GOVERNMENT POLTECHNIC DARBHANGA

Department of Electronics Engineering

3rd Semester:- Electronic Devices and Circuits

Lab Manual

subject code [P2021307]

LIST OF EXPERIMENTS

S.NO.	Experiment Name
1	Construct the circuit and plot the VI characteristics of the PN Junction Diode, find the cut in voltage
2	Construct the circuit and plot the characteristics of a Zener Diode. Find the breakdown voltage
3	Construct a Half Wave Rectifier and obtain regulation characteristics – Without Filters and with Filters. Compare the results
4	Construct a Full Wave Rectifier and obtain regulation characteristics – Without Filters and with Filters. Compare the results
5	Construct a Bridge Rectifier and obtain regulation characteristics – Without Filters and with Filters
6	Obtain the characteristics of DIAC and TRIAC
7	Simulate half wave, full wave and bridge rectifier using simulation tool like PSpice/ Orcad/ Multisim.
8	Develop a simulation model for Voltage Series and Voltage Shunt Feedback Amplifiers
9	Develop circuits for Voltage Series and Voltage Shunt Feedback Amplifiers and obtain output plots. Compare the results with the simulation model.
10	Develop a simulation model for Current Series and Current Shunt Feedback Amplifiers
11	Develop circuits for Current Series and Current Shunt Feedback Amplifiers and obtain output plots. Compare the results with the simulation model

List of Major Laboratory Equipment, Tools and Software:

S. NO.	Name of Equipment, Tools, and Software	Broad Specifications	Relevant Experiment/Practical Number
1	C.R.O	Dual Channel 100MHz	ALL
2	Function generator	100MHz Function & Arbitrary Generator, 500MSa/s-DG4102	ALL
3	Dual Power supply	Digital Dual Output DC Power Supply, Input Voltage: 230 V Ac, Output Voltage: 0 To 128 V	ALL
4	Bread Board	MB 102 Breadboard with Power Supply Module, Jumper Wires, Battery Clip,830 & 400 tie-Points	ALL
5	Digital Multimeter	DM-86 Digital Multimeter AC Frequency Response: 40-400Hz Low Battery Display: Approx. < 7.5V	ALL

Experiment:01

Construct the circuit and plot the VI characteristics of the PN Junction Diode, find the cut in voltage

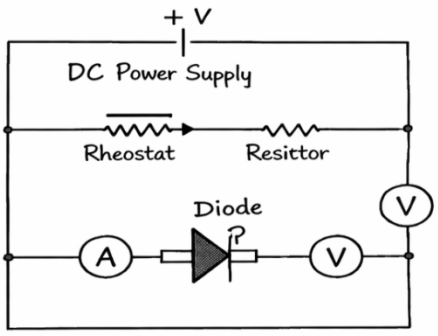
Aim

To construct the circuit and plot the **V–I characteristics** of a PN junction diode and determine its **cut-in voltage**.

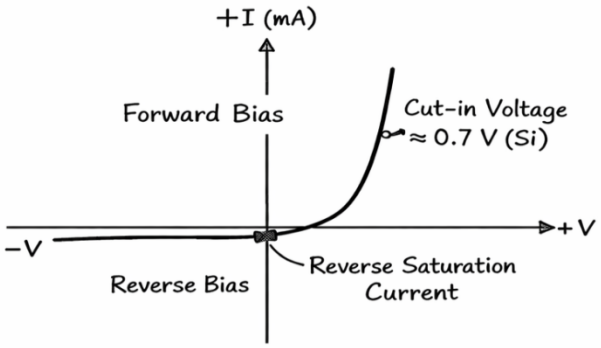
Apparatus Required

- PN Junction Diode
- DC Power Supply
- Ammeter (mA range)
- Voltmeter (0–5V)
- Resistor (1kΩ approx.)
- Breadboard & connecting wires

Circuit Diagram



Forward Bias Circuit Diagram



V-I Characteristics of PN Junction Diode

Procedure

Forward Bias

1. Connect the circuit in **forward bias** (P to +ve, N to –ve).
2. Increase supply voltage gradually.
3. Note down voltage (V) and current (I).
4. Record readings until current increases rapidly.

Reverse Bias

1. Reverse the diode connections.
2. Apply voltage slowly.
3. Measure **reverse current** (very small).
4. Note readings until breakdown (if allowed).

Observation Table

Forward Bias

Voltage (V)	Current (mA)
0.1	0
0.2	0
0.3	0
0.5	small
0.7	increases
0.8	rapid rise

Reverse Bias

Voltage (V)	Current (µA)
1	small
5	very small

Graph

- Plot **Voltage (V)** on X-axis
- Plot **Current (I)** on Y-axis

Curve shape:

- Forward: Exponential rise
- Reverse: Almost flat (small current)

Key Concept (Diode Equation)

$$I = Is\ (\frac{V}{e\eta V_T} - 1)$$

Cut-in Voltage (Knee Voltage)

- It is the voltage at which current starts increasing rapidly.
- Also called **threshold voltage**.

Typical Values:

- Silicon diode ≈ **0.7 V**
- Germanium diode ≈ **0.3 V**

Result

- The V–I characteristics of PN junction diode were plotted successfully.
- The **cut-in voltage** is found to be approximately:

0.7 V (for Silicon diode)

Precautions

- Do not exceed diode current rating
- Take readings carefully
- Ensure correct polarity
- Use proper range meters

Experiment:02

Construct the circuit and plot the characteristics of a Zener Diode. Find the breakdown voltage

Aim

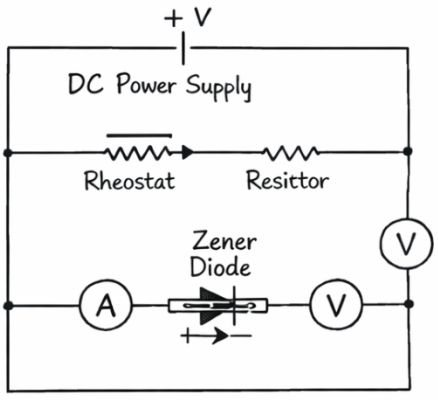
To construct the circuit and plot the **V–I characteristics of a Zener diode** and determine its **breakdown voltage**.

Apparatus Required

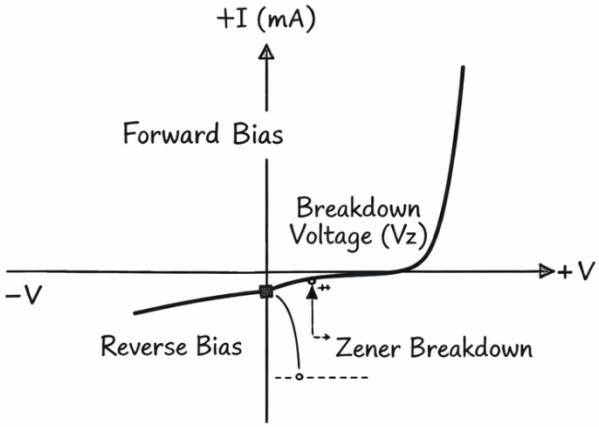
- Zener Diode
- DC Power Supply
- Resistor (≈1kΩ)
- Ammeter (mA range)
- Voltmeter
- Breadboard & wires

Circuit Diagram

.



Reverse Bias Circuit Diagram



V-I Characteristics of Zener Diode

Procedure

Forward Bias

1. Connect Zener in forward bias.
2. Increase voltage slowly.
3. Note voltage and current readings.
4. Observe behavior like normal diode.

Reverse Bias (Main Part)

1. Reverse the Zener diode connections.
2. Increase supply voltage gradually.
3. Measure voltage across diode and current.
4. At a certain voltage, current increases suddenly.
5. Note this voltage carefully.

Observation Table

Forward Bias

Voltage (V)	Current (mA)
0.2	0
0.5	small
0.7	increases

Reverse Bias

Voltage (V)	Current (mA)
2	very small
4	small
5	sudden rise
5.1	large

Graph

- X-axis → Voltage (V)
- Y-axis → Current (I)

Shape:

- Forward → same as PN diode
- Reverse → sharp vertical rise after breakdown

Zener Breakdown Condition

VZ = constant (in breakdown region)

Breakdown Voltage

- The voltage at which reverse current increases sharply is called **Zener Breakdown Voltage (Vz)**.

Typical Value:

- Example Zener diode ≈ **5.1 V**

Result

- The V–I characteristics of the Zener diode were plotted.
- The **breakdown voltage (Vz)** is found to be approximately:

Vz ≈ 5.1 V

Precautions

- Always use a **series resistor** to limit current
- Do not exceed power rating of Zener
- Take readings slowly and carefully
- Ensure correct polarity in reverse bias

Experiment:03

Construct a Half Wave Rectifier and obtain regulation characteristics – Without Filters and with Filters. Compare the results

Aim

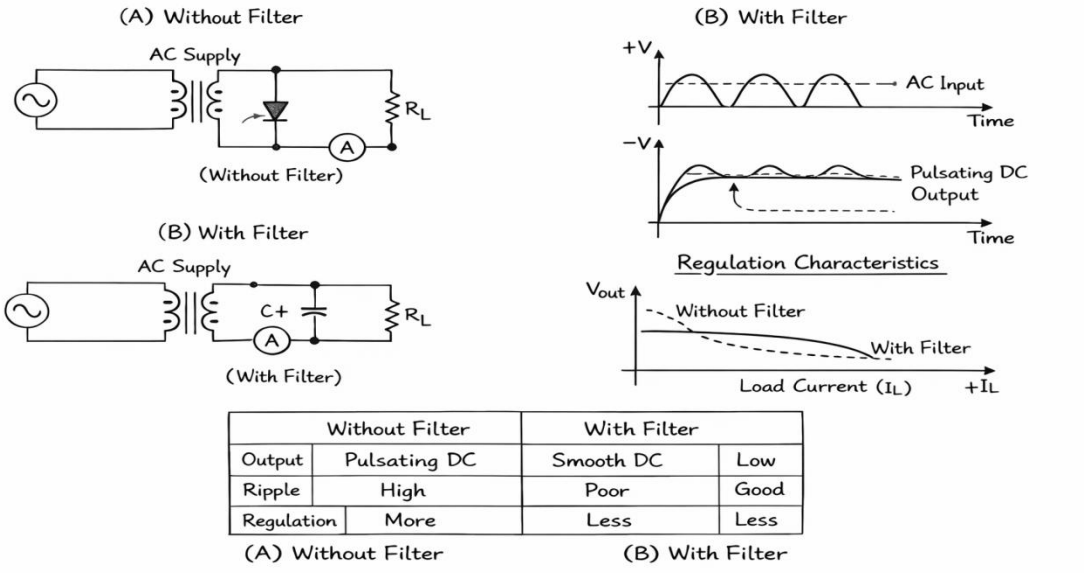
To construct a **Half Wave Rectifier** and obtain **regulation characteristics**:

- Without filter
- With filter (capacitor)
  And compare the results.

Apparatus Required

- Transformer (step-down)
- Diode
- Resistor (load RLR_LRL)
- Capacitor (filter)
- AC supply
- Voltmeter
- Ammeter
- Breadboard & wires

Circuit Diagram



	Without Filter	With Filter	
Output	Pulsating DC	Smooth DC	Low
Ripple	High	Poor	Good
Regulation	More	Less	Less

(A) Without Filter (B) With Filter

Procedure

Without Filter

1. Connect half wave rectifier circuit.
2. Apply AC input.
3. Measure output DC voltage across load.
4. Vary load resistance (or current).
5. Note voltage and current readings.

With Filter

1. Add capacitor across load RLR_LRL.
2. Repeat the above steps.
3. Record voltage and current.

Observation Table

Without Filter

Load Current (mA)	Output Voltage (V)
Low	High
Medium	Drops
High	More drop

With Filter

Load Current (mA)	Output Voltage (V)
Low	Nearly constant
Medium	Slight drop
High	Less variation

Graph

- X-axis → Load Current
- Y-axis → Output Voltage

Draw two curves:

- Without filter → steep drop
- With filter → flatter curve

Voltage Regulation Formula

% Regulation = $\frac{V_{NL}-V_{FL}}{V_{FL}}$

Where:

- V_{NL} = No-load voltage
- V_{FL} = Full-load voltage

Theory (Short for Exam)

- A **Half Wave Rectifier** converts AC to pulsating DC using one diode.
- Output contains **ripples**.
- A **capacitor filter** smooths the output by storing charge and reducing ripple.

Comparison of Results

Parameter	Without Filter	With Filter
Output Voltage	Low & fluctuating	Higher & smoother
Ripple	High	Low
Regulation	Poor	Improved
Efficiency	Lower	Better

Result

- Half wave rectifier constructed successfully.
- **Without filter:** Output is pulsating and poorly regulated.
- **With filter:** Output is smoother with better regulation.

Hence, **filter improves voltage regulation and reduces ripple**.

Precautions

- Check diode polarity
- Ensure proper grounding
- Do not exceed capacitor voltage rating
- Take accurate readings

Experiment:04

Construct a Full Wave Rectifier and obtain regulation characteristics – Without Filters and with Filters. Compare the results

Aim

To construct a **Full Wave Rectifier** and obtain **regulation characteristics**:

- Without filter
- With filter (capacitor)
  And compare the results.

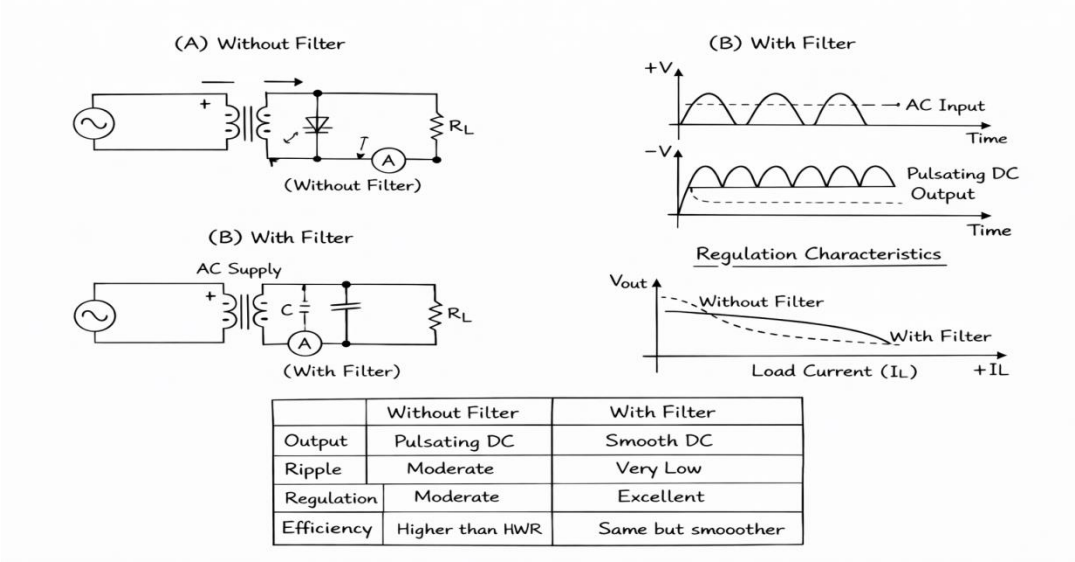
Apparatus Required

- Step-down Transformer (center-tapped or bridge type)
- Diodes (2 for center-tap / 4 for bridge)
- Load resistor RLR_LRL
- Capacitor (filter)
- AC supply
- Voltmeter, Ammeter
- Breadboard & wires

Circuit Diagram

Full Wave Rectifier (Without Filter)

(Bridge Type – commonly used in lab)



	Without Filter	With Filter
Output	Pulsating DC	Smooth DC
Ripple	Moderate	Very Low
Regulation	Moderate	Excellent
Efficiency	Higher than HWR	Same but smoother

Procedure

Without Filter

1. Connect full wave rectifier circuit.
2. Apply AC input.
3. Measure output voltage across RLR_LRL.
4. Vary load current.
5. Record voltage readings.

With Filter

1. Connect capacitor across load.
2. Repeat measurements.
3. Observe smoother output voltage.

Observation Table

Without Filter

Load Current (mA)	Output Voltage (V)
Low	High
Medium	Decreases
High	Drops more

With Filter

Load Current (mA)	Output Voltage (V)
Low	Nearly constant
Medium	Slight drop
High	Small variation

Graph

- X-axis → Load Current
- Y-axis → Output Voltage

Draw two curves:

- Without filter → noticeable drop
- With filter → flatter curve (better regulation)

Voltage Regulation Formula

% Regulation = $\frac{V_{NL}-V_{FL}}{V_{FL}}$X 100

Theory (Short & Important)

- A **Full Wave Rectifier** converts both halves of AC into DC.
- Output frequency = **2 × input frequency** → less ripple than half wave.
- Capacitor filter smooths output by charging & discharging.

Comparison of Results

Parameter	Without Filter	With Filter
Output Voltage	Pulsating DC	Smooth DC
Ripple	Moderate	Very low
Regulation	Better than HWR	Best
Efficiency	High (~81%)	Improved further

Result

- Full wave rectifier constructed successfully.
- **Without filter:** Output has ripple and moderate regulation.
- **With filter:** Output becomes smooth and well regulated.

Full wave rectifier gives **better performance than half wave**, especially with filter

Precautions

- Check diode connections carefully
- Ensure capacitor polarity
- Use proper rating components
- Avoid short circuits

Experiment:05

Construct a Bridge Rectifier and obtain regulation characteristics – Without Filters and with Filters

Aim

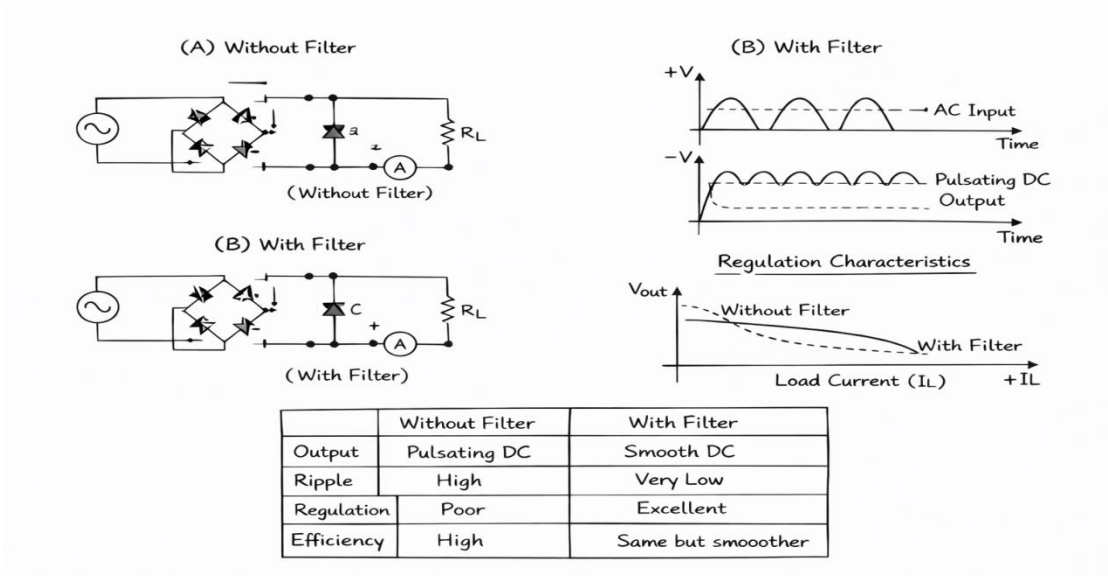
To construct a **Bridge Rectifier** and study regulation characteristics:

- **Without filter**
- **With filter**

Apparatus Required

- Transformer (step-down)
- 4 Diodes (for bridge)
- Capacitor (filter)
- Load resistor (RL)
- Voltmeter
- Ammeter
- CRO (optional)
- Connecting wires

Circuit Diagram



	Without Filter	With Filter
Output	Pulsating DC	Smooth DC
Ripple	High	Very Low
Regulation	Poor	Excellent
Efficiency	High	Same but smoother

(A) Without Filter

- AC → Transformer → **Bridge (4 diodes)** → Load resistor

(B) With Filter

- Same circuit + **capacitor connected across load (parallel)**

Working Principle

Without Filter

- During positive half cycle → two diodes conduct
- During negative half cycle → other two diodes conduct
- Output is **pulsating DC (full-wave)**

With Filter

- Capacitor charges to peak voltage
- Discharges slowly through load
- Output becomes **smooth DC**

Procedure

Step 1: Without Filter

1. Construct bridge rectifier circuit.
2. Apply AC supply.
3. Measure output voltage for different load currents.
4. Record readings.

Step 2: With Filter

1. Connect capacitor across load.
2. Repeat readings.
3. Observe improved output.

Regulation Characteristics

Formula

Voltage Regulation = $\frac{V_{NL}-V_{FL}}{V_{FL}}$X 100

Where:

- V_{NL} = No-load voltage
- V_{FL} = Full-load voltage

Graph

- X-axis → Load Current (IL)
- Y-axis → Output Voltage (Vout)

Observations

Without Filter

- Output is pulsating DC
- Ripple present
- Voltage drops with load

With Filter

- Output is smooth DC
- Ripple reduced significantly
- Voltage remains nearly constant

Comparison Table

Parameter	Without Filter	With Filter
Output	Pulsating DC	Smooth DC
Ripple	High	Very Low
Regulation	Poor	Excellent
Efficiency	High	Same but smoother

Result

The bridge rectifier was constructed and tested.

With filter gives better regulation and smoother output than without filter.

Precautions

- Check correct diode connections (bridge formation)
- Ensure capacitor polarity
- Use proper ratings
- Avoid short circuits

Experiment:06

Obtain the characteristics of DIAC and TRIAC

Aim

To obtain the V–I characteristics of:

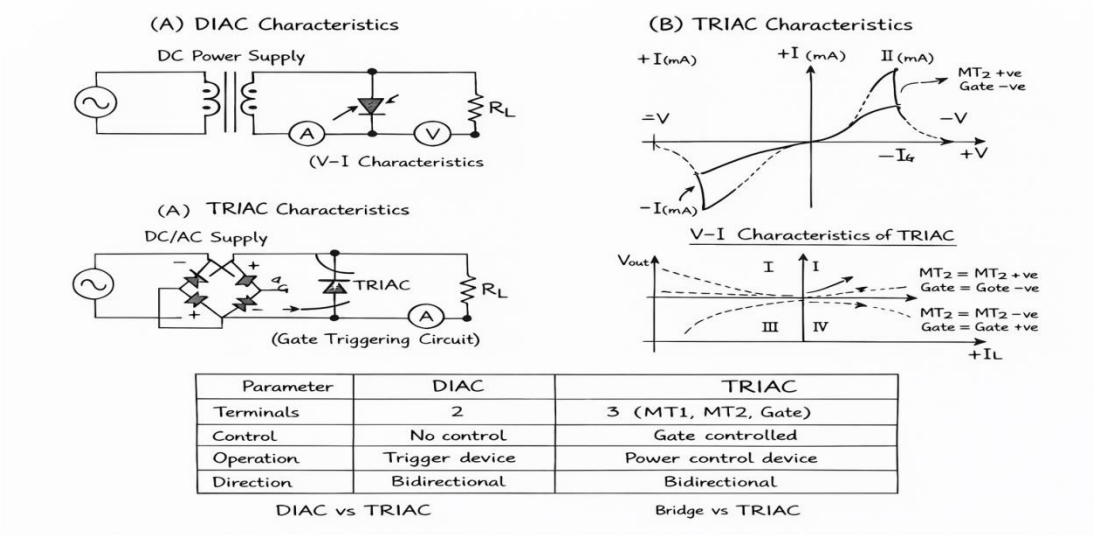
- **DIAC**
- **TRIAC**

Part A: DIAC Characteristics

Apparatus Required

- DIAC
- DC Power Supply
- Voltmeter
- Ammeter
- Resistor
- Connecting wires

Circuit Description



Parameter	DIAC	TRIAC
Terminals	2	3 (MT1, MT2, Gate)
Control	No control	Gate controlled
Operation	Trigger device	Power control device
Direction	Bidirectional	Bidirectional

DIAC vs TRIAC Bridge vs TRIAC

- DIAC connected in series with resistor
- Voltmeter across DIAC
- Ammeter in series

Working Principle

- DIAC conducts in **both directions**
- No conduction until **breakover voltage (VBO)**
- After VBO → sudden increase in current

Procedure

1. Connect circuit.
2. Increase voltage gradually.
3. Note voltage and current.
4. Repeat for both polarities.

Graph (V–I Characteristics)

- Symmetrical curve in **1st and 3rd quadrants**
- Sharp conduction after breakover

Result (DIAC)

Breakover voltage observed at ≈ **30–40 V** (typical)

Part B: TRIAC Characteristics

Apparatus Required

- TRIAC
- DC/AC Supply
- Gate triggering circuit
- Voltmeter
- Ammeter
- Resistor

Circuit Description

- TRIAC in series with load
- Gate terminal used for triggering

Working Principle

- Conducts in **both directions**
- Triggered by **gate signal**
- Operates in **four quadrants**

Procedure

1. Connect circuit with gate supply.
2. Apply voltage.
3. Trigger gate at different currents.
4. Observe conduction behavior.

Graph (V–I Characteristics)

Key Features

- Symmetrical in both directions
- Controlled conduction using gate
- Latching behavior

Quadrant Operation

1. **Quadrant I** → MT2 +ve, Gate +ve
2. **Quadrant II** → MT2 +ve, Gate –ve
3. **Quadrant III** → MT2 –ve, Gate –ve
4. **Quadrant IV** → MT2 –ve, Gate +ve

Result (TRIAC)

TRIAC conducts after gate triggering in both directions and shows symmetrical characteristics.

Comparison: DIAC vs TRIAC

Parameter	DIAC	TRIAC
Terminals	2	3 (MT1, MT2, Gate)
Control	No control	Gate controlled
Operation	Trigger device	Power control device
Direction	Bidirectional	Bidirectional

Precautions

- Do not exceed voltage ratings
- Use proper gate current (TRIAC)
- Take readings carefully

Experiment:07

Simulate half wave, full wave and bridge rectifier using simulation tool like PSpice/ Orcad/ Multisim.

Aim

To simulate and analyze:

- Half Wave Rectifier
- Full Wave Rectifier
- Bridge Rectifier

using simulation tools like
PSpice,
OrCAD, or
Multisim

1. Half Wave Rectifier Simulation

Circuit Components

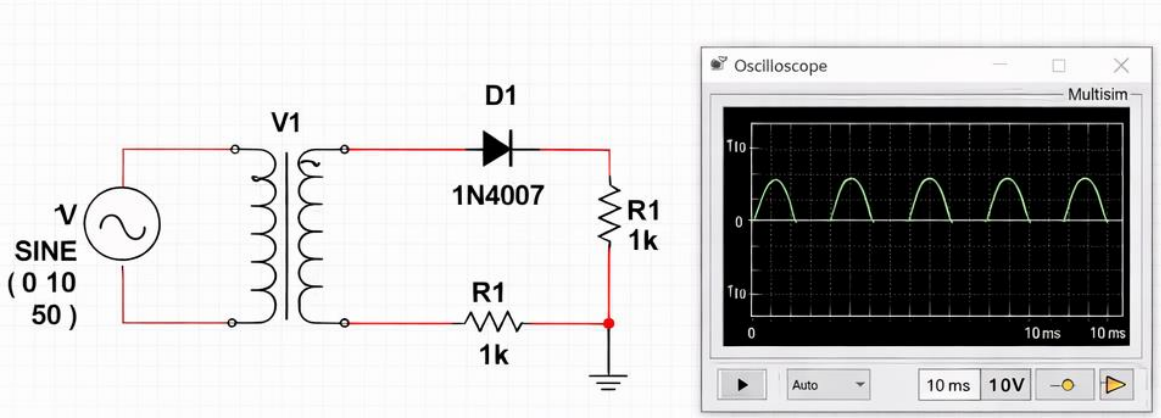
- AC Source (e.g., 10V peak, 50 Hz)
- Diode
- Load Resistor (RL)

Open simulation software.

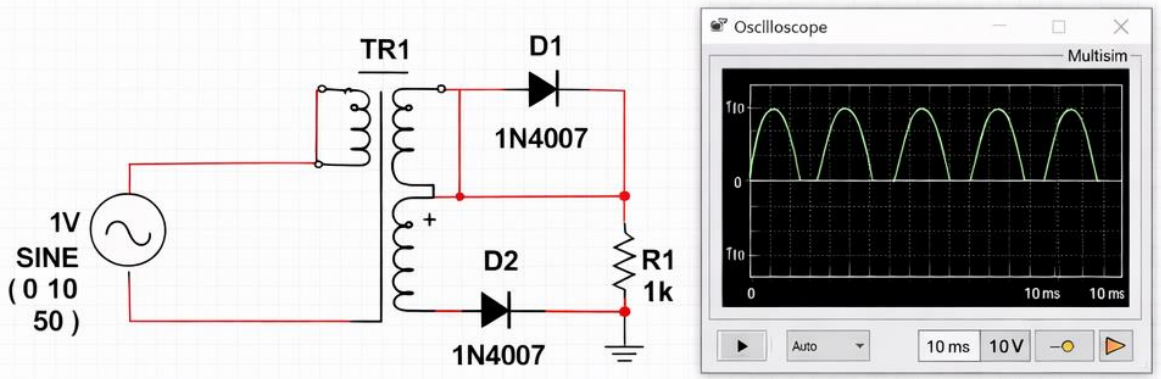
1. Place AC source, diode, and resistor.
2. Connect in series.
3. Add ground.
4. Run transient analysis.
5. Observe waveform on CRO/graph.

Output

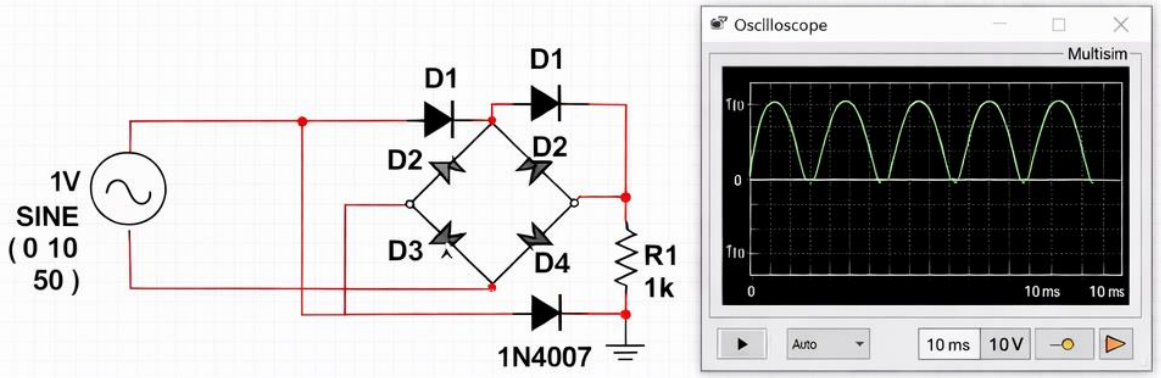
- Only **positive half cycles appear**
- Output is **pulsating DC**



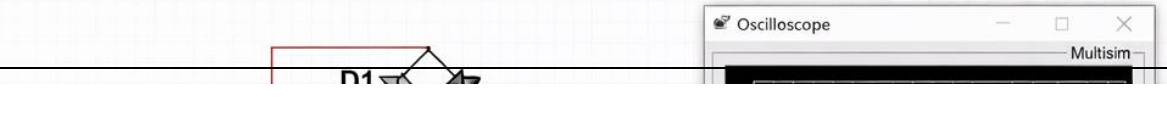
HALF WAVE RECTIFIER



FULL WAVE RECTIFIER



BRIDGE RECTIFIER



2. Full Wave Rectifier Simulation (Center-Tapped)

Components

- Center-tapped transformer
- 2 diodes
- Load resistor

Procedure

1. Place transformer with center tap.
2. Connect two diodes.
3. Connect load resistor.
4. Run simulation.

Output

- Both half cycles converted to DC
- Ripple frequency = **2 × input frequency**

3. Bridge Rectifier Simulation

Components

- AC Source
- 4 Diodes (Bridge)
- Load resistor

Procedure

1. Arrange 4 diodes in bridge form.
2. Connect AC input across bridge.
3. Connect load across output.
4. Run simulation.

Output

- Full wave output
- Smoother than half wave

Waveform Observations

Rectifier Type	Output Waveform
Half Wave	Half sine pulses
Full Wave	Full sine pulses
Bridge	Full sine pulses

With Filter (Optional Simulation)

- Add capacitor across load
- Output becomes smoother
- Ripple decreases

Comparison

Parameter	Half Wave	Full Wave	Bridge
Efficiency	Low	Medium	High
Ripple	High	Medium	Low
Output	Pulsating	Better	Smooth

Result

All rectifiers were successfully simulated using the software.

Bridge rectifier gives the **best output (least ripple and highest efficiency)**.

Conclusion

- Half wave → simplest but inefficient
- Full wave → better output
- Bridge → best performance

Experiment:08

Develop a simulation model for Voltage Series and Voltage Shunt Feedback Amplifiers

Aim

To develop and simulate:

- **Voltage Series Feedback Amplifier**
- **Voltage Shunt Feedback Amplifier**

using tools like
PSpice,
OrCAD, or
Multisim

1. Voltage Series Feedback Amplifier (Series–Shunt)

Theory

- Feedback is **voltage sampled** from output
- Feedback signal is **connected in series** with input
- Increases input impedance, decreases gain

Circuit Components

- Transistor (BJT CE configuration)
- Resistors (biasing + feedback resistor)
- Capacitors (coupling + bypass)
- AC signal source

Circuit Description

- Output voltage is taken across collector resistor
- A portion is fed back to **input in series** using feedback resistor (Rf)

Simulation Steps

1. Open **Multisim** (or PSpice).
2. Place BJT (e.g., BC547).
3. Add biasing resistors (R1, R2, Rc, Re).
4. Connect feedback resistor from **collector to base**.

5. Apply AC input.
6. Run AC analysis / transient analysis.

Expected Output

- Reduced gain
- Improved stability
- Less distortion

2. Voltage Shunt Feedback Amplifier (Shunt–Shunt)

Theory

- Output voltage sampled
- Feedback applied **in parallel (shunt)** with input
- Reduces input impedance and gain

Circuit Components

- BJT transistor
- Load resistor
- Feedback resistor
- Signal source

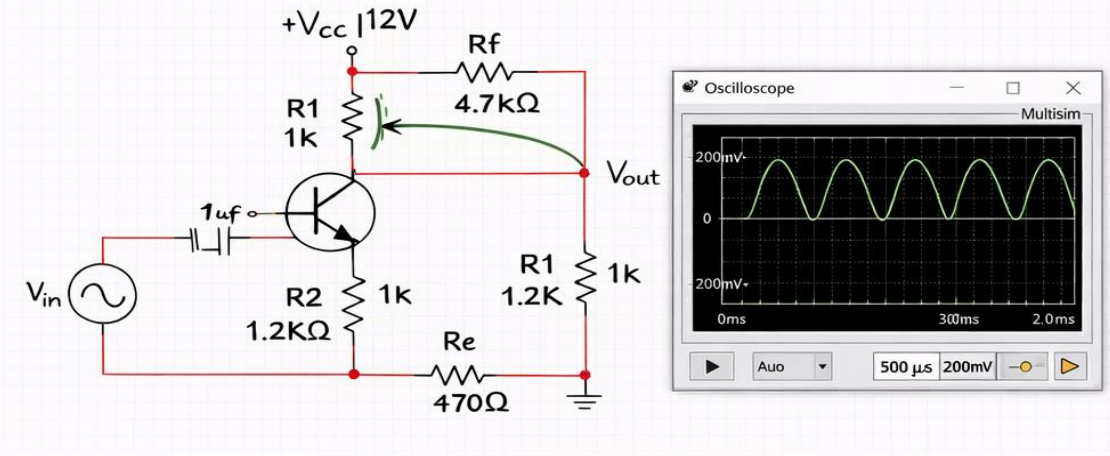
Circuit Description

- Feedback resistor connected from output to input **in parallel**
- Input current modified by feedback

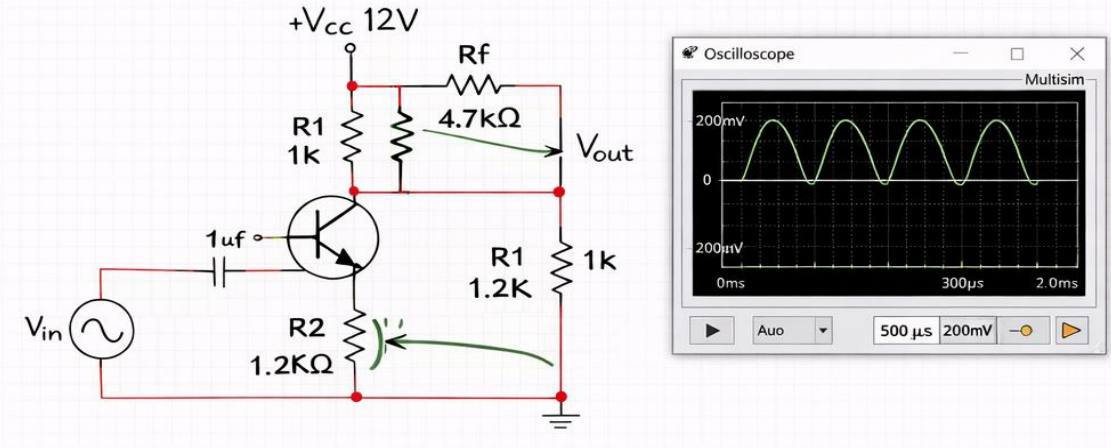
Simulation Steps

1. Place transistor and components.
2. Connect feedback resistor from output to input node.
3. Apply input signal.
4. Run simulation.

Voltage Series Feedback Amplifier (Series–Shunt)



VOLTAGE SERIES FEEDBACK AMPLIFIER (SHUNT–SHUNT)



	Voltage Series	Voltage Shunt
Feedback Type	Series	Shunt
Input Impedance	High	Low
Gain	Reduced	Reduced
Stability	High	High

Comparison:

- Voltage Series – used when high input impedance required

Expected Output

- Lower gain
- Improved bandwidth
- Better stability

Waveform Observation

- Compare input and output signals
- Observe phase shift (CE amplifier → 180° phase shift)
- Notice reduced amplitude due to feedback

Comparison

Parameter	Voltage Series	Voltage Shunt
Feedback Type	Series	Shunt
Input Impedance	High	Low
Gain	Reduced	Reduced
Stability	High	High

Result

Both feedback amplifiers were successfully simulated.

Feedback improves **stability, bandwidth, and reduces distortion**.

Conclusion

- Voltage series → used when **high input impedance** required
- Voltage shunt → used when **current control** needed