INTRODUCTION
TO
ELECTRICAL ENGINEERING

GROUP ASSIGNMENT-3

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PRESENTATION BY:-

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Question-1 [done by Gunnam Himamsh]

1.Perform the experiment for demonstrating the application of a diode as a Full-wave rectifier in Falstad circuit simulator

a) Explain the theory behind the experiment.

b) Draw the circuit diagrams, Mention the components used, and state the procedure of the experiment

c)Plot the input and output waveforms.

d)Compute/obtain the value of V_m, V_{rms}, V_{dc}, and ripple factor.

e) Redo the experiment using a capacitive filter and plot the input and output waveforms

f)Compute/obtain the value of V_m,V_{rpp}, $V_{r,rms}$, V_d

A) Theory of Full wave rectifier: -

A full wave rectifier is defined as a type of rectifier that converts both halves of each cycle of an alternating wave (AC signal) into a pulsating DC signal. Full-wave rectifiers are used to convert AC voltage to DC voltage, requiring multiple diodes to construct. Full wave rectification is the process of converting an AC signal to a DC signal.

Circuits that convert alternating current (AC) into direct current (DC) are known as rectifiers. If such rectifiers rectify both the positive and negative half cycles of an input alternating waveform, the rectifiers are full-wave rectifiers.

In a full-wave rectifier, the two cycles of the supply input are rectified. To implement this technique basic full-wave rectifier requires two diodes. Each diode is utilized during each cycle. When the positive cycle is applied one diode conducts and during a negative cycle, the other tends to conduct.

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

1. Four Diodes
2. Resistive Load

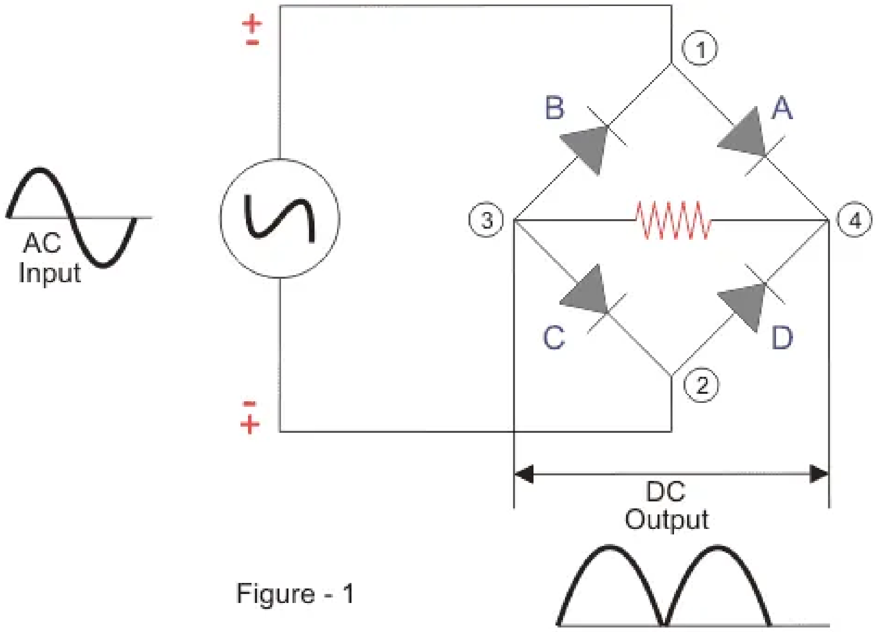


Figure - 1

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

Principle of Full Wave Bridge Rectifier

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

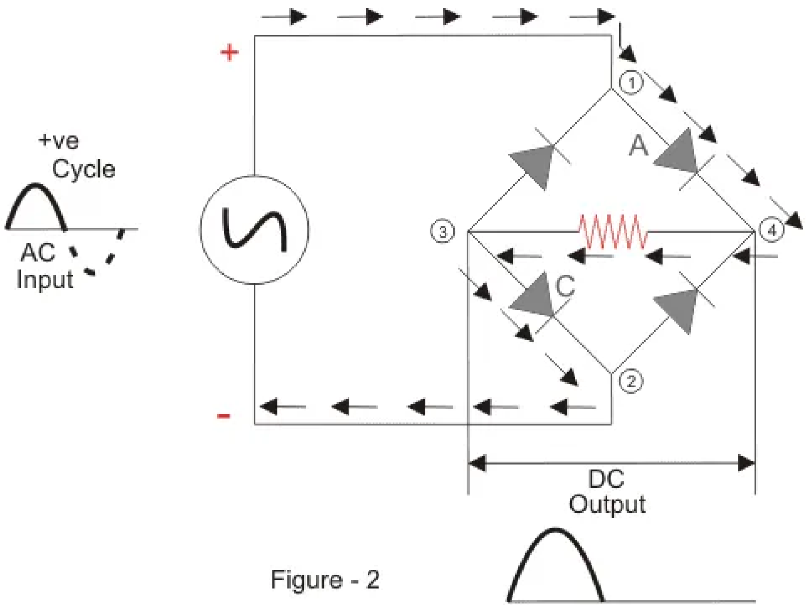


Figure - 2

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.

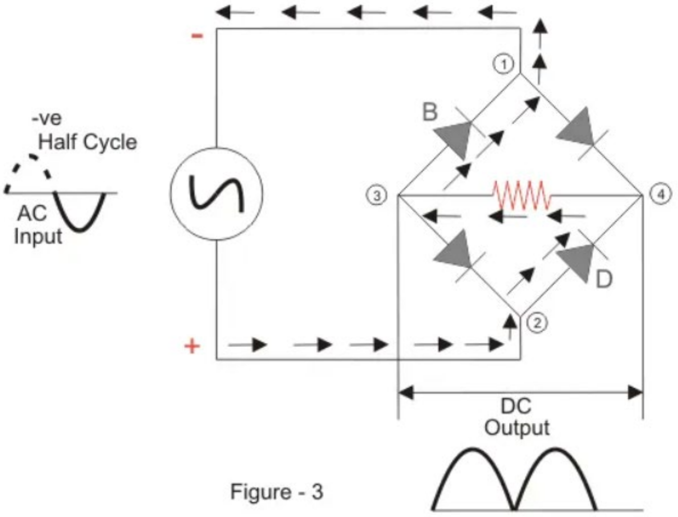


Figure - 3

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

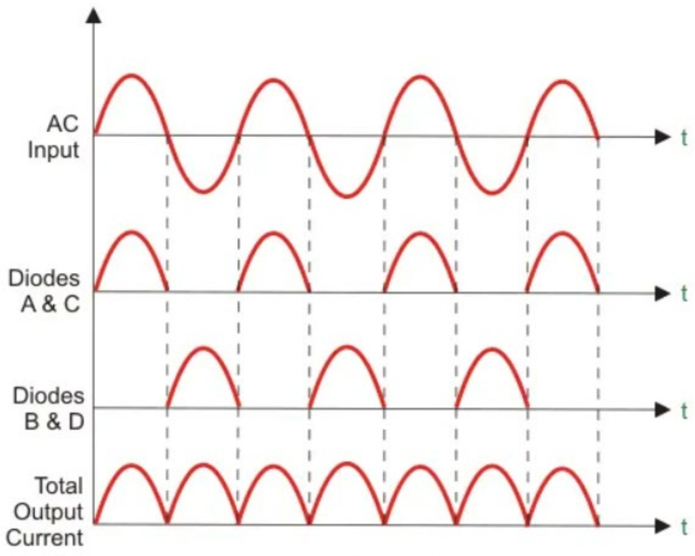


Figure - 4

Advantages of Full Wave Rectifiers

The advantages of full wave rectifiers include:

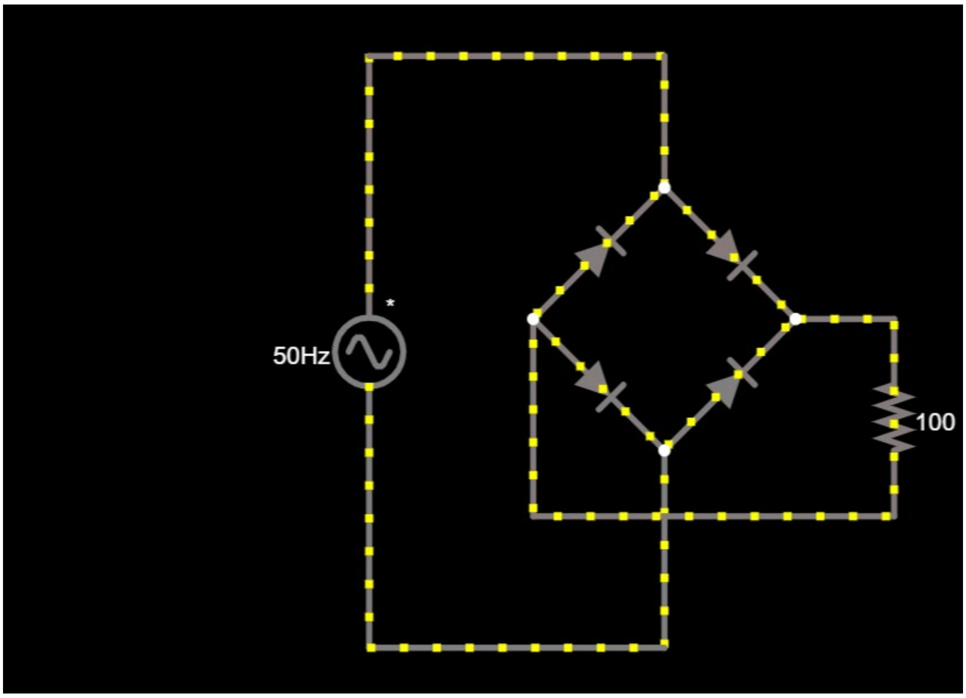
- Full wave rectifiers have higher rectifying efficiency than half-wave rectifiers This means that they convert AC to DC more efficiently.
- They have low power loss because no voltage signal is wasted in the rectification process.
- The output voltage of a centre-tapped full wave rectifier has lower 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.

B) Circuit diagram: -



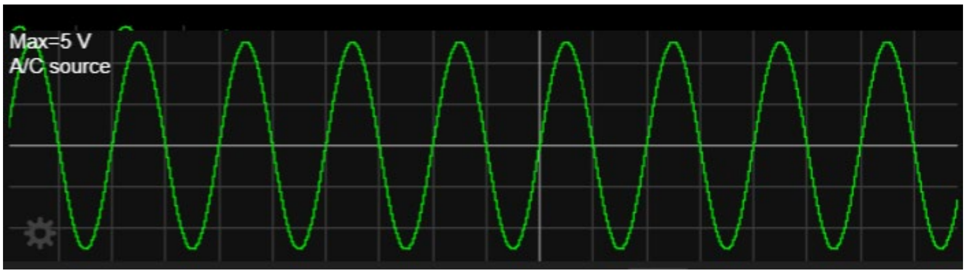
Components used: - Ac voltage source, 4diodes, resistor, Wires

Procedure: -

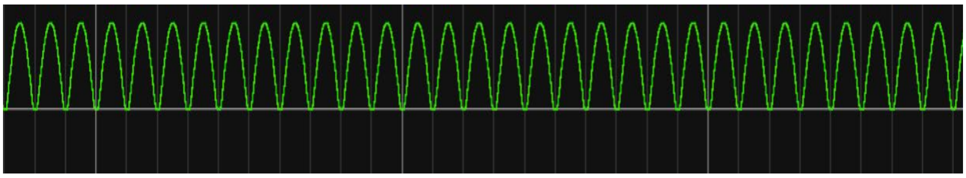
Draw an Ac voltage source as input and connect 4 diodes and connect them with help of wires as shown in the figure in those 4 diodes.

When voltage is in forward bias 2 diodes are in on position and when diode is in reverse bias 2 diodes are in off position that can be seen in above figure.

Input wave form: -



Output wave form: -



D)Input peak voltage(Vm)=3.728V

We know that for full wave rectifier Vrms=Vm/sqrt(2)

=3.728/1.414

=2.636V

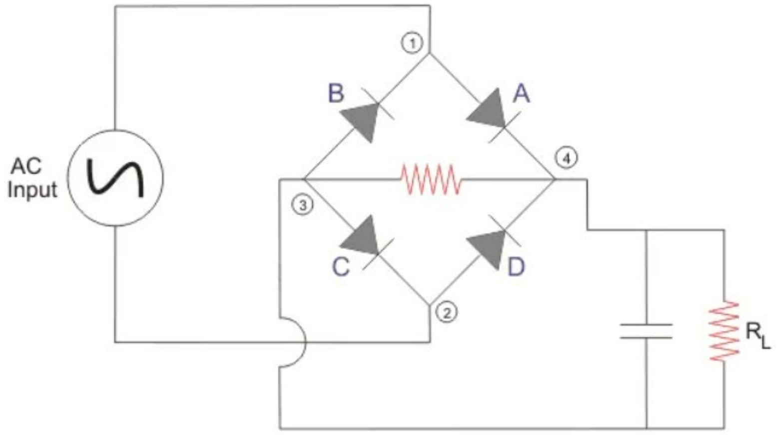
Next is Vdc=0.636*Vm =0.636*3.728= 2.371

Ripple factor =0.482 (For Full wave rectifier).

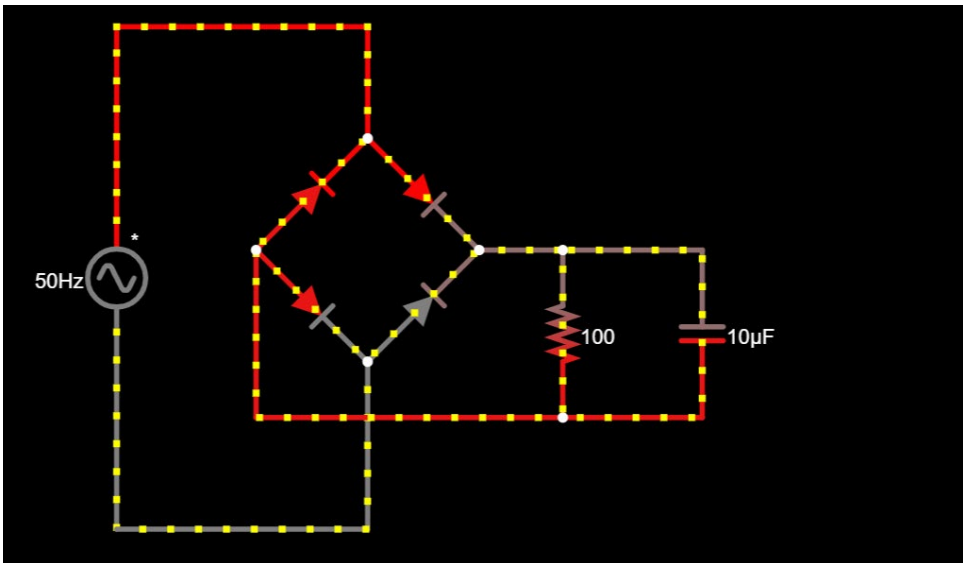
E) -**Filter Circuit**

We get a pulsating DC voltage with many ripples as the output of the full wave bridge rectifier. We cannot use this voltage for practical applications.

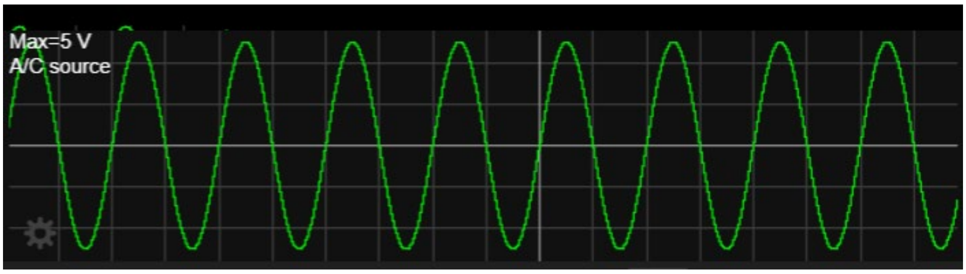
So, to convert the pulsating DC voltage to pure DC voltage, we use a filter circuit as shown above. Here we place a capacitor across the load. The working of the capacitive filter circuit is to short the ripples and block the DC component so that it flows through another path, and that is through the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



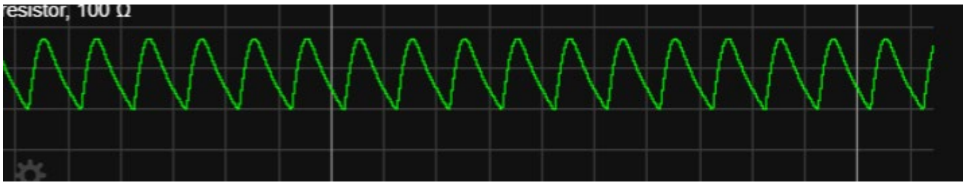
After redoing the experiment using capacitive filter the picture is



The input waveform is:-



The output waveform is as below: -



F) Here the peak voltage (Vm)=3.728V

Next is peak to peak voltage Vrpp=3.716-2.135=1.581

Next is Vr,rms=Vrpp/2*Sqrt(3)

=1.581/2*1.732

=0.4477

Next is Vdc=Vm-Vrpp/2

=3.728-1.581/2

=2.9375

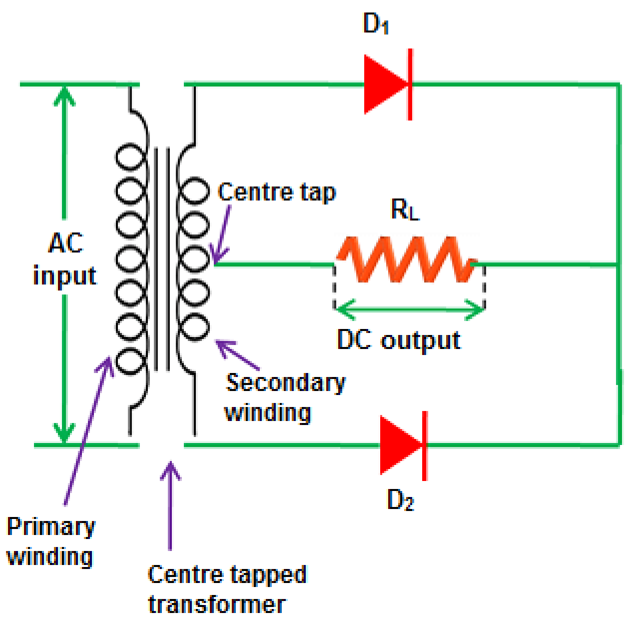
Next is ripple factor r=¼/*sqrt(3)*RL*C

=1/0.433*50*100*10*10^-6µF

=0.28

G) Repeat (a) to (f) for centre-tapped Full wave rectifier

A centre tapped full wave rectifier is a type of rectifier which uses a centre tapped transformer and two diodes to convert the complete AC signal into DC signal. The centre tapped full wave rectifier is made up of an AC source, a centre tapped transformer, two diodes, and a load resistor.



Components used: -

Centre tapped transformer, 2diodes, Load resistor, Ac voltage source,

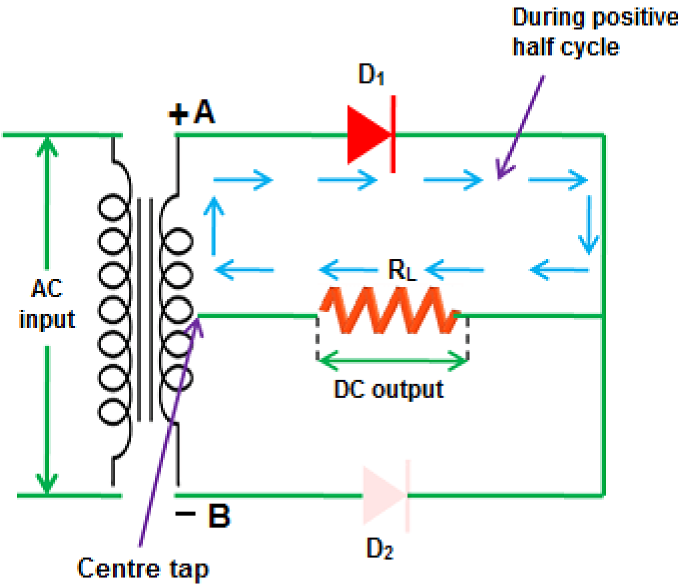
Procedure: - The AC source is connected to the primary winding of the centre tapped transformer. A centre tap (additional wire) connected at the exact middle of the secondary winding divides the input voltage into two parts.

The upper part of the secondary winding is connected to the diode D_1 and the lower part of the secondary winding is connected to the diode D_2. Both diode D_1 and diode D_2 are connected to a common load R_L with the help of a centre tap transformer. The centre tap is generally considered as the ground point or the zero-voltage reference point.

The centre tapped full wave rectifier uses a centre tapped transformer to convert the input AC voltage into output DC voltage.

When input AC voltage is applied, the secondary winding of the centre tapped transformer divides this input AC voltage into two parts: positive and negative.

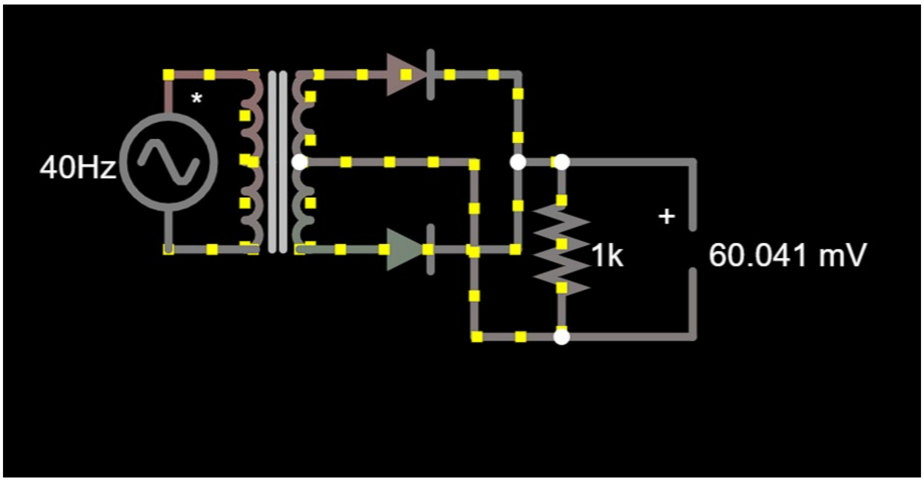
During the positive half cycle of the input AC signal, terminal A become positive, terminal B become negative and centre tap is grounded (zero volts). The positive terminal A is connected to the p-side of the diode D_1 and the negative terminal B is connected to the n-side of the diode D_1. So, the diode D_1 is forward biased during the positive half cycle and allows electric current through it.



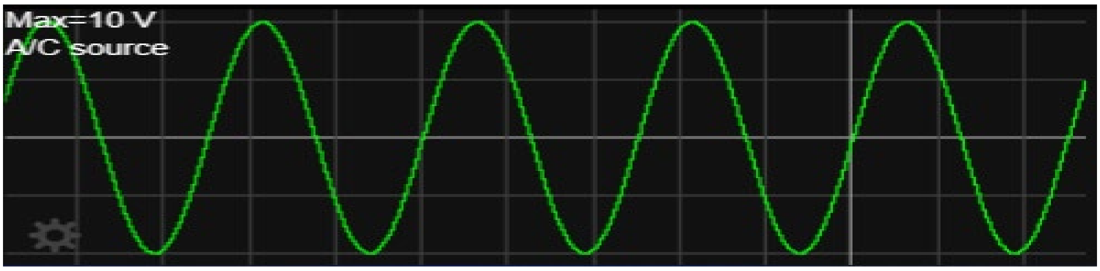
On the other hand, the negative terminal B is connected to the p-side of the diode D_2 and the positive terminal A is connected to the n-side of the diode D_2. So, the diode D_2 is reverse biased during the positive half cycle and does not allow electric current through it.

The diode D_1 supplies DC current to the load R_L. The DC current produced at the load R_L will return to the secondary winding through a centre tap.

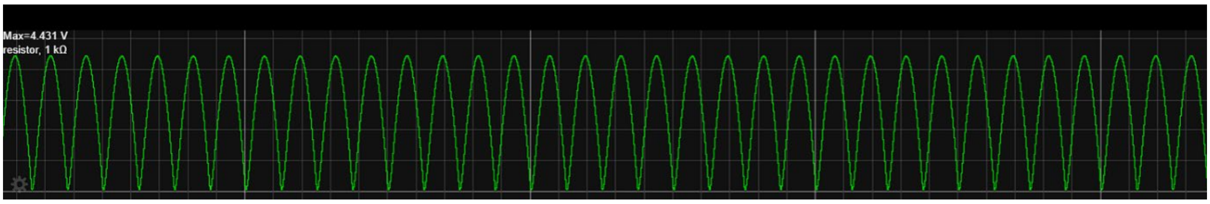
Falstad Simulator Circuit:



Input waveform: -



Output Waveform: -



Now the value of Vm =4.431

Vrms=Vm/sqrt (2)

=4.431/1.414

=3.13336

Value of Vdc=2Vm/π

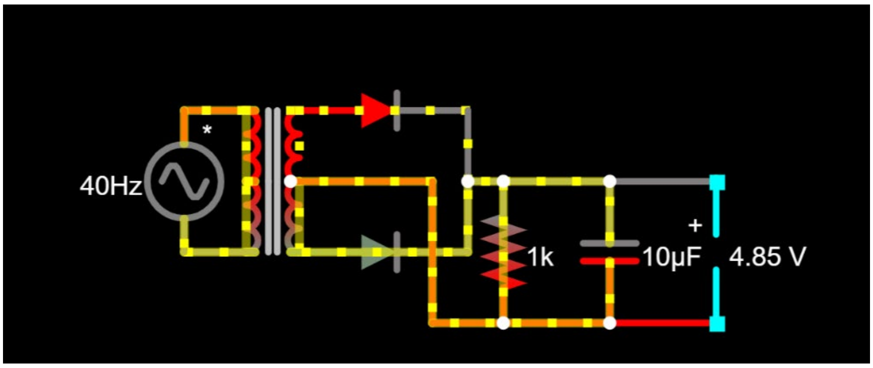
=2*3.728/ π

= 2.3733

Value of ripple factor is π/2*sqrt(2)

=1.11

Centre tapped Transformer with filter: -



Value of Vm is= 4.857V

Next is Vrpp=(1/fRLC)(Vm/2-0.7)

=(1/40*1000*10*10^-6)(4.857/2-0.7)

=4.321

Next is Vdc =(1-(1/2fRLC)) * (Vm/2-0.7)

=(1-0.2)(4.857/2-0.7)

=(0.8)(1.7285)

=1.3828

Next Vr,rms=Vrpp/2*sqrt(3)

=4.321/3.464

=1.247

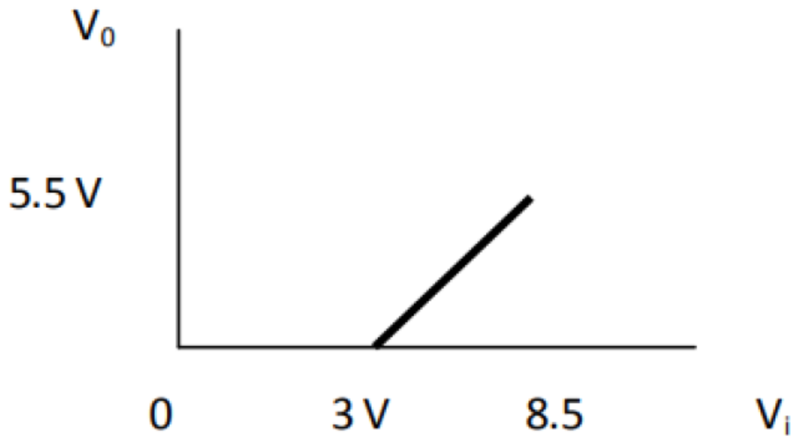
Next ripple factor r=¼*sqrt(3)*40*10*10^-6*1000

= ½ * 0.77 = 0.385

QUESTION-2 [Done by Vikhyat Bansal]

Design a circuit to obtain the following transfer characteristic. Plot the input and output waveforms using Falstad circuit simulator.

[Hint: Half-wave rectifier and DC source].



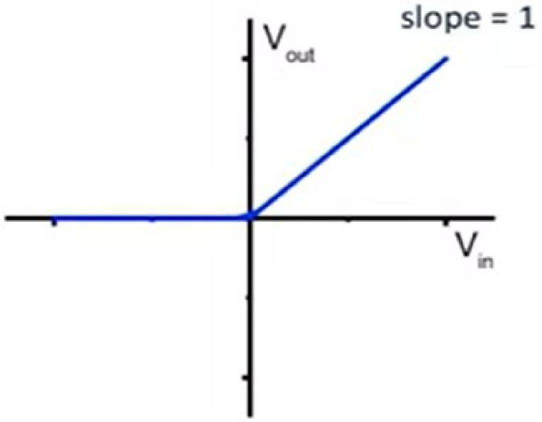
Ans.
Voltage Transfer characteristic:

- Graphical representation of the behavior of a circuit in form of voltage.
- A plot of output voltage versus input voltage.

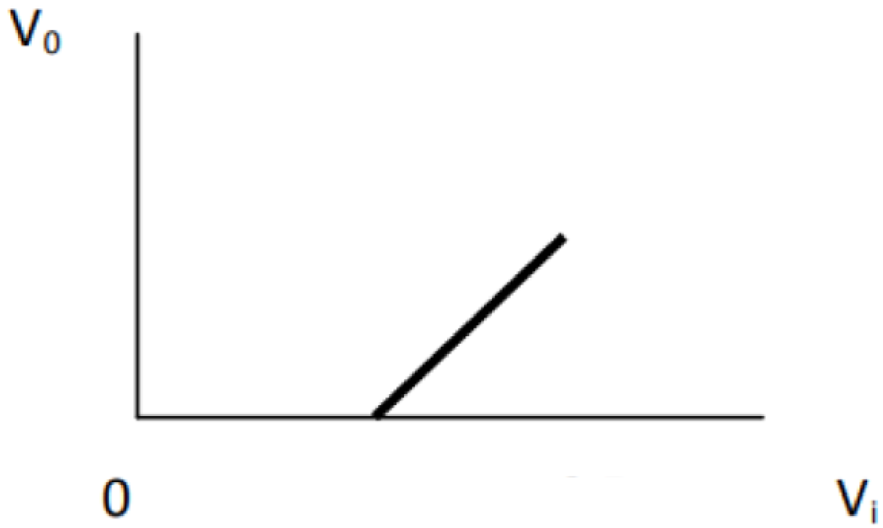
We are going for a half wave rectifier and VTC of an ideal half wave looks something like this,

Positive Half-Wave Rectifier

$$V_{out} = \begin{cases} V_{in} & V_{in} > 0 \\ 0 & V_{in} \leq 0 \end{cases}$$



Voltage Characteristic of a non-ideal half wave rectifier:

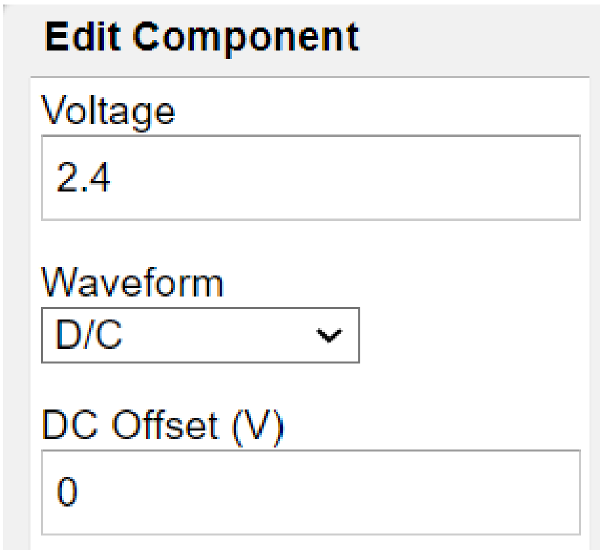


- From above figure, it can be understood that there is some unknown component which must be added in series with diode [as default diode is no more than 0.7V which is not sufficient to create a cut in voltage of 3V] or resistor.
- The unknown component can be figured out using KVL which will lead us to the conclusion that an external DC source must be added in series with diode or resistor to produce a cut in voltage as high as 3V.
- Using the concept of Series Diode Configuration and KVL, we can figure **out the direction of terminal of External DC source** that should be added in series with diode.

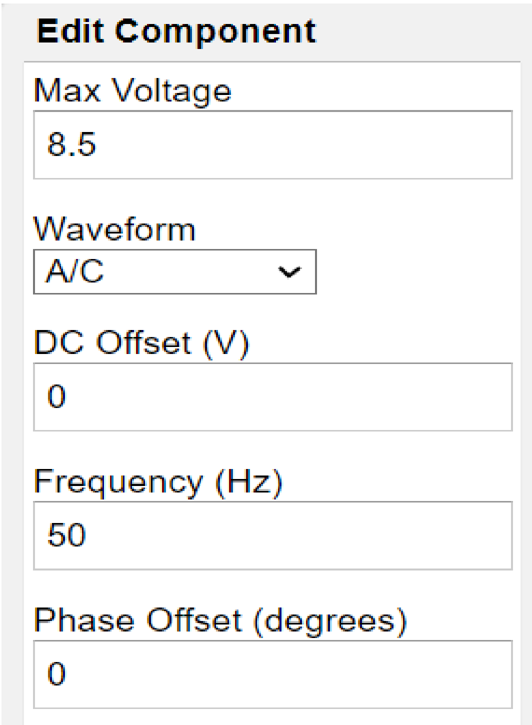
$$+V_{in} - V_D - V_{EXT} - V_{out} = 0$$

Components Used with Values:

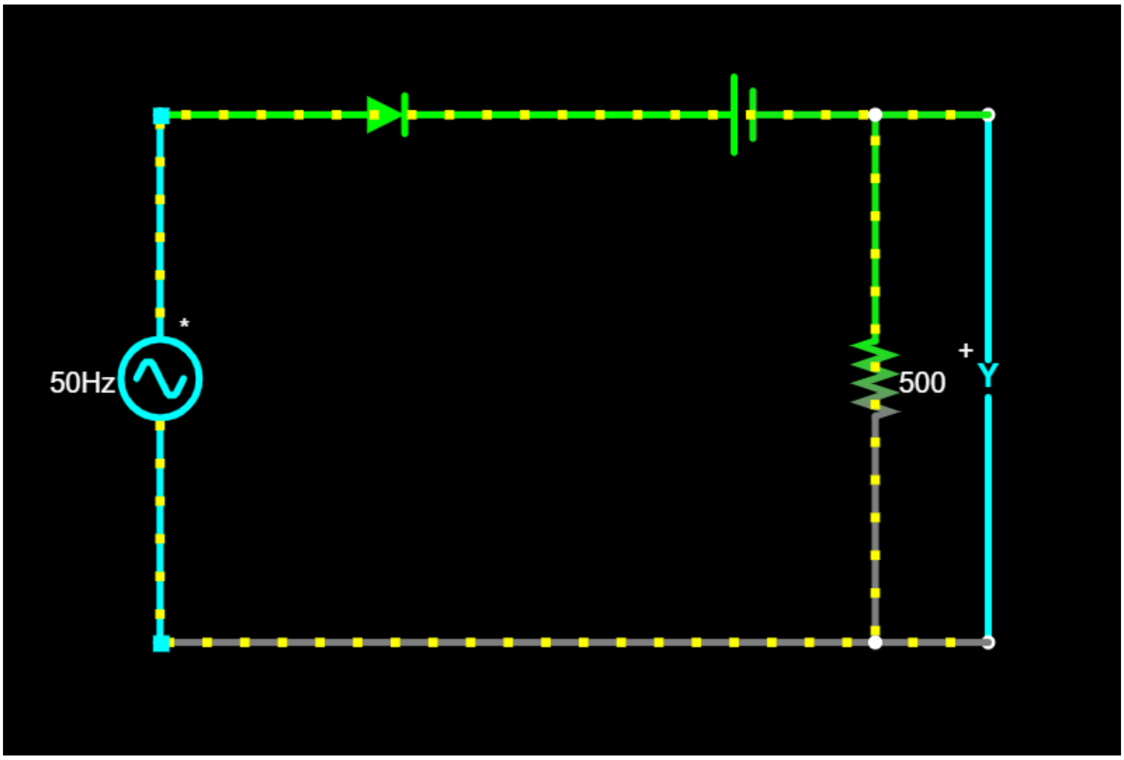
- Wires
- General Diode (Silicon Diode)
- External DC Source:



- Resistor (500Ohm)
- Voltmeter (or Analog voltage)
- A/C Input Source:



FALSTAD Simulator Circuit [COMPLETE]



CALCULATION:

$$+V_{in} - V_D - V_{EXT} - V_{out} = 0$$

$$+8.5 - 0.6 - 2.4 - 5.5 = 0$$

Where,

$+V_{in}$: A/C Input Source

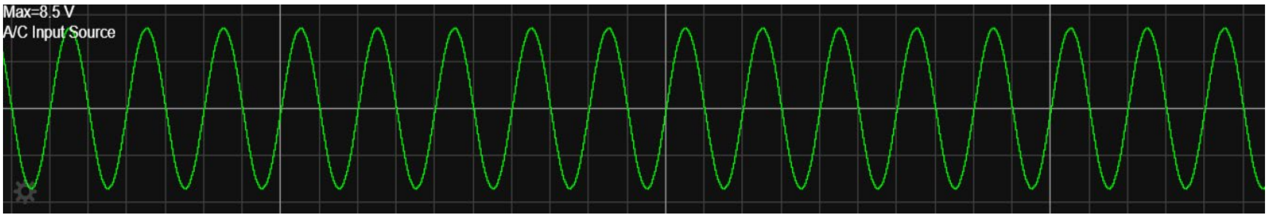
$-V_D$: Voltage due to diode

$-V_{EXT}$: External DC Source

$-V_{out}$: DC output

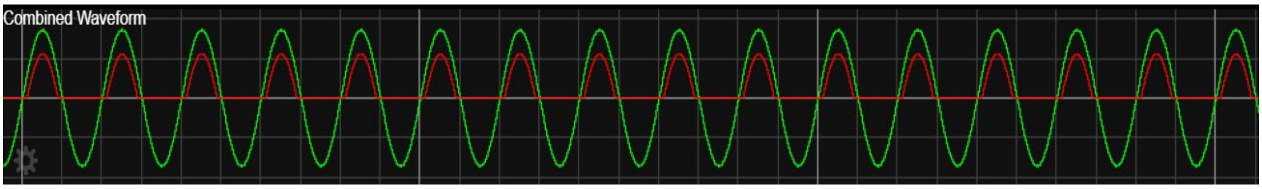
Input and Output Waveforms

Input Waveform:

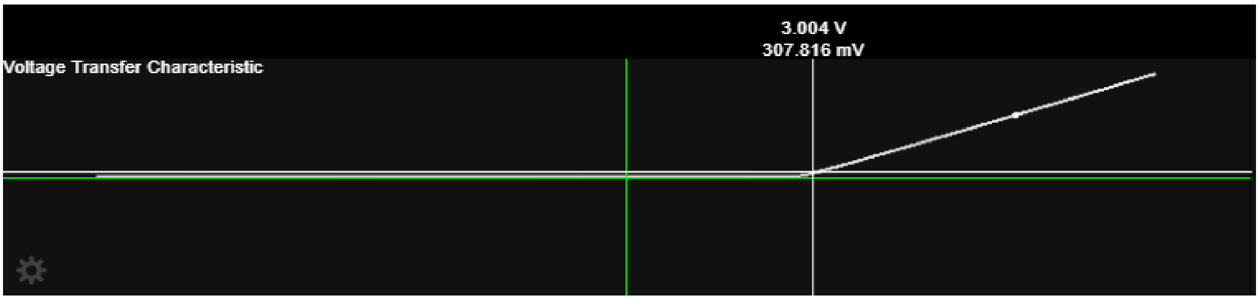


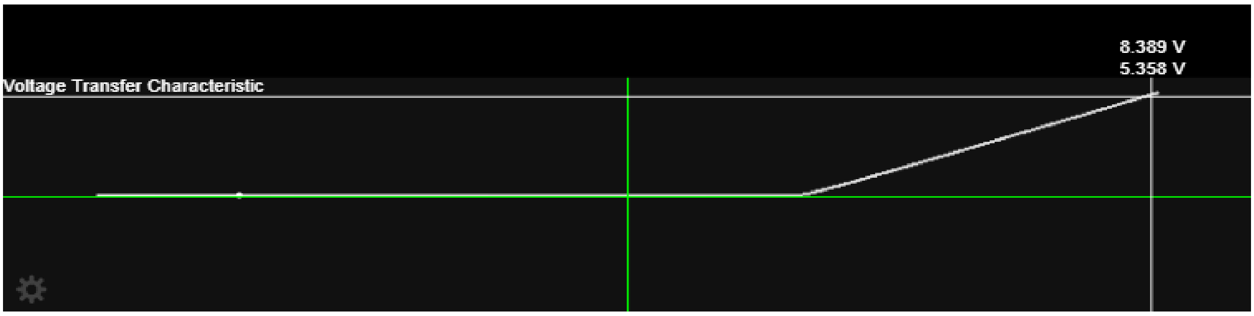
Output Waveform:

Combined Waveform:



Transfer Characteristic using FALSTAD Simulator:





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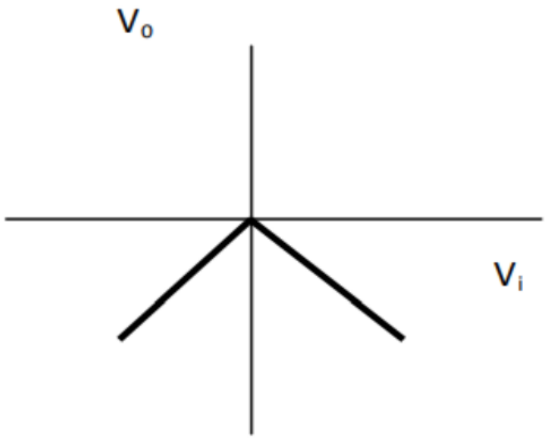
Press: CTRL + Scroll UP{Mouse}

LINK TO THE CIRCUIT OF QUESTION 2

QUESTION-3[Done by Gajula Sri Vatsanka]

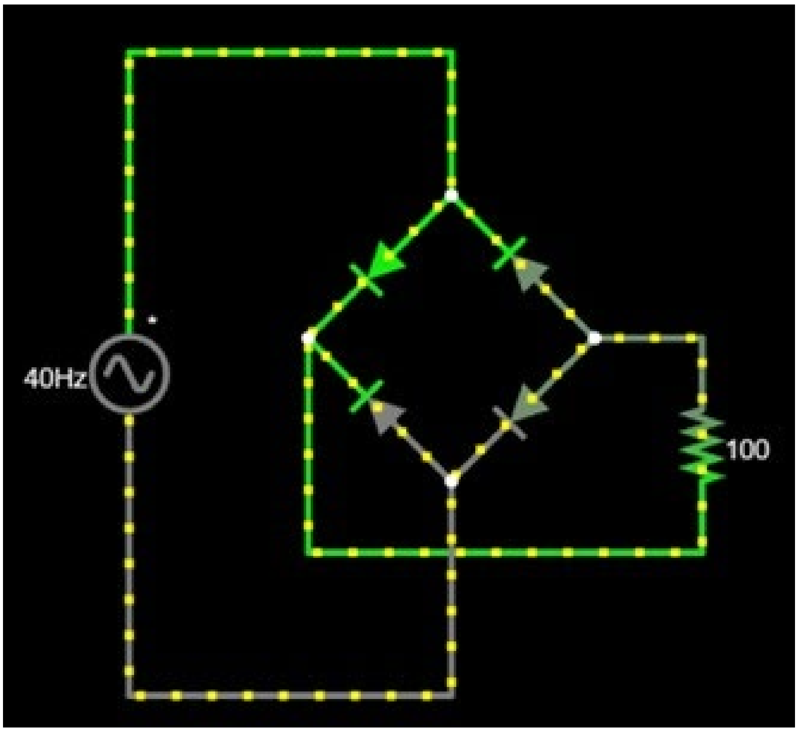
3. Obtain the following transfer characteristics. Plot the input and output waveforms using Falstad circuit simulator.



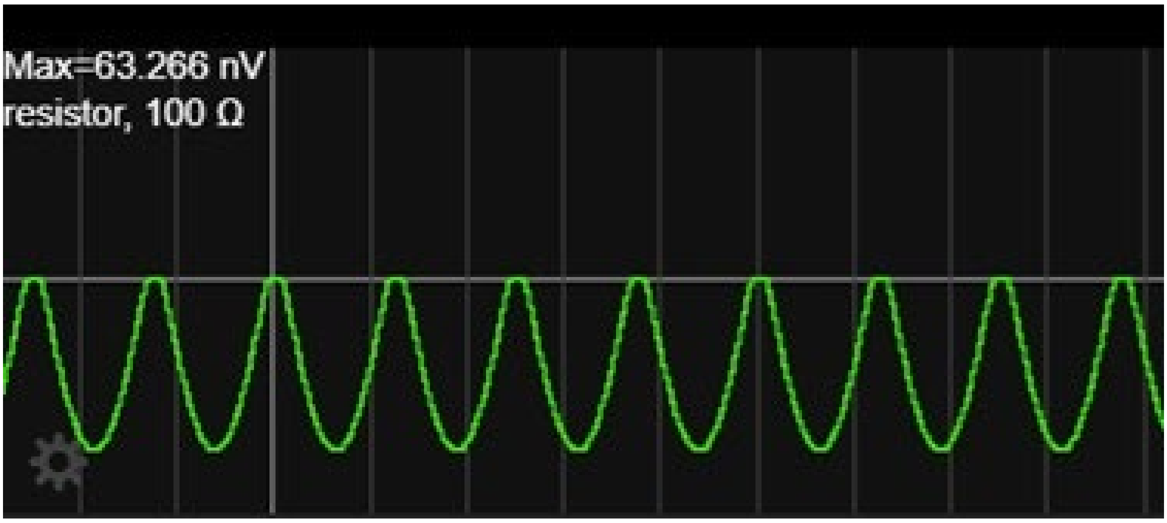
during -ve half cycle, the graph is y = x . ----->Vi = Vo

during +ve half cycle, the graph is y = -x --------> Vi = -Vo

so it is a full wave rectifier, but the output is negative instead of positive




Max=5 V
A/C source


Max=63.266 nV
resistor, 100 Ω

<u>QUESTION-4[Done by M.prasanna teja]</u>

Design and study the following shunt clippers using diodes in the Falstad circuit simulator. Explain the working of the circuit diagram and plot the input and output waveforms.

a)Positive clipper clipping at +3V

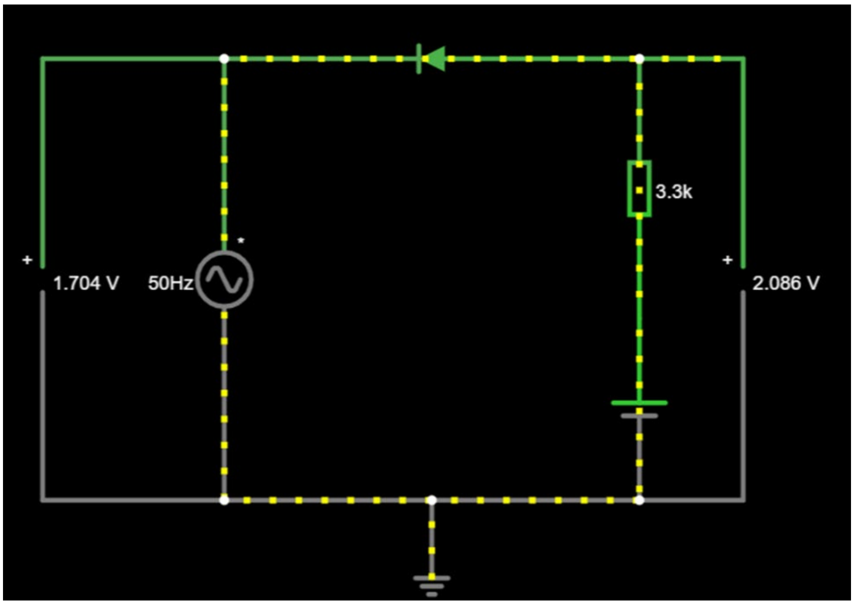
b)Negative clipper clipping at -3 V

c)Slicer slicing at -3 V and -5 V

d)Double clipper clipping at +3V and –5V

<u>ANSWER:-</u>

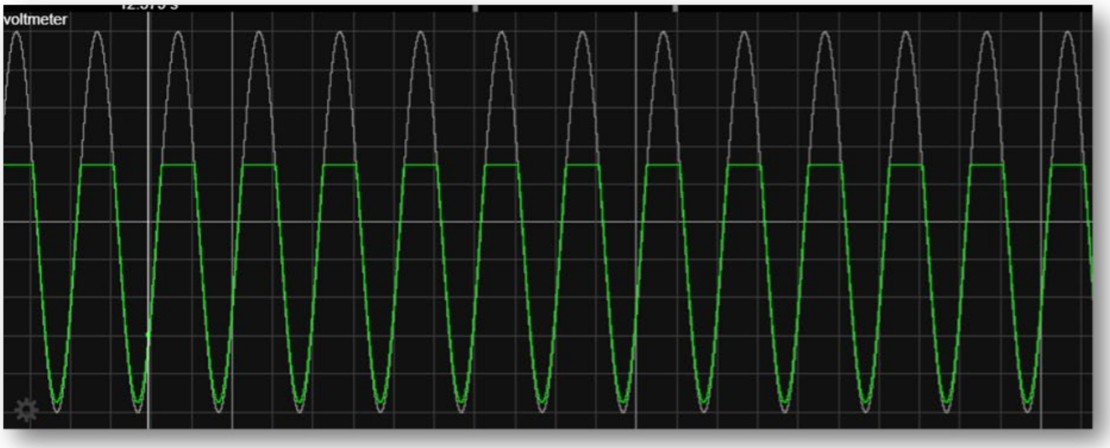
a)Positive clipper clipping at +3V

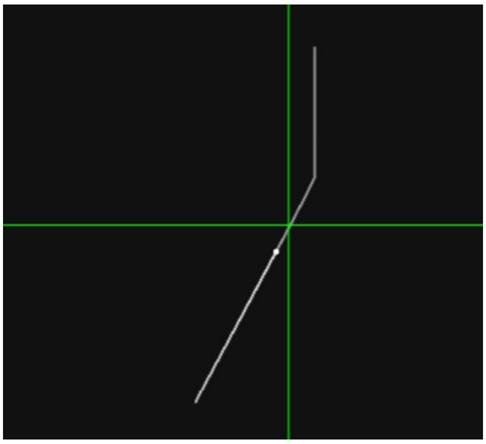


Components in the Circuit :

- An AC source of frequency 50hz and max voltage of 10V.
- A resistor of 3.3K ohm and DC voltage   connected of 3V which is grounded.
- An ideal diode connected with the resistor and AC input voltage.
- 2 voltmeters are used to measure the voltage output & input.

Plot of both input & output voltage





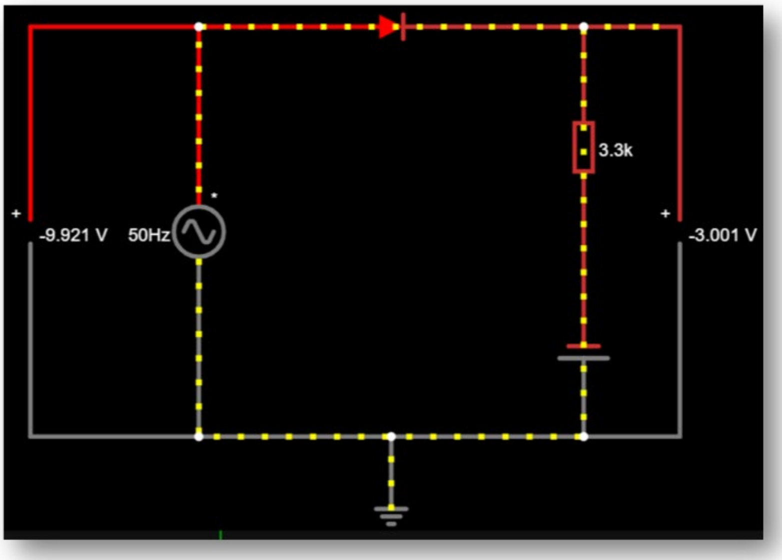
WORKING OF THE CIRCUIT: -

- During the positive part of the half cycle the diode doesn't conducts the current to flow inside and the respective voltage will be the DC voltage(3v).(diode is in reverse bias)
- Similarly during the negative part of the input voltage the diode allows the current in the circuit and the voltage across the points will be same as input voltage.(diode is in forward bias)
- As for the + part of the wave it gets clamped at 3v , it is called clamping circuit.
- Like this the mechanism goes in the circuit.

+ part ----> reverse bias

- part ----> forward bias

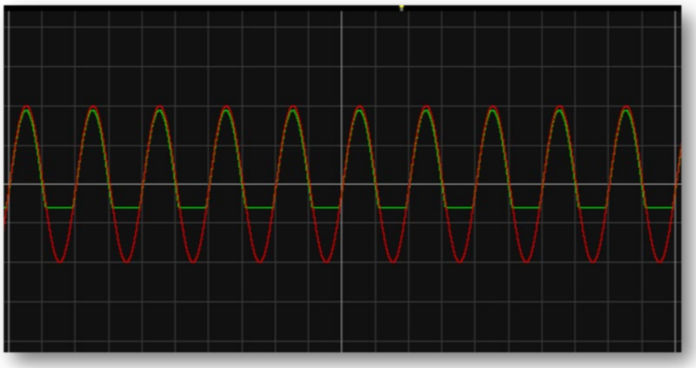
b) Negative clipper clipping at -3 V



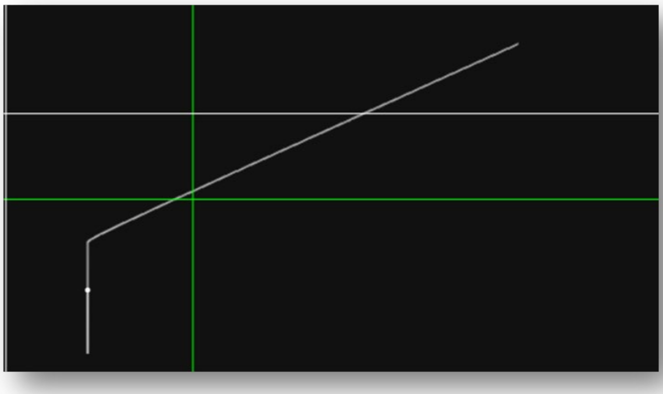
COMPONENTS USED IN CIRCUIT

- An AC source of frequency 50hz and max voltage of 10V.
- A resistor of 3.3K ohm and DC voltage connected of ' -3V 'which is grounded.
- An ideal diode connected with the resistor and AC input voltage.
- 2 voltmeters are used to measure the voltage output & input.

Plot between input & output voltage: -



Plot between input and output voltage characterstics:-



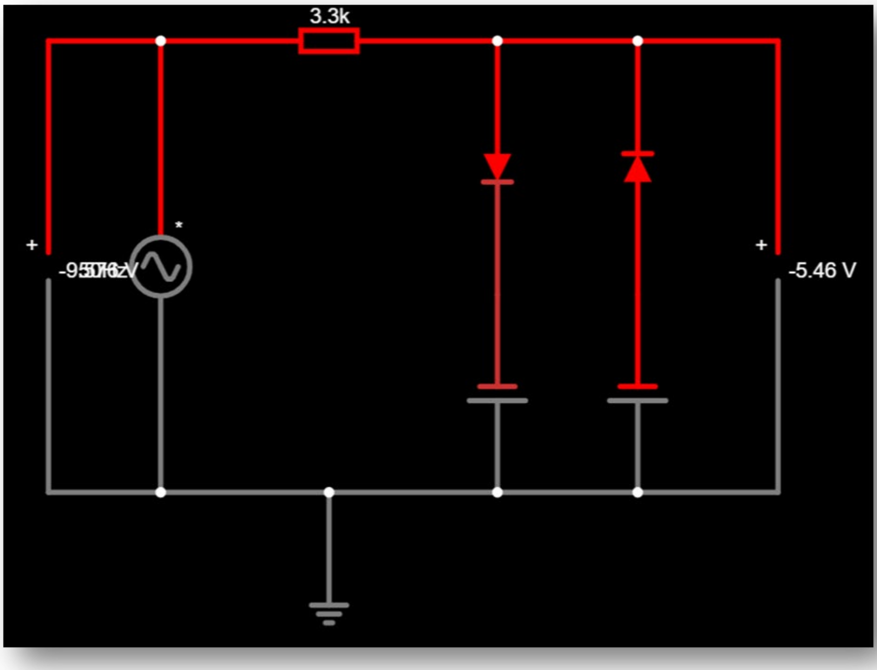
Y axis – V in

MECHANISM IN THE CIRCUIT: -

- During the positive part of the half cycle the diode conducts the current to flow inside and the respective voltage gets noted(diode is in forward bias)
- Similarly during the negative part of the input voltage the diode breaks the current in the circuit and the voltage across the points will be the DC voltage we supplied i.e 3V.(diode is in reverse bias)
- As for the - part of the wave it gets clamped at 3v , it is called clamping circuit.
- Like this the mechanism goes in the circuit.

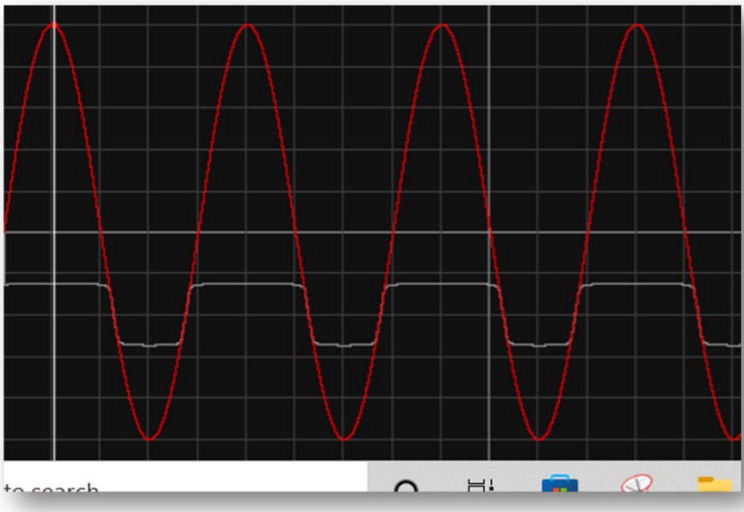
+ part ----> forward bias

- part -----> reverse bias



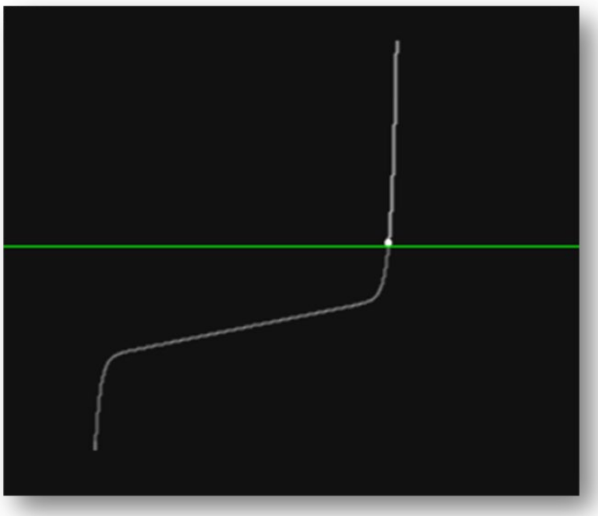
- A AC source of frequency 50hz and max voltage of 10V.
- A resistor of 3.3K ohm and DC voltage connected of ' -3V &-5V' which are grounded.
- 2 ideal diodes are connected oppositely with the resistor and AC input voltage.
- 2 voltmeters are used to measure the voltage output & input.

Plot between input & output voltage



red – inp volt
white – out volt

Plot between input and output voltage characterstics



X axis – V out
Y axis – V in

Working of the circuit....

▪In this circuit we are having 2 diodes connected in opposite direction , so only one diode conducts the current at a time & other doesn't.

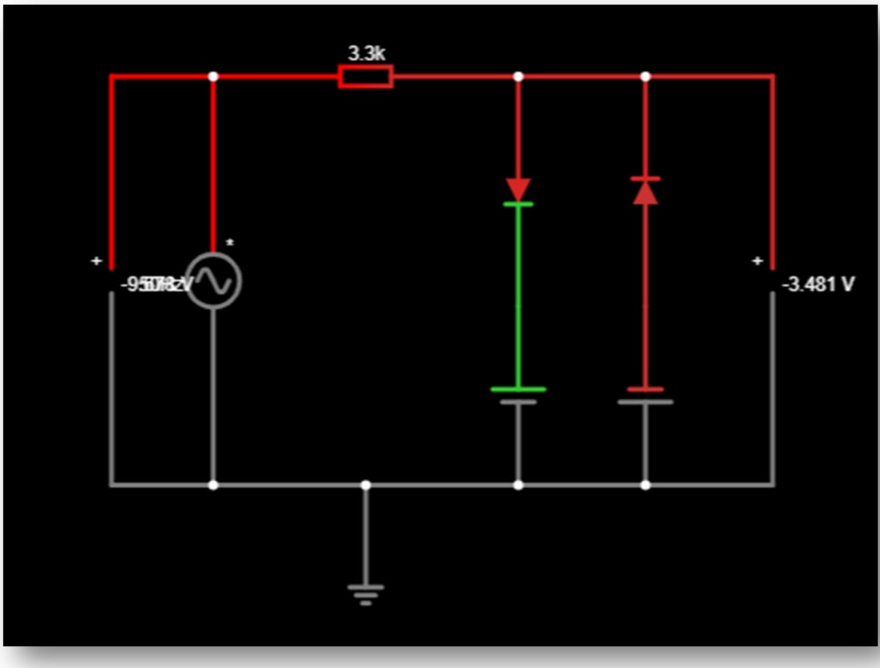
▪So, during the positive part of the half cycle the 1'st diode conducts the current to flow and 2 nd doesn't, by anlysing the circuit, the output voltage for + cycle will be the DC voltage supplied to the 2 diode (3v).

▪Similarly during the negative part of the input voltage the 2'nd diode allows the current in the circuit and 1'st doesn't, by anlysing the circuit ,the voltage across the points will be voltage across 1'st diode(5v).

▪Like this the mechanism goes in the circuit.

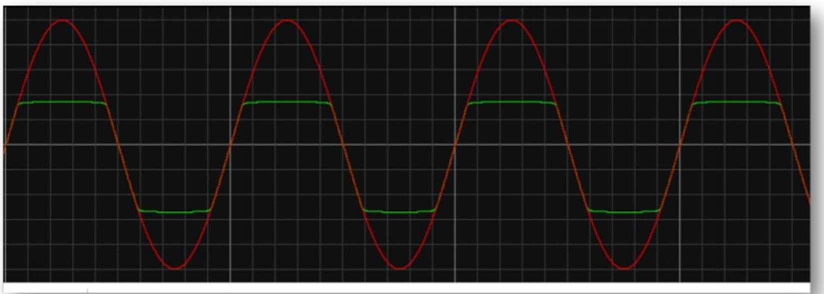
+ part ----> 1 st - forward bias & 2 nd - reverse bias
- part -----> 1 st - reverse bias & 2 nd - forward bias

d)Double clipper clipping at +3V and -5V



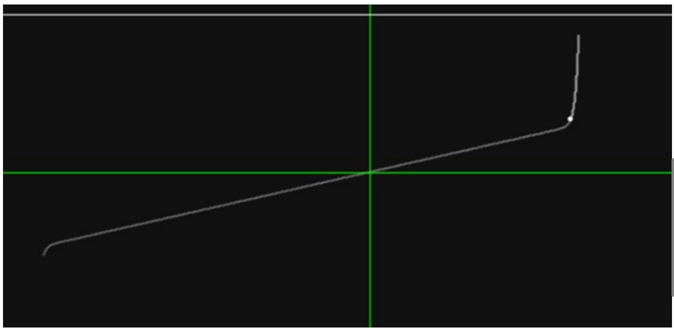
<u>Components used in the circuit:</u>

- An AC source of frequency 50hz and max voltage of 10V.
- A resistor of 3.3K ohm and 2 DC voltage's connected of ' +3v ' & '-5v' which is grounded.
- 2 ideal diodes are connected oppositely with the resistor and AC input voltage.
- 2 voltmeters are used to measure the voltage output & input.



Plot between input & output voltage

red – inp volt
green – out volt



X axis – V out
Y axis – V in

Plot between input and output voltage characterstics

Working of the circuit:-

- In this circuit we are having 2 diodes connected in opposite direction, so only one diode conducts the current at a time & other doesn't. The dc voltages are also connected in opposite direction which are grounded.
- So, during the positive part of the half cycle the 1'st diode conducts the current to flow and 2 nd doesn't, by analysing the circuit, the output voltage for + cycle will be the DC voltage supplied to the 2 diode (3v).
- Similarly. during the negative part of the input voltage, the 2'nd diode allows the current in the circuit and 1'st doesn't, by anlysing the circuit, the voltage across the points will be the DC voltage supplied to 1'st diode(-5v).
- Like this the mechanism goes in the circuit.

+ part ----> 1 st - forward bias & 2 nd - reverse bias
- part -----> 1 st - reverse bias & 2 nd - forward bias

THANK YOU