SNS COLLEGE OF TECHNOLOGY

Kurumbapalayam (Po), Coimbatore – 641 107

An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A' Grade

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF COMPUTER SCIENCE AND DESIGN

COURSE NAME : 23EET103- ELECTRIC CIRCUITS AND ELECTRON DEVICES

I YEAR /II SEMESTER

Unit-5 - RECTIFIERS AND POWER SUPPLIES

Topic : **Rectifiers:** Half wave

Story Telling

Topics for discussion

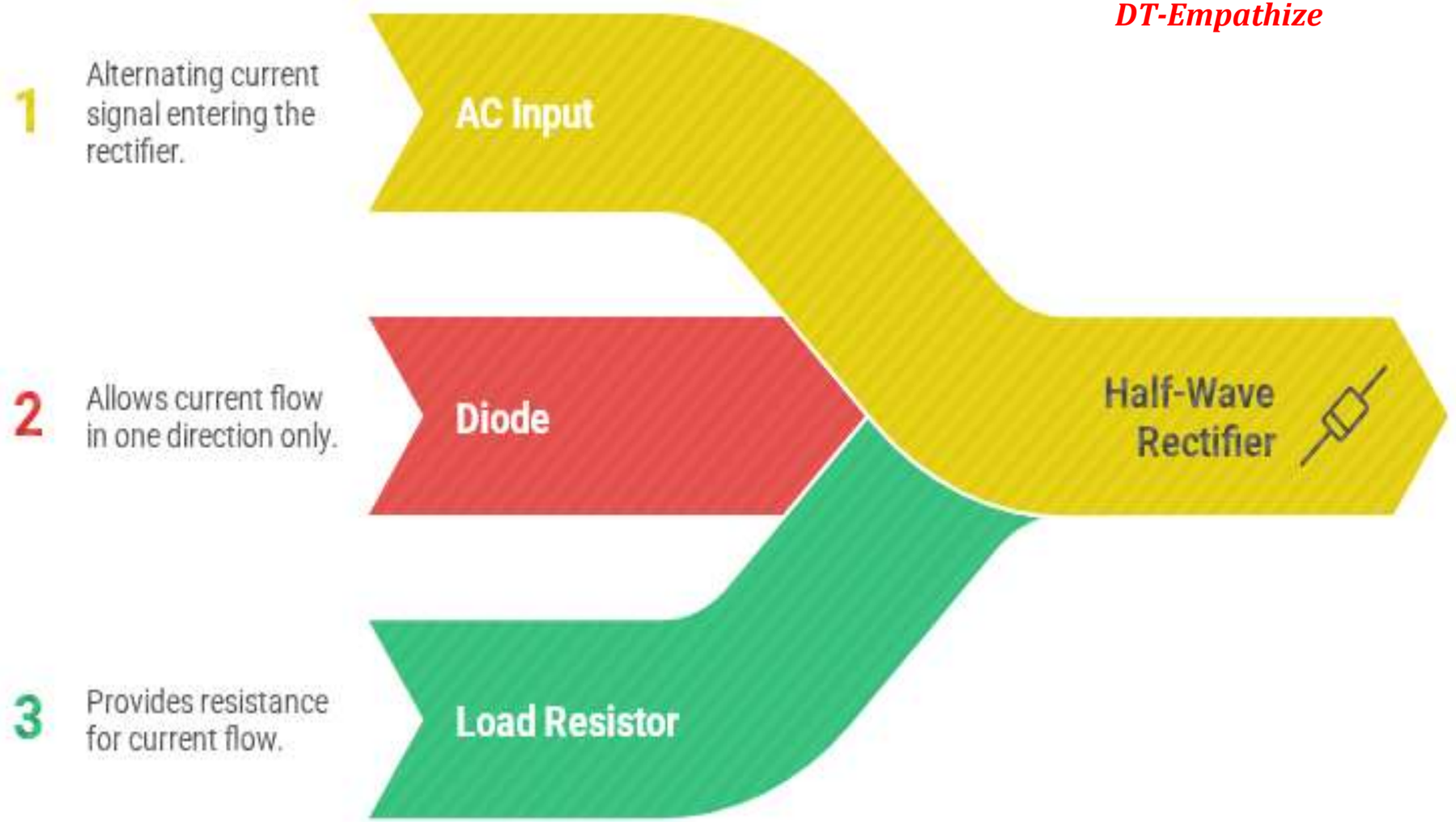
Half Wave Rectifier Circuit
Working of Half Wave Rectifier
Half Wave Rectifier Waveform
Half Wave Rectifier Capacitor Filter
Half Wave Rectifier Formula
Ripple Factor of Half Wave Rectifier
Efficiency of Halfwave Rectifier
RMS value of Half Wave Rectifier
Form factor of a Halfwave Rectifier
Applications of Half Wave Rectifier
Disadvantages of Half Wave Rectifier

What is Half-wave rectifiers

Half-wave rectifiers transform AC voltage to DC voltage. A halfwave rectifier circuit uses only one diode for the transformation.

A halfwave rectifier is defined as a type of rectifier that allows only one-half cycle of an AC voltage waveform to pass while blocking the other half cycle. In this session, let us know in detail about the half-wave rectifier.

DT-Empathize



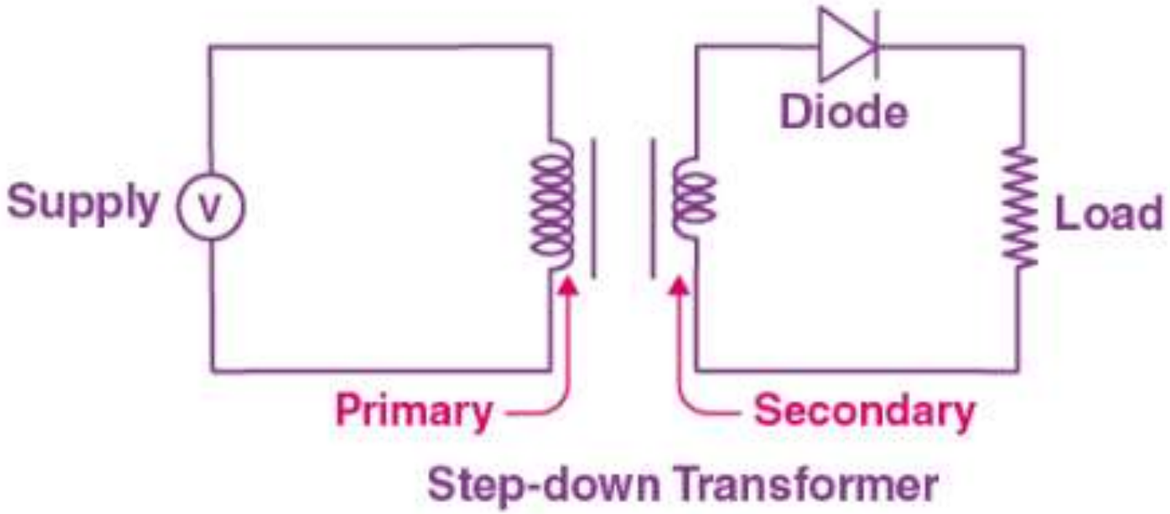
Half Wave Rectifier Circuit

A half-wave rectifier is the simplest form of the rectifier and requires only one diode for the construction of a halfwave rectifier circuit.

A halfwave rectifier circuit consists of three main components as follows:

A diode
A transformer
A resistive load

Given below is the half-wave rectifier diagram:



Working of Half Wave Rectifier

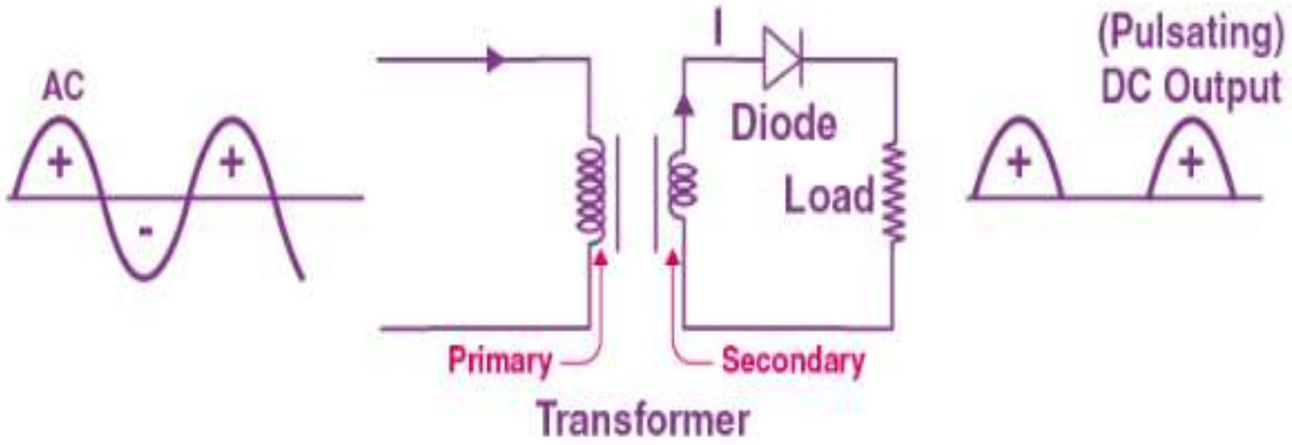
DT-DEFINE

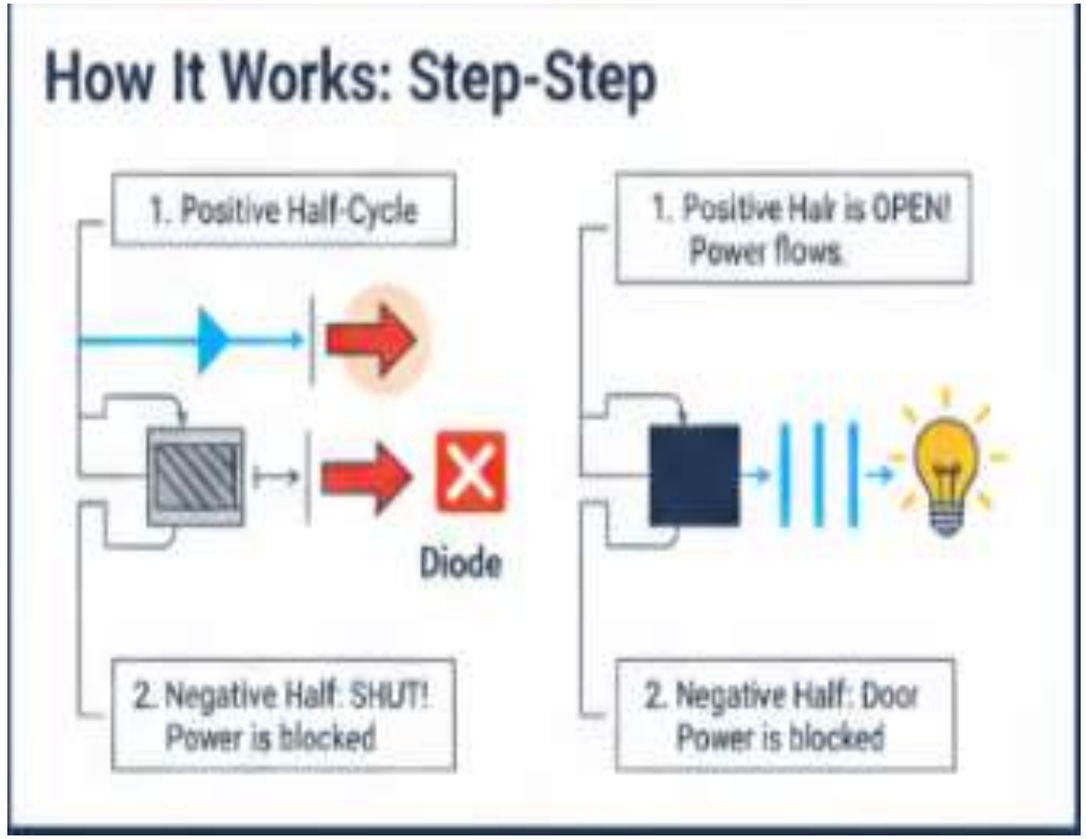
In this section, let us understand how a half-wave rectifier transforms AC into DC.

A high AC voltage is applied to the primary side of the step-down transformer. The obtained secondary low voltage is applied to the diode.

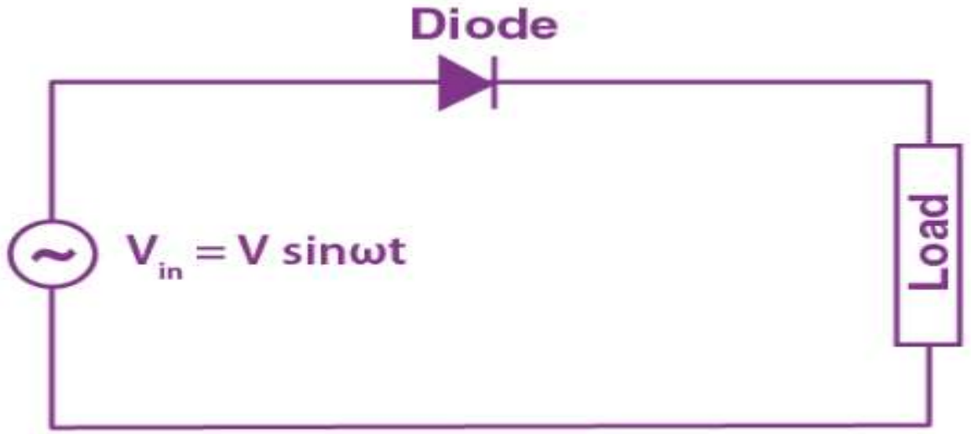
The diode is forward biased during the positive half cycle of the AC voltage and reverse biased during the negative half cycle.

The final output voltage waveform is as shown in the figure below:





For better understanding, let us simplify the half-wave circuit by replacing the secondary transformer coils with a voltage source as shown below:



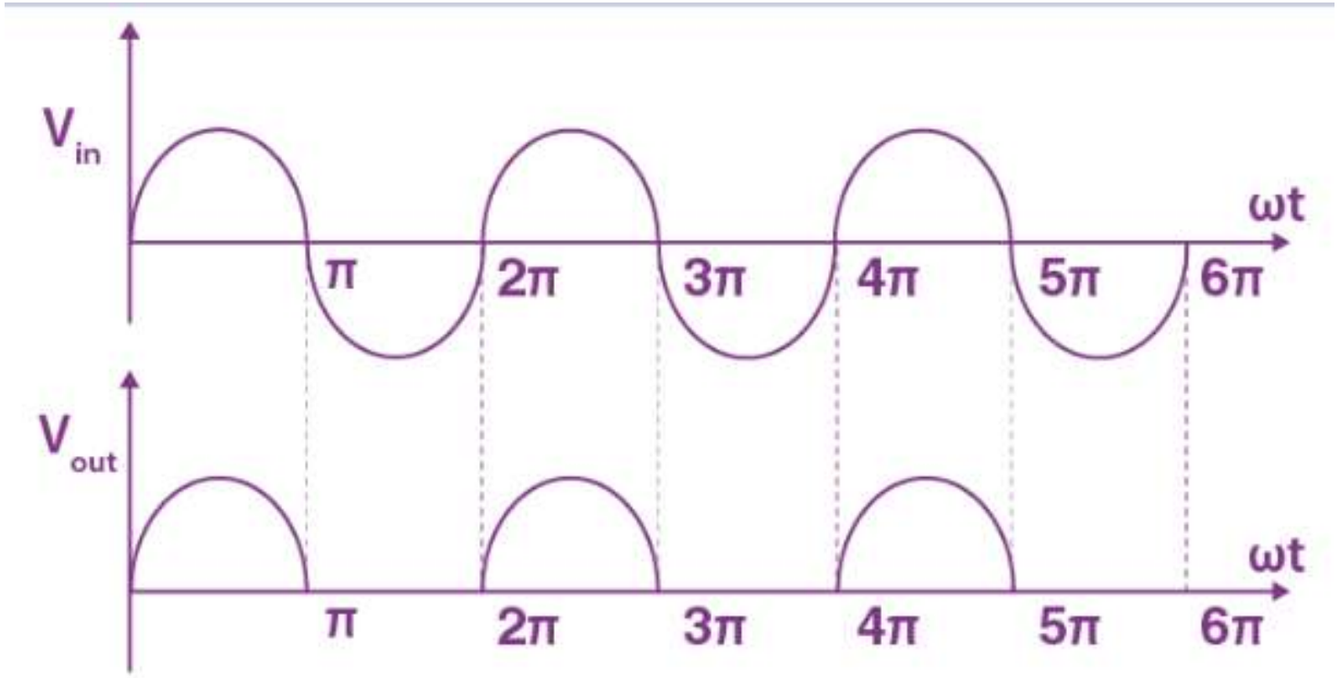
For the positive half cycle of the AC source voltage, the circuit effectively becomes as shown below in the diagram:

When the diode is forward biased, it acts as a closed switch. But, during the negative half cycle of the AC source voltage, the equivalent circuit becomes as shown in the figure below

When a diode is reverse biased, it acts as an open switch. Since no current can flow to the load, the output voltage is equal to zero.

Half Wave Rectifier Waveform

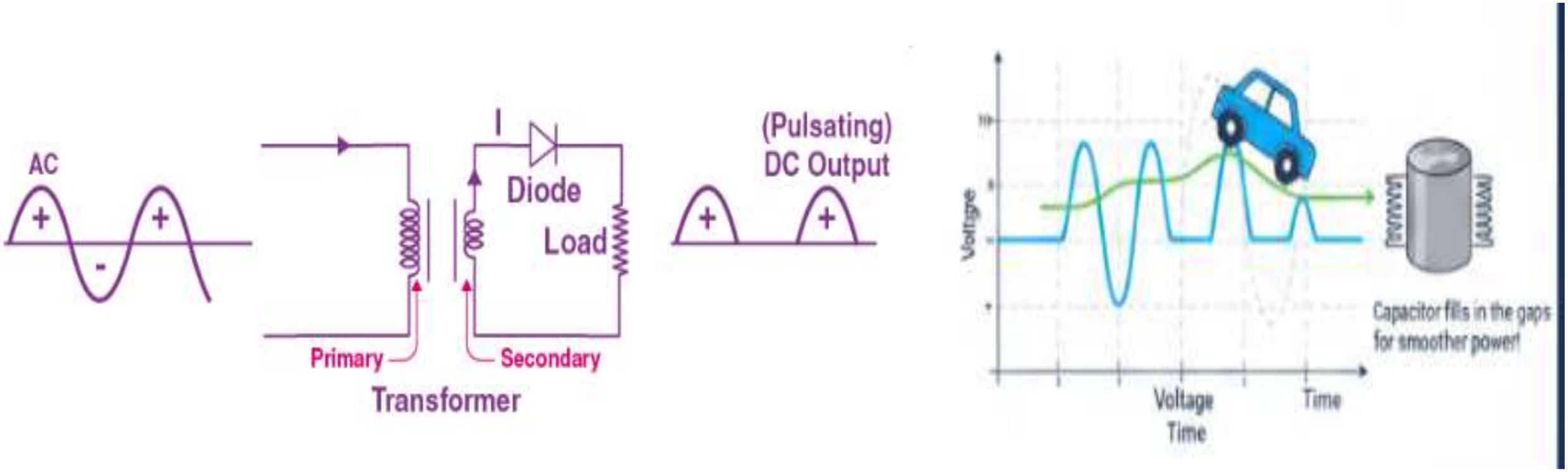
The halfwave rectifier waveform before and after rectification is shown below in the figure.



Half Wave Rectifier Capacitor Filter

The output waveform of a halfwave rectifier is a pulsating DC waveform. Filters in halfwave rectifiers are used to transform the pulsating waveform into constant DC waveforms. A capacitor or an inductor can be used as a filter.

The circuit diagram below shows how a capacitive filter is used with halfwave rectifier to smoothen out a pulsating DC waveform into a constant DC waveform.



Applications of Half Wave Rectifier

Here are a few common applications of half wave rectifiers:

They are used for signal demodulation purpose

They are used for rectification applications

They are used for signal peak applications

Disadvantages of Half Wave Rectifier

Power loss

Low output voltage

The output contains a lot of ripples

RMS value of Half Wave Rectifier

The RMS value of the load current for a half-wave rectifier is given by the formula:

$$I_{rms} = \frac{I_m}{2}$$

Form factor of a Halfwave Rectifier

The form factor is the ratio between RMS value and average value and is given by the formula:

$$\text{Form Factor} = \frac{\text{RMS Value}}{\text{Average Value}}$$

Half Wave Rectifier Formula

Ripple Factor of Half Wave Rectifier

Ripple factor determines how well a halfwave rectifier can convert AC voltage to DC voltage.
Ripple factor can be quantified using the following formula:

$$\gamma = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}$$

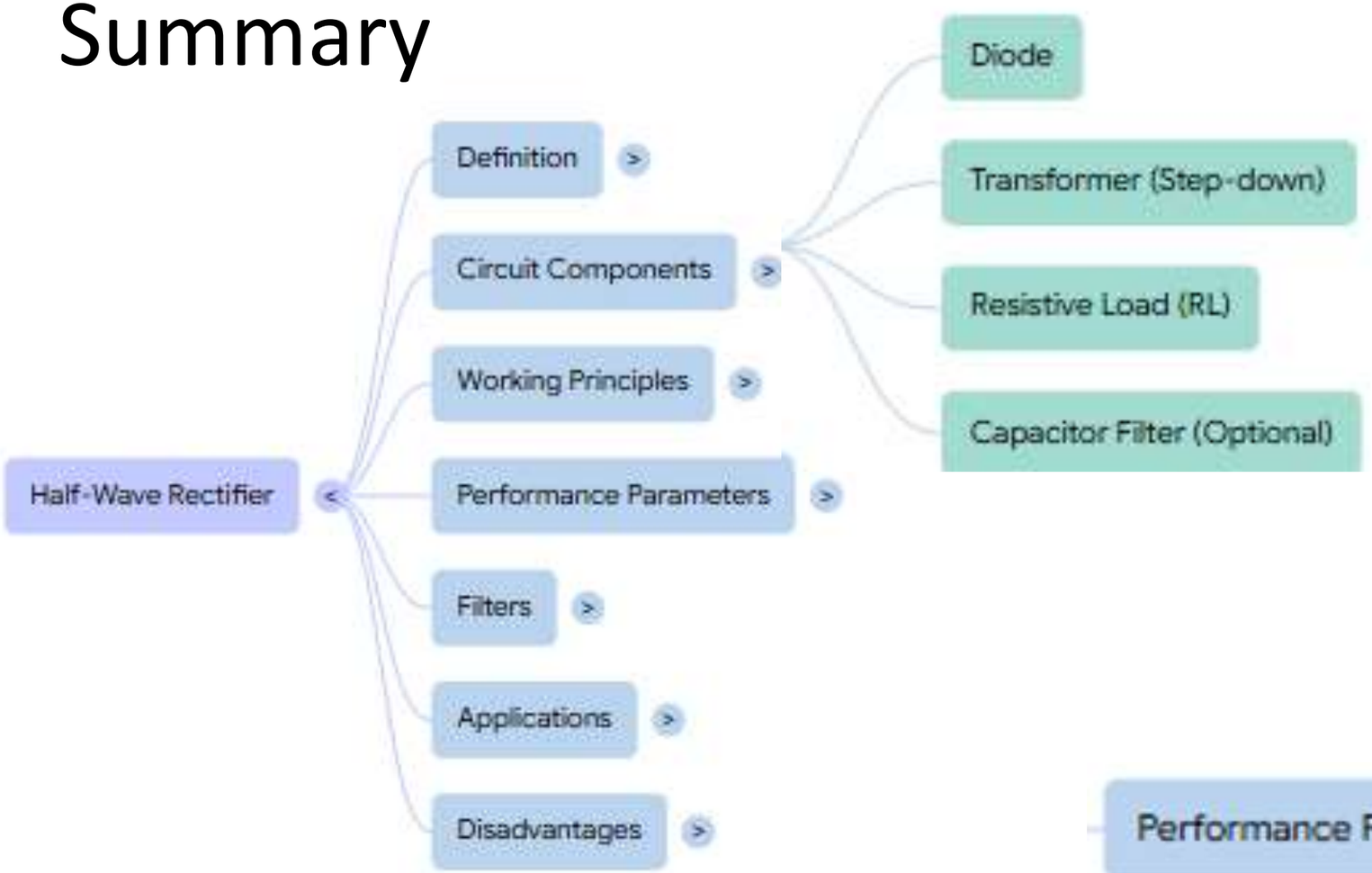
The ripple factor of a halfwave rectifier

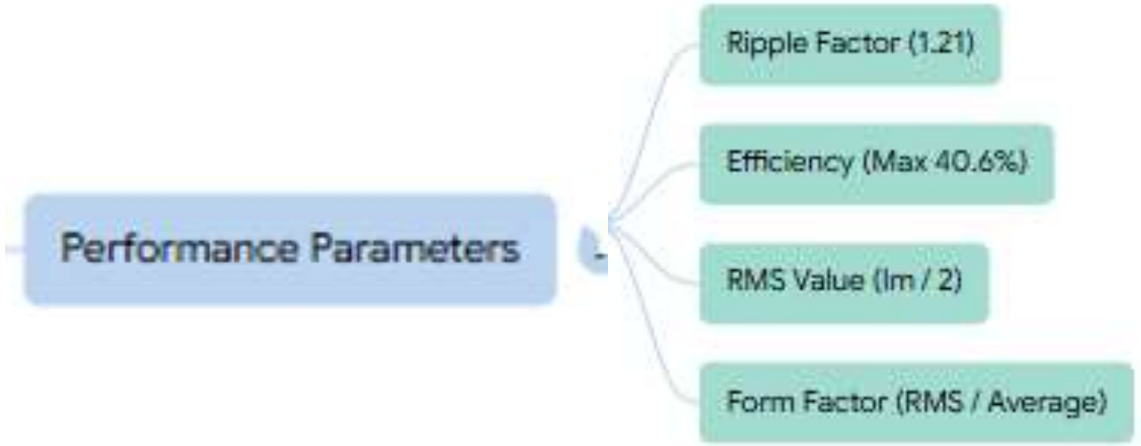
Efficiency of Halfwave Rectifier

The efficiency of a halfwave rectifier is the ratio of output DC power to the input AC power.
The efficiency formula for halfwave rectifier is given as follows;

$$\eta = \frac{P_{DC}}{P_{AC}}$$

Summary


Half-Wave Rectifier
Definition
Circuit Components
Working Principles
Performance Parameters
Filters
Applications
Disadvantages
Diode
Transformer (Step-down)
Resistive Load (RL)
Capacitor Filter (Optional)


Performance Parameters
Ripple Factor (1.21)
Efficiency (Max 40.6%)
RMS Value (Im / 2)
Form Factor (RMS / Average)

Quiz / Gamified Questions:

1.A diode in a half wave rectifier conducts during:

A) Positive half cycle

B) Negative half cycle

C) Both half cycles

D) None

(Correct: A)

1.Scenario: You have a small sensor circuit that requires 5V DC but your supply is 9V AC. You want a simple rectification solution. Would a half wave rectifier be ideal? Why or why not?

1.Real-time: If the AC input is 10V RMS and the diode is ideal, calculate the average DC output voltage.

Assessment Q&A

Question	Answer
1. Why is ripple factor of half wave rectifier 1.21 and not zero?	**Answer:** Only positive half-cycle is passed → output is pulsing, not constant DC Ripple factor = √(Vrms² – Vdc²)/Vdc = 1.21
2. Can we use half wave rectifier for 100 W laptop charger? Why/Why not?	**Answer:** NO → Not practical Reasons (with icons): • Efficiency only 40.6% → 60 W wasted as heat → diode will burn • High ripple damages laptop battery & components • Transformer core saturation due to DC component • Needs at least full-wave + big filter capacitor
3. Curiosity Challenge: Design a circuit to get smooth DC from half wave rectifier (Hint: Add one component)	**Answer Revealed:** Add one **Electrolytic Capacitor** across load RL **Diagram (before → after):** • Left: Pulsating half-wave output (jagged) • Right: Smooth DC after adding 1000 µF capacitor (almost flat line)

References

Muthusubramanian R, Salivahanan S, "Basic Electrical and Electronics Engineering", TataMcGrawHillPublishers,2014.
Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020.

Thank you