply output currents up to 150 mA; but external transistors can be added to provide any desired load current. The circuit features extremely low standby current drain and provision is made for either linear or fold-back current limiting. The LM723/LM723C is also useful in a wide range of Regulator other applications such as a shunt regulator, a current regulator or a temperature control. This practical will help the students to develop practical skills to build high voltage regulator using IC 723.

II. Industry/Employer Expected outcomes

- Maintain electronic equipment/systems comprising of discrete electronic components.

III. Course level learning outcomes (cos)

- Maintain DC regulated power supply.

IV. Laboratory learning outcomes.

1. Build High voltage regulator circuit using IC LM723 (7V-30V)
2. Calculate load and line regulation.

V. Relevant affective domain related outcomes.

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipment

VI. Relevant theoretical Background.

The 723 voltage regulator is commonly used for series voltage regulator applications. It can be used as both positive and negative voltage regulator. LM723 IC can also be used as a temperature controller, current regulator or shunt regulator and it is available in both Dual-In- Line and Metal Can packages.

Features of 723 Voltage Regulator:-

- 150 mA output current without external pass transistor
- Output currents in excess of 10A possible by adding external transistors
- Input voltage ranges from 9.5 to 40V.
- Output voltage adjustable from 2V to 37V
- Can be used as either a linear or a switching regulator
- Reference voltage Vref = 6.8V to 7.5V.
- Line regulation= 0.5% Vo = 0.001%Vo.
- Load regulation 0.6% Vo= 0.003% Vo.
- Short circuit current limit Isc = 65mA at Rsc = 100 and Vo= 0.
- Quiescent current drain is 3.5mA, typically 1.3mA.

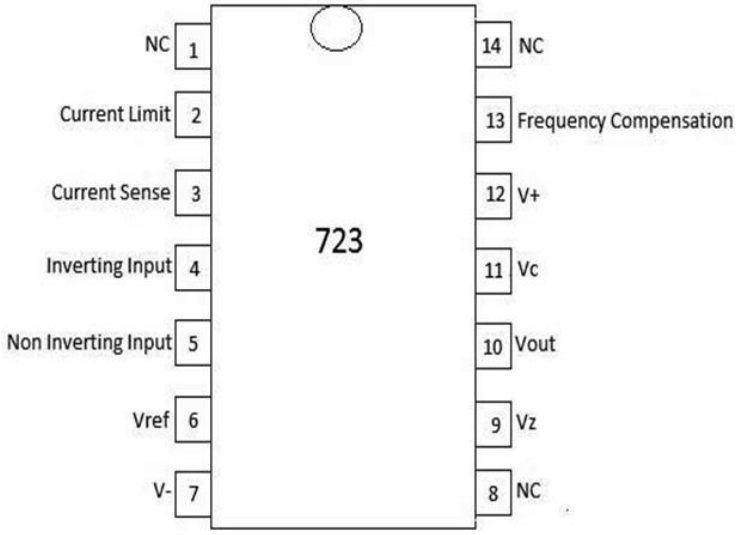


Figure 30.1: Pin configuration of IC LM723

Block diagram of IC 723.
Includes, voltage reference source, error amplifier, a series pass transistor and a current limit transistor all are included in 14 pin DIP package. It has temperature compensated 6.2 V Zener, which is biased with constant current source. A reference voltage amplifier generates the precise reference voltage in between 6.8 to 7.5 V. The output of error amplifier drives the series pass transistor Ql to give output voltage. Transistor Q2 is connected internally to provide short circuit current limiting.

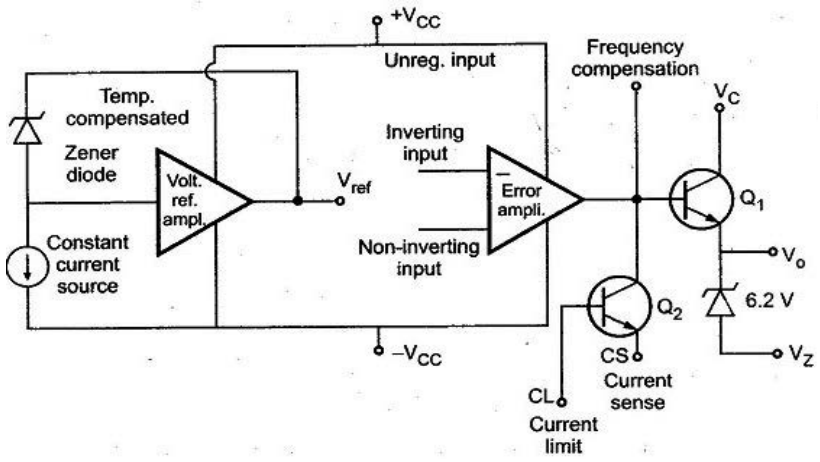
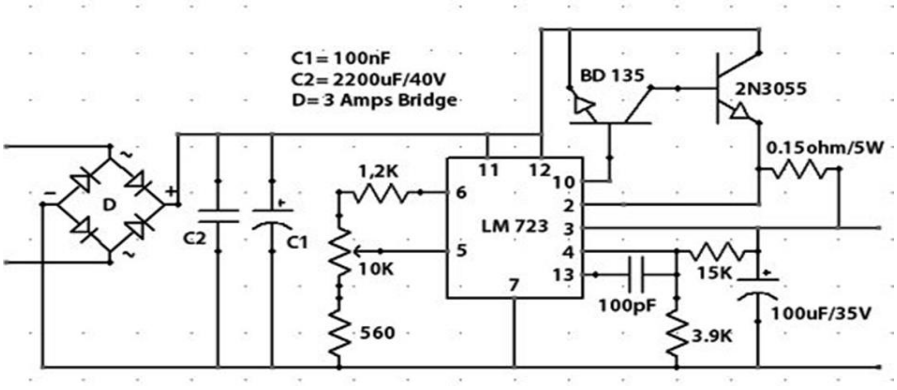


Figure 30.2: Block diagram of IC LM723

VII. Practical circuit diagram

a. Sample



b. Actual circuit diagram used in Laboratory with equipment specifications.

VIII. Required resources /apparatus/equipment with specifications.

S. No.	Instrument/Component	Specification	Quantity	Remark
1.	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	1 No.	
2.	DC Power Supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current. Or rectifier - filter output	1 No.	
3.	Regulator IC	LM 723	1 No.	
4.	Resistor	1.2KQ, 560Q, 3.9 KQ,10 Kn ,0.15Q/5W,10KQ variable resistor	1 No each	
5.	Capacitor	100 pF,100 Nf,100 µF,2200 µF.	1 No each	
6.	Breadboard	5.5 cmX 17 cm	1 No.	
7.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

1. Ensure proper connections are made to the equipment.

IX. Precautions to be followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off condition initially.
3. Ensure the polarity and appropriate range of multimeter

X. Procedure.

1. Build circuit on breadboard as per circuit diagram.
2. To find out line regulation vary the input voltage in steps keeping load constant.
3. Measure the output voltage.
4. To find out Load regulation vary the load in steps keeping input voltage constant.
5. Measure Output voltage

XI. Observation table

Measurement of V in and Vo for Line Regulation

RL = (to be kept constant)

Table 26.1: Measurement of Vin and Vo for Line Regulation

Sr. No.	Input Voltage (Vin) in Volts	Output Voltage (Vo) in Volts
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Table 30.2: Measurement ofIL and Vo for Load Regulation

Vin = (to be kept constant)

Sr. No.	Load Current (IL) in mA	Output Voltage (Vo) in Volts
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Calculations:

i. Line Regulation = Vout/ Vin

ii. Load Regulation =

$$\% \text{ Regulation} = \frac{V_{no\text{-}load} - V_{full\text{-}load}}{V_{full\text{-}load}} \times 100$$

Where

$V_{no\text{-}load}$ is the no-load voltage and

$V_{full\text{-}load}$ is the full-load voltage.

XII. Results.

%Line Regulation =.....

%Load Regulation= .....

XIII. Interpretation of results.(Give meaning of the above obtained results)

XIV. Conclusion and recommendations.(Actions/decisions to be taken based on the interpretation of results).

XV. Practical related questions

1. State the output voltage ranges for low voltage and high voltage regulator?
2. List the IC used as variable voltage regulator and fixed regulators
3. State equivalent IC's for adjustable voltage regulation.
4. Draw the metal can package ofIC 723.

[Space for Answers]

XVI. References/suggestions for further readings

Voltage Regulator Circuit Manual by Robert J. Traister ,Publisher : Academic Presss
http://www.ti.com/lit/ds/symlink/lm723.pdf
https://www.youtube.com/watch?v=veXShWaCliA
https://www.youtube.com/watch?v=tNqT7vCDswk
https://www.youtube.com/watch?v=mG9JoklITxU

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (l0)**	**Total (25)**	