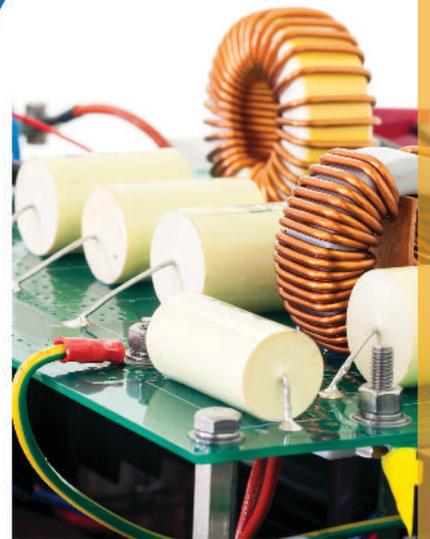
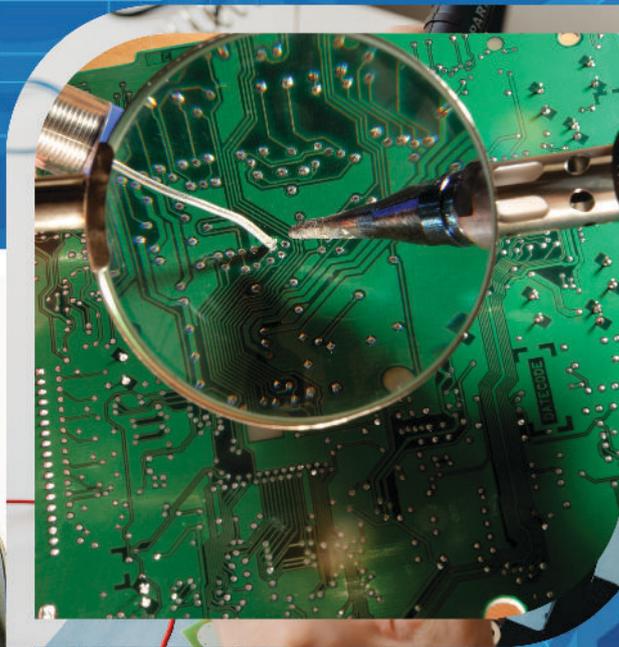


# BASIC

## DC POWER SUPPLY



Norhafiza binti Sharom  
Fauziah binti Aliman  
Lian Ai Chen

# BASIC

# DC POWER SUPPLY

**Norhafiza binti Sharom**

**Fauziah binti Aliman**

**Lian Ai Chen**

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Special thanks go to our families and friends for their patience and understanding during the countless hours we dedicated to this project. Your encouragement and belief in us kept us motivated.

Thank you

# PREFACE



**T**his e-book on Basic DC Power Supply covers the fundamental principles of designing DC power supply circuits. It is organized into five key components: Transformer, Rectifier, Filter, Regulator, and Voltage Divider. The e-book stands out for its clear and concise text, designed to be easily understood and referenced by students and readers. It includes illustrations that relate directly to the topics discussed, providing a visual context to enhance comprehension.

We hope this e-book proves to be a valuable resource for students and general readers alike, contributing to a deeper understanding of DC power supplies.



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# Introduction

DC Power Supply

# Introduction to DC Power Supply

---



# WHAT

IS DC  
POWER  
SUPPLY

**GET ANSWER**



# Introduction to DC Power Supply

---

A DC power supply converts alternating current (AC) from the mains into direct current (DC) suitable for powering electronic devices. It typically consists of several key components, including a transformer, rectifier, filter, voltage regulator, and voltage divider.

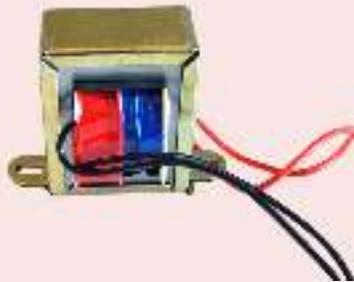


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# Components of a DC Power Supply

---

AC Input -> Transformer -> Rectifier -> Filter -> Voltage Regulator -> Voltage Divider -> DC Output



Transformer



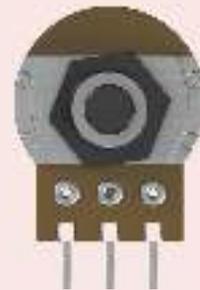
Rectifier



Filter



Voltage Regulator



Voltage Divider

# Components of a DC Power Supply

---

## Transformer

Steps down the input AC voltage to a lower level suitable for rectification.

## Rectifier

Converts AC to pulsating DC by allowing current to flow in one direction only. Common rectifier types include diode bridges or more complex rectifier circuits.

## Filter

Smooths the pulsating DC output from the rectifier, reducing ripple voltage and making the output more stable.

## Voltage Regulator

Ensures that the output voltage remains constant despite fluctuations in input voltage or load changes. This can be achieved through various types of voltage regulation circuits, such as linear regulators or switching regulators.

## Voltage Divider

Divides DC voltage to several voltages

1. What is the function of a DC Power Supply?
2. Identify the function of a voltage regulator in DC Power Supply.
3. Based on Figure 1, name the block of 'P' and 'R'.

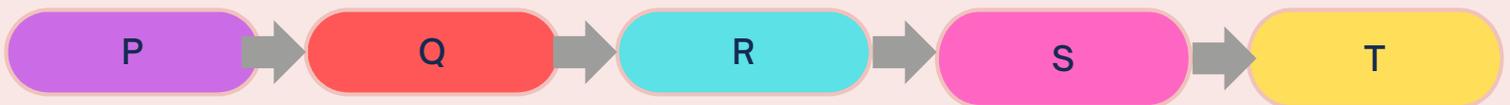


Figure 1



# Tutorial Answer

---

1. The function of a DC Power Supply is to convert alternating current (AC) from the mains into direct current (DC)
2. The voltage regulator is used to maintain the DC output voltage.
3. 'P' is transformer and 'R' is filter.





**Block 1**

---



# Transformer

DC Power Supply

---



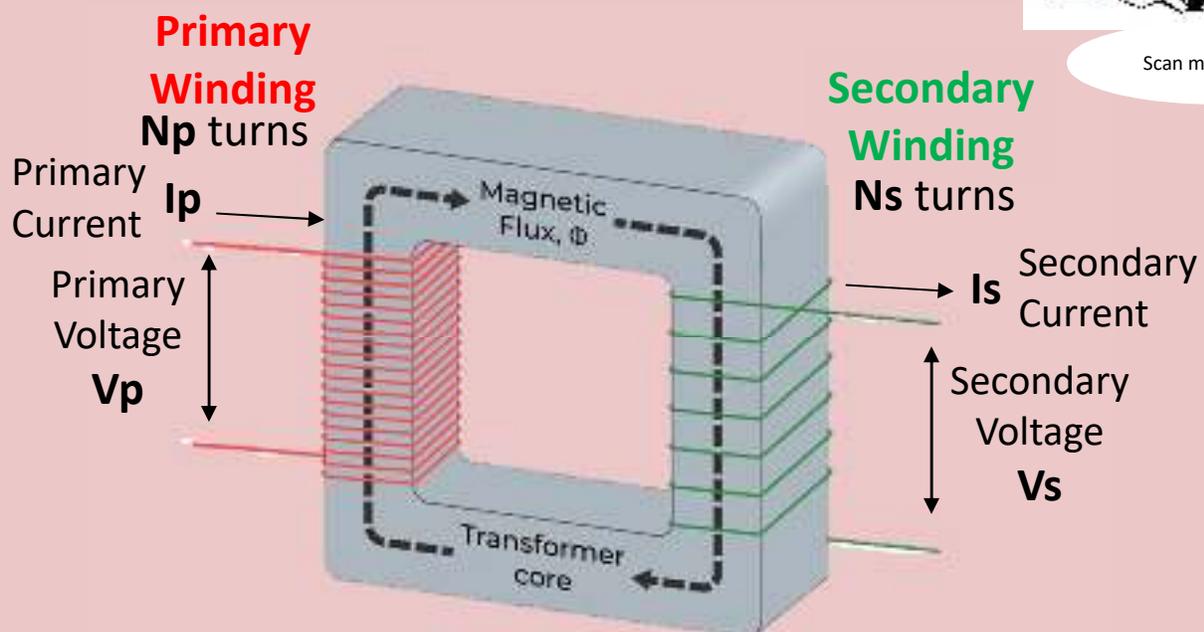
# Transformer

A basic transformer is defined as a passive electrical device constructed of two coils of wire (winding) magnetically coupled that transfers electrical energy from one coil to another through the process of electromagnetic induction.

It is most commonly used to increase ('step up') or decrease ('step down') voltage levels between circuits



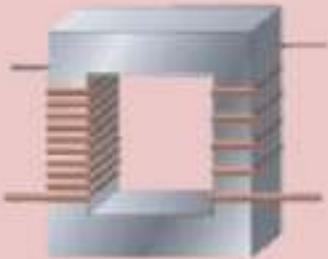
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# Transformer

---

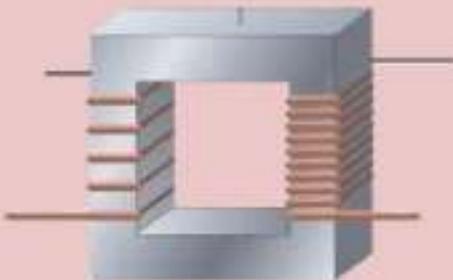
## Step-down



## Operation

A transformer that decreases voltage between the primary to secondary windings is defined as a step-down transformer.

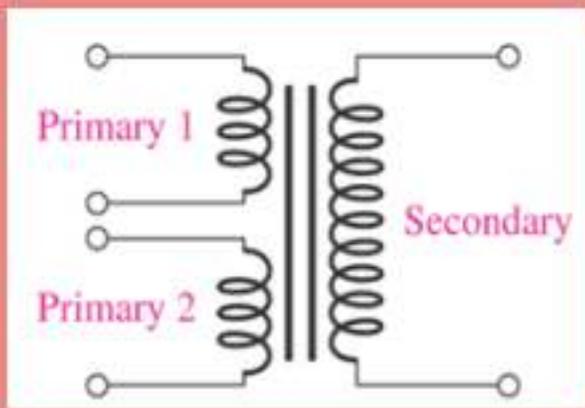
## Step-up



## Operation

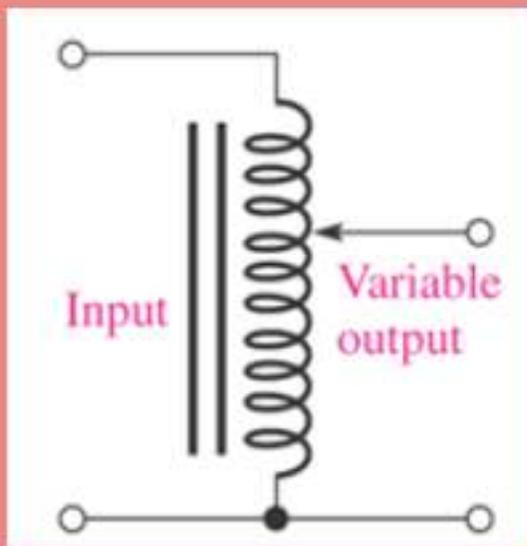
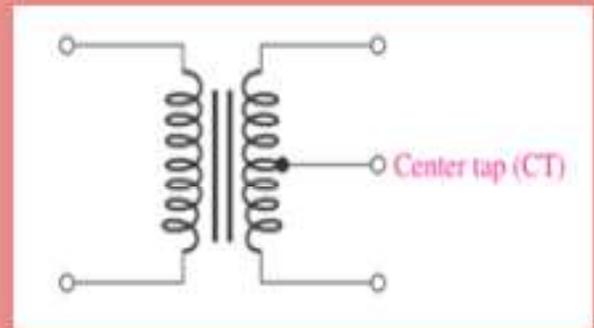
- A transformer that increases voltage between the primary to secondary windings is defined as a step-up transformer.

# Types of Transformer



Multiple Winding

Center-tap Transformer



Auto Transformer

# Ratio Transformer

---

$$n = \frac{V_P}{V_S} = \frac{I_S}{I_P} = \frac{N_P}{N_S}$$



# Function of the Transformer (Step down)

---

An electrical device that steps down alternating current (AC) voltage or current to a lower AC voltage or current.



1. By referring to Figure 1 below, determine the following:

- i. Secondary voltage
- ii. Secondary current

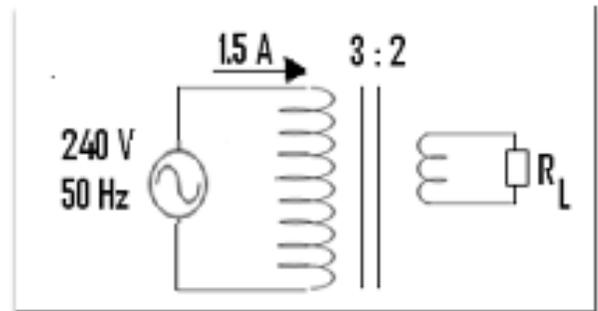


Figure 1

2. List THREE (3) types of transformer.
3. Explain the function of transformer in DC power supply.
4. By using the suitable diagram, sketch the basic transformer.
5. Show the equation of turn ratio using voltage value.

# Tutorial Answer

---

1. Determine the following:

$$\mathbf{i.} \quad \frac{V_P}{V_S} = \frac{N_P}{N_S}$$

$$\frac{240}{V_S} = \frac{3}{2}$$

$$\frac{V_S}{240} = \frac{2}{3}$$

$$V_S = \frac{2}{3} \times 240 \\ = 160 \text{ V}$$

$$\mathbf{ii.} \quad \frac{I_S}{I_P} = \frac{N_P}{N_S}$$

$$\frac{I_S}{1.5} = \frac{3}{2}$$

$$I_S = \frac{3}{2} \times 1.5$$

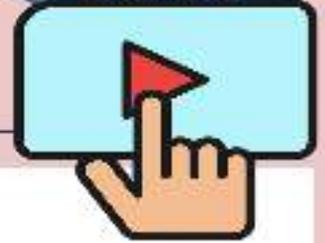
$$= 2.25 \text{ A}$$

2. THREE (3) types of transformer.

i. Auto transformer

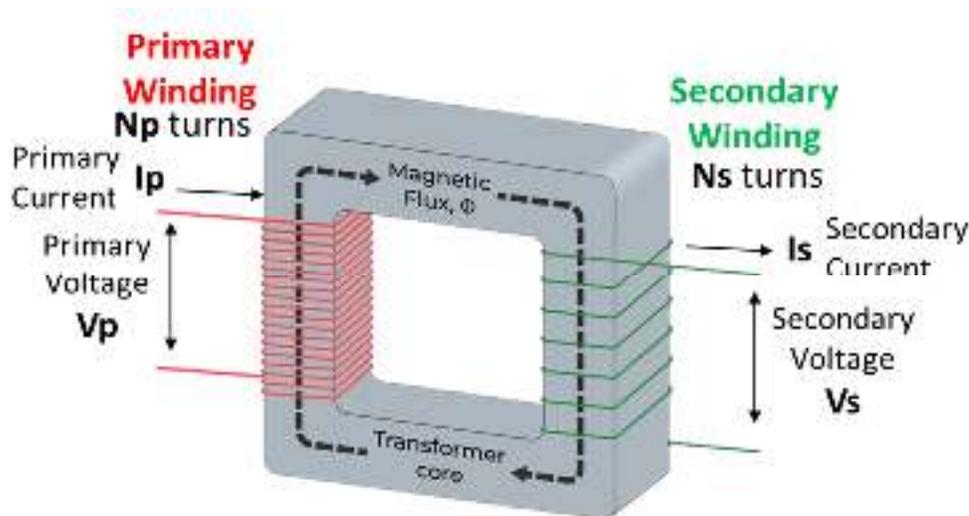
ii. Center-tap transformer

iii. Multiple winding transformer



## Tutorial Answer

- The function of transformer in DC power supply is to step down current or voltage AC to a smaller current or voltage AC.
- Diagram of the basic transformer.



- The equation of turn ratio using voltage value.

$$n = \frac{V_P}{V_S}$$



## Block 2

---



# Rectifier

DC Power Supply

---



# Introduction to Rectifier

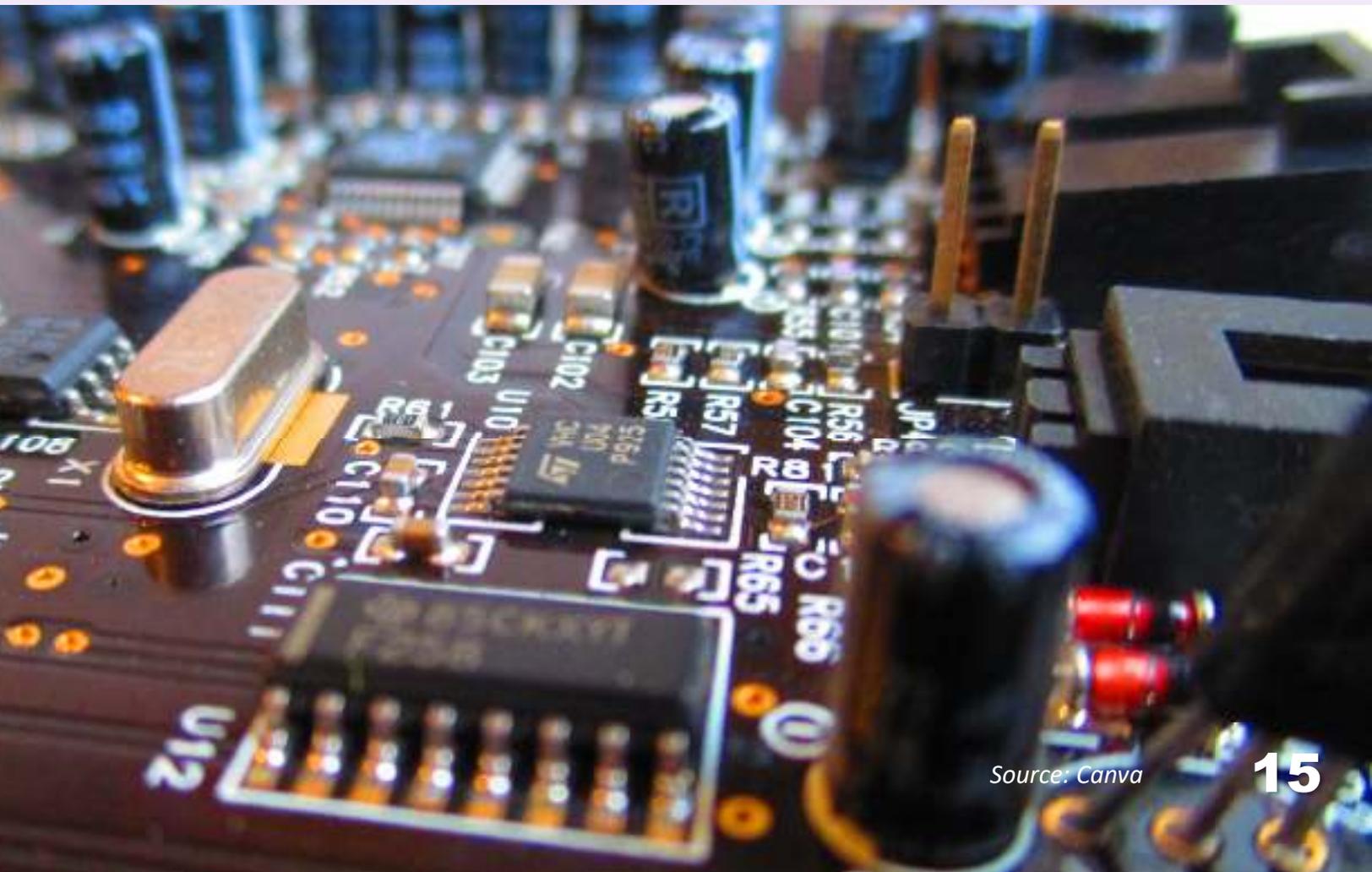
---

The rectifier is a crucial component in a DC power supply, responsible for converting alternating current (AC) input into pulsating direct current (DC).

This conversion is essential because most electronic devices require a steady DC voltage to operate.



Scan me for voice



# Function of the Rectifier

---

The primary function of the rectifier is to change the alternating voltage (AC) from the mains power source into direct voltage (DC). In other words, it converts the alternating current, which changes direction periodically, into a unidirectional current flow.

AC



DC pulsating



# Types of Rectifiers

---

## Half-Wave Rectifier

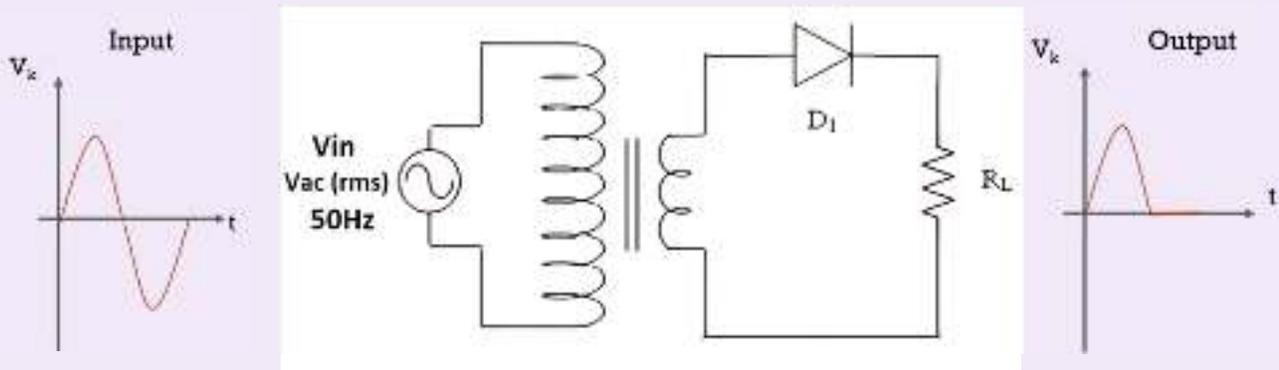
This simple rectifier uses a single diode to allow current flow in only one direction during half of the AC cycle. It's less efficient and produces more ripple compared to full-wave

## Full-Wave Rectifier

Full-wave rectifiers use multiple diodes arranged in a bridge configuration (Bridge Rectifier) or center-tapped configuration to allow current flow in the same direction during both halves of the AC cycle. This results in a more efficient conversion with less ripple.

# Types of Rectifiers

## Half-Wave Rectifier



### Operation

When the secondary AC voltage swings positive,

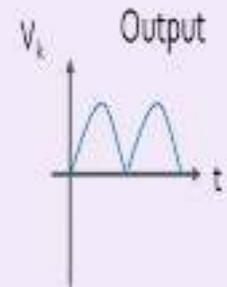
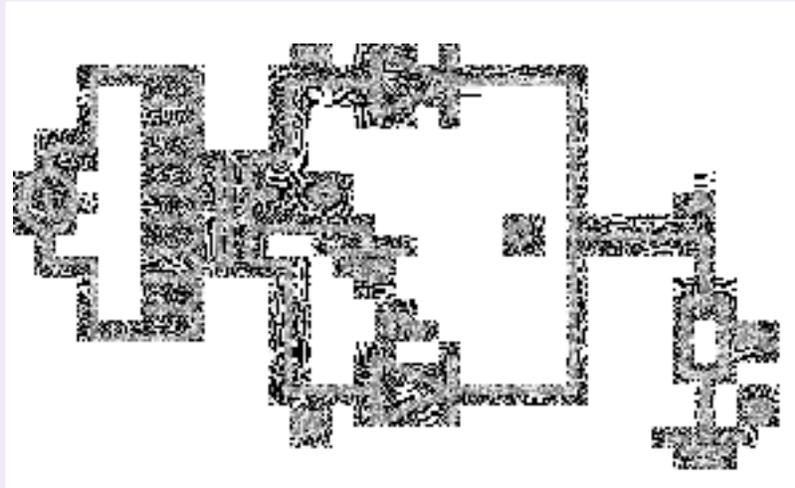
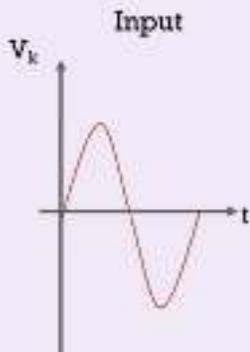
- Diode  $D_1$  turns 'ON' and the circuit is connected.
- Current flows in the circuit and produces half waveform across the load

When secondary AC voltage swings negative,

- Diode  $D_1$  turns 'OFF' and the circuit is opened
- No current flows in the circuit and NO waveform is produced across the load

# Types of Rectifiers

## Full-Wave Rectifier : Center-tapped



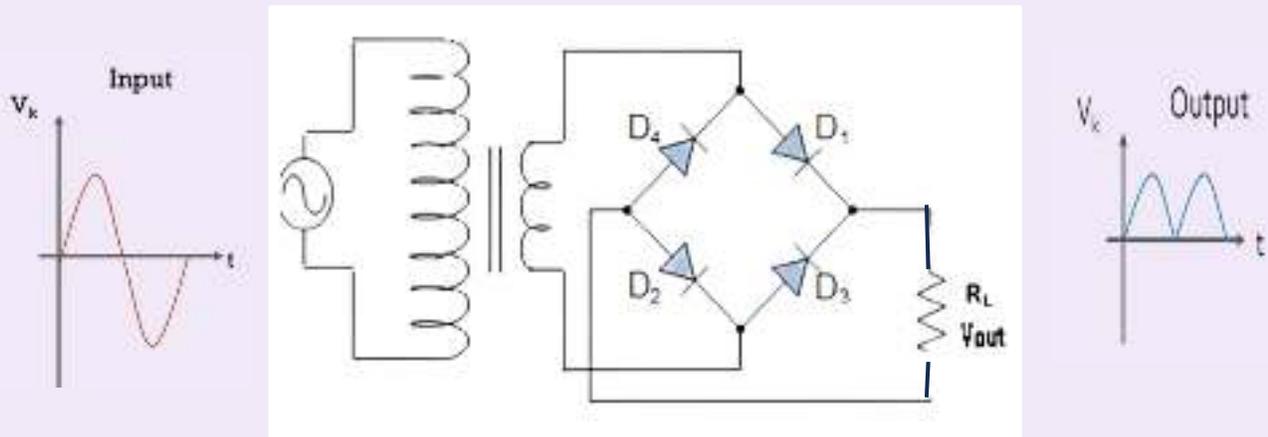
### Operation

- When  $V_{in}$  swings positive, a positive voltage is developed on M so D1 is ON while a negative voltage is developed on N so D2 is OFF.
- Electrons flow through the load and develop a positive output half-cycle across the load ( $V_{out}$ ).

- When  $V_{in}$  swings negative, a negative voltage is developed on M so D1 is OFF while a positive voltage is developed on N turning ON D2.
- Current flows through the load, developing another positive output half-cycle across the load ( $V_{out}$ )

# Types of Rectifiers

## Full-Wave Rectifier : Bridged Rectifier



### Operation

- When the  $V_{in}$  swings positive, a positive potential is applied to the top of the bridge, causing D<sub>1</sub> to turn ON, while a negative potential is applied to the bottom of the bridge, causing D<sub>2</sub> to turn ON.
- With D<sub>1</sub> and D<sub>2</sub> ON and D<sub>3</sub> and D<sub>4</sub> OFF, current will flow up through the load as indicated by the arrow (I), developing a positive output half-cycle across the load (V<sub>out</sub>).

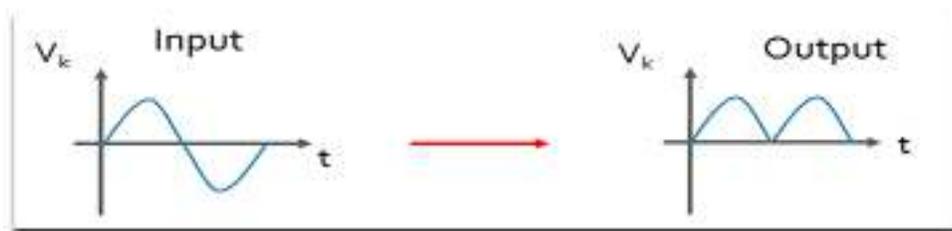
- When  $V_{in}$  swings negative, a negative potential is applied to the top of the bridge, causing D<sub>4</sub> to turn ON, while a positive potential is applied to the bottom of the bridge, causing D<sub>3</sub> to turn ON.
- With D<sub>4</sub> and D<sub>3</sub> ON and D<sub>1</sub> and D<sub>2</sub> OFF, electrons will flow up through the load as indicated by the arrow (I), developing another positive output half-cycle across the load (V<sub>out</sub>).

1. Identify the function of a rectifier.
2. The main function of the rectifier in the power supply unit is to convert the Alternating Current (AC) to Direct Current (DC) power. List TWO (2) types of rectifier circuits that are commonly used in this power supply unit. How many diodes are used in the rectifier circuit respectively?
3. Draw the input and output waveforms of half-wave rectifier.
4. Draw a bridge rectifier circuit and explain its operation.



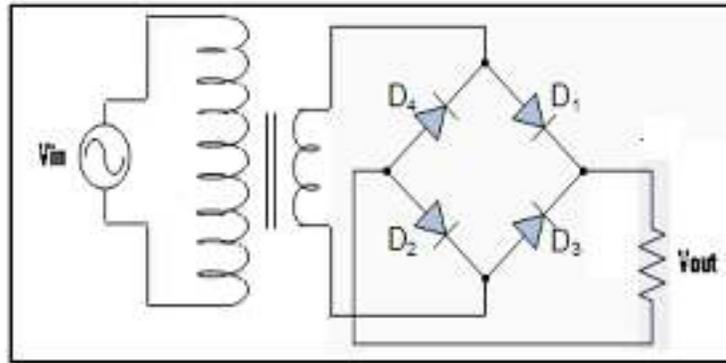
# Tutorial Answer

1. The rectifier is used to convert the AC voltage to pulsating DC output voltage.
2. TWO (2) types of rectifier circuits and number of diodes are used in the rectifier circuit respectively:
  - Full wave rectifier using center tap transformer – use 2 diodes
  - Full wave rectifier using bridge rectifier – use 4 diodes
  - Half wave rectifier – use 1 diode
3. The input and output waveforms of half-wave rectifier.



# Tutorial Answer

## 4. Bridge rectifier circuit



Operation:

- When the  $V_{in}$  swings positive, a positive potential is applied to the top of the bridge, causing  $D_1$  to turn ON, while a negative potential is applied to the bottom of the bridge, causing  $D_2$  to turn ON.
- With  $D_1$  and  $D_2$  ON and  $D_3$  and  $D_4$  OFF, current will flow up through the load as indicated by the arrow (I), developing a positive output half-cycle across the load ( $V_{out}$ ).
- When  $V_{in}$  swings negative, a negative potential is applied to the top of the bridge, causing  $D_4$  to turn ON, while a positive potential is applied to the bottom of the bridge, causing  $D_3$  to turn ON.
- With  $D_4$  and  $D_3$  ON and  $D_1$  and  $D_2$  OFF, electrons will flow up through the load as indicated by the arrow (I), developing another positive output half-cycle across the load ( $V_{out}$ ).



## Block 3

---



# Filter

DC Power Supply

---



# Introduction of Filter

---

Filtering or smoothing the rectified voltage is used to obtain a pure DC from the pulsating DC.

# Function of the Filter

---



To get smooth DC voltage from pulsating DC input



The small amount of fluctuation in the filter output voltage is called ripple.

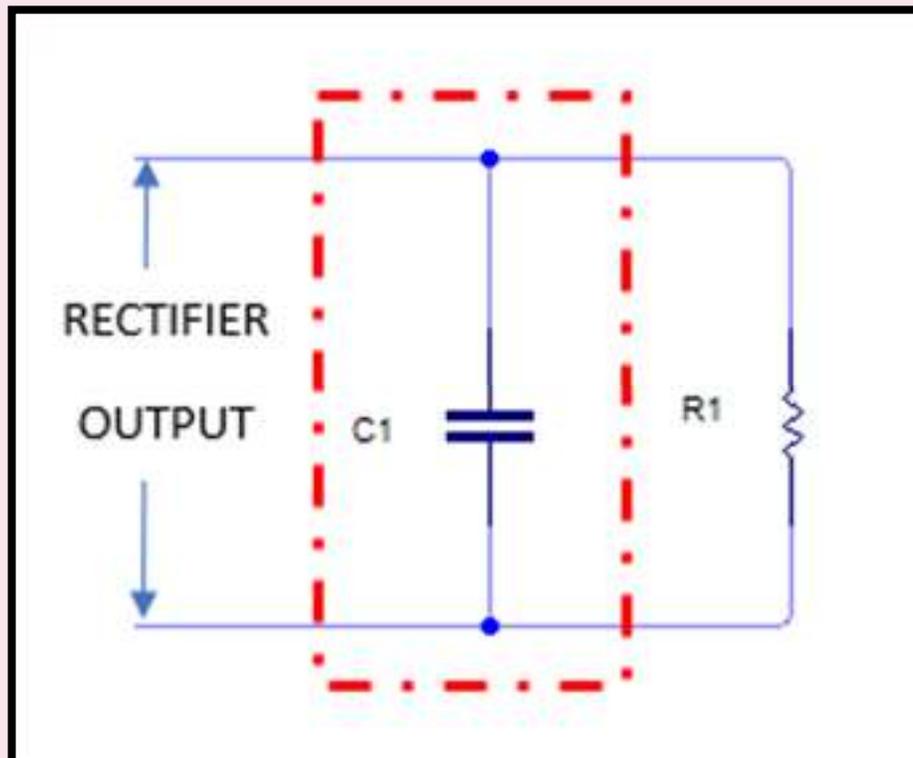


Removes the ac component from the output of rectifier and produces the pure dc output across the load

# Types of Filter

## Capacitor Filter

A capacitor, C is connected at the end of rectifier circuit and parallel with the load resistor.

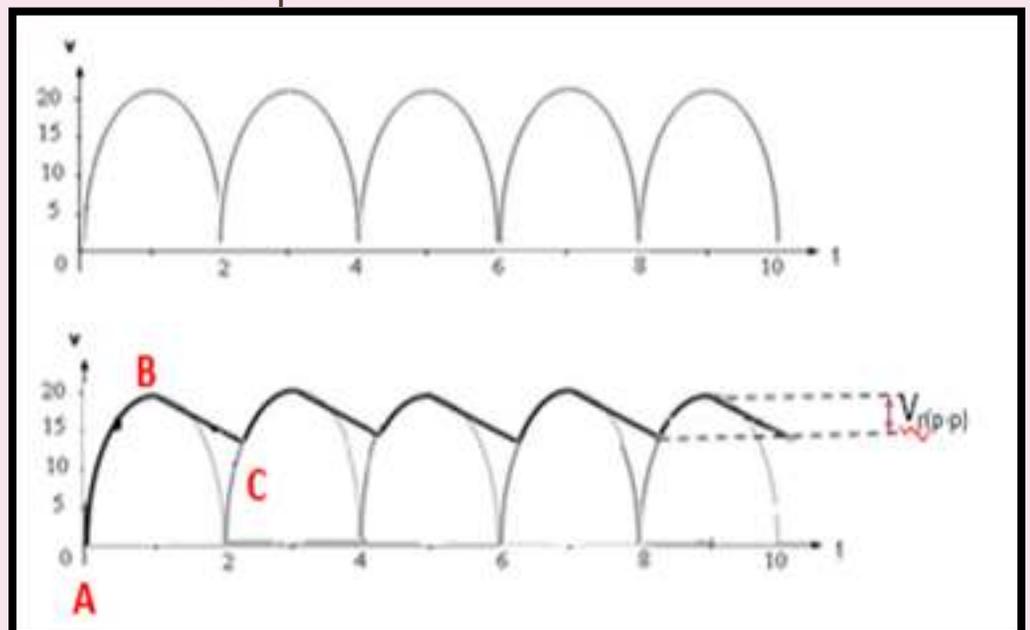


# Types of Filter

## Capacitor Filter

- When the voltage from the rectifier circuit increases, it charges the capacitor until the peak value  $V_m$  of the rectifier voltage (A – B).
- After that, the rectifier voltage starts to decrease causing the capacitor to discharge through the load and the voltage across it decreases (B-C).
- The process is repeated. The little ripple is left in the output.

Waveform output full wave rectifier



Waveform output c filter

# Types of Filter

---

## Capacitor Filter

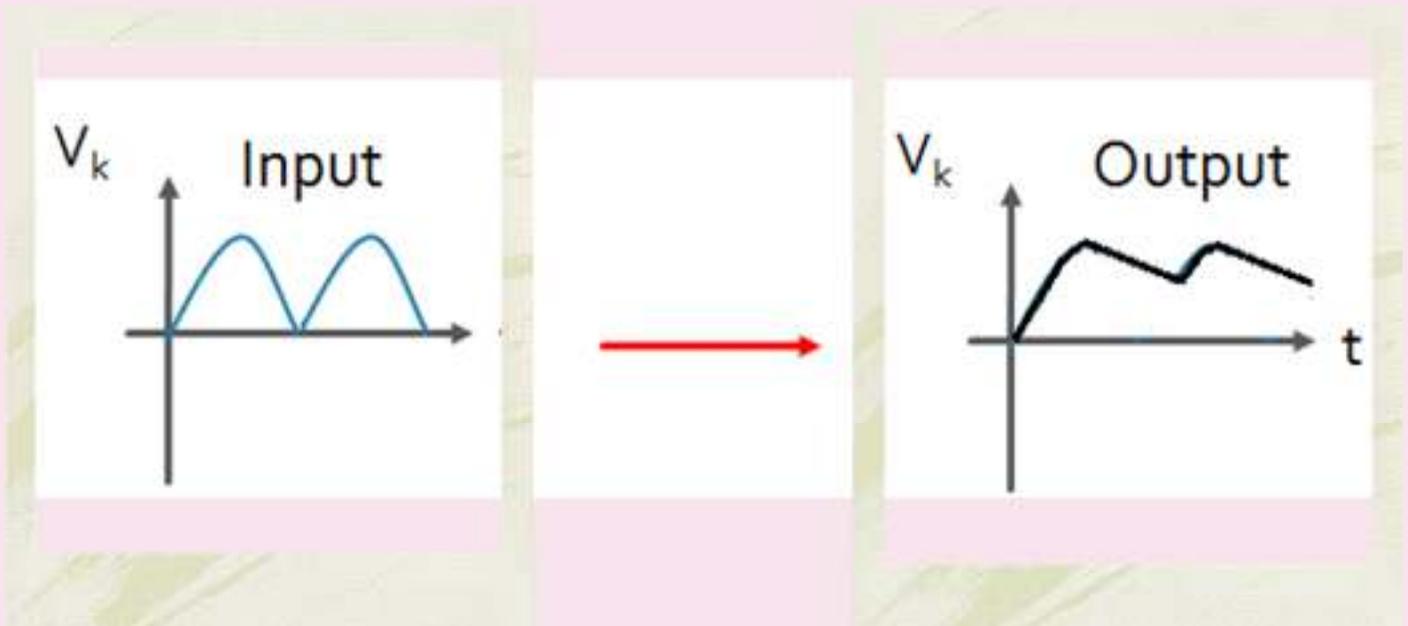
- ✓ The larger valued capacitor is used, the ripple voltage becomes lesser.
- ✓ Popular because of its low cost, small size, lightweight and good characteristics.
- ✓ The disadvantage of this filter is the output voltage is not pure dc and has much less variation (or ripple) than the unfiltered output of the rectifier.

# Types of Filter

---

## Capacitor Filter

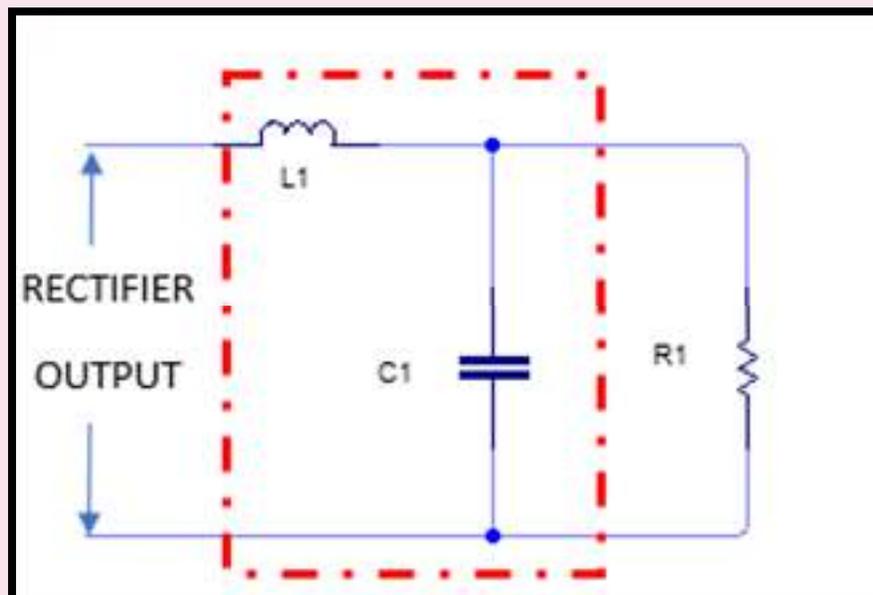
### Waveform Input and Output



# Types of Filter

## Choke Input Filter

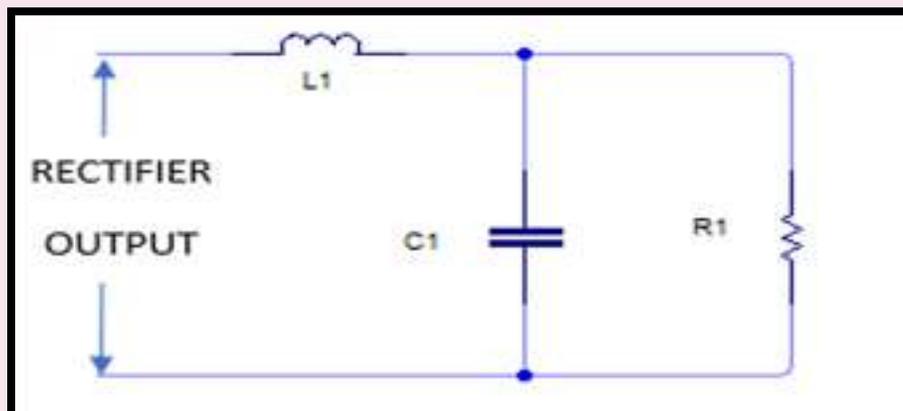
A choke  $L$  is connected in series with the rectifier circuit and a Capacitor filter across the load resistor



# Types of Filter

## Choke Input Filter

- The pulsating output from the rectifier circuit contains AC and DC components.
- The choke allow high opposition to the passage of AC component but blocking opposition to the DC component.
- The resulting AC component appears across the choke while the DC component passes through the choke to the load.
- It reduced pulsation across the load, R.

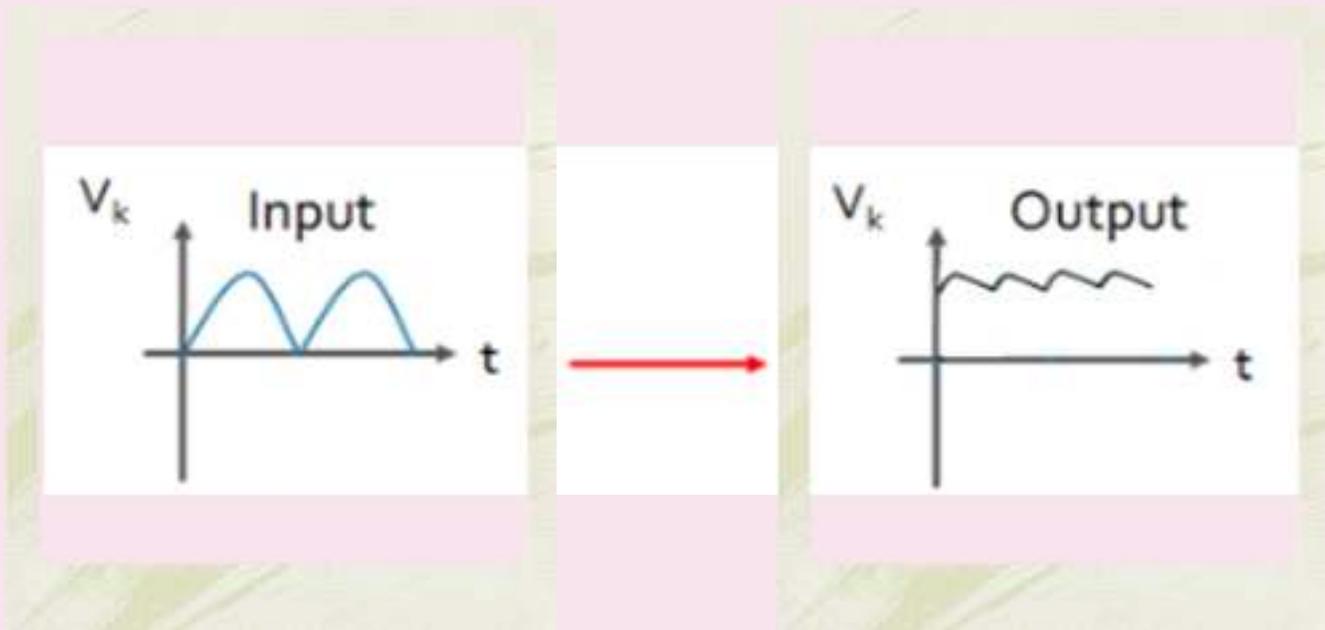


# Types of Filter

---

## Choke Input Filter

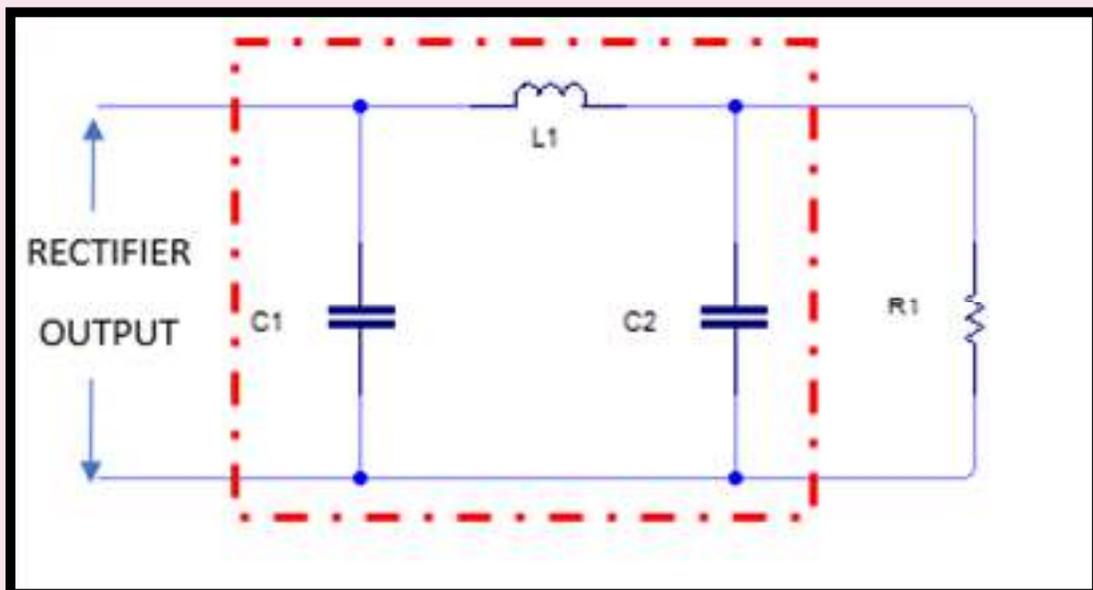
### Waveform Input and Output



# Types of Filter

## Capacitor Input Filter Or Pi Filter

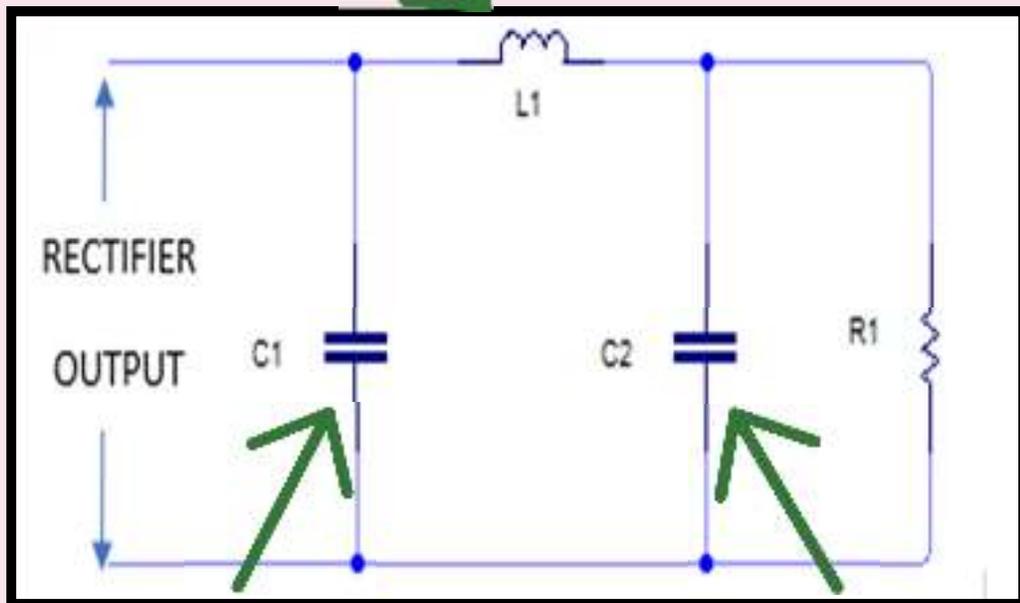
A filter capacitor  $C_1$  connected across the rectifier output, a choke  $L$  in series and another filter capacitor  $C_2$  connected across resistor as load



# Types of Filter

## Capacitor Input Filter Or Pi Filter

- Give high reactance to AC component of rectifier output
- Give zero reactance to DC component



- Give low reactance to AC component of rectifier output.
- Give infinite reactance to DC component

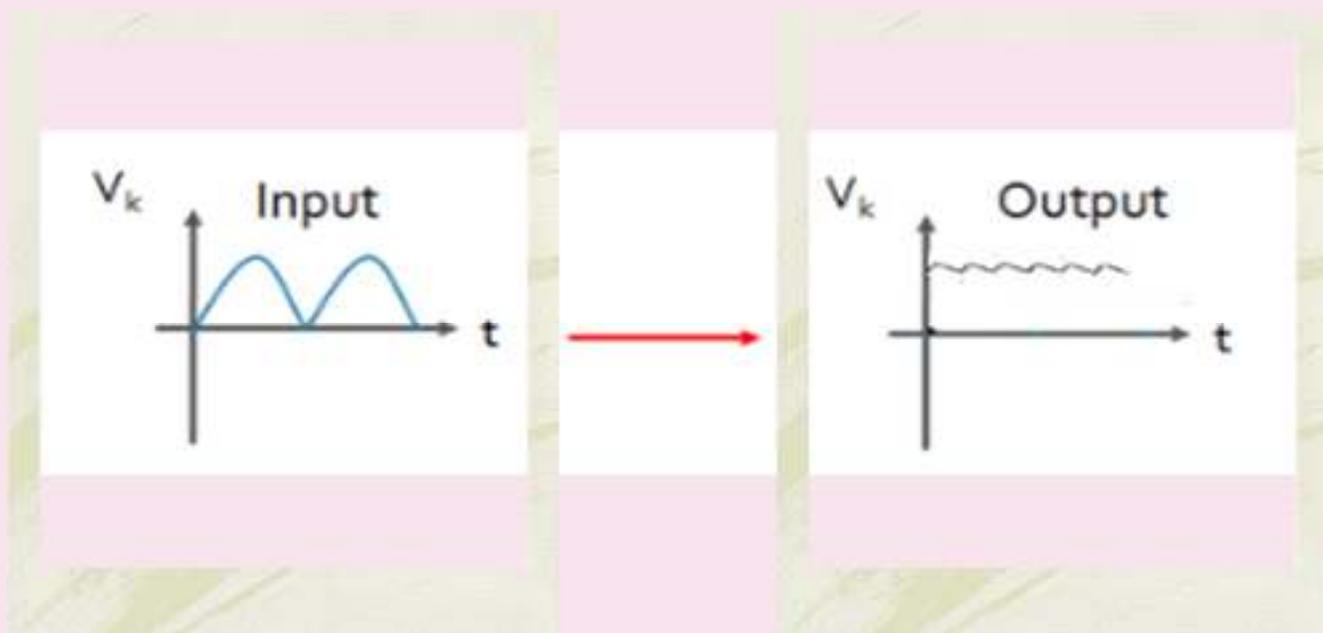
Only DC component appears across the load

# Types of Filter

---

## Capacitor Input Filter Or Pi Filter

### Waveform Input and Output



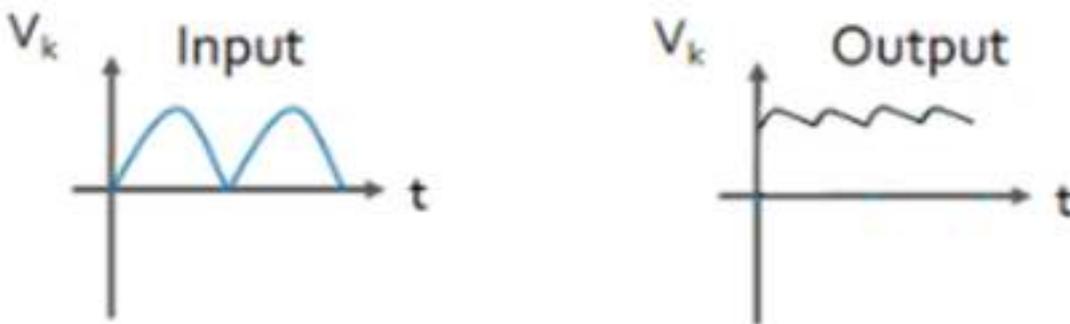
1. List THREE (3) types of filter.
2. By using the diagram, explain the pi filter.
3. Explain the function of filter.
4. Draw the input and output waveforms of filter.
5. Explain the operation of capacitor filter.





3. The function of filter is to get smooth DC voltage called ripple from pulsating DC input

4. The input and output waveforms of filter



Source: pixabay



5. The operation of capacitor filter.

When the voltage from rectifier circuit increases, it charges the capacitor until the peak value  $V_m$  of the rectifier voltage. After that, the rectifier voltage starts to decrease causing the capacitor to discharge through the load and the voltage across it decreases. The process is repeated. The little ripple is left in the output.



Source: pixabay



**Block 4**

---



# **Voltage Regulator**

DC Power Supply

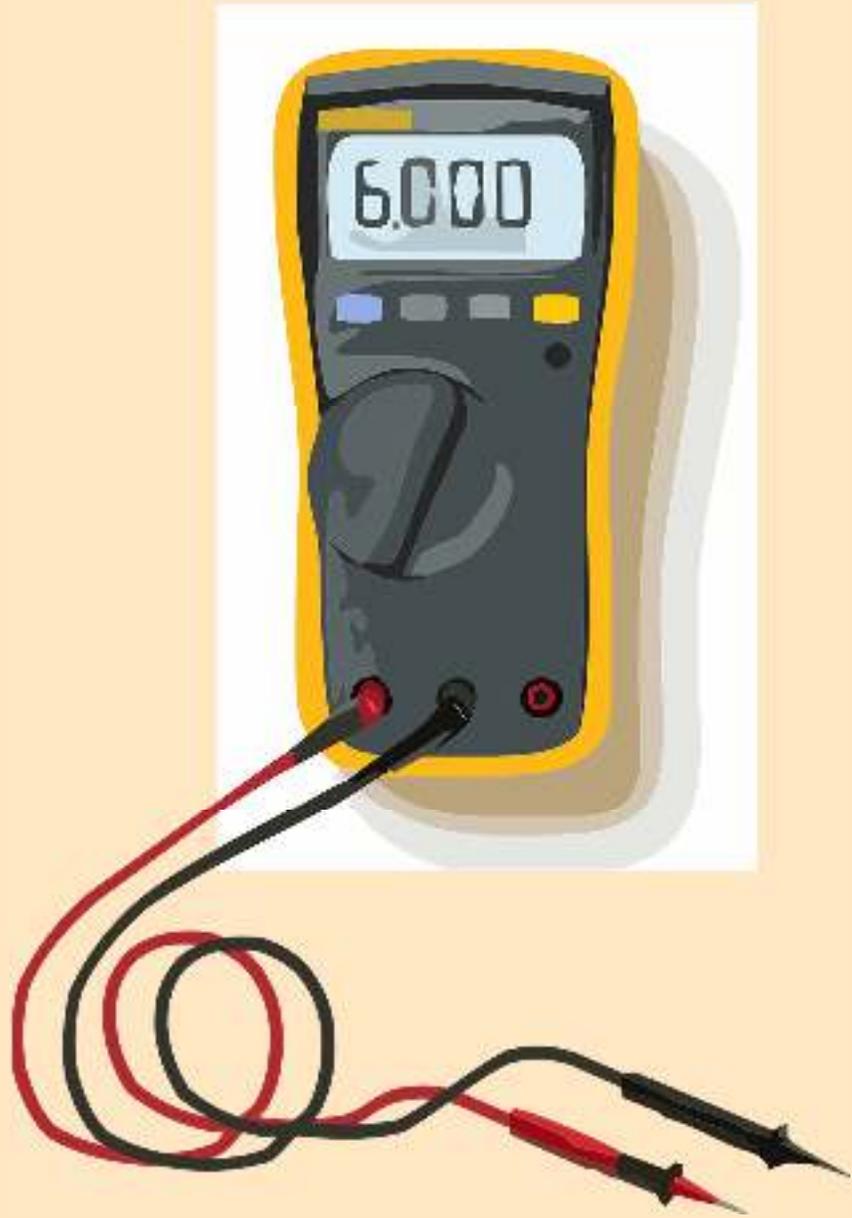
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# Introduction of Voltage Regulator

---

A voltage regulator is a system designed to automatically maintain a constant voltage.



# Function of Voltage Regulator

---

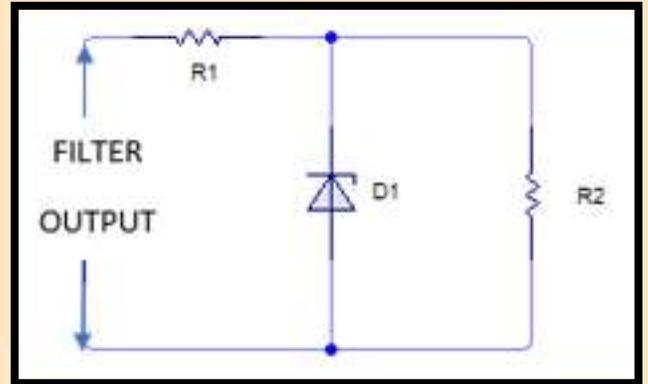
To ensure the output voltage to remain constant whether the current load changes or there are fluctuations in the input AC voltage.



Source: Canva

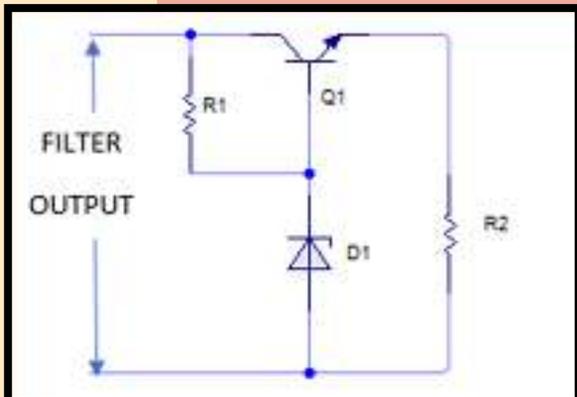
# Types of Voltage Divider

Zener Diode  
Voltage  
Regulator

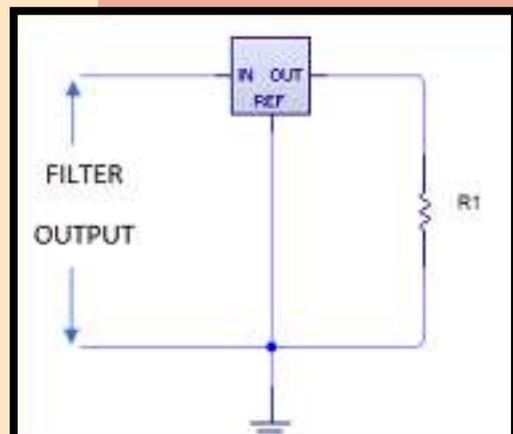


## TYPES OF FILTER

Transistor Series  
Voltage  
Regulator



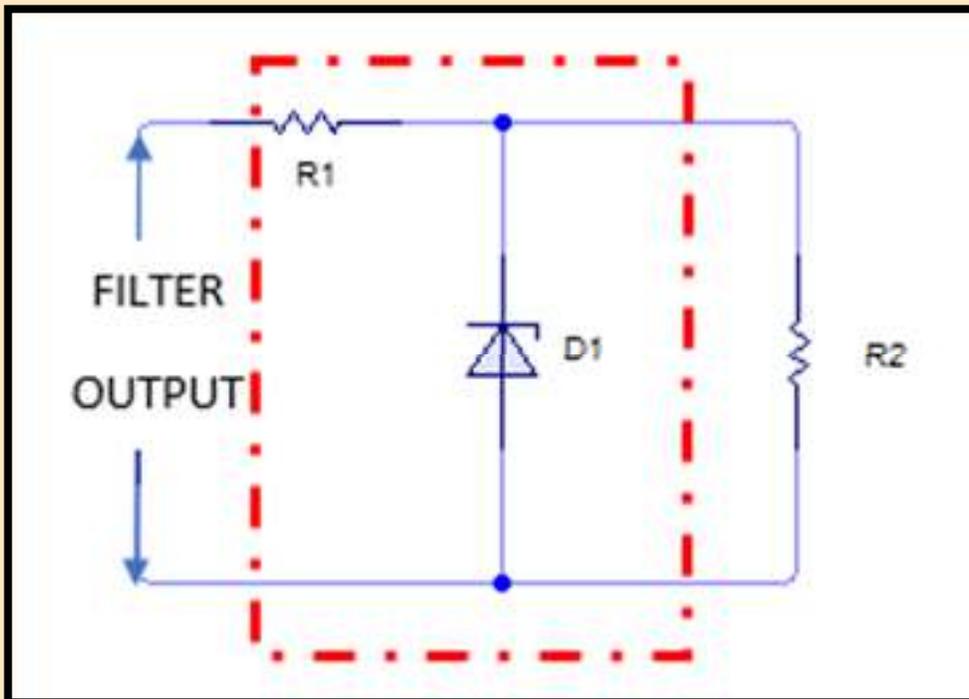
IC Voltage  
Regulator



# Types of Voltage Divider

## Zener Diode Voltage Regulator

A zener diode is connected parallel with load resistor to make it reverse bias.

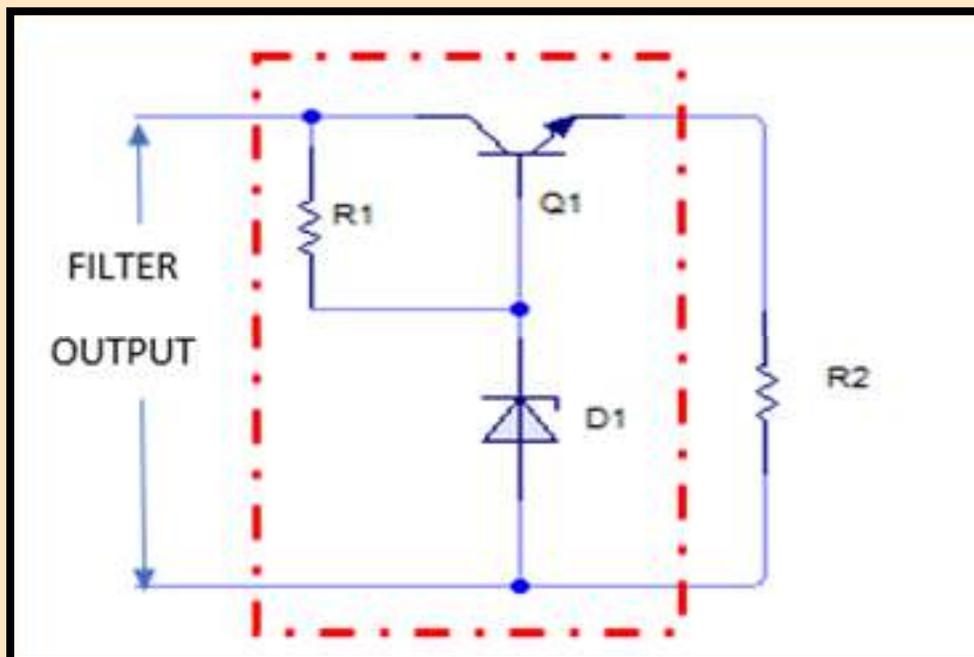


# Types of Voltage Divider

## Transistor Series Voltage Regulator



This regulator has a transistor in series with Zener diode and both in parallel to the load.

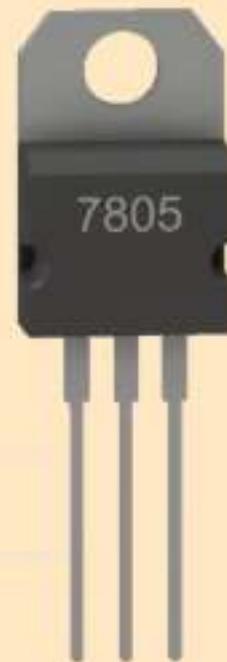
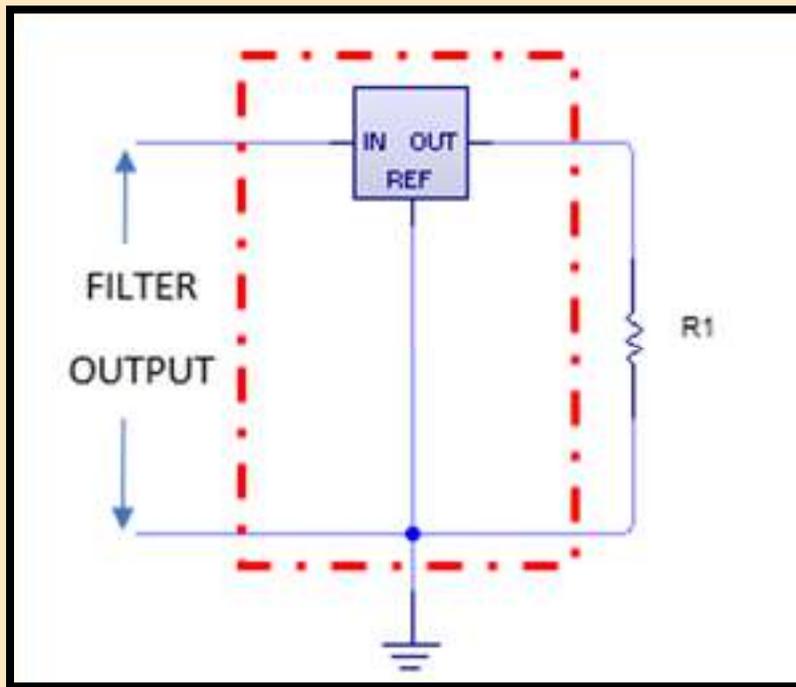


# Types of Voltage Divider

## Integrated Circuit Voltage Regulator



IC voltage regulators has three-terminal components.



# Types of Voltage Divider

---

Integrated Circuit Voltage Regulator

## TYPES

- ✓ Fixed positive voltage regulator
- ✓ Fixed negative voltage regulator

# Types of Voltage Divider

---

## Integrated Circuit Voltage Regulator

Fixed positive voltage regulator

78XX

The **78XX** series of regulators are used to supply a positive output voltage, with the last two digits specifying the output voltage.

For example :

7805 = +5V

7810 = +10V

# Types of Voltage Divider

## Integrated Circuit Voltage Regulator



Fixed positive voltage regulator

type number	output voltage (V)	minimum input voltage (V)
7805	+5	+7.3
7806	+6	+8.3
7808	+8	+10.5
7810	+10	+12.5
7812	+12	+14.5
7815	+15	+17.7
7818	+18	+21.0
7824	+24	+27.1

# Types of Voltage Divider

---

## Integrated Circuit Voltage Regulator

Fixed negative voltage regulator

79XX

The 79XX series of regulators are used to supply a negative output voltage, with the last two digits specifying the output voltage.

For example :

7905 = -5V

7912 = -12V

# Types of Voltage Divider

## Integrated Circuit Voltage Regulator



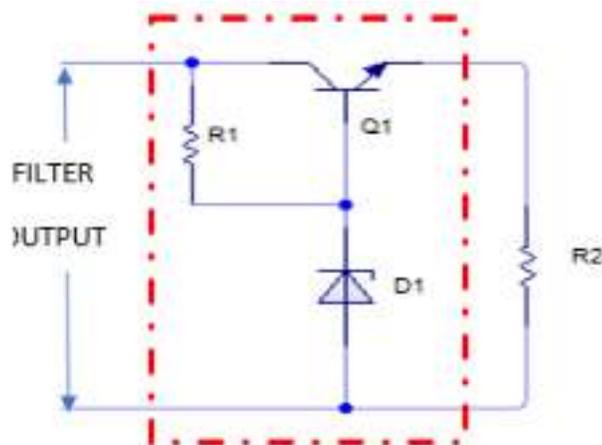
Fixed negative voltage regulator

type number	output voltage (V)	minimum input voltage (V)
7905	-5	-7.3
7906	-6	-8.4
7908	-8	-10.5
7909	-9	-11.5
7912	-12	-14.6
7915	-15	-17.7
7918	-18	-20.8
7924	-24	-27.1

1. List THREE (3) types of voltage regulator.
2. By using the diagram, explain the transistor series regulator.
3. Explain the function of voltage regulator.
4. Draw the input and output waveforms of voltage regulator.
5. Explain the output of LM7912 and LM7809.

1. THREE (3) types of voltage regulator is Zener Diode Voltage Regulator, Transistor Series Voltage Regulator and IC voltage regulator
2. The transistor series regulator.

This regulator has a transistor in series with Zener diode and both in parallel to the load.



3. The function of a voltage regulator is to ensure the output voltage to remain constant whether the current load changes or there are fluctuations in the input AC voltage.

4. The input and output waveforms of a voltage regulator.



5. The output of LM7912 is -12V and LM7809 is +9V



## Block 5

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# Voltage Divider

DC Power Supply

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# Introduction of Voltage Divider

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A voltage divider is a simple circuit that can reduce voltage.

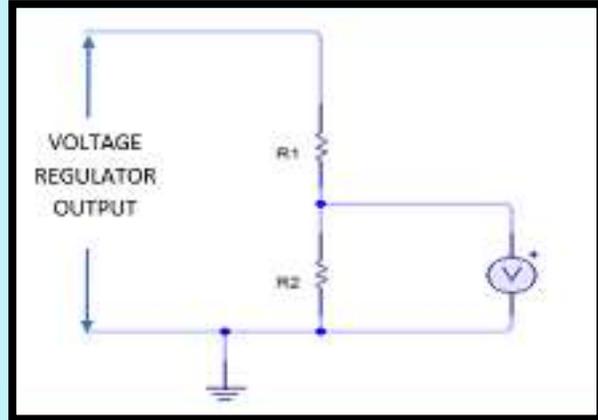
# Function of Voltage Divider

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- To scale down input voltage to a smaller voltage based on the ratio of the 2 resistors.
- Usually consists of resistors that are connected in series

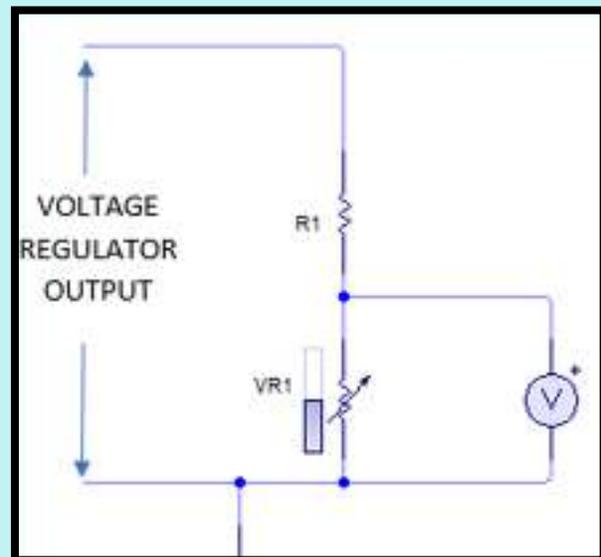
# Types of Voltage Divider

Fixed Voltage  
Divider



## TYPES OF VOLTAGE DIVIDER

Variable Voltage  
Divider

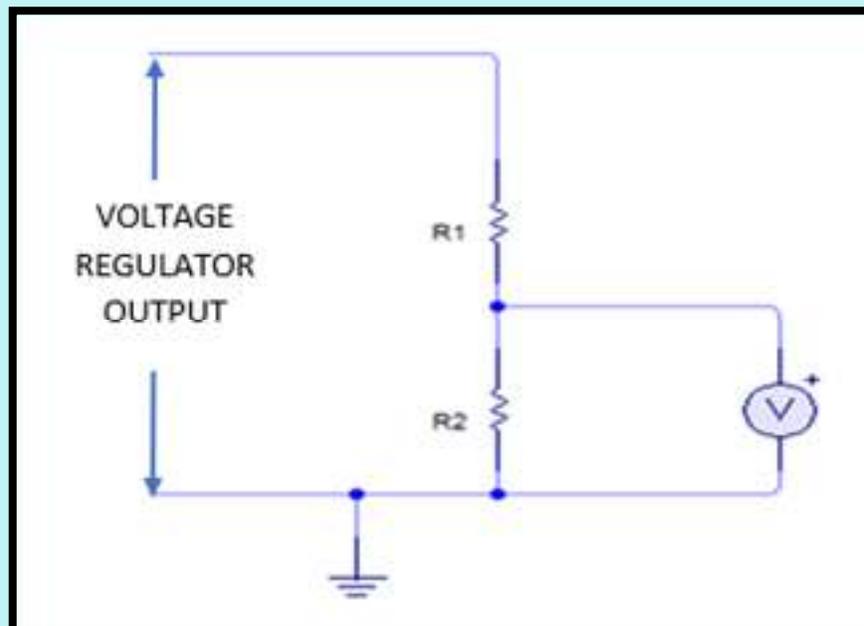


# Types of Voltage Divider

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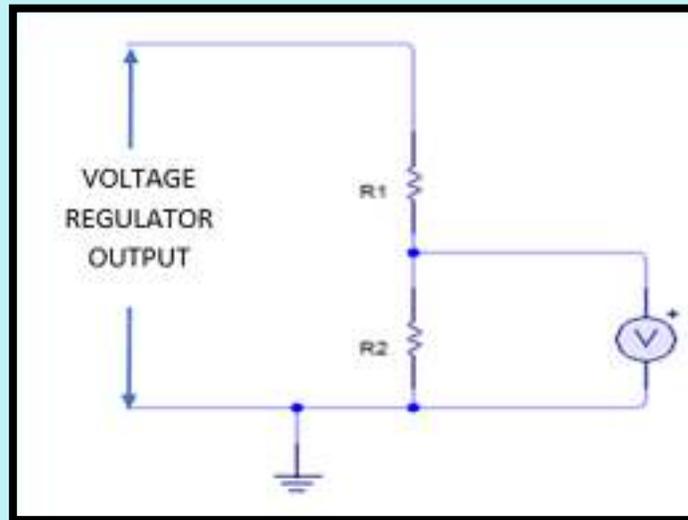
## Fixed Voltage Divider

Consists of TWO resistors connected in series.



# Types of Voltage Divider

## Fixed Voltage Divider



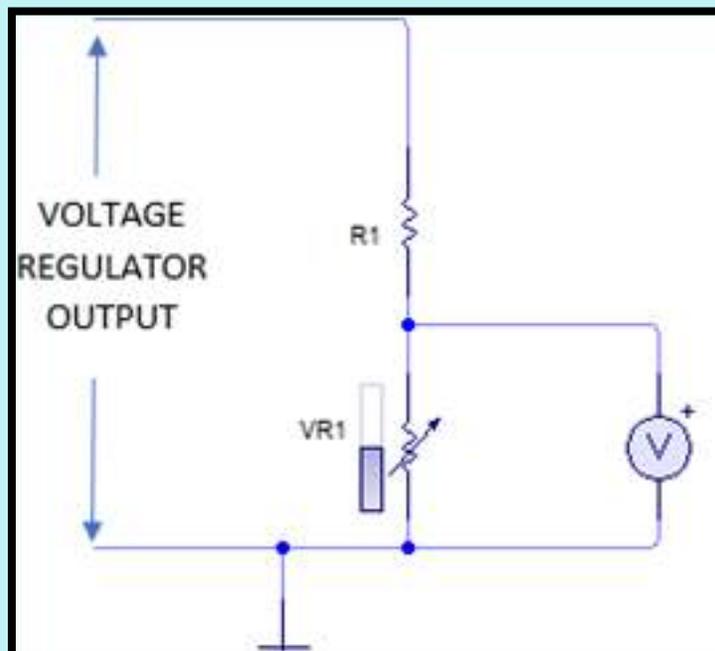
$$V_{R1} = \frac{R_1}{R_1 + R_2} (V_{IN})$$

$$V_{R2} = \frac{R_2}{R_1 + R_2} (V_{IN})$$

# Types of Voltage Divider

## Variable Voltage Divider

Consists of one resistor and variable resistor connected in series.



# QUESTION



# Video simulation DC power supply

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<https://youtu.be/es2YP9aO6xc>



# References

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# **Basic DC Power Supply**

Unlock the essentials of DC power supply design with this comprehensive e-book, "Basic DC Power Supply." Structured around five core components—Transformer, Rectifier, Filter, Regulator, and Voltage Divider—this guide demystifies the intricacies of power supply circuits.

With clear, accessible text and thoughtfully curated illustrations, readers will find a user-friendly resource that enhances understanding and retention. Whether you're a student diving into electronics or a curious reader seeking to grasp the fundamentals, this e-book serves as an invaluable tool.

Join us on a journey to master the principles of DC power supplies and empower your knowledge for practical applications in electronics!

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