SNS COLLEGE OF TECHNOLOGY

Kurumbapalayam (Po), Coimbatore – 641 107
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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

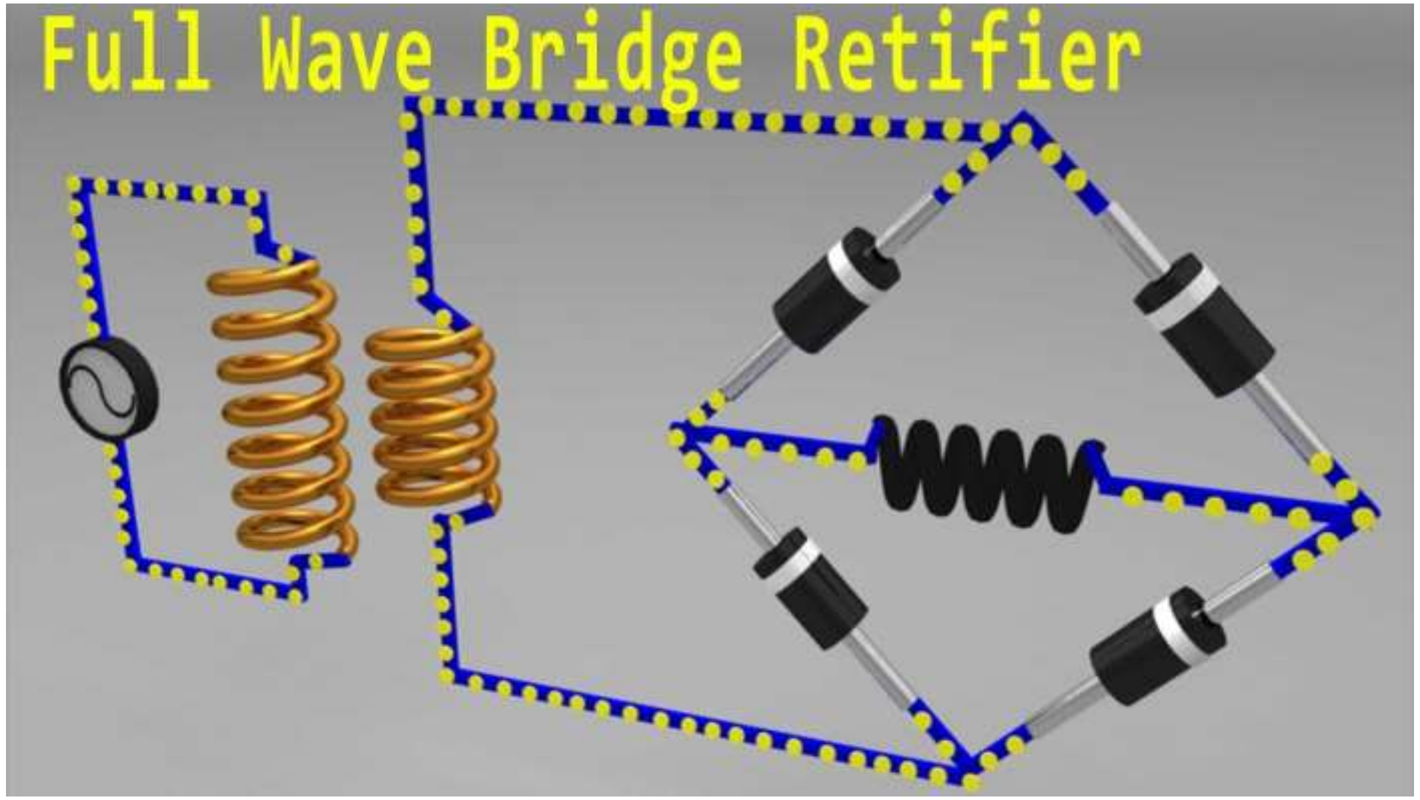
I YEAR /II SEMESTER

Unit-5 - RECTIFIERS AND POWER SUPPLIES

Topic : **Bridge Rectifiers**

Here is an in-depth empathy for why bridge rectifiers are used

1. **Maximum Efficiency: Utilizing the Full Wave**
2. **Eliminates Costly & Heavy Components**
3. **Lower Ripple Factor & Better Performance**
4. **Better Transformer Utilization (TUF)**
5. **Increased Reliability and Safety**



Full Wave Bridge Rectifier

Construction of Full Wave Bridge Rectifier

A full wave bridge rectifier is a rectifier that will use four diodes or more than that in a bridge formation.

A full wave bridge rectifier system consists of

- Four Diodes
- Resistive Load

We use the diodes, namely A, B, C and D, which form a bridge circuit. The circuit diagram is as follows.

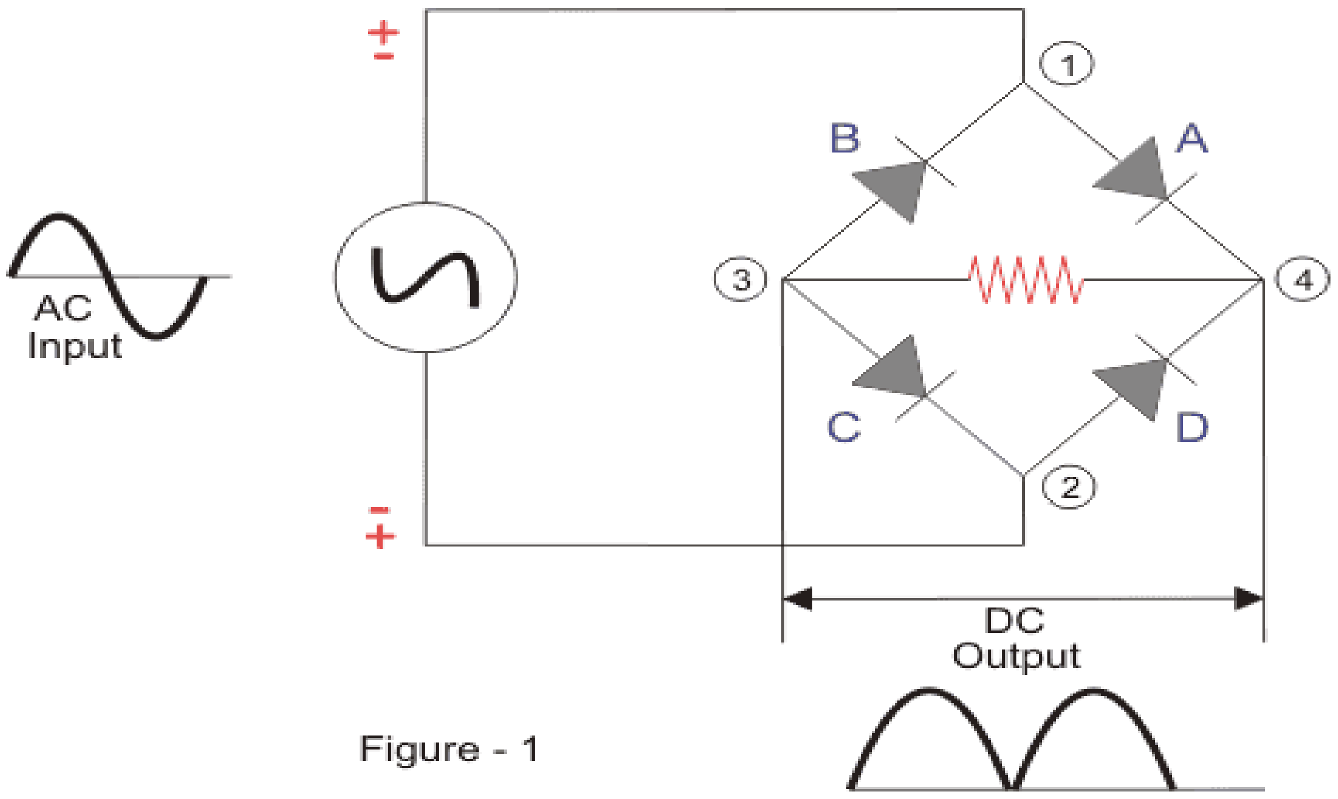


Figure - 1

Principle of Full Wave Bridge Rectifier

DT-DEFINE

We apply an AC across the bridge. During the positive half-cycle, terminal 1 becomes positive, and terminal 2 becomes negative.

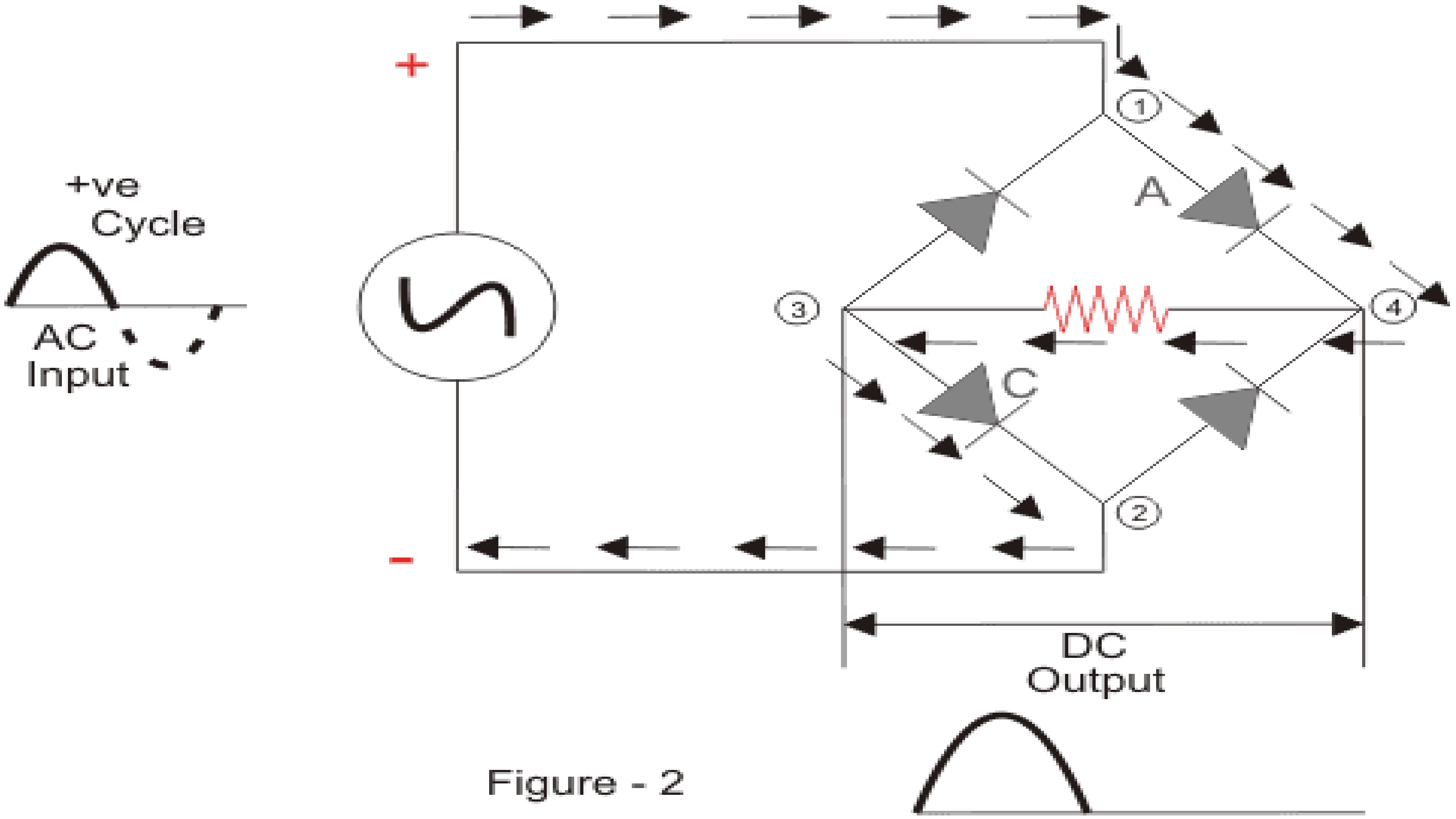


Figure - 2

This will cause the diodes A and C to become forward-biased, and the current will flow through it. Meanwhile, diodes B and D will become reverse-biased and block current through them. The current will flow from 1 to 4 to 3 to 2.

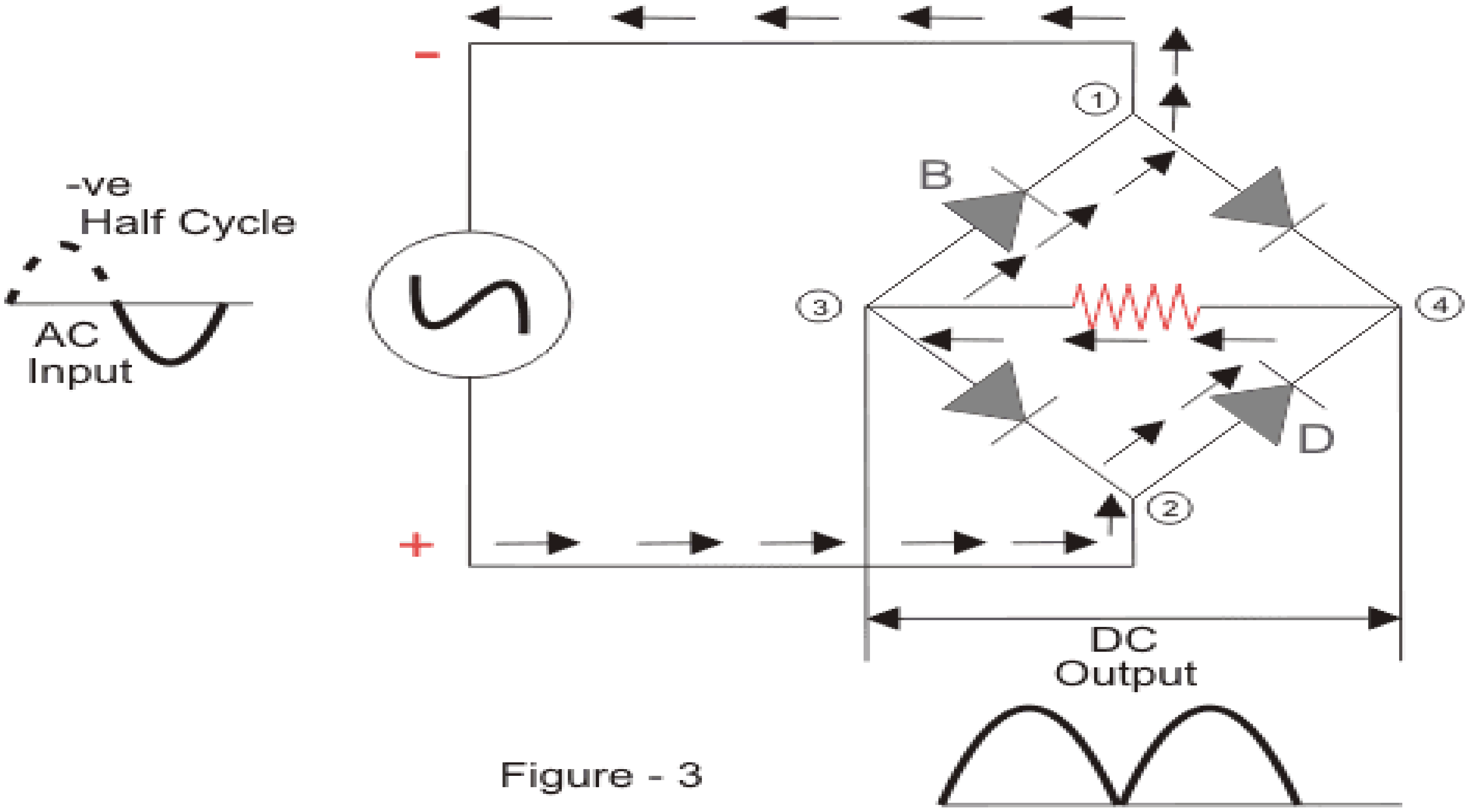


Figure - 3

During the negative half-cycle, terminal 1 will become negative, and terminal 2 will become positive.

This will cause the diodes B and D to become forward-biased and will allow current through them. At the same time, diodes A and C will be reverse-biased and will block the current through them. The current will flow from 2 to 4 to 3 to 1.

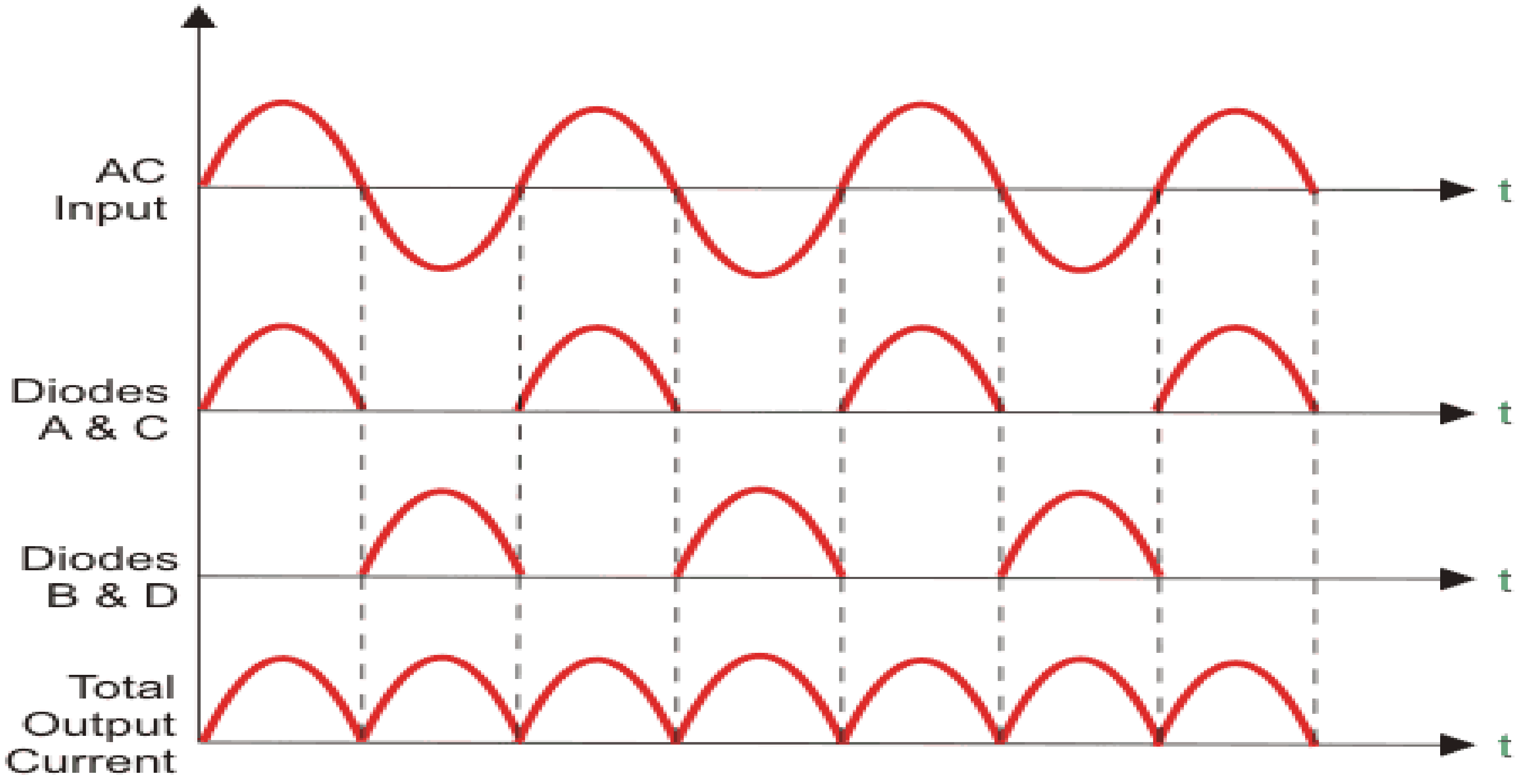


Figure - 4

Filter Circuit

DT-IDEATE

The output from a full wave bridge rectifier is a pulsating DC voltage with noticeable ripples, which is unsuitable for practical applications without further modification.

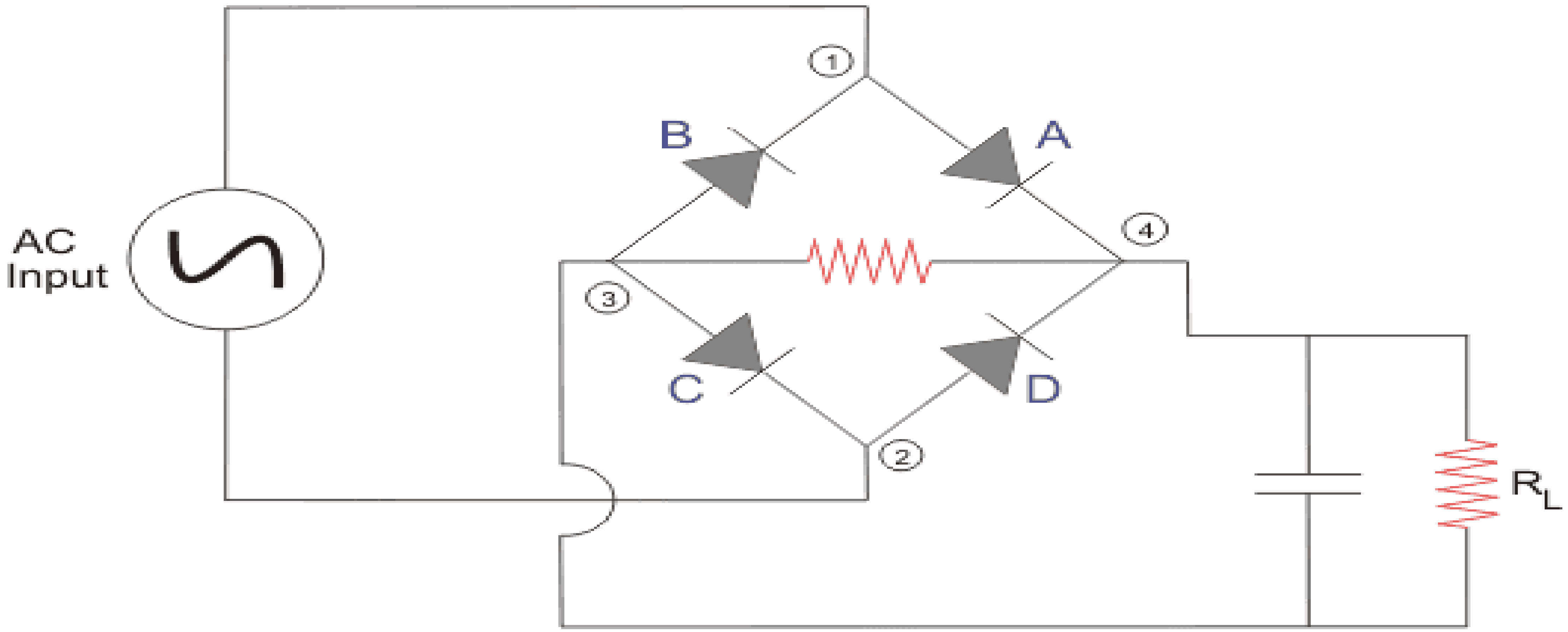


Figure - 5

So, to convert the pulsating DC voltage to pure DC voltage, we use a filter circuit as shown above. Here we place a capacitor across the load. The working of the capacitive filter circuit is to short the ripples and block the DC component so that it flows through another path, and that is through the load.

During the half-wave, the diodes A and C conduct. It charges the capacitor immediately to the maximum value of the input voltage. When the rectified pulsating voltage starts decreasing and less than the capacitor voltage, the capacitor starts discharging and supplies current to the load.

This discharging is slower when compared to the charging of the capacitor, and it does not get enough time to discharge entirely, and the charging starts again in the next pulse of the rectified voltage waveform.

So around half of the charge present in the capacitor gets discharged. During the negative cycle, the diodes B and D start conducting, and the above process happens again. This causes the current to continue to flow through the same direction across the load.

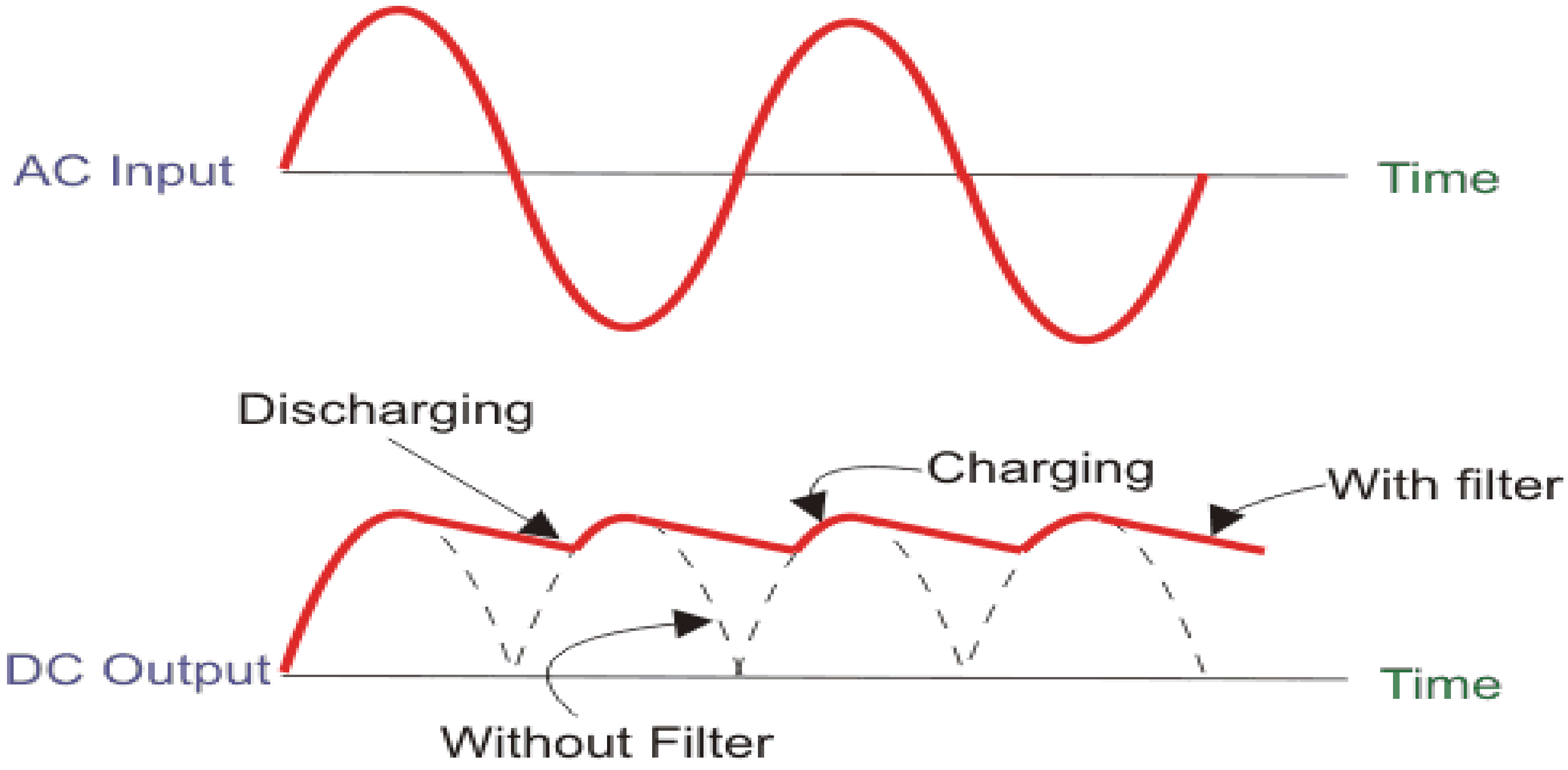
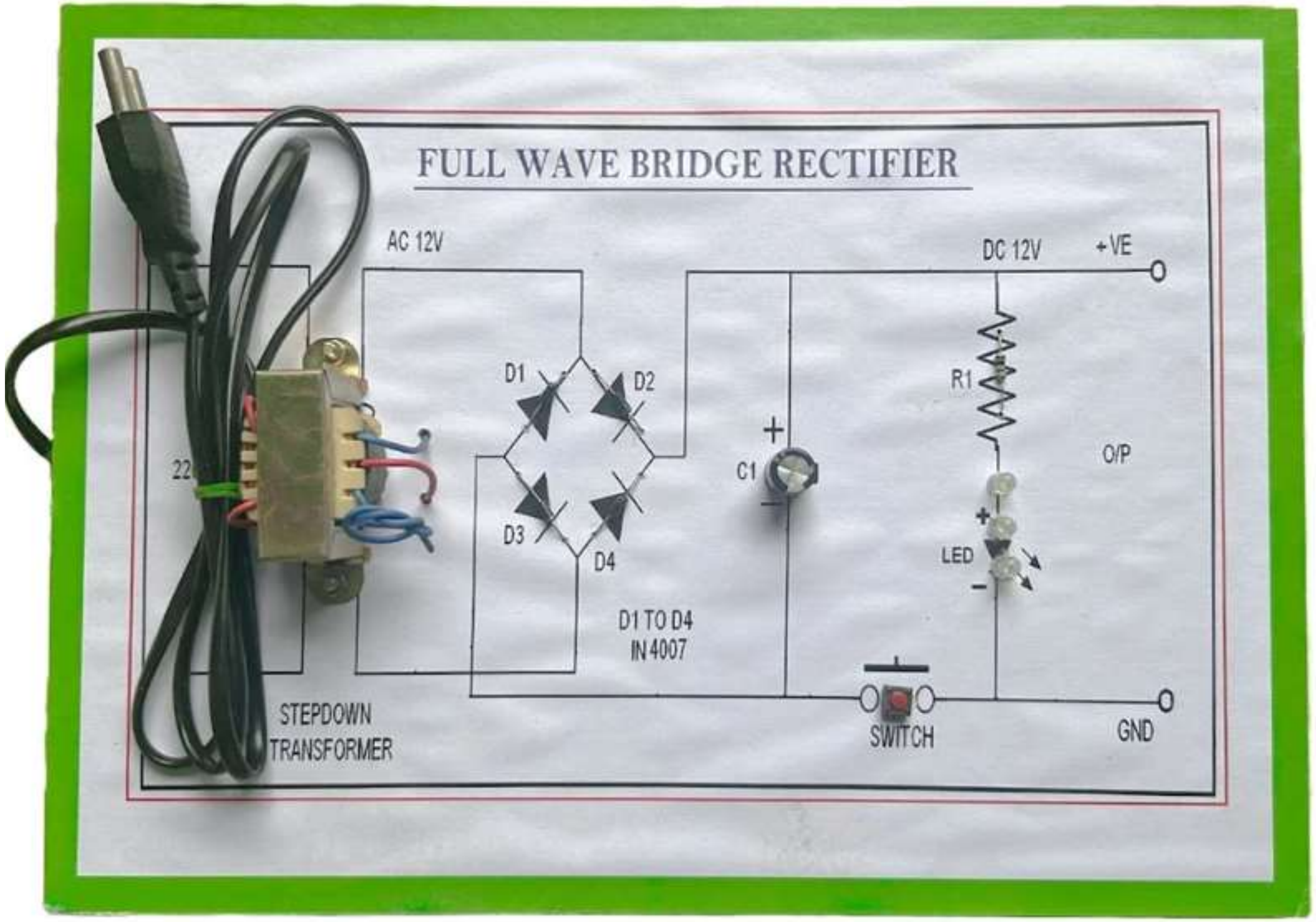

AC Input
Time
Discharging
Charging
With filter
DC Output
Time
Without Filter

Figure - 6

DT- Prototype



Full Wave Rectifier Formula

DT-Test

We will now derive the various formulas for a full wave rectifier based on the preceding theory and graphs above.

Ripple Factor of a Full Wave Rectifier (γ)

'Ripple' is the unwanted AC component remaining when converting the AC voltage waveform into a DC waveform.

Even though we try out best to remove all AC components, there is still some small amount left on the output side which pulsates the DC waveform. This undesirable AC component is called 'ripple'.

To quantify how well the half-wave rectifier can convert the AC voltage into DC voltage, we use what is known as the ripple factor (represented by γ or r).

The ripple factor is the ratio between the RMS value of the AC voltage (on the input side) and the DC voltage (on the output side) of the rectifier.
The formula for ripple factor is:

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

Where V_{rms} is the RMS value of the AC component, and V_{dc} is the DC component in the rectifier.
The ripple factor of a centre-tapped full-wave rectifier is equal to 0.48 (i.e. $\gamma = 0.48$).

Note: To construct a good rectifier, we need to keep the ripple factor as minimum as possible. We can use capacitors or inductors to reduce the ripples in the circuit.

Efficiency of a Full Wave Rectifier (η)

Rectifier efficiency (η) is the ratio between the output DC power and the input AC power. The formula for the efficiency is equal to:

$$\eta = \frac{P_{dc}}{P_{ac}}$$

The efficiency of a centre-tapped full-wave rectifier is equal to 81.2% (i.e. $\eta_{max} = 81.2\%$)
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Form Factor of a Full Wave Rectifier (F.F)

DT-Test

The form factor is the ratio between RMS value and average value.

$$FF = \frac{RMS\ value}{Average\ value}$$

The formula for form factor is given below:

The form factor of a centre-tapped full wave rectifier is equal to 1.11 (i.e. FF = 1.11).

Advantages of Full Wave Rectifiers

The advantages of full wave rectifiers include:

Full wave rectifiers have higher rectifying efficiency than half-wave rectifiers. This means that they convert AC to DC more efficiently.

They have low power loss because no voltage signal is wasted in the rectification process.

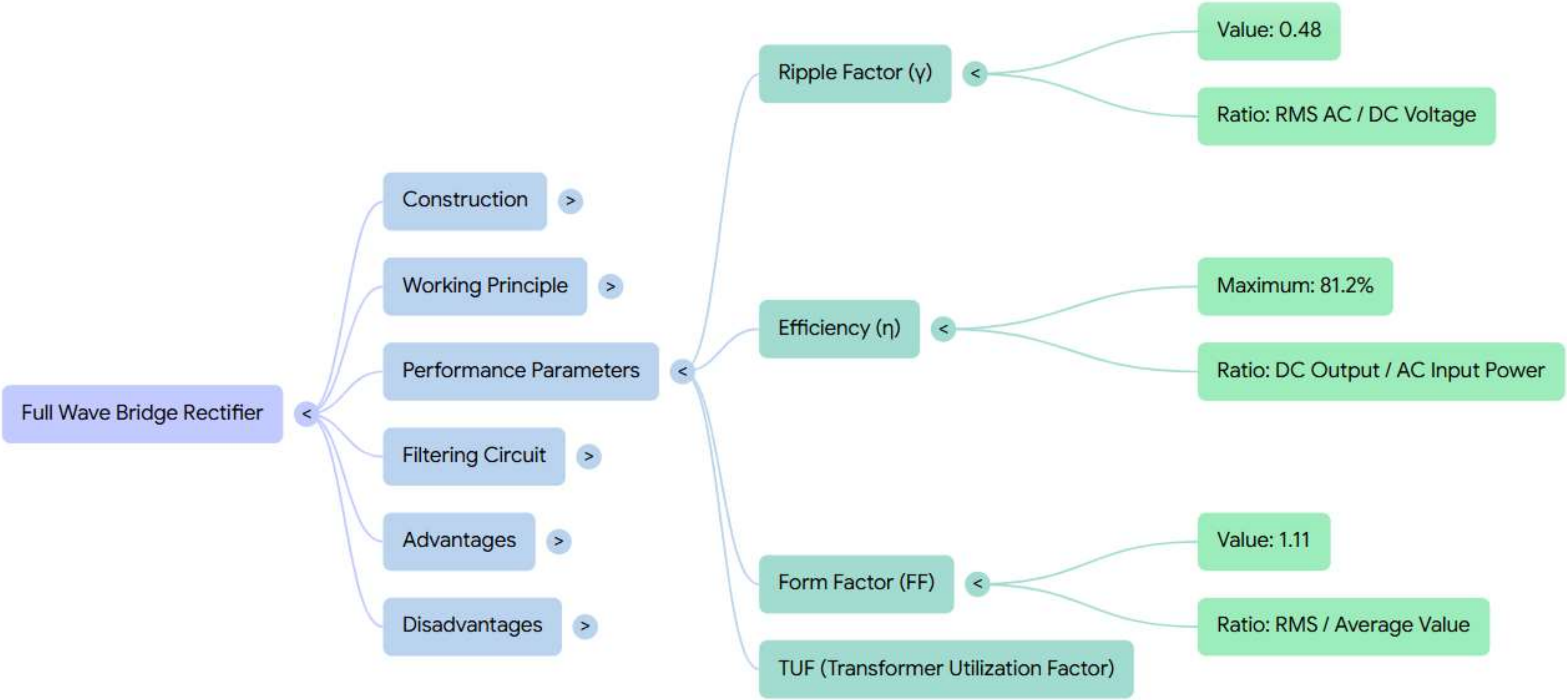
The output voltage of a centre-tapped full wave rectifier has lower ripples than a halfwave rectifiers.

Disadvantages of Full Wave Rectifiers

The disadvantages of full wave rectifiers include:

The centre-tapped rectifier is more expensive than a half-wave rectifier and tends to occupy a lot of space.

Summary


Full Wave Bridge Rectifier
Construction
Working Principle
Performance Parameters
Filtering Circuit
Advantages
Disadvantages
Ripple Factor (γ)
Value: 0.48
Ratio: RMS AC / DC Voltage
Efficiency (η)
Maximum: 81.2%
Ratio: DC Output / AC Input Power
Form Factor (FF)
Value: 1.11
Ratio: RMS / Average Value
TUF (Transformer Utilization Factor)

•Quiz: How many diodes are required for a bridge rectifier?
A) 1
B) 2
C) 4
D) 3
(Correct: C)

•Scenario: Your circuit doesn't have a centre-tapped transformer. Which rectifier would you choose and why?

•Real-time: The bridge rectifier output shows ripple voltage. Suggest a simple filtering method to reduce it.

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.