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COURSE: MCT 510

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1. Single phase half wave controlled rectifier

A rectifier circuit generally converts AC input to DC output. The single phase half wave controlled rectifier converts the AC input to a DC output only for positive half cycle of the AC input supply. In this type of rectifier, the starting point of load current can be changed by controlling the firing angle of SCR. The single Phase Half Wave Controlled Rectifier circuit consists of a Thyristor, an AC voltage source and load. The load may be purely resistive, Inductive or a combination of resistance and inductance

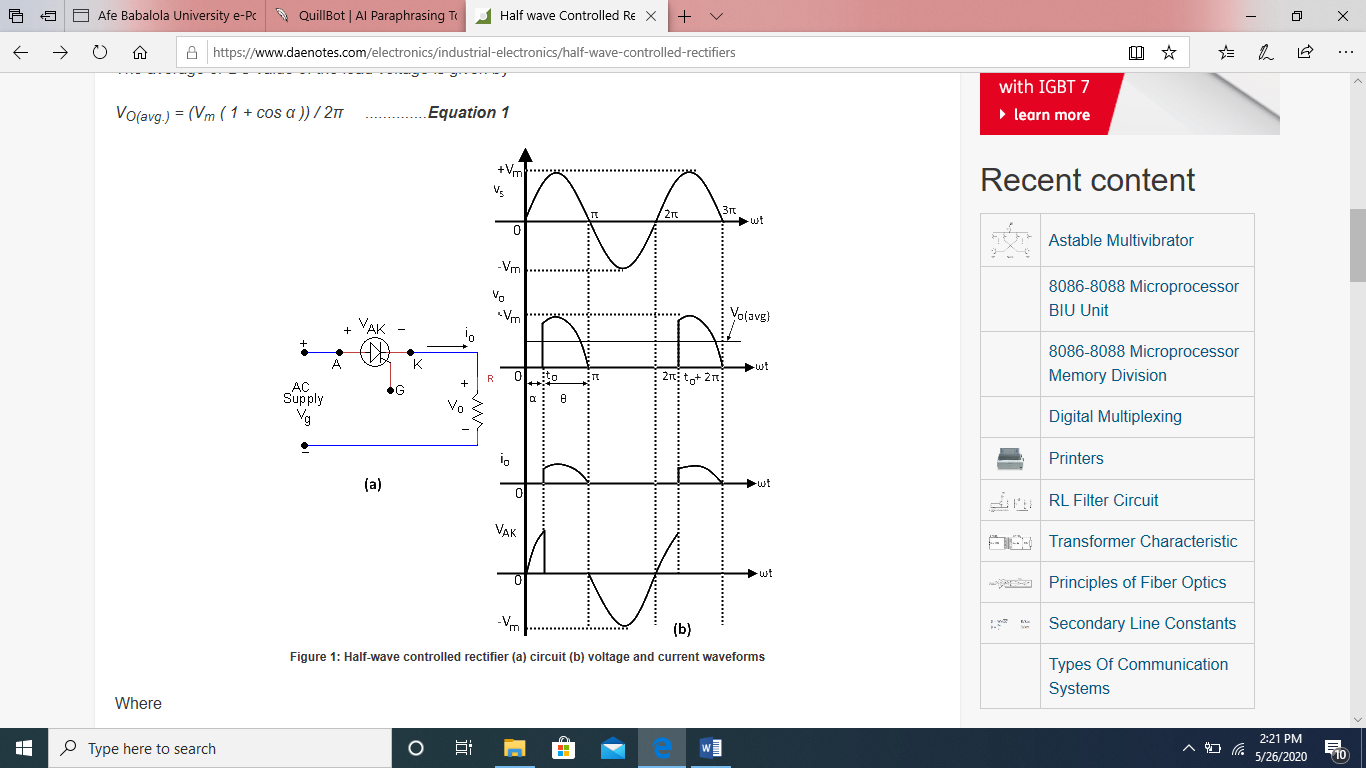


Figure1a: Single phase half wave rectifier circuit

Source: https://www.daenotes.com/electronics/industrial-electronics/half-wave-controlled-rectifiers

Where

v0 = Load output voltage

i0 = Load current

VT = Voltage across the Thyristor T

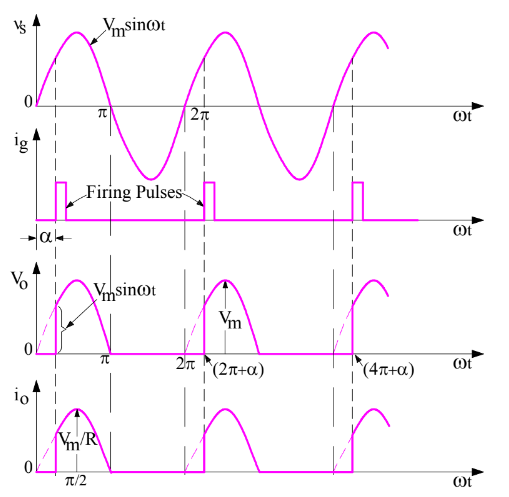


Figure 1b: wave circuit diagram for single phase half wave rectification circuit.

Source: https://electricalbaba.com/single-phase-half-wave-controlled-rectifie

This converter is not normally used in industrial applications because it’s output as high

ripple content and low ripple frequency.

1. single phase full wave controlled rectifier using a center tapped transformer

A full wave rectifier is a type of rectifier which converts both half cycles of the AC signal into pulsating DC signal. The center tapped full wave rectifier is a type of rectifier which uses a center tapped transformer and two SCRs (thyristors) to convert the complete AC signal into DC signal.

The center tapped full wave rectifier is made up of an AC source, a center tapped transformer, two diodes, and a load resistor.

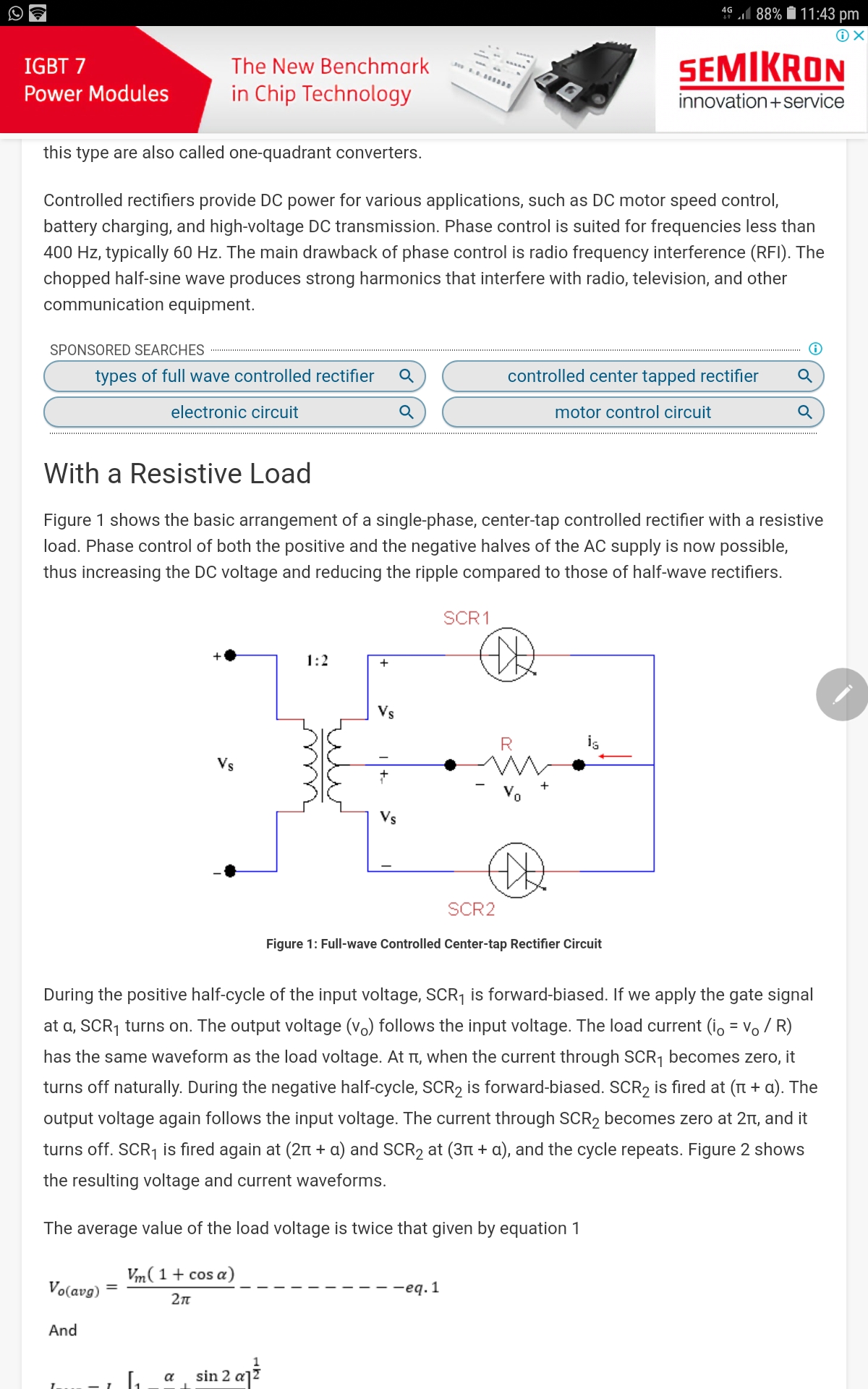


Figure2a: single phase full wave controlled rectifier using a center tapped transformer

Source: https://www.daenotes.com/electronics/devices-circuits/center-tapped-full-wave-rectifier

During the positive half cycle of the input voltage SCR1 is forward biased. Applying a gate signal at 𝛼, turns on SCR 1. The output voltage (Vo) follows the input voltage. The load current has the same wave form as the load voltage .At π, when the current through SCR1 becomes zero, it turns off naturally. During the negative half cycle, SCR2 is forward biased. SCR2 is fired at (π+𝛼), the output voltage then follows the input voltage. The current through SCR2 becomes zero at 2 and it turns off. SC 1 is fired at (2π +𝛼) and SCR 2 at (3π+𝛼) and the cycle repeats

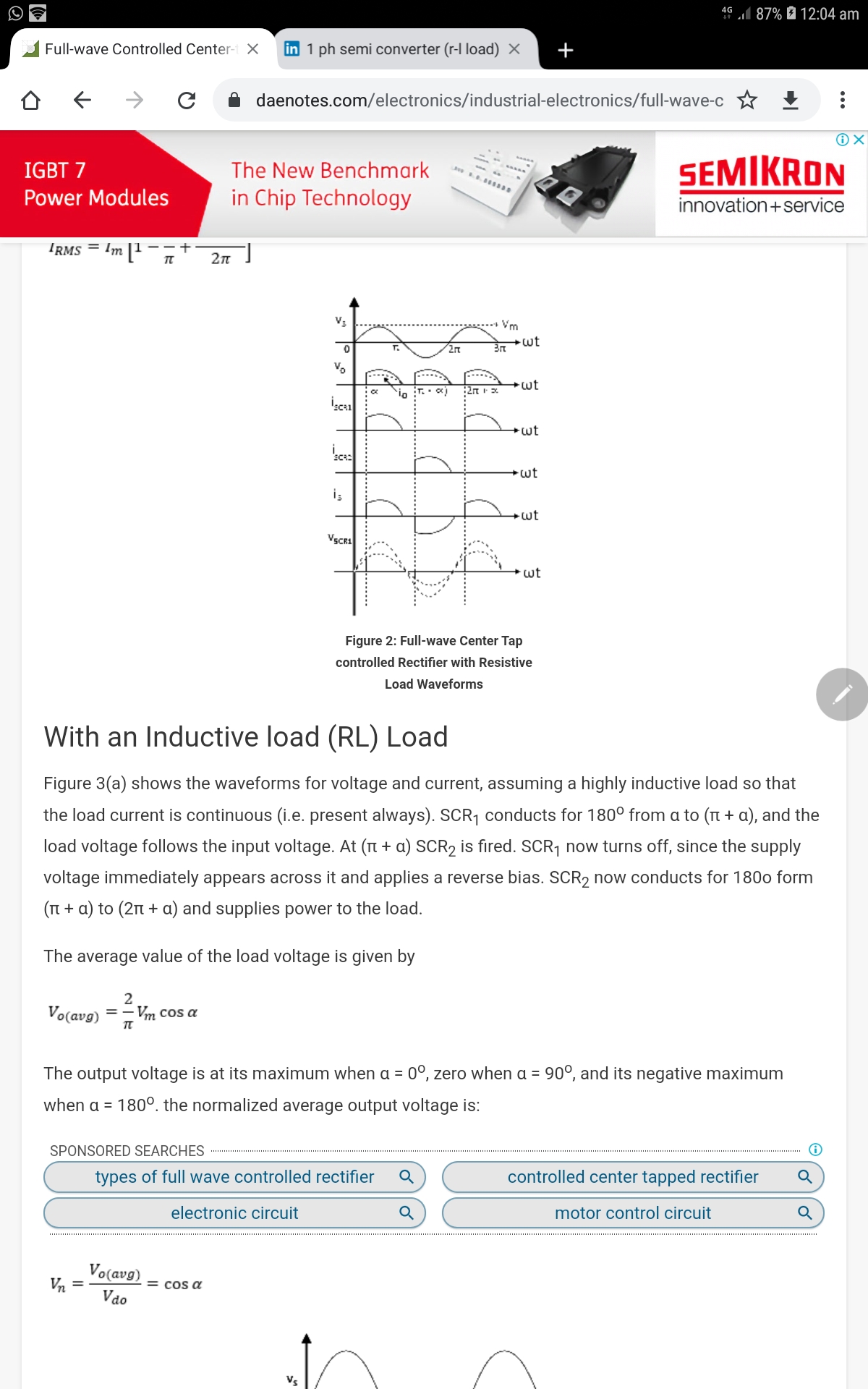
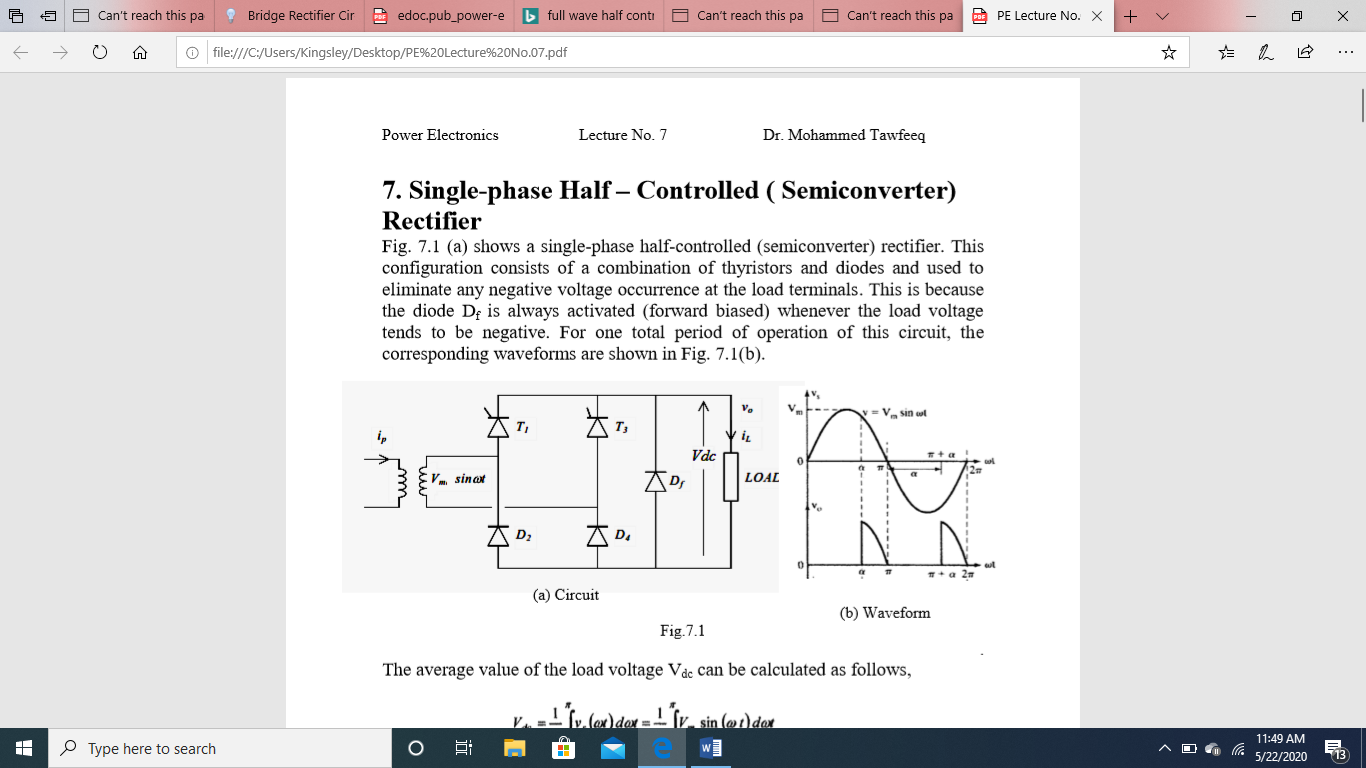


Figure 2b: wave form of single phase full wave controlled rectifier using a center tapped transformer

Source: https://www.daenotes.com/electronics/devices-circuits/center-tapped-full-wave-rectifier

1. single phase full wave rectifier (semi- converter bridge configuration):

This configuration consists of a combination of two thyristors and diodes and used to eliminate any negative voltage occurrence at the load terminals. This is because the diode Dғ is always activated (forward biased) whenever the load voltage tends to be negative. For one total period of operation of this circuit, the corresponding waveforms are shown in Figure 3.



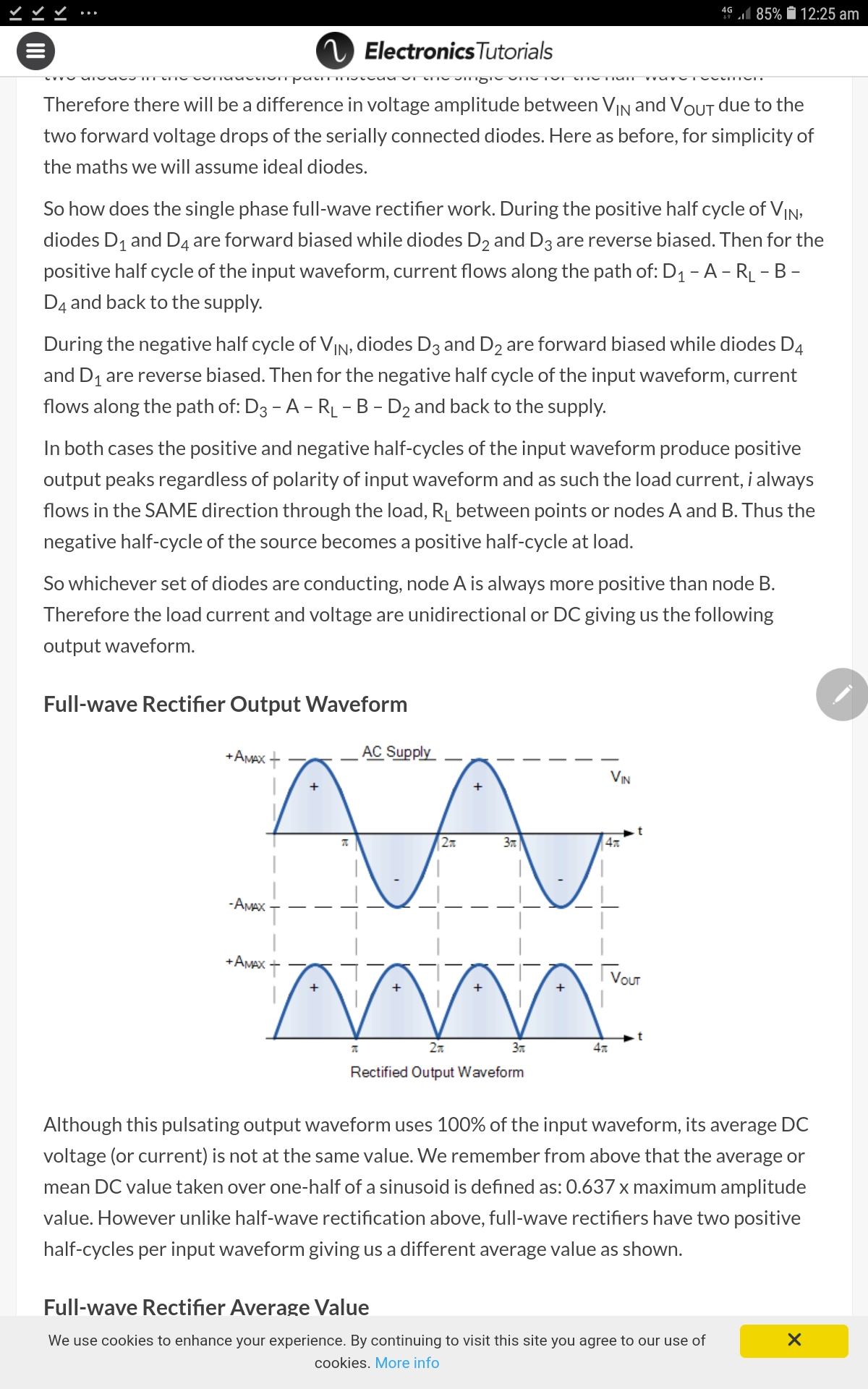


Figure 3: single phase full wave rectifier (semi- converter bridge configuration)

1. Three phase full wave rectifier (semi converter bridge configuration)

This converter consists of three thyristors and three diodes with freewheeling diode across the load. It gives positive voltage and positive current only (not regenerative converter) that is, it operates in the first quadrant only Figure4.

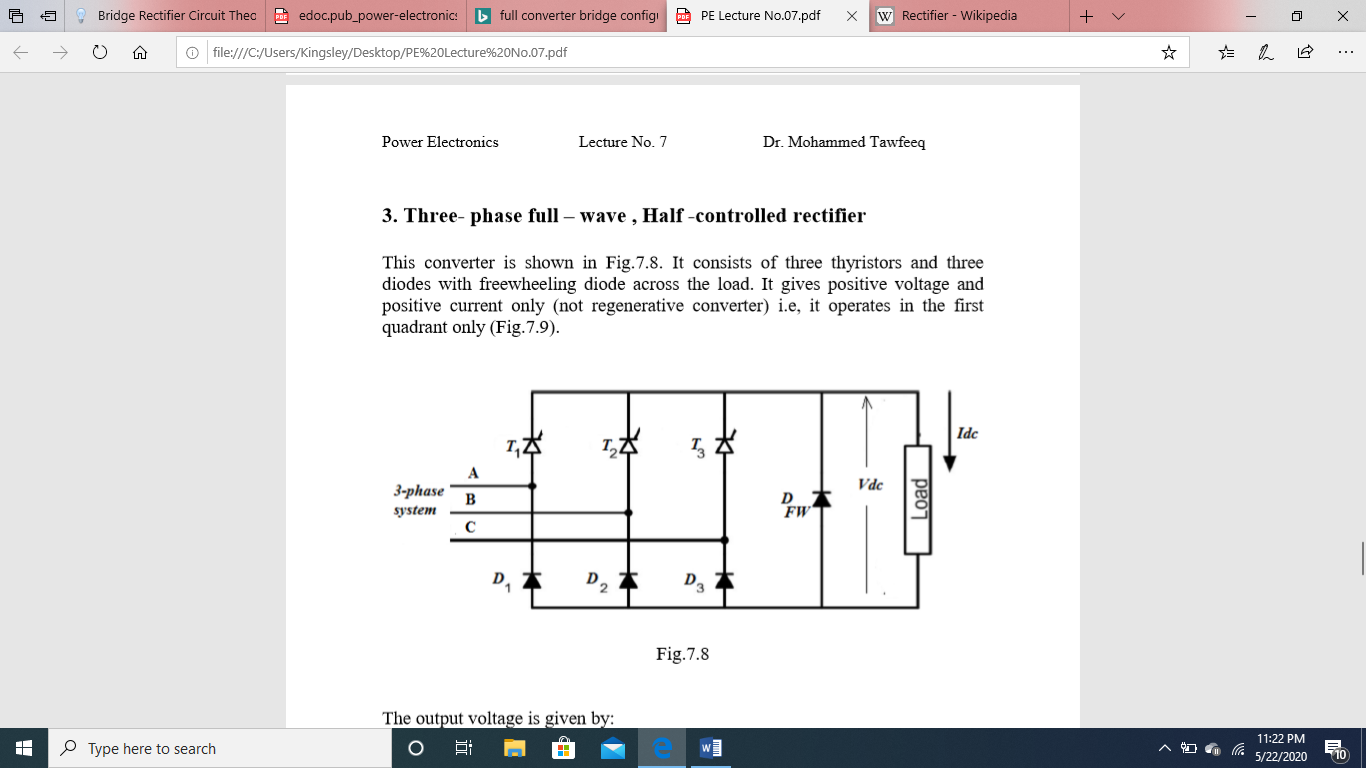


Figure 4: Three phase full wave rectifier (semi converter configuration)

Source: power Electronics by Dr. Mohammed Tawfeeq

1. Single phase full wave rectifier ( Full converter bridge configuration)

This bridge configuration of diodes provides full-wave rectification because at any time two of the four diodes are forward biased while the other two are reverse biased. Thus there are two diodes in the conduction path instead of the single one for the half-wave rectifier. Therefore there will be a difference in voltage amplitude between VIN and VOUT due to the two forward voltage drops of the serially connected diodes. During the positive half cycle of VIN, diodes D1 and D4 are forward biased while diodes D2 and D3 are reverse biased. Then for the positive half cycle of the input waveform, current flows along the path of: D1 – A – RL – B – D4 and back to the supply.

During the negative half cycle of VIN, diodes D3 and D2 are forward biased while diodes D4 and D1 are reverse biased. Then for the negative half cycle of the input waveform, current flows along the path of: D3 – A – RL – B – D2 and back to the supply.

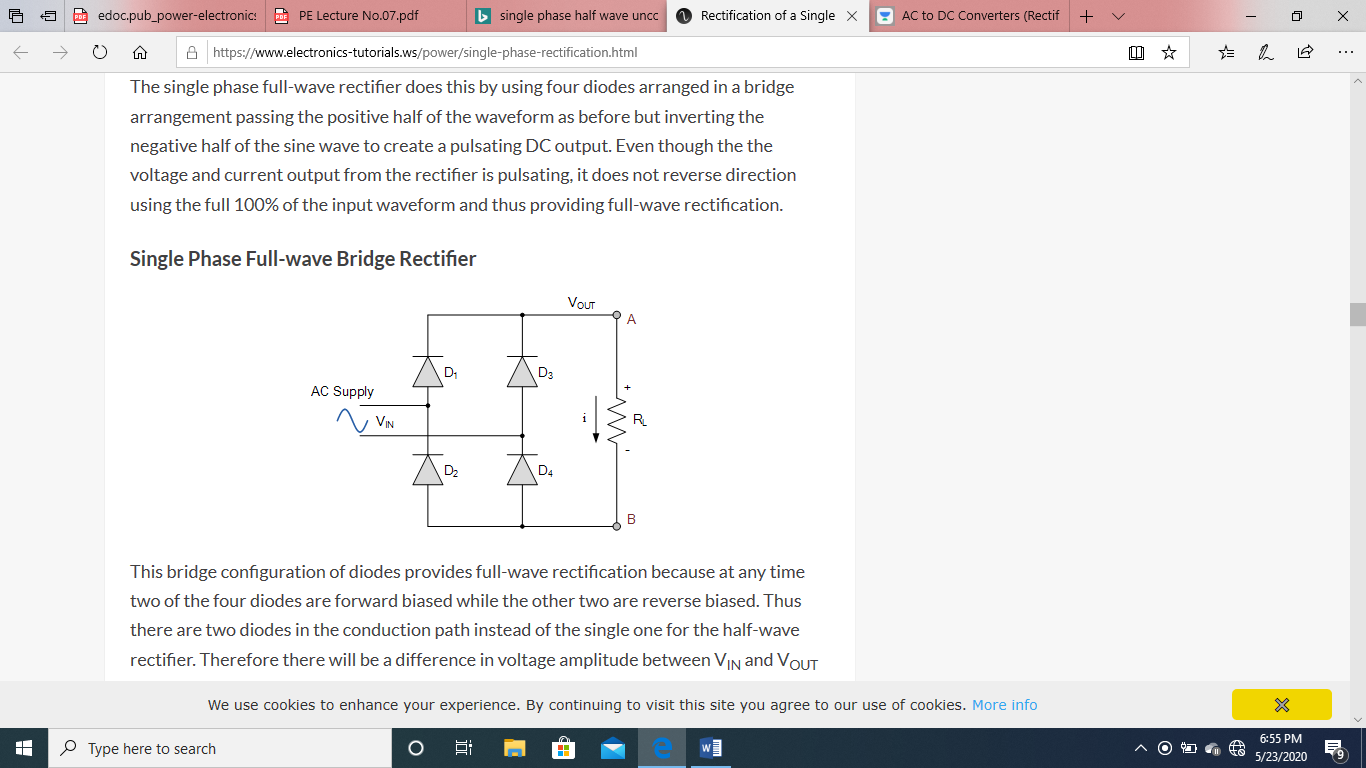


Figure5a: Single phase full wave rectifier

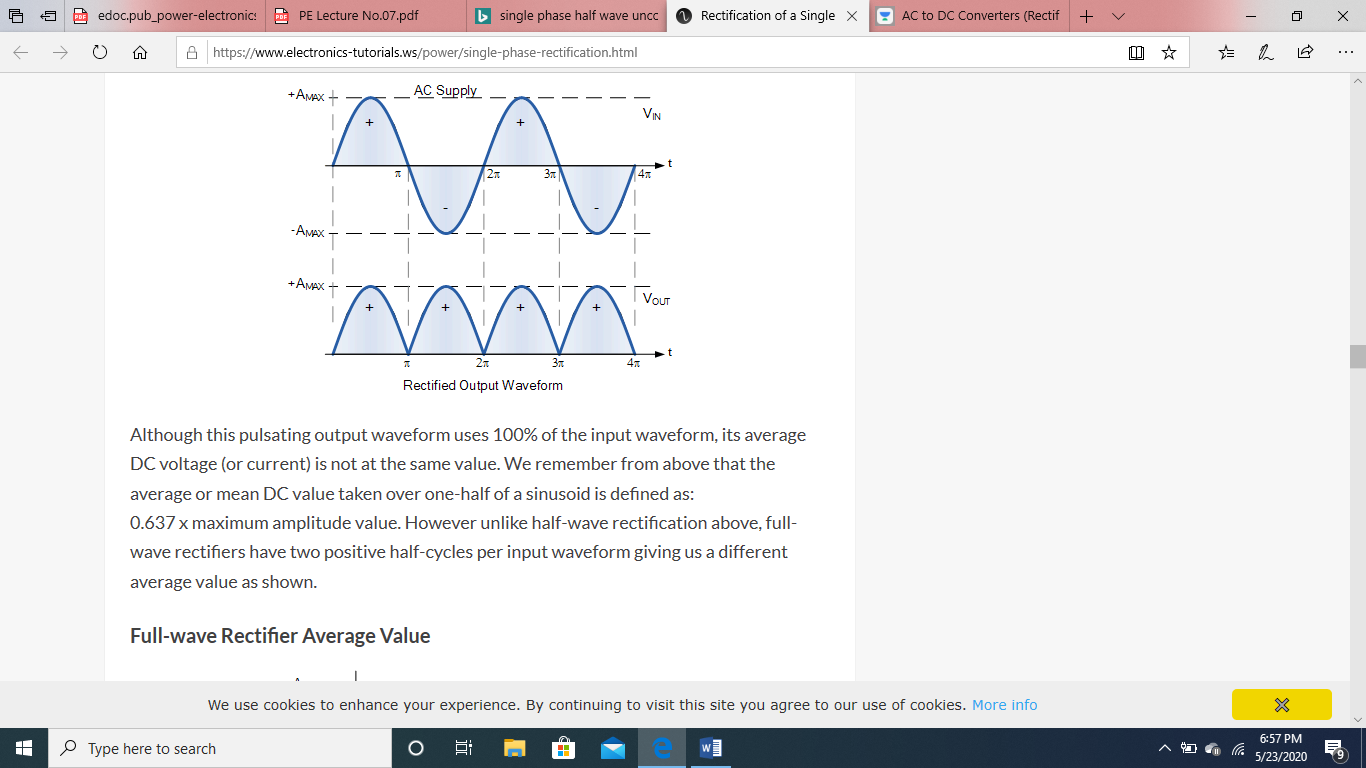


Figure 5b: output wave form of Single phase full wave rectifier

1. Three phase full wave rectifier full converter bridge configuration

Three phase rectification converts 3 phase Ac supply into a pulsating Dc voltage. The circuit configuration of the three- phase full – wave controlled rectifier is shown in Figure 6a, it consists of six thyristors connected in form of full wave bridge rectification which are turned on at appropriate times by suitable gate trigger signals. In this circuit, the Thyristor which has the most positive voltage at its anode conducts when triggered, and the Thyristor with the most negative voltage at its cathode returns the load current, if triggered. The waveforms can also be seen in figure 6b,

- Commutation of the load current from one Thyristor to the next occurs at the firing instant, when the incoming thyristors reverse biases the previously conducting thyristors.

-The output dc voltage waveform is determined by the difference of potentials of the positive and negative rails.

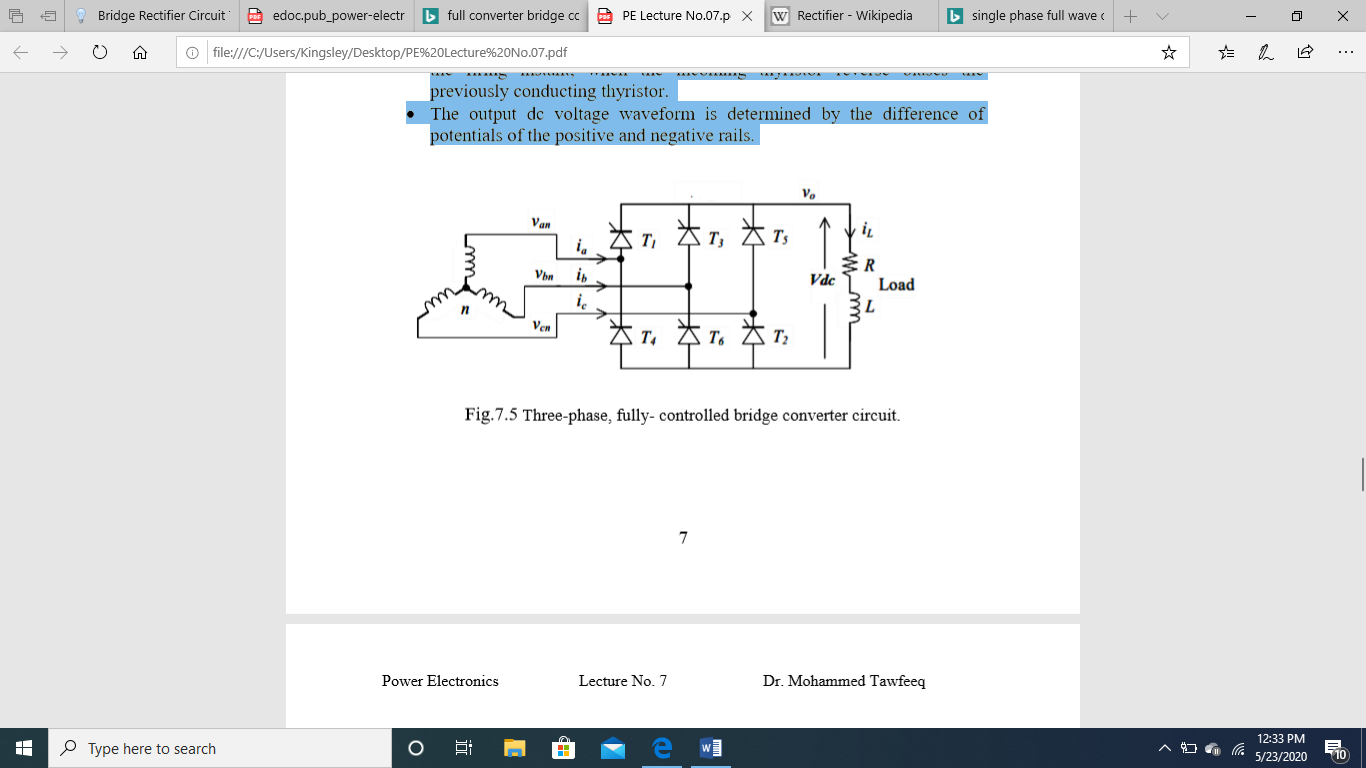


Figure 6a: Three phase full wave rectifier full converter bridge configuration

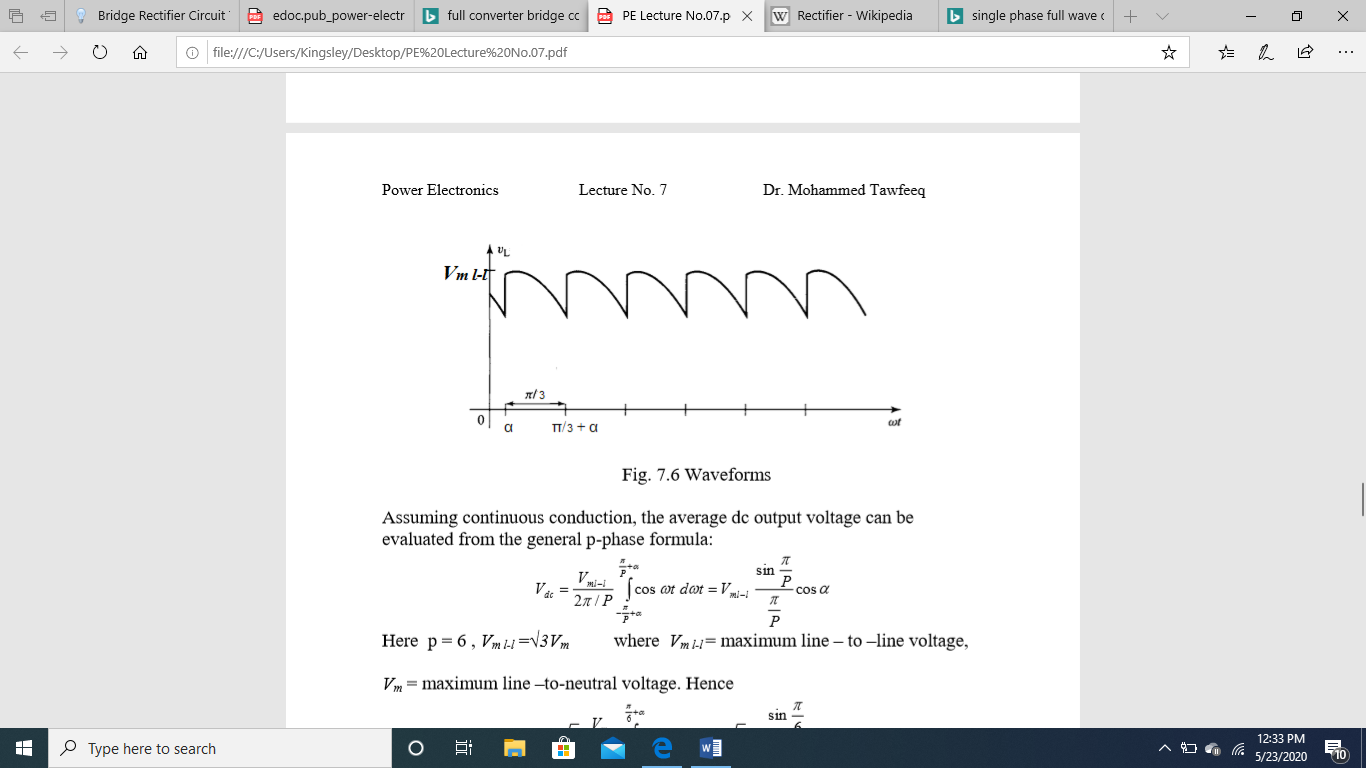


Figure 6b: wave form for three phase full wave rectifier full converter bridge configuration

Source: power Electronics by Dr. Mohammed Tawfeeq

1. Single Phase Half wave uncontrolled rectifier

single phase uncontrolled half-wave rectifiers are the simplest and possibly the most widely used rectification circuit for small power levels as their output is heavily affected by the reactance of the connected load. During each positive half cycle of the AC sine wave, the diode is forward biased as the anode is positive with respect to the cathode resulting in current flowing through the diode. Since the DC load is resistive (resistor ,R) the current flowing in the load resistor is therefore proportional to the voltage (ohm’s law) and the voltage across the load resistor will therefore be the same as the supply voltage ,Vs that is the ‘DC’ voltage across the load is sinusoidal for the first half only so Vout =Vs

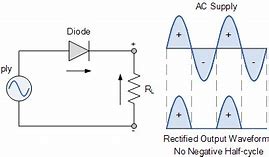


Figure 7: Single Phase half wave uncontrolled rectifier and its wave form

1. Single phase full wave uncontrolled rectifier

Unlike the half wave, the full-wave rectifier utilizes both halves of the input sinusoidal waveform to provide a unidirectional output. The single phase full-wave rectifier achieves this by using two diodes in which only one diode will be forward biased and conducts during each half cycle. The full-wave rectifier basically consists of two half-wave rectifiers connected together to feed the load.

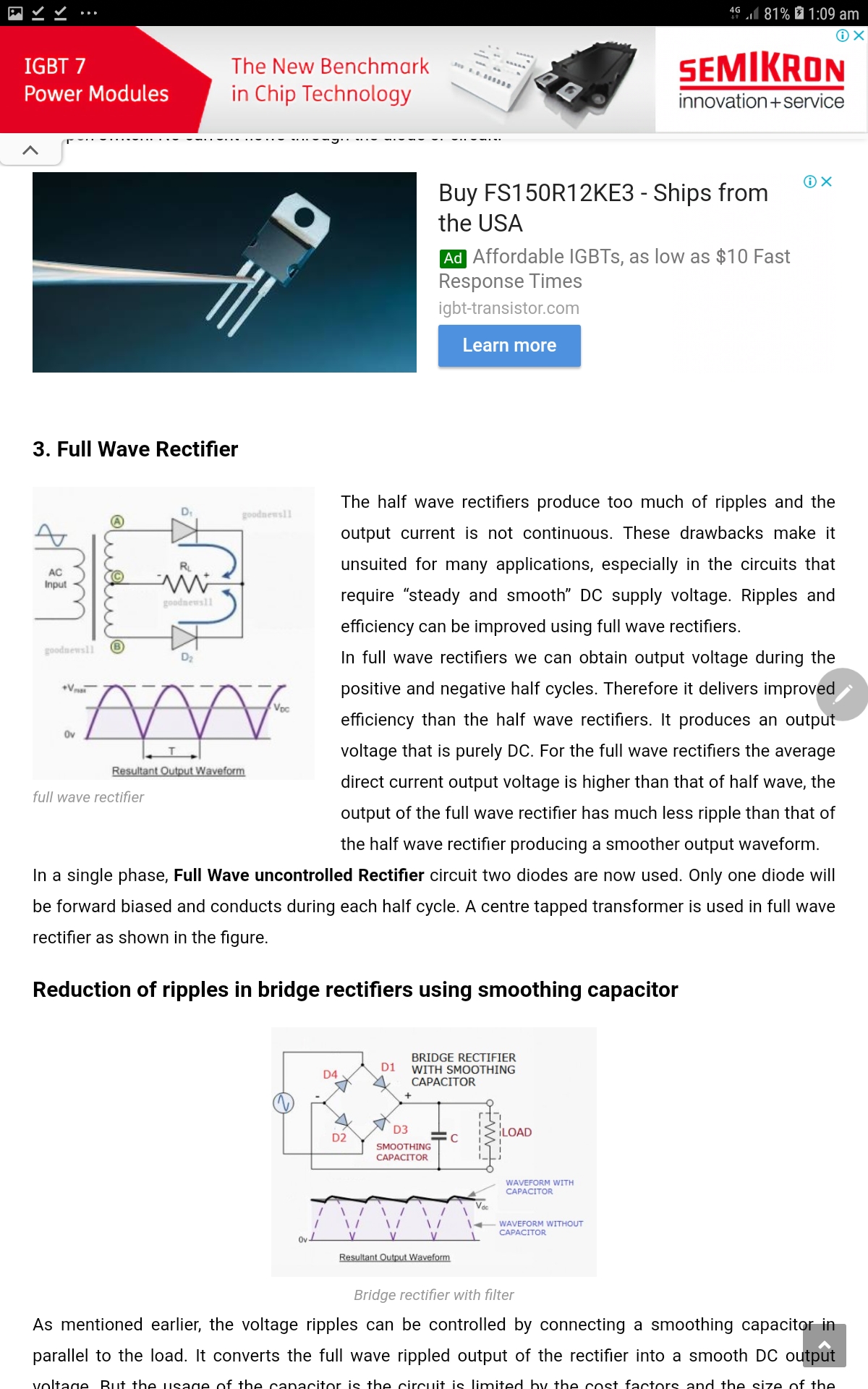


Figure 8: Single phase full wave uncontrolled rectifier

1. Single phase full wave uncontrolled rectifier using Centre tapped transformer

A center tapped full wave rectifier is a type of rectifier which uses a center tapped transformer and two diodes to convert the complete AC signal into DC signal. The center tapped full wave rectifier is made up of an AC source, a center tapped transformer, two diodes, and a load resistor. The AC source is connected to the primary winding of the center tapped transformer. A center tap (additional wire) connected at the exact middle of the secondary winding divides the input voltage into two parts. The upper part of the secondary winding is connected to the diode D1 and the lower part of the secondary winding is connected to the diode D2. Both diode D1 and diode D2 are connected to a common load RL with the help of a center tap transformer. The center tap is generally considered as the ground point or the zero voltage reference point

During the positive half cycle of the input AC signal, terminal A become positive, terminal B become negative and center tap is grounded (zero volts). The positive terminal A is connected to the p-side of the diode D1 and the negative terminal B is connected to the n-side of the diode D1. So the diode D1 is forward biased during the positive half cycle and allows electric current through it.

On the other hand, the negative terminal B is connected to the p-side of the diode D2 and the positive terminal A is connected to the n-side of the diode D2. So the diode D2 is reverse biased during the positive half cycle and does not allow electric current through it.

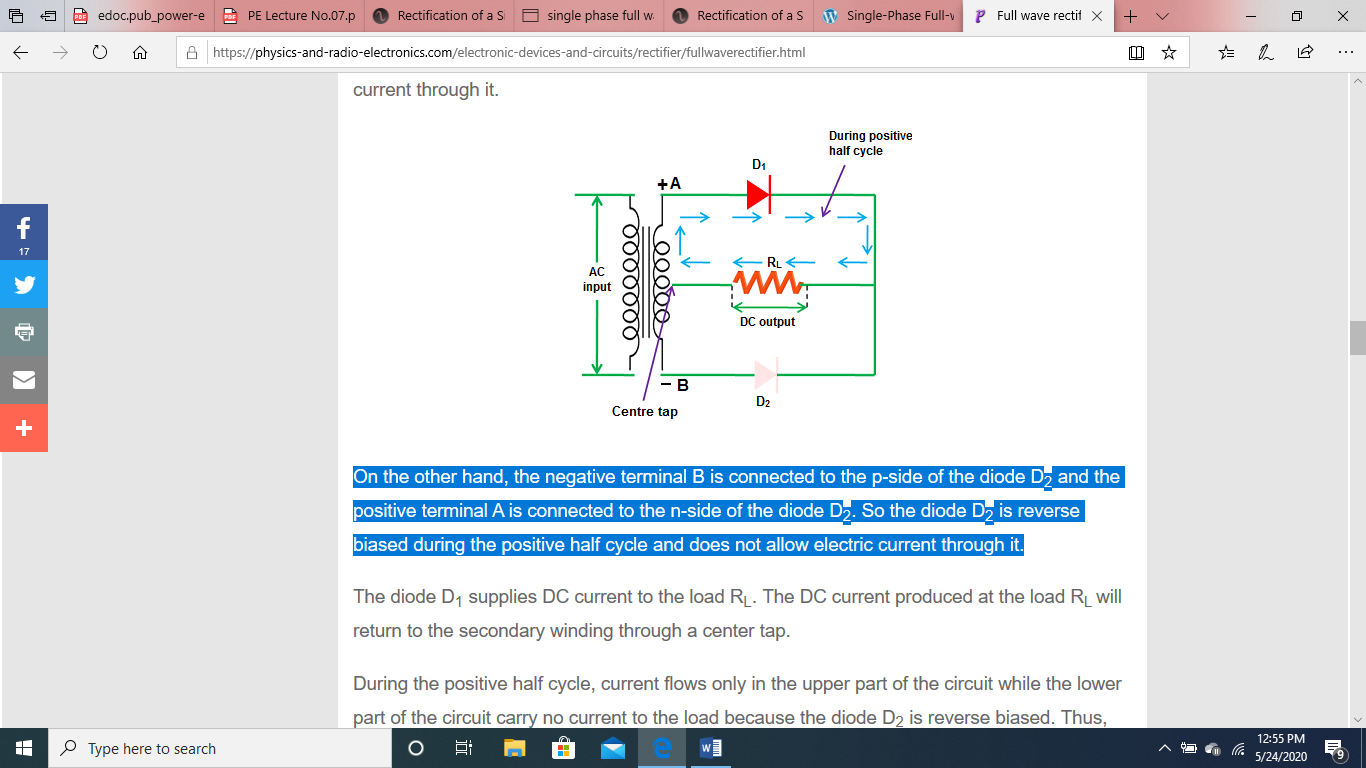


Figure 9: Single phase full wave uncontrolled rectifier using Centre tapped transformer

Source: https://physics-and-radio-electronics.com/electronic-devices-and-circuits/rectifier/fullwaverectifier.html

1. single phase full wave uncontrolled rectifier using bridge configuration

This type of single phase rectifier uses four individual rectifying diodes connected in a closed loop “bridge” configuration to produce the desired output. The main advantage of this bridge circuit is that it does not require a special Centre tapped transformer, thereby reducing its size and cost. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown in Figure 10.

The four diodes labelled D1 to D4 are arranged in “series pairs” with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load.

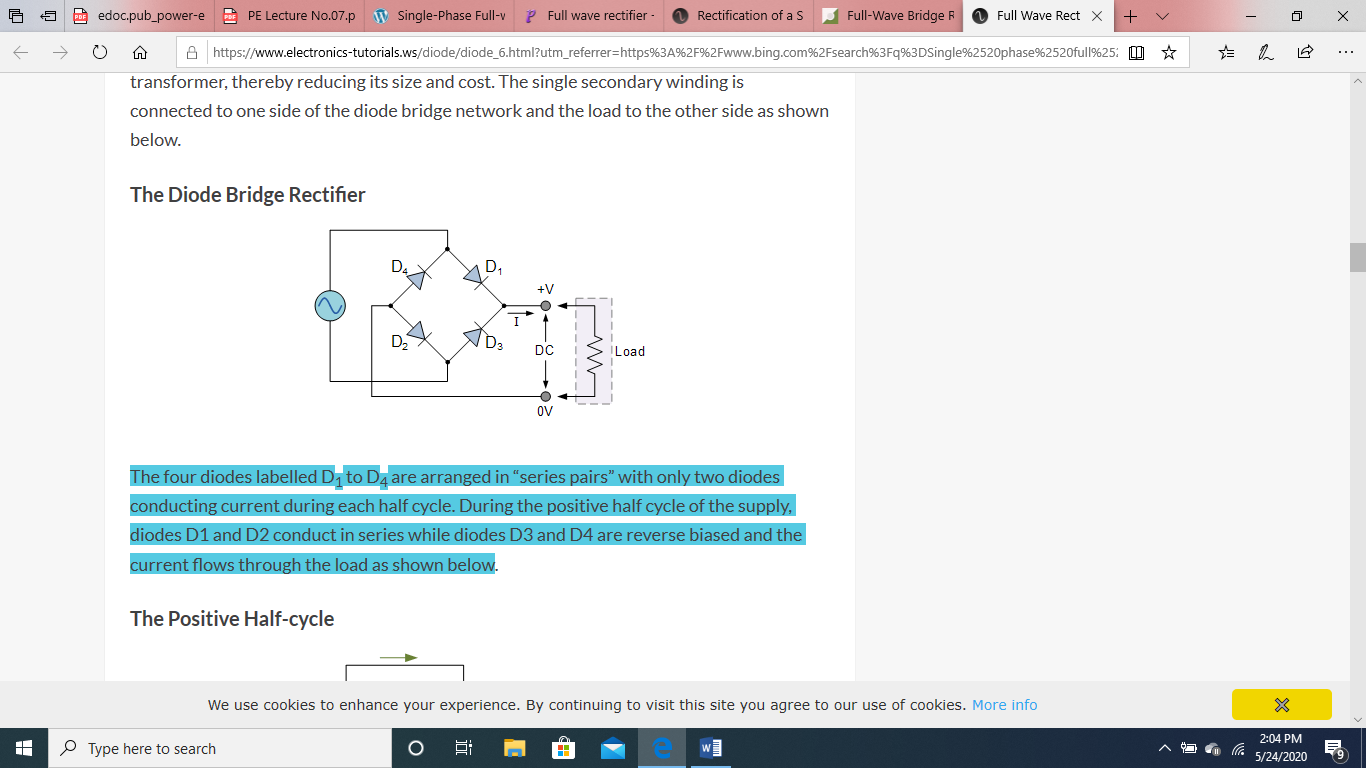


Figure 10: single phase full wave uncontrolled rectifier using bridge configuration

1. Three phase full wave uncontrolled rectifier using the bridge configuration

The full-wave, three-phase uncontrolled bridge rectifier circuit uses six diodes, two in a phase similar to the single-phase bridge rectifier. A 3-phase full-wave rectifier is

Produced using two half-wave rectifier circuits. The benefit here is that the circuit generates a lower ripple output than the previous half-wave 3-phase rectifier, because it has a frequency of six times the input limit.

Also, the full-wave rectifier can be fed from a balanced 3–phase 3-wire delta connected supply as no fourth neutral (N) wire is required.

Diodes D1 D3 D2 and D4 form a bridge rectifier network between phases A and B, as do diodes D3 D5 D4 and D6 between phases B and C and D5 D1 D6 and D2 between phases C and A. Thus diodes D1 D3 and D5 feed the positive line, depending on which one has a more positive voltage at the terminal of the anode. Likewise, diodes D2 D4 and D6 feed the negative line and whichever diode has a more negative voltage at its cathode terminal conducts.

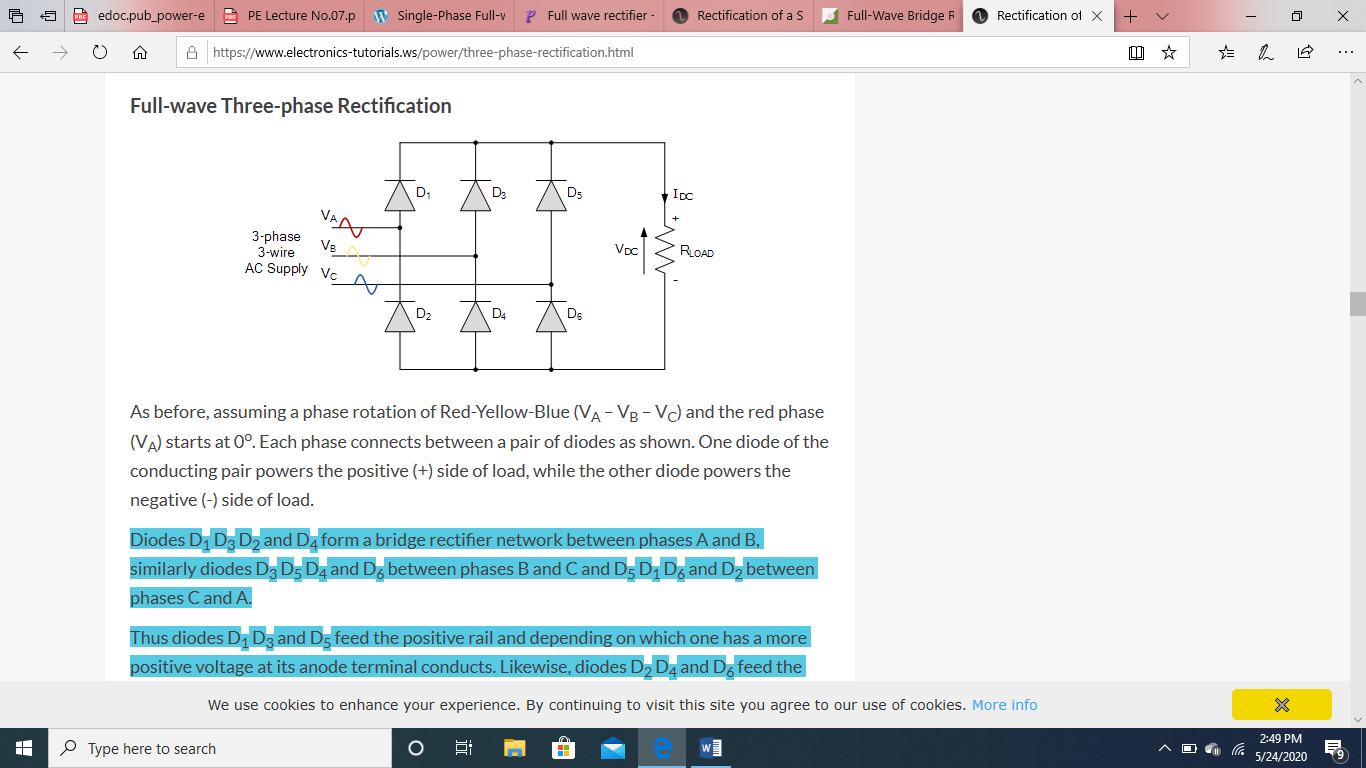


Figure 11a: Three phase full wave uncontrolled rectifier using the bridge configuration

Source: https://www.electronics-tutorials.ws/power/three-phase-rectification.html

The wave form of a three phase full wave uncontrolled rectifier using the bridge configuration can be seen in Figure 11b.

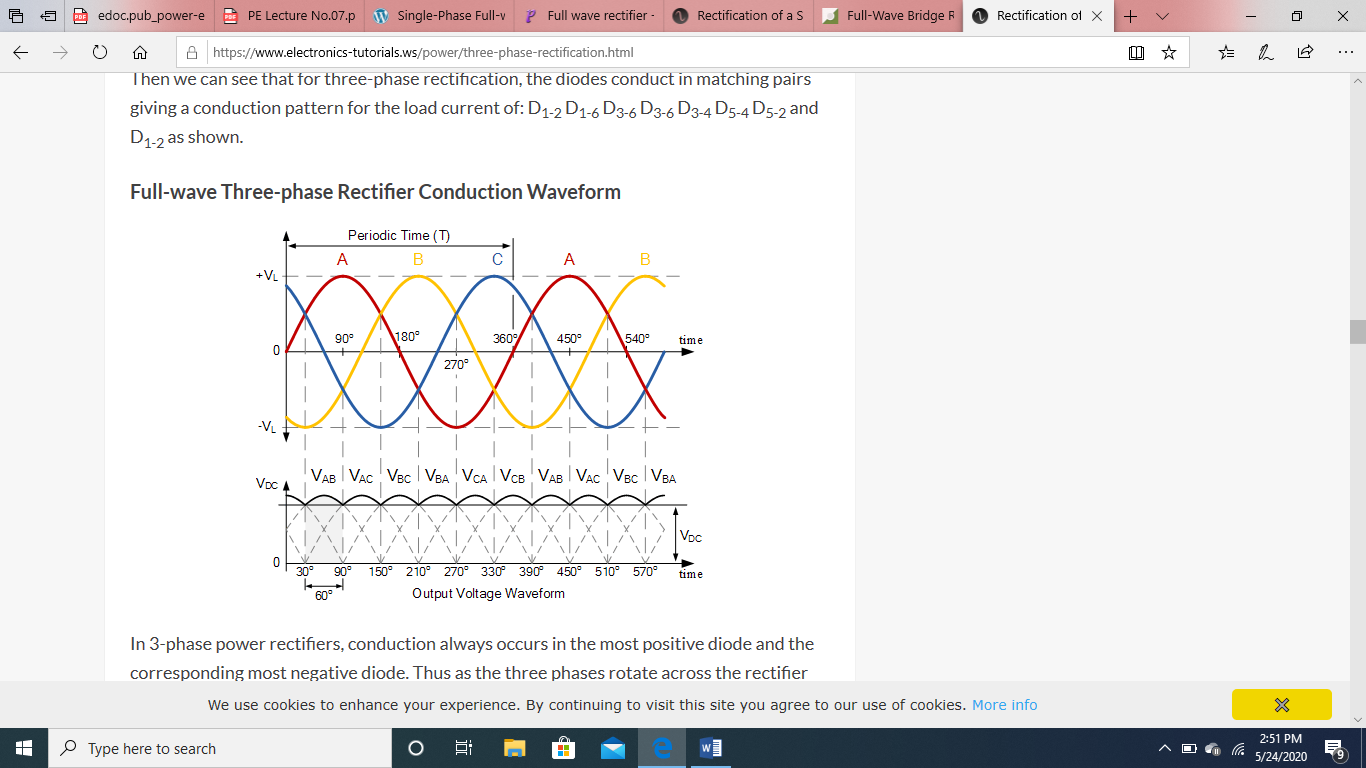


Figure 11b: Three phase full wave uncontrolled rectifier using the bridge configuration

Source: https://www.electronics-tutorials.ws/power/three-phase-rectification.html

References

https://www.electronics-tutorials.ws/power/three-phase-rectification.html

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