GOVERNMENT POLTECHNIC DARBHANGA

Department of Electronics Engineering

2nd Semester:- Fundamentals of Electronics Engg. Lab Manual Subject Code [P2421102]

LIST OF EXPERIMENTS

S.NO.	Experiment Name
1.	V-I characteristics of Zener diode.
2.	Test the functionality of Half wave rectifier.
3.	Test the functionality of Full wave rectifier.
4.	Construct the power supply of +5V.
5.	Construct the power supply of -5V
6.	Identify the given transistor.
7.	Test the input and output characteristics of the CE amplifier.
8.	Test the input and output characteristics of the CC amplifier.

List of Major Laboratory Equipment, Tools and Software:

S. NO.	Name of Equipment, Tools, and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Oscilloscope	Dual Channel 20MHz	All
2.	Function generator	100MHz Function & Arbitrary Generator, 500MSa/s-DG4102	All
3.	Digital IC Trainer Kits	Power Supply: +5V, +/- 12V Display Type: 2 Digit BCD to Decimal Display	All
4.	Logic Gates and other ICs	Basic Gates, IC 7476, multiplexer, de-multiplexer, ADC, DAC IC's	13 to 23
5.	Bread Board	MB 102 Breadboard with Power Supply Module, Jumper Wires, Battery Clip,830 & 400 tie-Points	All
6.	Digital Multimeter	DM-86 Digital Multimeter AC Frequency Response: 40-400Hz Low Battery Display: Approx. < 7.5V	All
7.	IC Tester	□ Package: Digital ICs of 14, 16, 18,20,24,28 & 40 pins dual in line. □ Range: Tristate, Open Collector & Bidirectional TTL/CMOS ICs. □ Method: Truth table comparison. □ Sockets: 20 and 40 pin ZIF. □ Keyboard: 24 feather touch keys. □ Display: 16 digit 0.5" Seven segment LED display. □ Voltage: 230 volts + 10% 50Hz, AC.	All

Experiment:01

V-I characteristics of Zener diode

Aim

To study the **V–I characteristics** of a Zener diode and determine its **breakdown voltage (Vz)**.

Apparatus Required

- Zener Diode
- DC Power Supply
- Resistor (current limiting)
- Voltmeter
- Ammeter
- Breadboard / Trainer Kit
- Connecting Wires

Theory

A Zener diode is a special semiconductor device that allows current to flow:

- In **forward bias** like a normal diode
- In **reverse bias** after a certain voltage called **Zener breakdown voltage (Vz)**

In reverse bias:

- Current is very small initially
- At breakdown voltage, current increases sharply while voltage remains almost constant

This property is used for **voltage regulation**.

Circuit Diagram (Description for Drawing)

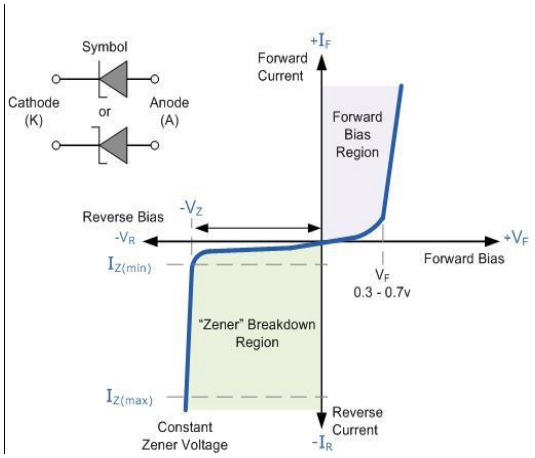
1. Forward Bias

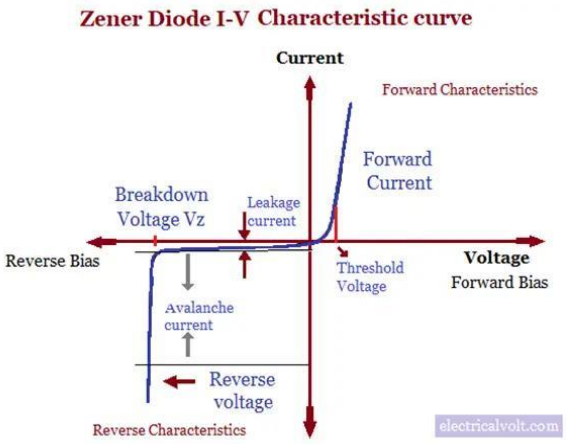
- Positive of supply → anode
- Negative → cathode
- Ammeter in series
- Voltmeter across diode

2. Reverse Bias

- Positive → cathode

- Negative → anode
- Same measurement setup





Procedure

A. Forward Bias

1. Connect circuit in forward bias
2. Increase voltage gradually
3. Note corresponding current
4. Record readings

B. Reverse Bias

1. Reverse diode connections
2. Increase voltage slowly
3. Observe small leakage current
4. At breakdown, current rises sharply
5. Record readings

Observation Table

Forward Bias

S. No	Voltage (V)	Current (mA)

Reverse Bias

S. No	Voltage (V)	Current (mA)

Graph

Plot two graphs:

1. **Forward Characteristics**
   - X-axis → Voltage
   - Y-axis → Current
   - Curve rises sharply after threshold
2. **Reverse Characteristics**
   - X-axis → Reverse Voltage
   - Y-axis → Reverse Current
   - Sharp rise at breakdown voltage

Key Point (Very Important ⋆)

- The point where reverse current increases suddenly is called **Zener Breakdown Voltage (Vz)**

Result

- Breakdown voltage of given Zener diode:
  Vz = _____ V

Precautions

- Always use a series resistor
- Increase voltage slowly
- Do not exceed rated current
- Check polarity carefully

Conclusion

The V–I characteristics confirm that the Zener diode maintains nearly constant voltage in breakdown region, making it useful for voltage regulation

Experiment:02

Test the functionality of Half wave rectifier.

Aim

To construct and test the functionality of a half-wave rectifier and observe its input and output waveforms.

Apparatus Required

- Diode (e.g., PN junction diode)
- Step-down transformer (230V to 6V/12V)
- Resistor (Load resistor RLR_LRL)
- CRO (Cathode Ray Oscilloscope)
- Breadboard / Circuit board
- Connecting wires

Theory

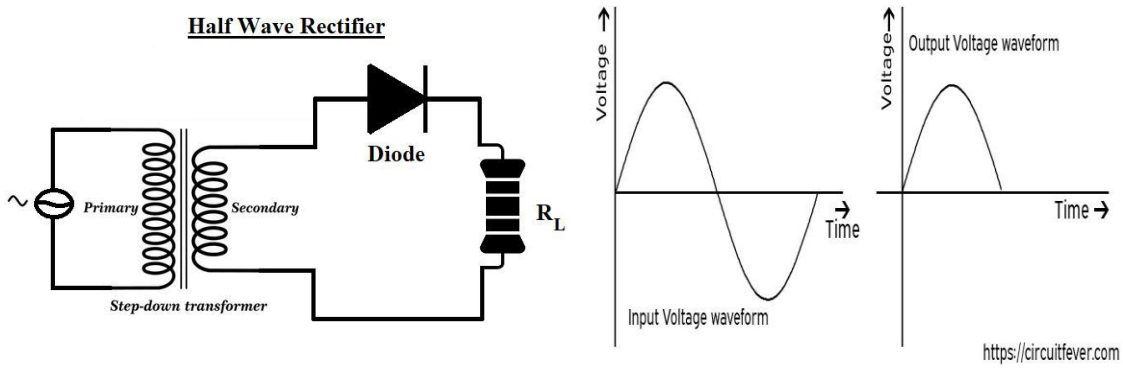
A half-wave rectifier converts **AC (Alternating Current)** into **pulsating DC** using a single diode.

- During **positive half cycle** → diode conducts → output appears
- During **negative half cycle** → diode blocks → no output

Thus, only one half of the AC waveform is allowed, producing a pulsating DC output.

Circuit Diagram (Explanation)

- Transformer secondary is connected to diode
- Diode is connected in series with load resistor
- Output is taken across load resistor



Procedure

1. Connect the circuit as per diagram.
2. Switch ON the AC supply.
3. Observe input waveform using CRO.
4. Observe output waveform across load resistor.
5. Note the shape and amplitude of waveforms.
6. Measure peak input and output voltages.

Observation Table

Parameter	Value
Input Voltage	_____ V
Output Voltage	_____ V
Frequency	_____ Hz

Waveforms

Input (AC waveform):

```
~ Sinusoidal wave (both +ve and -ve)
```

Output (Half-wave rectified):

```
Only positive half cycles appear
```

Key Formulae

- Average Output Voltage:

  $V_{dc} = \frac{Vm}{\pi}$

- RMS Value:

  $Vrms = \frac{Vm}{2}$

- Efficiency:

  η =40.6%

Result

The half-wave rectifier was successfully constructed and tested. The output waveform shows only the positive half cycles, confirming rectification.

Precautions

- Ensure correct diode polarity
- Avoid loose connections
- Use proper CRO calibration
- Do not exceed voltage ratings

Conclusion

The circuit works as expected, converting AC into pulsating DC using only one diode, but with low efficiency and high ripple.

Experiment:03

Test the functionality of Full wave rectifier.

Aim

To construct and test the functionality of a full-wave rectifier and observe its input and output waveforms.

Apparatus Required

- Diodes (2 for center-tapped / 4 for bridge rectifier)
- Step-down transformer (230V to 6V/12V)
- Load resistor RLR_LRL
- CRO (Cathode Ray Oscilloscope)
- Breadboard / Circuit board
- Connecting wires

Theory

A full-wave rectifier converts **AC into pulsating DC** by using both half cycles of the input signal.

- **Positive half cycle** → one set of diodes conducts
- **Negative half cycle** → another set conducts
- Output is always in the **same direction**

Hence, output frequency is **twice** the input frequency and ripple is reduced compared to half-wave rectifier.

Circuit Diagram (Explanation)

Two common types:

1. **Center-tapped rectifier** (2 diodes)
2. **Bridge rectifier** (4 diodes)

In exams, most common:
AC → diode network → load resistor → output across RL

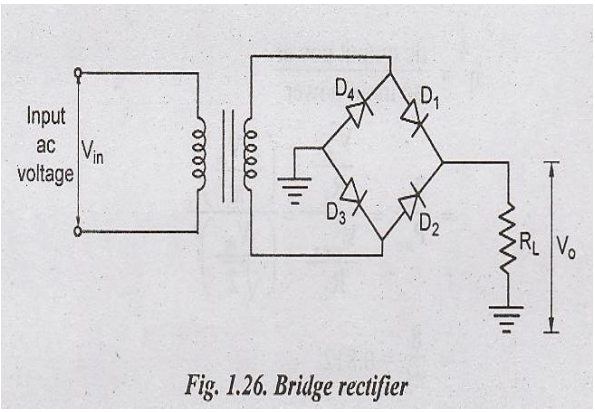
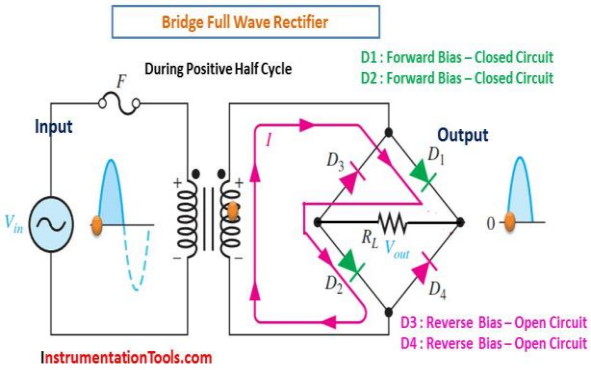


Fig. 1.26. Bridge rectifier



Procedure

1. Connect the circuit (bridge or center-tapped) properly.
2. Switch ON the AC supply.
3. Observe input waveform on CRO.
4. Observe output waveform across load resistor.
5. Measure peak input and output voltages.
6. Compare both waveforms.

Observation Table

Parameter	Value
Input Voltage	_____ V
Output Voltage	_____ V
Frequency	_____ Hz

Waveforms

Input (AC waveform):

```
~ Sinusoidal (positive and negative cycles)
```

Output (Full-wave rectified):

```
Both halves converted to positive pulses
(continuous pulsating DC)
```

Key Formulae

- Average Output Voltage:
- $V_{dc} = \frac{2Vm}{\pi}$

- RMS Value:
- Vrms = $\frac{Vm}{\sqrt{2}}$
- Efficiency:

  η = 81.2%

- Ripple Factor:

  r = 0.482

Result

The full-wave rectifier was successfully constructed and tested. The output waveform shows rectification of both half cycles, producing smoother DC compared to half-wave rectifier.

Precautions

- Check diode connections carefully
- Ensure correct transformer connections
- Avoid loose wiring
- Use proper CRO settings

Conclusion

The full-wave rectifier is more efficient and produces less ripple than a half-wave rectifier, making it more suitable for DC power applications.

Experiment:04

Construct the power supply of +5V

Aim

To design and construct a regulated **+5V DC power supply** using a rectifier, filter, and voltage regulator.

Apparatus Required

- Step-down transformer (230V AC to 9V/12V AC)
- Diodes (for bridge rectifier – 4 diodes or IC bridge)
- Capacitor (e.g., 1000µF, 25V)
- Voltage regulator IC 7805 voltage regulator
- Resistor (optional for load)
- LED (for output indication)
- Breadboard / PCB
- Connecting wires

Theory

A regulated +5V power supply converts **AC to stable DC** through three stages:

1. **Rectification** – converts AC to pulsating DC (using bridge rectifier)
2. **Filtering** – smoothens DC using capacitor
3. **Regulation** – maintains constant +5V using 7805 voltage regulator

The regulator ensures output remains **constant despite input fluctuations**.

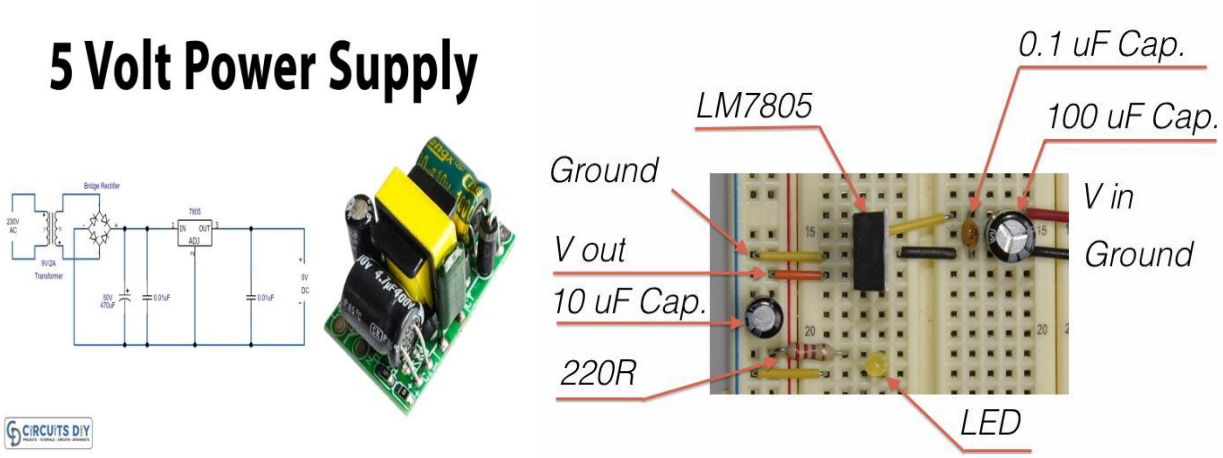
Block Diagram

AC Supply → Transformer → Rectifier → Filter → Regulator → +5V Output

Circuit Description

- Transformer steps down voltage to 9–12V AC
- Bridge rectifier converts AC to DC
- Capacitor reduces ripple
- 7805 voltage regulator gives fixed +5V output

Output is taken across regulator terminals.



Procedure

1. Connect transformer to AC mains.
2. Connect secondary to bridge rectifier.
3. Add capacitor across rectifier output.
4. Connect output to input pin of 7805 voltage regulator.
5. Connect ground and output pins properly.
6. Add LED (with resistor) at output for indication.
7. Switch ON supply.
8. Measure output voltage using multimeter.

Observation Table

Parameter	Value
Input AC Voltage	_____ V
Rectified Voltage	_____ V
Output Voltage	≈ 5V

Important Formula

Ripple Voltage:

$$Vr = \frac{I}{fc}$$

Output Waveform

- After rectifier → pulsating DC
- After filter → smooth DC
- After regulator → constant +5V

Result

The +5V regulated power supply was successfully constructed, and output voltage obtained was approximately **+5V DC**.

Precautions

- Ensure correct polarity of capacitor and regulator
- Avoid short circuit at output
- Use proper heat sink for regulator if needed
- Check all connections before switching ON

Conclusion

A stable +5V DC supply was obtained using rectification, filtering, and regulation. This circuit is widely used for powering digital electronics like microcontrollers.

Experiment:05

Construct the power supply of -5V

Aim

To design and construct a regulated **–5V DC power supply** using rectifier, filter, and voltage regulator.

Apparatus Required

- Step-down transformer (230V AC to 9V/12V AC)
- Diodes (4 for bridge rectifier)
- Capacitor (e.g., 1000µF, 25V)
- Voltage regulator IC 7905 voltage regulator
- Resistor (for load)
- LED (optional indicator)
- Breadboard / PCB
- Connecting wires

Theory

A –5V power supply provides a **regulated negative voltage**. It works in three stages:

1. **Rectification** – converts AC to pulsating DC
2. **Filtering** – smoothens the DC using capacitor
3. **Regulation** – maintains constant **–5V** using 7905 voltage regulator

Unlike +5V, the polarity is reversed (negative with respect to ground).

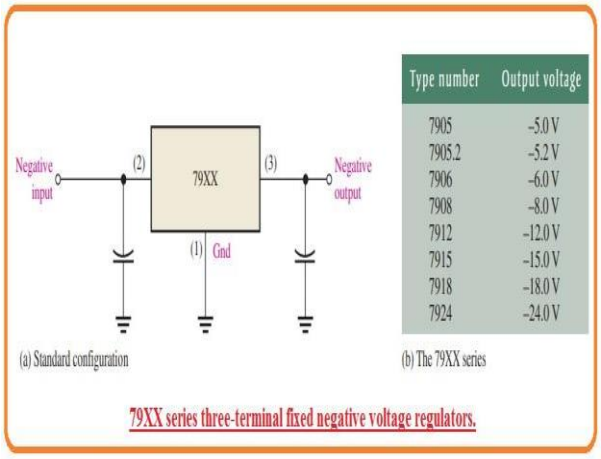
Block Diagram

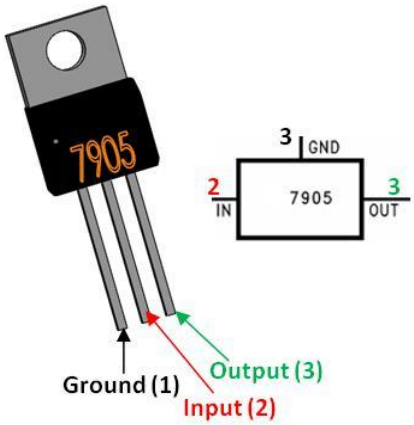
AC Supply → Transformer → Rectifier → Filter → Regulator → –5V Output

Circuit Description

- Transformer steps down AC voltage
- Bridge rectifier converts AC to DC
- Filter capacitor smoothens the ripple
- 7905 voltage regulator produces **–5V output**

Output is taken between **ground and negative terminal**.





Procedure

1. Connect transformer to AC supply.
2. Connect secondary to bridge rectifier.
3. Connect capacitor across rectifier output (observe polarity).
4. Connect input pin of 7905 voltage regulator.
5. Connect ground and output pins properly.
6. Add load resistor or LED (optional).
7. Switch ON the supply.
8. Measure output voltage using multimeter (should be ≈ –5V).

Observation Table

Parameter	Value
Input AC Voltage	_____ V
Rectified Voltage	_____ V
Output Voltage	≈ –5V

Important Formula

Ripple Voltage

$$Vr = \frac{I}{fc}$$

Waveforms

- After rectifier → pulsating DC
- After filter → smoother DC
- After regulator → constant –5V

Result

The –5V regulated power supply was successfully constructed and tested. The output obtained is approximately **–5V DC**.

Precautions

- Ensure correct polarity of capacitor (very important)
- Connect regulator pins correctly
- Avoid short circuits
- Use heat sink if regulator heats up

Conclusion

A stable –5V DC supply was obtained using rectification, filtering, and regulation. This is useful in analog circuits, op-amp applications, and dual power supplies.

Experiment:06

Identify the given transistor.

Aim

To identify the type of the given transistor (NPN or PNP) and determine its terminals (**Emitter, Base, Collector**).

Apparatus Required

- Given transistor (unknown)
- Multimeter (Digital/Analog)
- Connecting probes

Theory

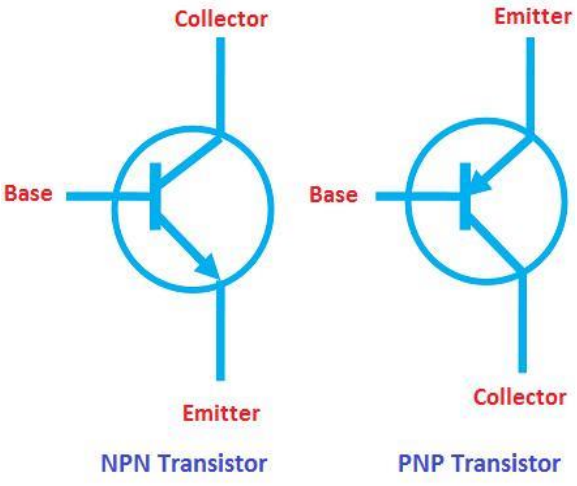
A transistor is a three-terminal semiconductor device:

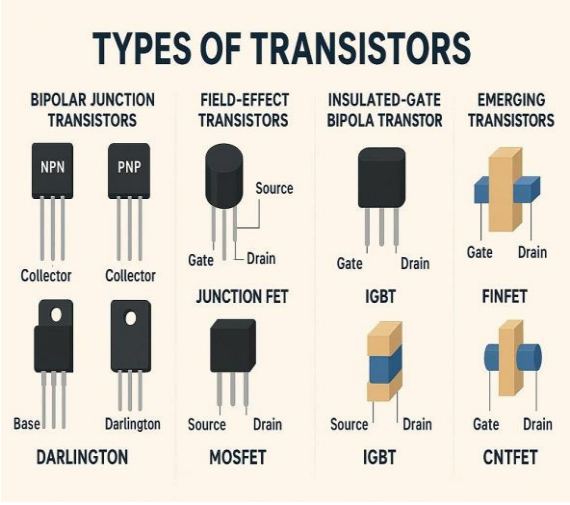
- **Emitter (E)**
- **Base (B)**
- **Collector (C)**

A transistor behaves like **two PN junctions**:

- Base–Emitter junction
- Base–Collector junction

Identification is based on **junction testing using a multimeter (diode mode)**.





Identification Method

Step 1: Find the Base Terminal

1. Set multimeter to **diode mode**.
2. Place one probe on a terminal and check continuity with the other two.
3. If current flows in **both directions (with one fixed probe)** → that terminal is **Base**.

Step 2: Identify NPN or PNP

- If conduction occurs when:
  - **Red probe on Base** → transistor is **NPN**
- If conduction occurs when:
  - **Black probe on Base** → transistor is **PNP**

Step 3: Identify Collector and Emitter

- Measure voltage drop:
  - **Emitter–Base junction** has slightly **lower voltage drop**
  - **Collector–Base junction** has slightly **higher voltage drop**

Lower drop → **Emitter**
Higher drop → **Collector**

Observation Table

Terminal Pair	Reading (V)	Inference
B–E	____	
B–C	____	

Result

- Type of transistor: **NPN / PNP**
- Terminals identified as:
  - Emitter → _____
  - Base → _____
  - Collector → _____

Precautions

- Do not apply high voltage
- Ensure proper multimeter settings
- Avoid touching terminals with fingers
- Check readings carefully

Conclusion

The given transistor was successfully identified by testing its PN junction characteristics using a multimeter.

Experiment:07

Test the input and output characteristics of the CE amplifier.

Aim

To study and plot the **input and output characteristics** of a **Common Emitter (CE) amplifier**.

Apparatus Required

- Transistor (NPN, e.g., BC547)
- Resistors (for biasing and load)
- DC power supply
- Signal generator
- CRO (Cathode Ray Oscilloscope)
- Ammeter, Voltmeter / Multimeter
- Breadboard and wires

Theory

In a **Common Emitter (CE) amplifier**:

- Input is applied between **Base–Emitter**
- Output is taken between **Collector–Emitter**

It provides:

- **High voltage gain**
- **Moderate current gain**
- **Phase inversion (180°)** between input and output

Circuit Description

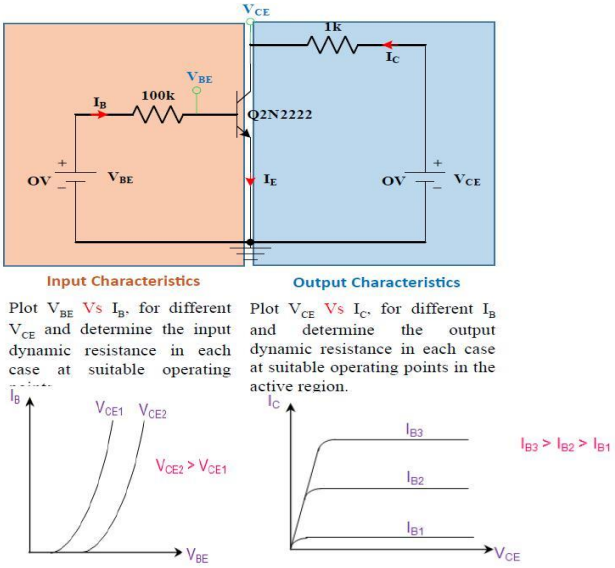
- Base is biased using resistor network
- Input signal applied to base
- Output taken from collector
- Emitter is grounded

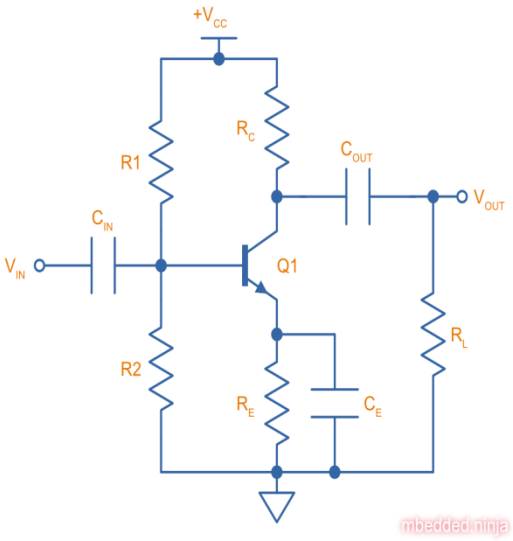
Procedure

A. Input Characteristics (I_B vs V_{BE})

1. Keep **collector-emitter voltage (V_{CE}) constant**.

2. Vary **base-emitter voltage (V_{BE})**.
3. Measure corresponding **base current (I_B)**.
4. Tabulate readings.
5. Plot graph: **I_B vs V_{BE}**.





B. Output Characteristics (I_C vs V_{CE})

1. Keep **base current (I_B) constant**.
2. Vary **collector-emitter voltage (V_{CE})**.
3. Measure corresponding **collector current (I_C)**.
4. Repeat for different values of I_B.
5. Plot graph: **I_C vs V_{CE}**.

Observation Tables

Input Characteristics

V_{BE} (V)	I_B(µA)

Output Characteristics

V_{CE} (V)	I_C (mA)	I_B = const

Graphs

Input Characteristic (Diode-like curve)

I_B vs V_{BE}

Shows exponential increase like a PN junction diode.

Output Characteristic

I_C vs V_{CE}

Regions observed:

- **Cut-off region**
- **Active region (used for amplification)**
- **Saturation region**

Key Parameters

- **Input Resistance:**

  Rin = $\frac{V_{BE}}{I_B}$

- **Output Resistance:**

  Rout = $\frac{V_{CE}}{I_C}$

- **Current Gain:**

  β = $\frac{I_C}{I_B}$

Result

The input and output characteristics of the CE amplifier were plotted successfully. The transistor operates properly in **cut-off, active, and saturation regions**.

Precautions

- Maintain proper biasing
- Do not exceed voltage/current limits
- Ensure correct transistor connections
- Take readings carefully

Conclusion

The CE amplifier shows **good amplification in the active region** with high gain and phase inversion, making it widely used in electronic circuits.

Experiment:08

Test the input and output characteristics of the CC amplifier.

Aim

To study and plot the **input and output characteristics** of a **Common Collector (CC) amplifier**.

Apparatus Required

- Transistor (NPN, e.g., BC547)
- Resistors (biasing and load)
- DC power supply
- Signal generator
- CRO (Cathode Ray Oscilloscope)
- Ammeter and Voltmeter / Multimeter
- Breadboard and connecting wires

Theory

In a **Common Collector (CC) amplifier**:

- Input is applied between **Base–Collector**
- Output is taken between **Emitter–Collector**
- Collector is common to both input and output

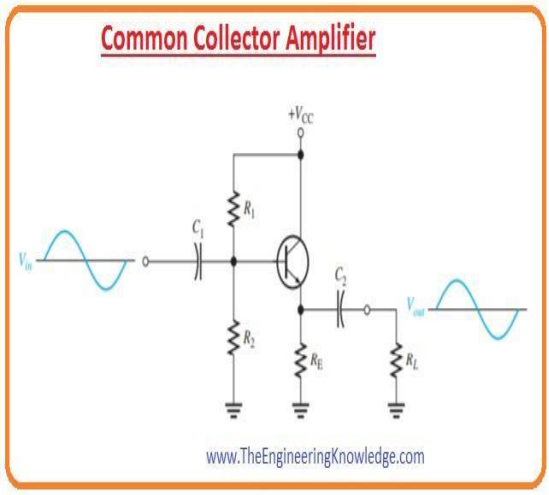
Key features:

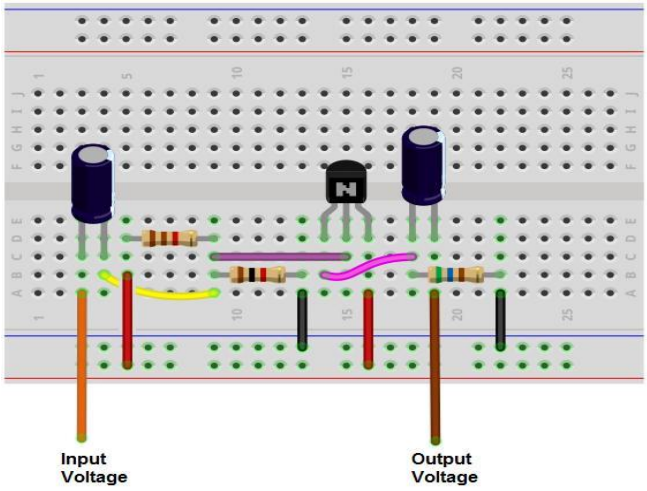
- **High input resistance**
- **Low output resistance**
- **Voltage gain ≈ 1**
- **No phase inversion**

It is mainly used as a **buffer amplifier**.

Circuit Description

- Base is biased using resistors
- Input signal applied to base
- Output taken from emitter
- Collector connected to supply





Procedure

A. Input Characteristics (I_B vs V_{BC})

1. Keep **emitter voltage (V_{EC}) constant**.
2. Vary **base-collector voltage (V_{BC})**.
3. Measure corresponding **base current (I_B)**.
4. Tabulate readings.
5. Plot graph: **I_B vs V_{BC}**.

B. Output Characteristics (I_E vs V_{EC})

1. Keep **base current (I_B) constant**.
2. Vary **emitter-collector voltage (V_{EC})**.
3. Measure corresponding **emitter current (I_E)**.
4. Repeat for different values of I_B.
5. Plot graph: **I_E vs V_{EC}**.

Observation Tables

Input Characteristics

V_{BC} (V)	I_B (µA)

Output Characteristics

V_{EC}(V)	I_E (mA)	I_B = const

Graphs

Input Characteristic

I_B vs V_{BC}

Shows diode-like behavior.

Output Characteristic

I_E vs V_{EC}

Nearly linear; indicates low output resistance.

Key Parameters

- **Input Resistance:**

Rin = $\frac{V_{BC}}{I_B}$

- **Output Resistance:**

  Rout = $\frac{V_{EC}}{I_E}$

- **Current Gain:**

  $\gamma = \frac{I_E}{I_B}$

Result

The input and output characteristics of the CC amplifier were plotted successfully. The amplifier shows **high input impedance and low output impedance**.

Precautions

- Ensure correct transistor connections
- Maintain constant biasing conditions
- Avoid excessive current/voltage
- Take accurate readings

Conclusion

The CC amplifier acts as an **emitter follower** with unity voltage gain and is widely used for **impedance matching and buffering applications**.