ASSIGNMENT-4

INTRODUCTION TO ELCTRICAL ENGINEERING

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Contributed By: -

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

a) Forward biased positive clipper
b) Reverse biased positive clipper
c) Forward biased negative clipper
d) Reverse biased negative clipper

ANS.

Clipper Circuit: Clipper circuits are the electronic circuits that clip off or remove a portion of an AC signal, without causing any distortion to the remaining part of the waveform.
Main component used in Clipper Circuit are DIODES.

There are two types of Clipper Circuit:

i) Series Clippers (Biased)
ii) Series Clippers (Non-Biased)
iii) Shunt Clippers (Biased)
iv) Shunt Clippers (Non-Biased)

The series configuration is defined as one where the diode is in series with the load, whereas the parallel variety has the diode in a branch parallel to the load.

Biased Positive and Negative Clipper

A biased clipper comes in handy when a small portion of positive or negative half cycles of the signal voltage is to be removed. When a small portion of the positive half cycle is to be removed, it is called a biased positive clipper. Similarly, when a small portion of the negative half cycle is to be removed it is called biased negative clipper.

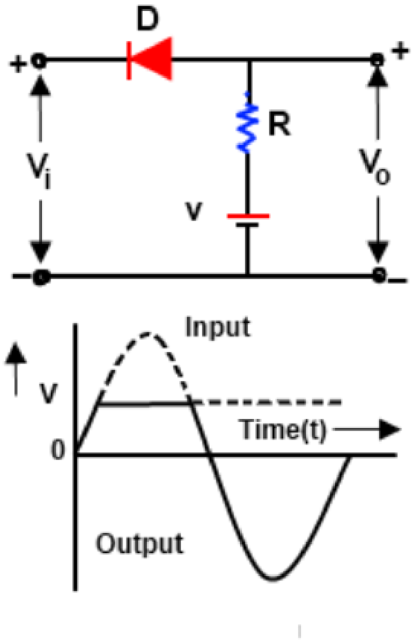
To produce diode clipping circuits for voltage waveforms at different levels, a bias voltage, V_{BIAS} is added in series with the diode to produce a combination clipper as shown. The voltage across the series combination must be greater than V_{BIAS} + 0.7V before the diode becomes sufficiently forward biased to conduct. For example, if the V_{BIAS} level is set at 4.0 volts, then the sinusoidal voltage at the diode's anode terminal must be greater than **4.0 + 0.7 = 4.7 volts** for it to become forward biased. Any anode voltage levels above this bias point are clipped off.

Components Used:

- Wires
- A/C Input Voltage Source [10 V input]
- Diode
- Resistance [100 Ohm]
- 2-Terminal Voltage Source [5 V Bias voltage]
- Voltmeter

a) Forward biased positive clipper [Positive biased positive clipper]

CIRCUIT:



(a) Positive Biased

WORKING

During positive half cycle the terminal A is positive with respect to B. This reverse biases the diode and it acts as an open switch. Therefore, all the applied voltage drops across the diode and none across the resistor. As a result of this there is no output voltage during the positive half cycle of the input voltage.

During the negative half cycle of the input voltage the terminal B is positive with respect to A. Therefore, it forward biases the diode and it acts as a closed switch. Thus, there is on voltage drop across diode during the negative half cycle of input voltage.

Clippers prevent both polarities of a wave form exceeding a specific amplitude level. However, a positive clipper is that which removes or clips the positive half completely.

V_{BIAS} is used to do biasing and clip a certain portion of half cycle rather than clipping a complete half cycle.

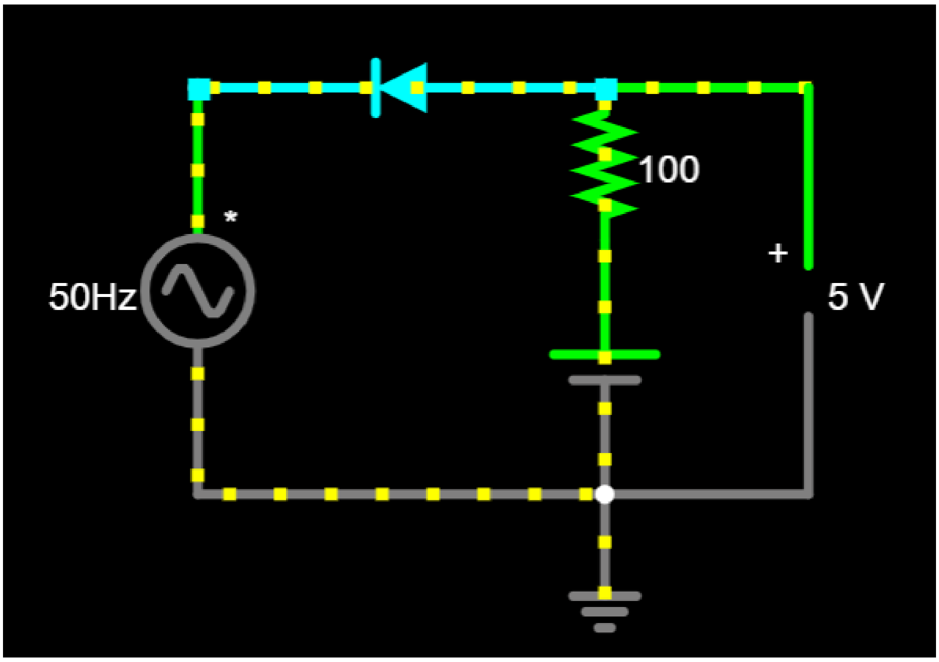
It may be observed that the clipping takes place during the positive cycle only when the input voltage is greater than battery voltage ($V_i > V_B$). The shifting level can be shifted up or down by varying the bias voltage (V_B).

V_{BIAS} is positively biased which is used to add waveform in output in positive half cycle.

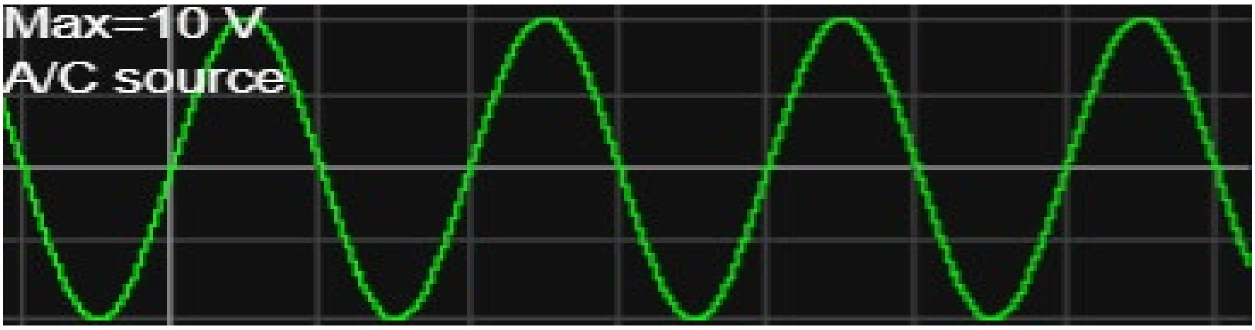
$V_{BIAS} + V_{DIODE} < V_{INPUT}$

Any input voltage levels above this bias point are clipped off.

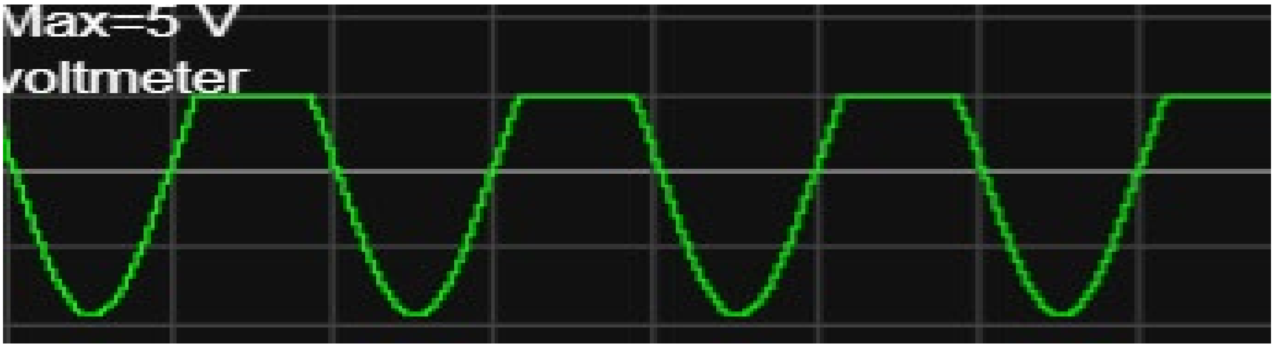
FALSTAD CIRCUIT:



Input Waveform:



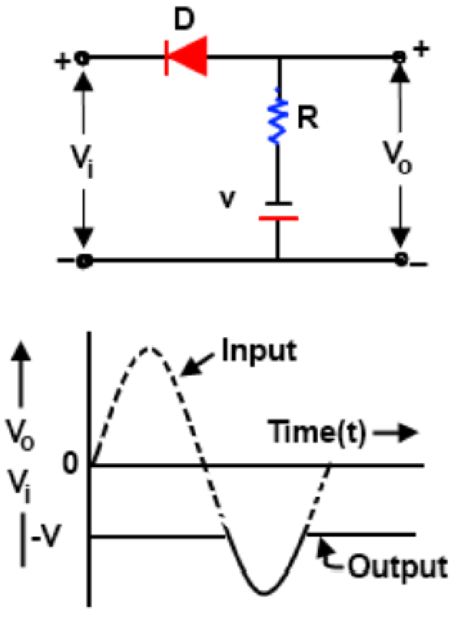
Output Waveform:



LINK

b) Reversed biased positive clipper [Negative biased positive clipper]

CIRCUIT



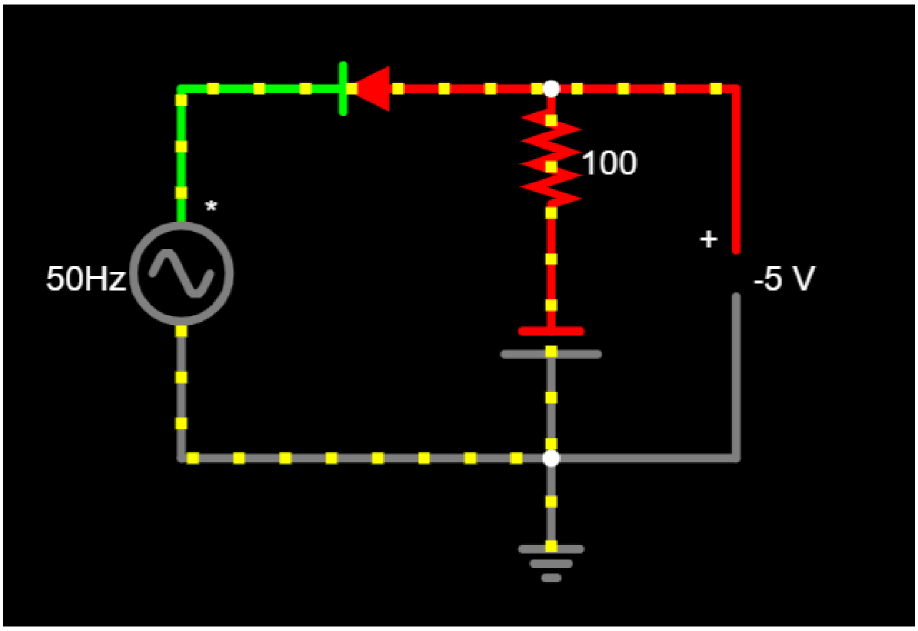
(b) Negative Biased

V_{BIAS} is negatively biased which is used to clip waveform in output in positive half cycle.

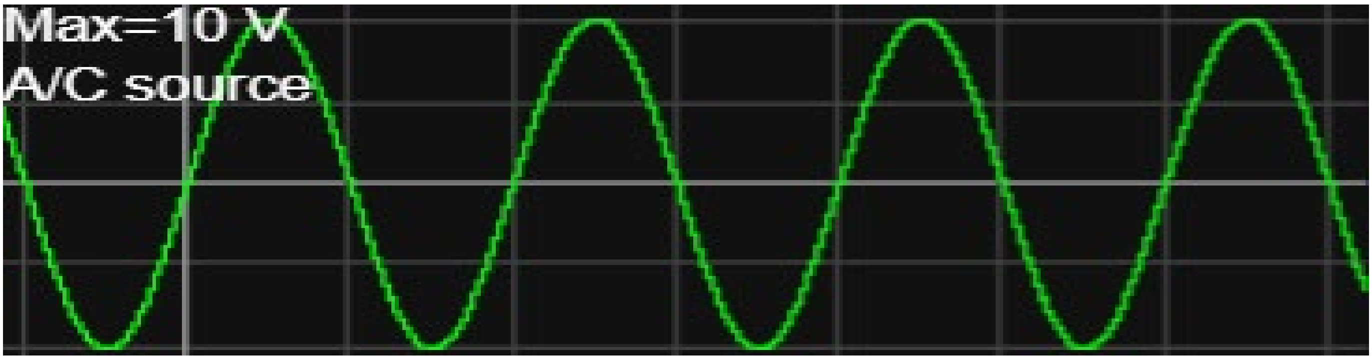
$+V_{BIAS} - V_{INPUT} + V_{DIODE} < V_{OUTPUT}$

Any input voltage levels above this bias point are clipped off.

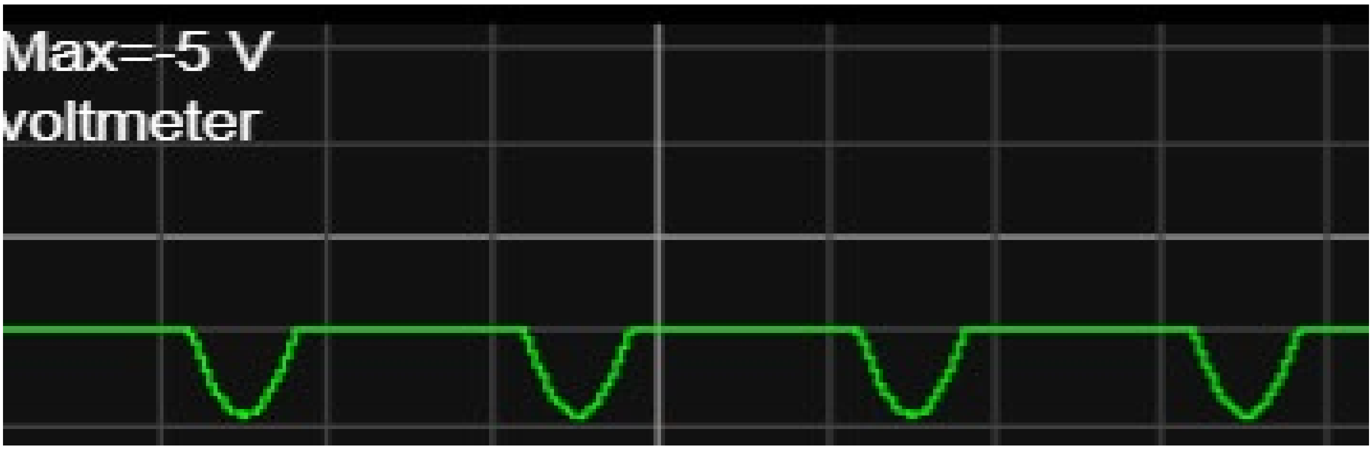
FALSTAD CIRCUIT:



Input Waveform:



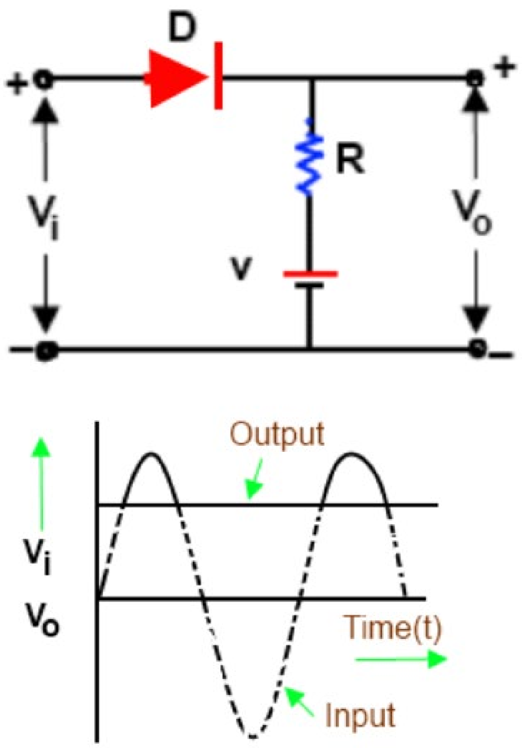
Output Waveform:



[LINK]

c) Forward biased negative clipper [Positive biased negative clipper]

CIRCUIT



(a) Positive biased

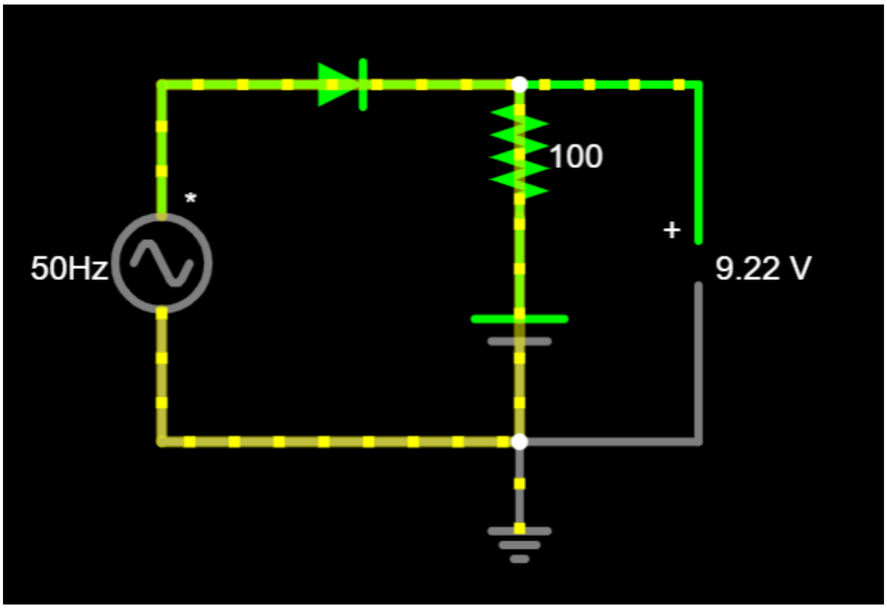
V_{BIAS} is positively biased which is used to clip waveform in output in negative half cycle.

$+ V_{INPUT} - V_{DIODE} < V_{OUTPUT}$

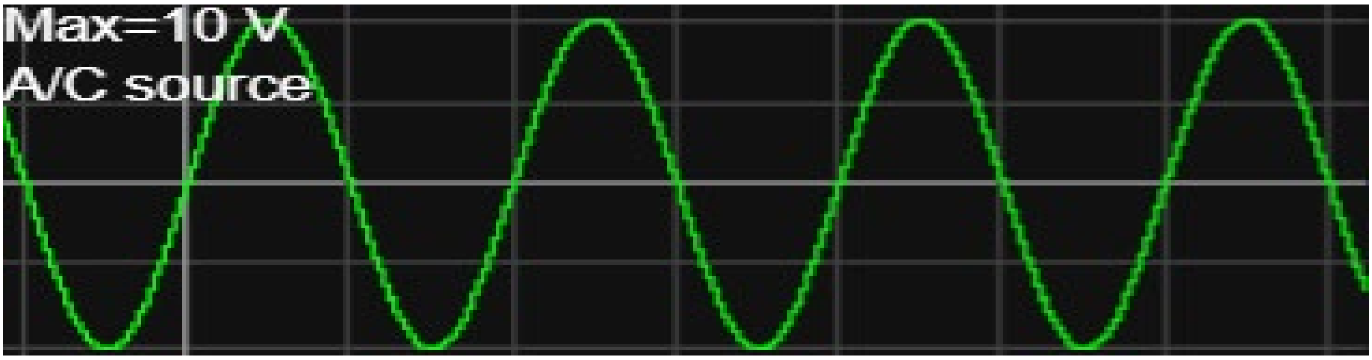
$+V_{BIAS} < V_{OUTPUT}$

Any input voltage levels above this bias point are clipped off.

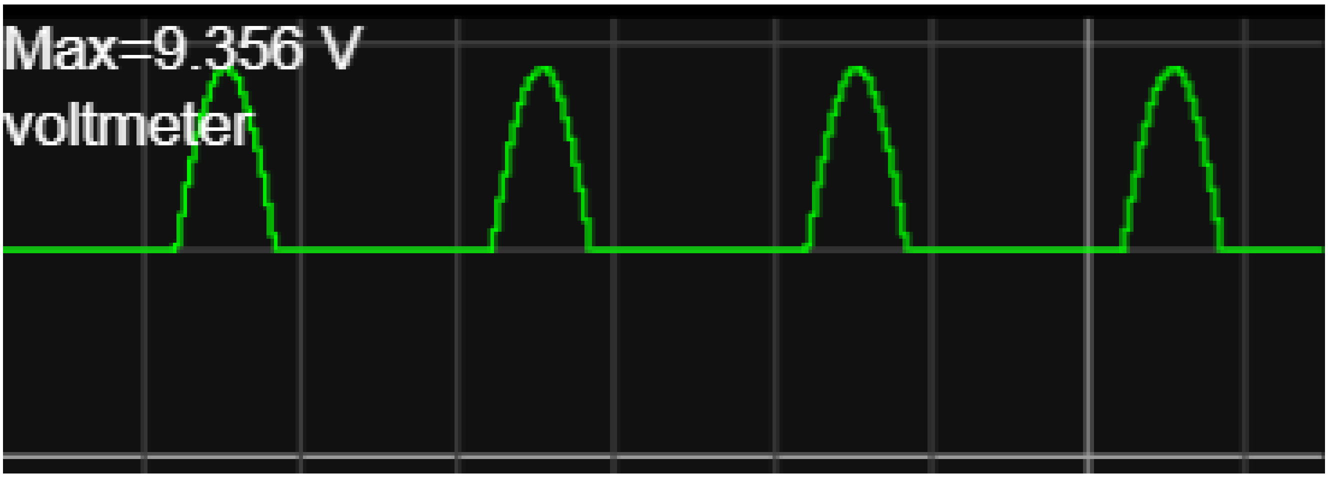
FALSTAD CIRCUIT:



Input Waveform:



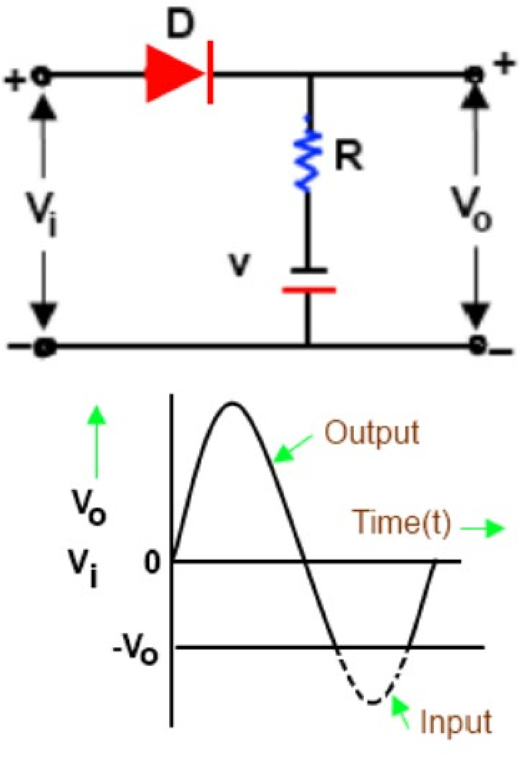
Output Waveform:



[LINK]

d) Reverse biased negative clipper [Negative biased negative clipper]

CIRCUIT



(b) Negative biased

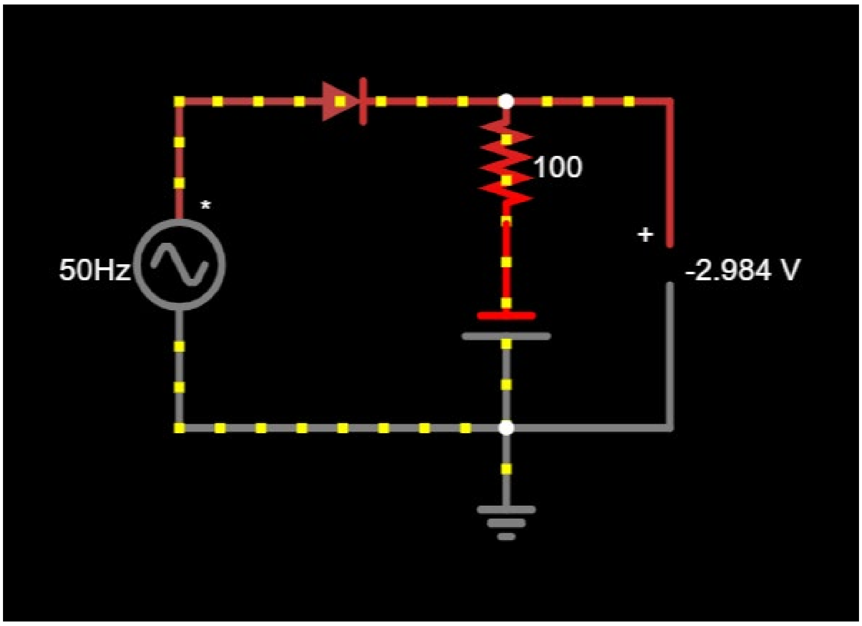
V_{BIAS} is negatively biased which is used to clip waveform in output in negative half cycle.

$+ V_{INPUT} - V_{DIODE} < V_{OUTPUT}$

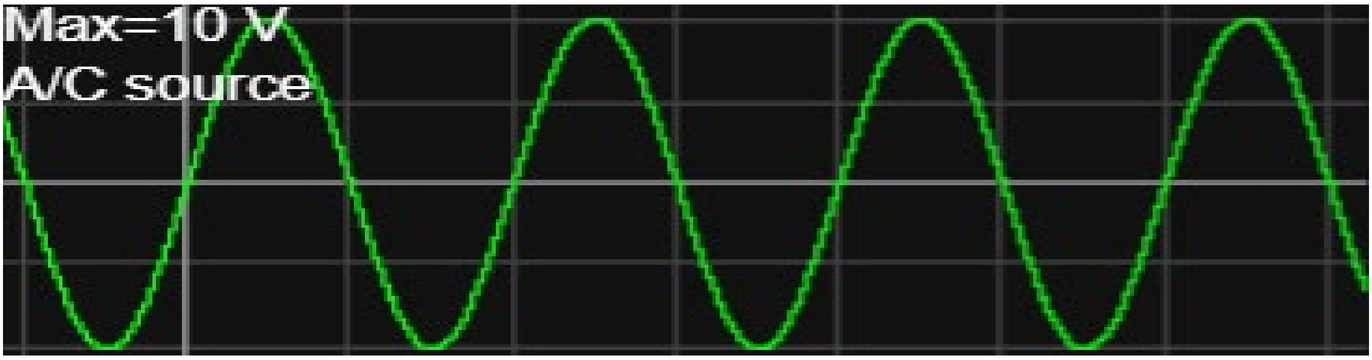
$+V_{BIAS} < V_{OUTPUT}$

Any input voltage levels above this bias point are clipped off.

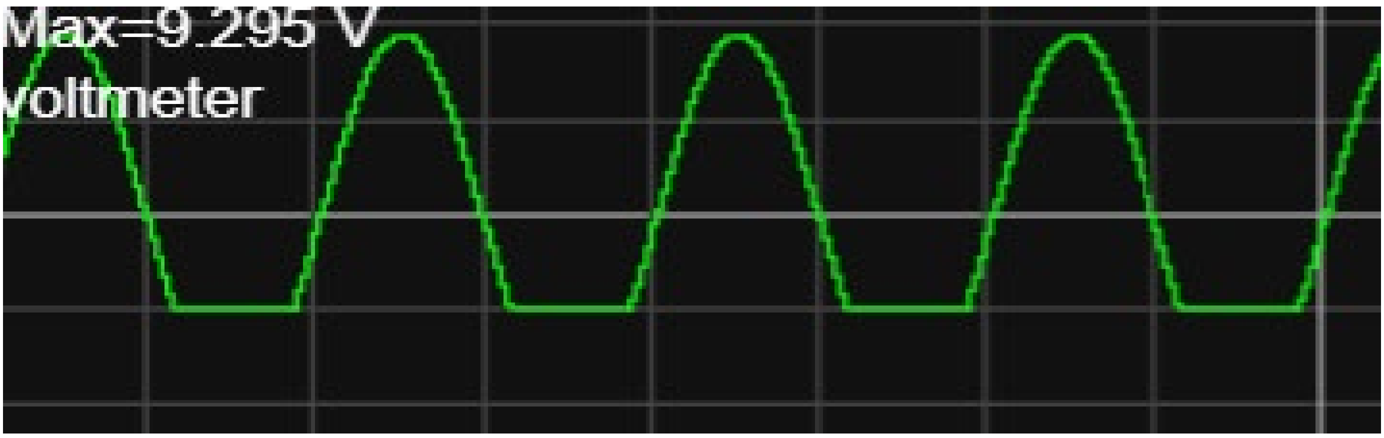
FALSTAD CIRCUIT:



Input Waveform:



Output Waveform:



LINK

Question-2

2.Design and study the following clippers using Zener diodes in the Falstad circuit simulator. Explain the working of the circuit diagram and plot the input and output waveforms. (Assume any values, if not given)

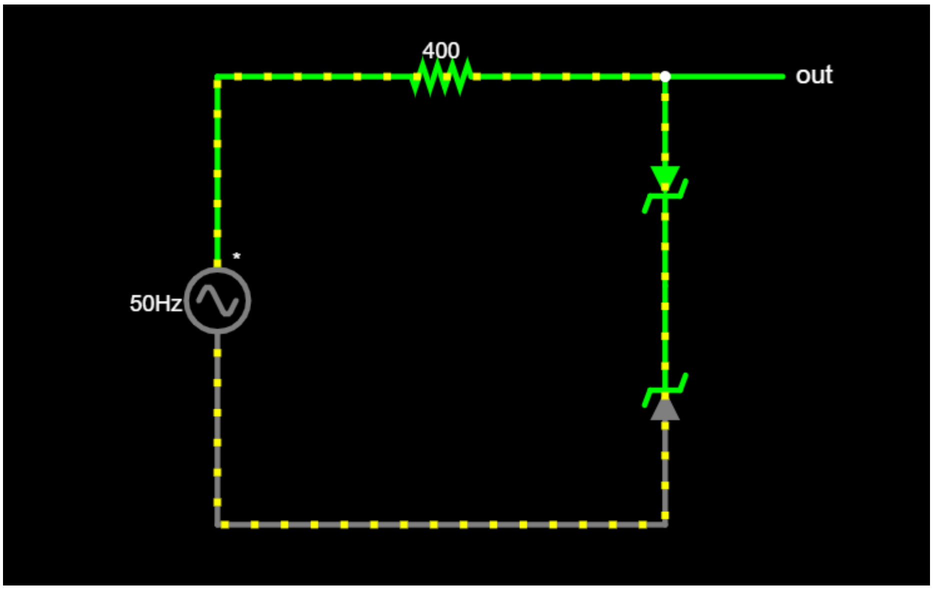
a) Double clipper clipping at +V and -V

b) Double clipper clipping at +VZand -VD

c) Series clipper clipping a part of the negative half cycle

A)

Circuit Diagram



Components used :-

1)AC voltage

2)Zener Diodes

3)Resistor

4)Analog Output

1. To begin, create an AC voltage (2 terminals) with a maximum voltage of 10 and a frequency of 100.

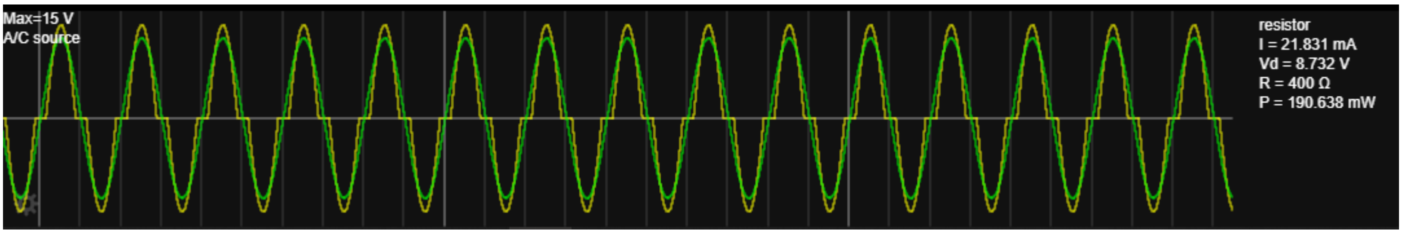
2. Connect the AC voltage supply to the 400 resister on one end.

3. Connecting the resistor to the two Zener diodes

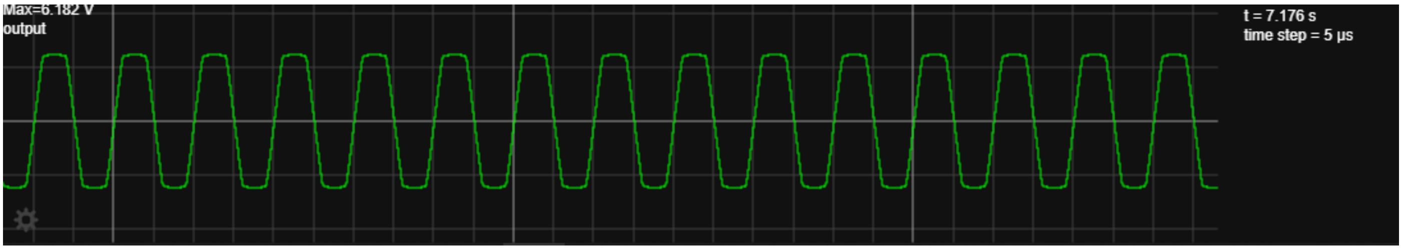
4. Connect the resister to the analogue output.

5. The output voltage of the input current is calculated using the analogue output.

Input Waveform:-



Output : -



Inference: -

• It generates a non-linear waveform from an input signal.

• It modifies the input waveform's slope.

• It cuts a portion of the input wave while leaving the rest of the wave alone.

• The circuit clipped the input wave section from both positive and negative waves, as can be seen.

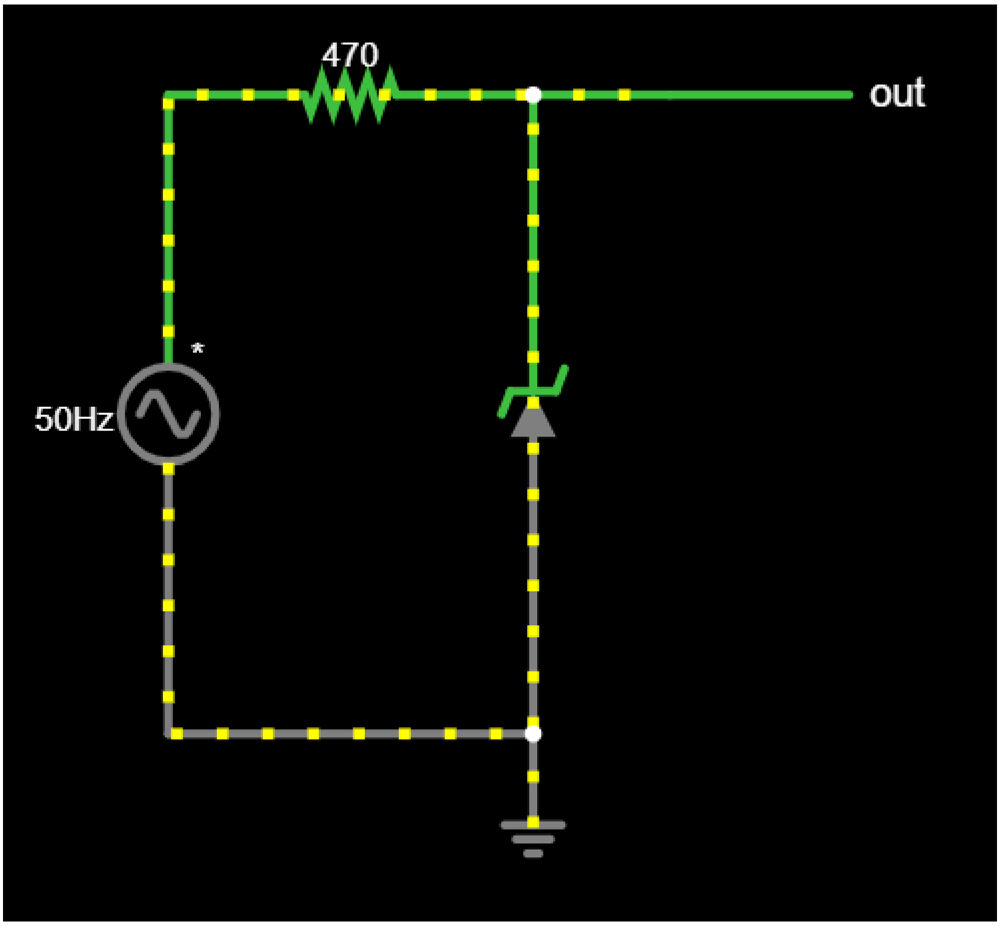
• The clipped and clamped principle is used in this circuit for both positive and negative output waves.

• The wave was not totally cut.

• All it did was clamp the output waves while clipping the input waves.

b) Double clipper clipping at +VZand -VD

Circuit diagram : -



Components used :-

1)AC voltage

2)Zener Diodes

3)Resistor

4)Analog Output

Procedure: -

1. We will clip the circuit two times in this circuit.

2. To begin, create an AC voltage (2 terminals) with a maximum voltage of 10 and a frequency of 100.

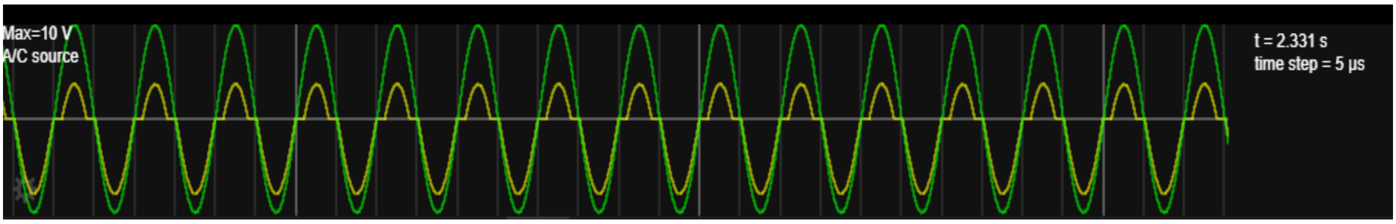
3. Connect the AC voltage supply to the 400 resister on one end.

4. Connecting the Zener Diode to the Resistor

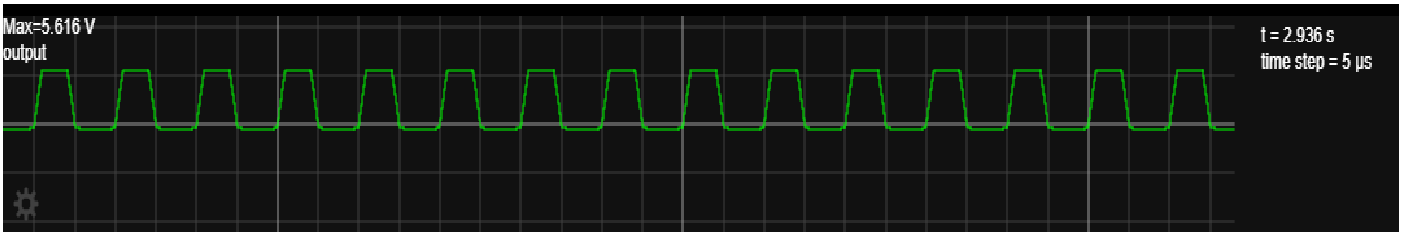
5. Connect the resister to the analogue output.

6. The output voltage of the input current is calculated using the analogue output.

Input waveform: -



Output waveform : -



Inference: -

• It transforms an input waveform into a non-linear waveform and adjusts the slope of the input waveform.

• It cuts a portion of the input wave while leaving the rest of the wave alone.

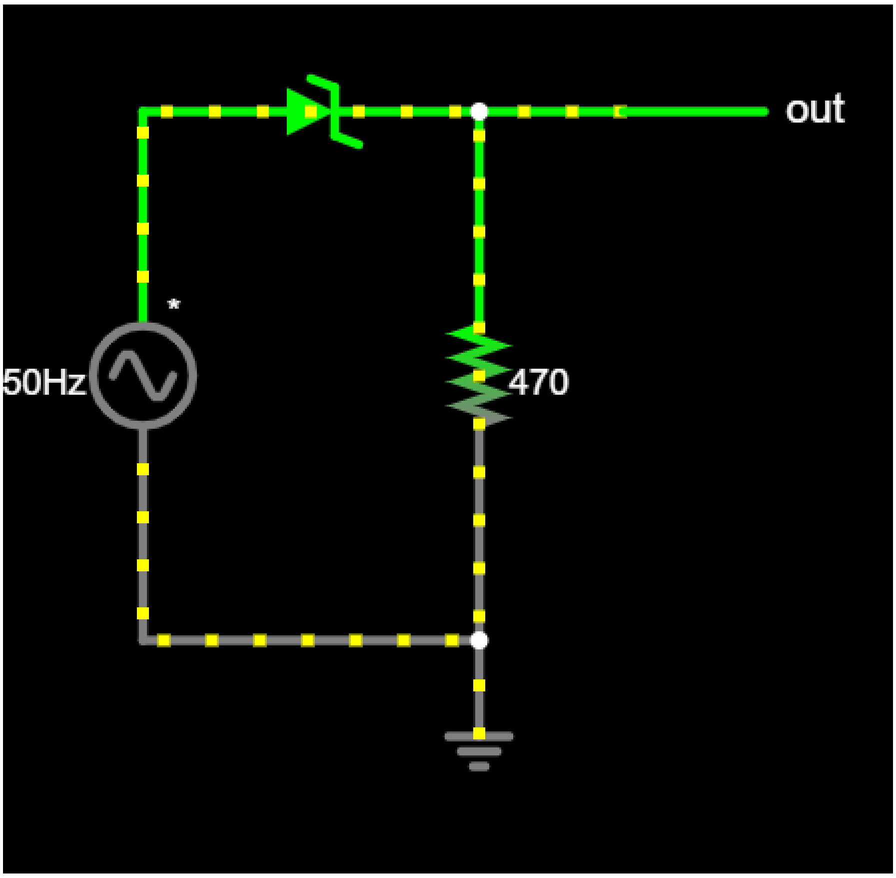
• The graph shows that it completely clipped the input waveform from the positive wave and generated a positive waveform.

• As a result, the negative waveform from the input waveform was clipped, and the output was a partially clipped negative waveform in the same output.

• It signifies that the negative output wave is present in the circuit clamping idea.

c) Series clipper clipping a part of the negative half cycle.

Circuit Diagram: -



Components used :-

1)AC voltage

2)Zener Diodes

3)Resistor

4)Analog Output

Procedure : -

1. The circuit's key idea is to connect the resister to the input voltage's opposite side.

2. To begin, create an AC voltage (2 terminals) with a maximum voltage of 10 and a frequency of 100.

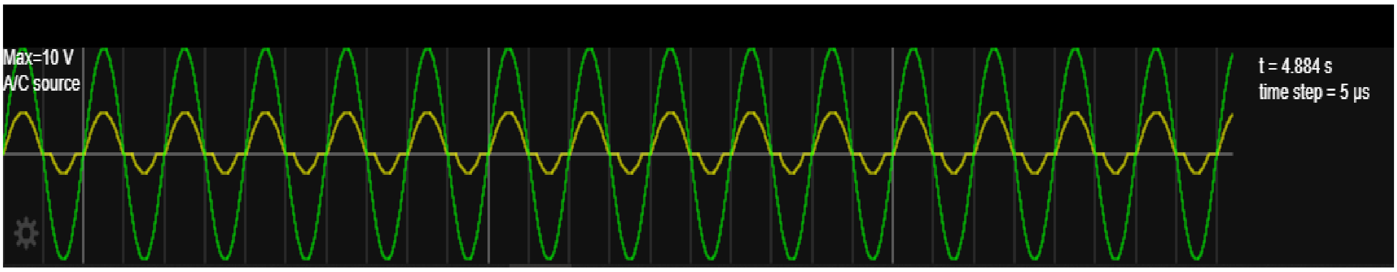
3. Connect the Zener diode to one end of the AC voltage source.

Connecting the Zener diode

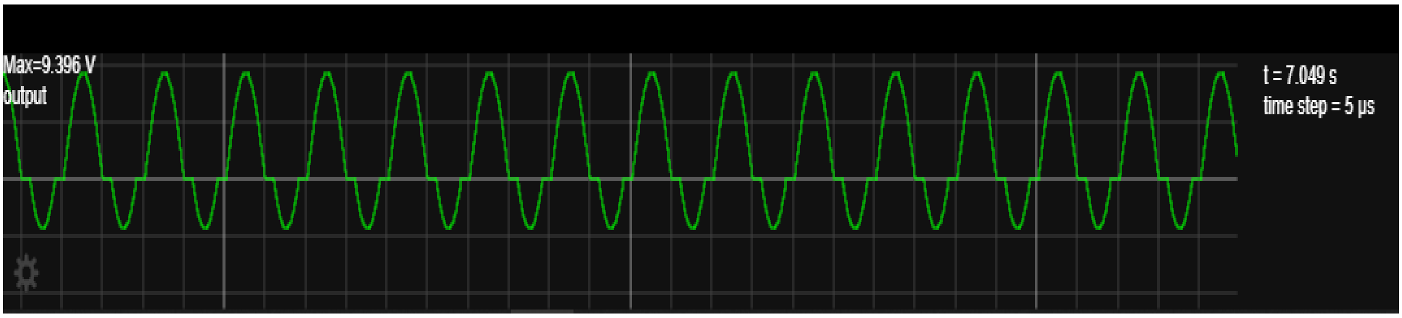
5. Connect the Zener diode to the analogue output.

6. The output voltage of the input current is calculated using the analogue output.

Input waveform : -



Output waveform: -



Inference : -

The Zener diode is linked in series with the analogue output in this circuit.

Clipping occurs solely during the waveform's negative cycle.

Peak to peak, or 10 to -10, is the voltage of an A/C voltage source.

Because there is a barrier potential of 0.6 V in the positive half cycle, the maximum voltage is 10V, and we can see cutoff at 9.6V.

The diode becomes reverse biassed in the negative half cycle, and it does not conduct if the input voltage is less than 5.6V.

The amplitude drops by 4.4V as a result of the breakdown voltage.

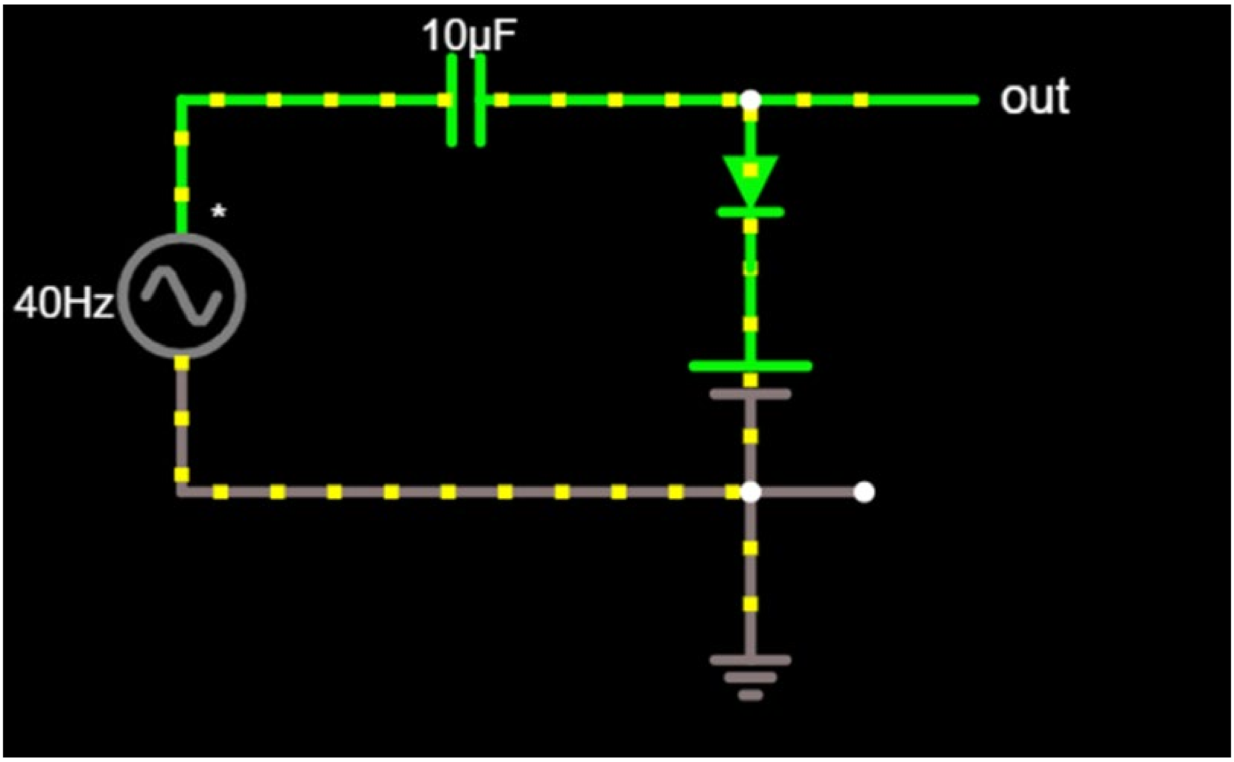
Question-3 : -

3.a) Design a clamper circuit which clamps an input sinusoidal wave negatively at, exactly +5 volts. Explain the working of the circuit diagramand plot the input and output waveforms.

b) Design a clamper circuit using zener diode which clamps an input sinusoidal wave positively at –VZ volts. Explain the working of the circuit diagram and plot the input and output waveforms.

Answer: -

Circuit Diagram : -



Working of circuit: -

❖ Basically, this circuit is a negative clamper with a positive voltage values in other terms we call it as reference voltage.

❖ The specific voltage, which is added to the output is to raise the clamper level.

In graphs we get 2 half cycles

Positive half cycle and negative half cycle

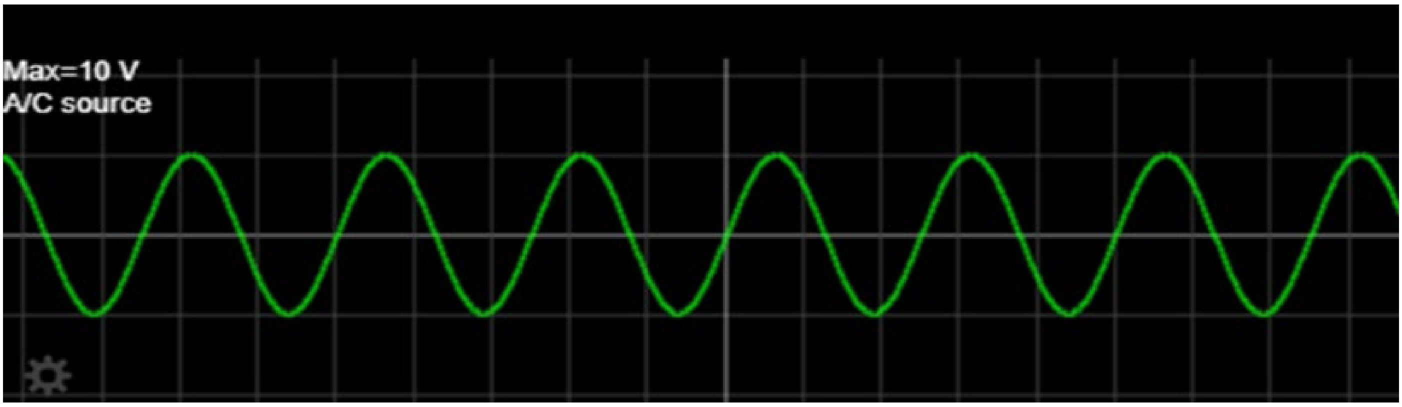
❖ **<u>Positive half cycle:</u>**

Here capacitor does not get charged. Although diode conducts, the output is equal to the applied positive reference voltage.

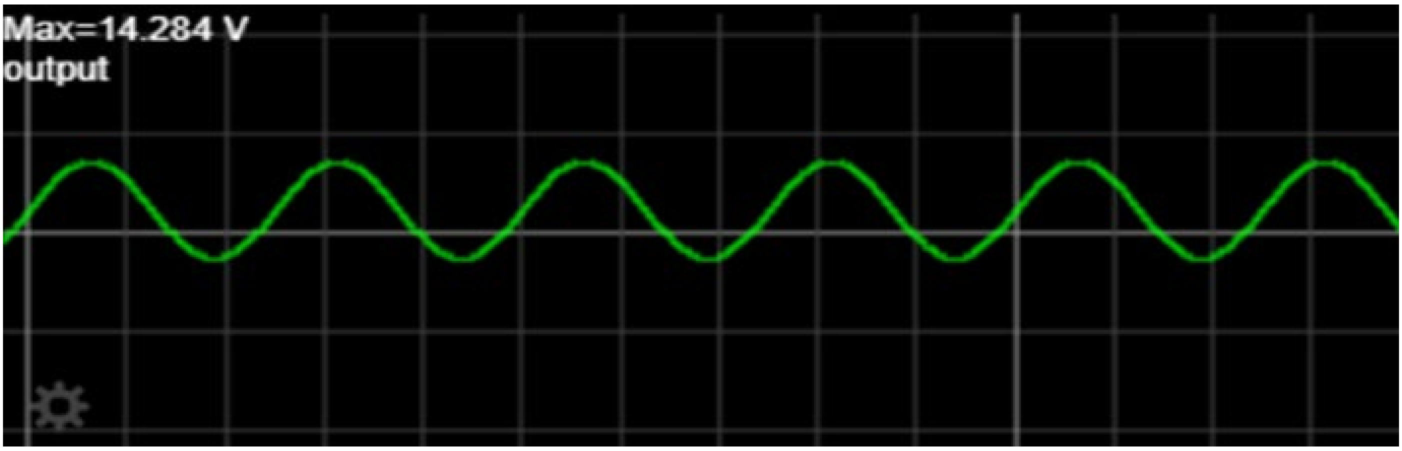
- ❖ **Negative half cycle:**

when the diode is open and the voltage across the capacitor forms it leads to the negative half cycle.

Input waveform :-

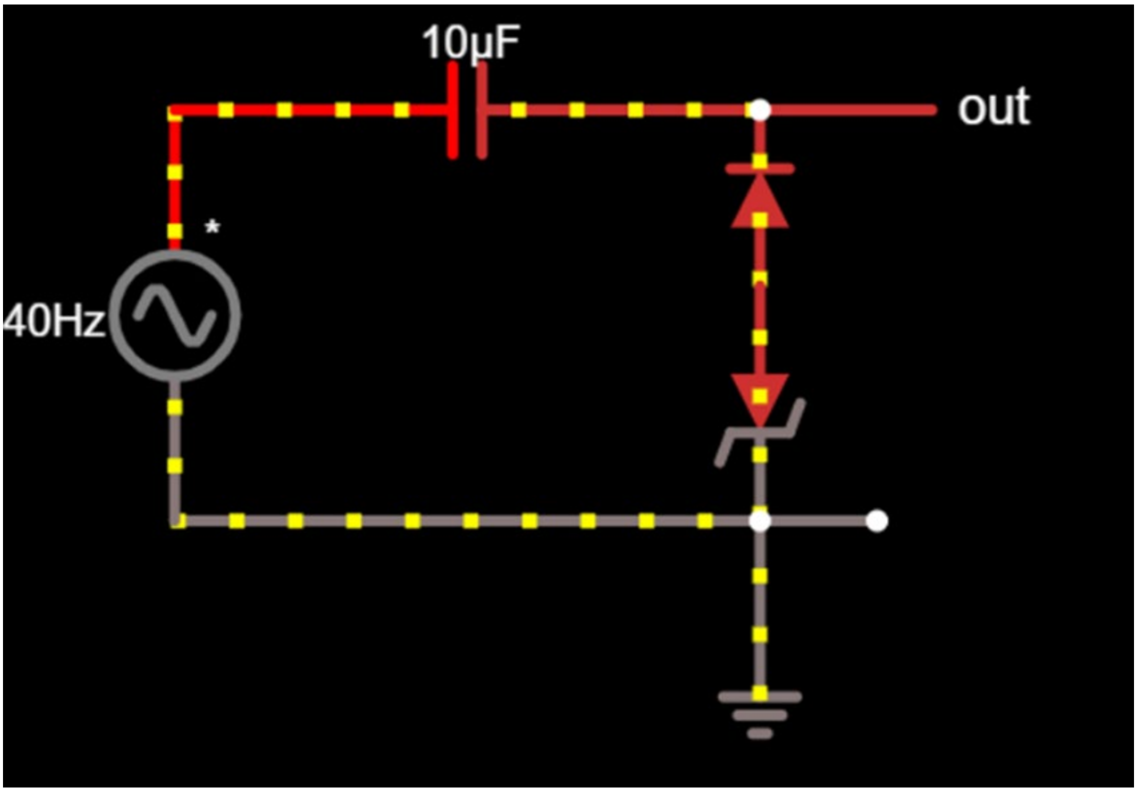


Output waveform : -



b) Design a clamper circuit using zener diode which clamps an input sinusoidal wave positively at –VZ volts. Explain the working of the circuit diagram and plot the input and output waveforms.

Circuit Diagram: -



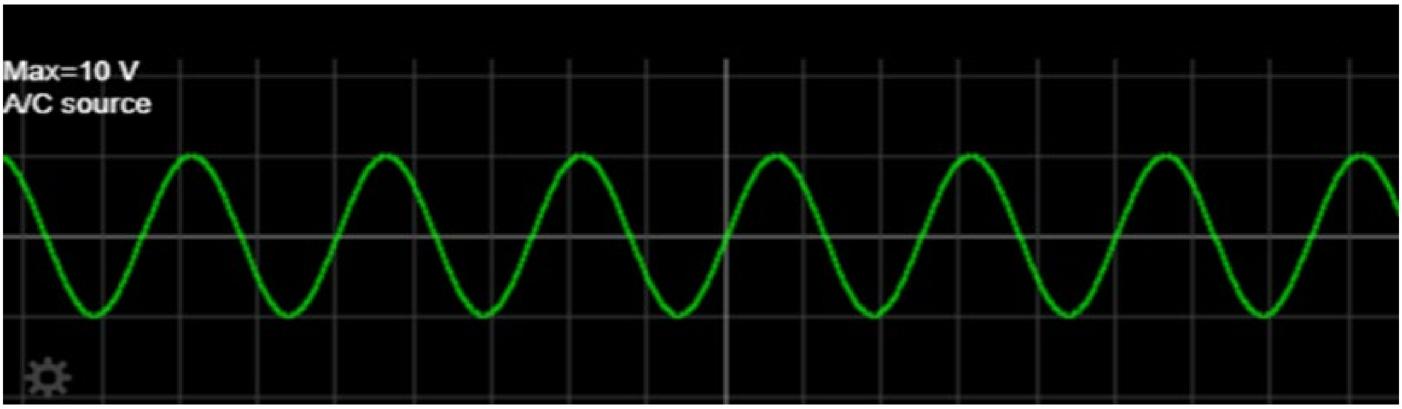
Working of circuit Diagram : -

Here we use this formula to describe the working

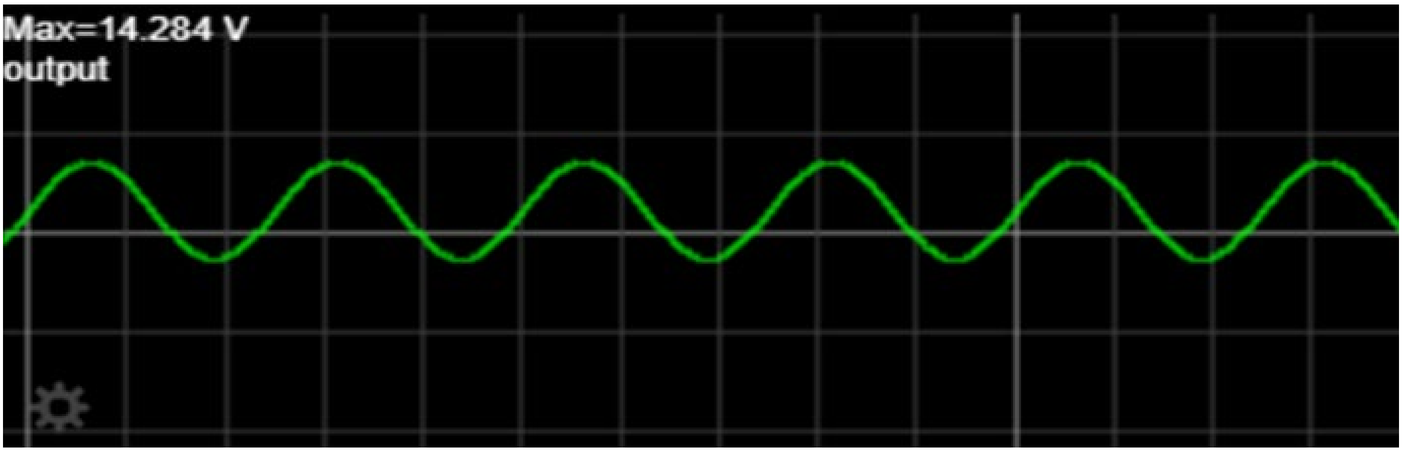
$$V_O = V_I + (V_M - V_Z)$$

- ❖ The diode is forward biased during the negative cycle, so the input is grounded.
- ❖ The capacitor charges during the positive cycle, and the diode is biased in reverse. As a result, the output voltage is increased.

Input waveform: -



Output waveform: -



4. Perform the experiment for demonstrating Common-Base Characteristics of an NPN transistor in Falstad circuit simulator.

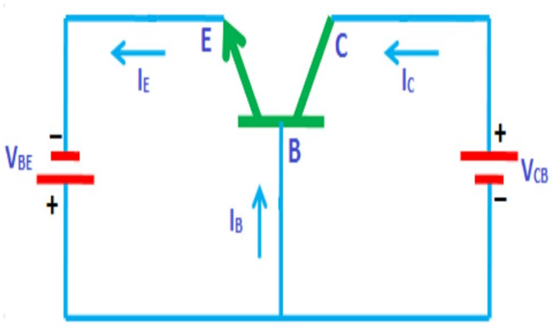
a) Explain the theory behind the experiment.
b) Draw the circuit diagrams, Mention the components used, and state the procedure of the experiment.
c) Plot the input and output characteristics
d) Calculate the following parameters – dynamic input resistance – dynamic output resistance – Common-base current gain
e) Comment on the values obtained in (d).

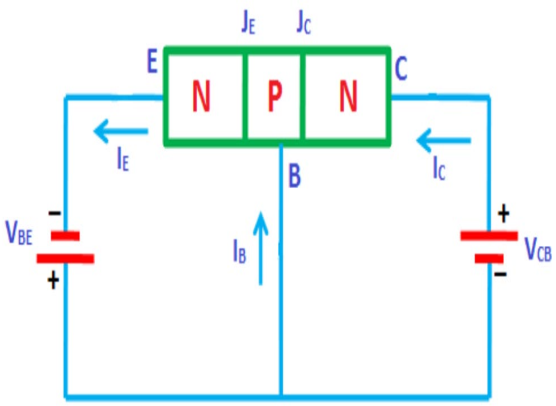
Ans.
a) The npn transistor is formed when a single p-type semiconductor layer is sandwiched between two n-type semiconductor layers.

The base-emitter junction JE is forward biased by the supply voltage VBE while the collector-base junction JC is reverse biased by the supply voltage VCB.

Due to the forward bias voltage VBE, the free electrons (majority carriers) in the emitter region experience a repulsive force from the negative terminal of the battery similarly holes (majority carriers) in the base region experience a repulsive force from the positive terminal of the battery.

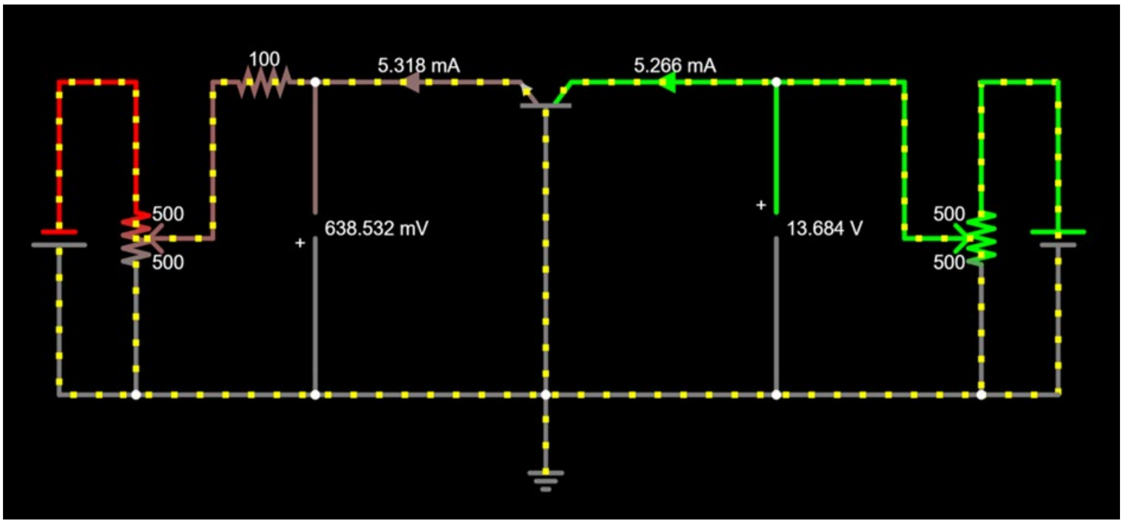
As a result, free electrons start flowing from emitter to base similarly holes start flowing from base to emitter. Thus, free electrons which are flowing from emitter to base and holes which are flowing from base to emitter conducts electric current. The actual current is carried by free electrons which are flowing from emitter to base. However, we follow the conventional current direction which is from base to emitter. Thus, electric current is produced at the base and emitter region.





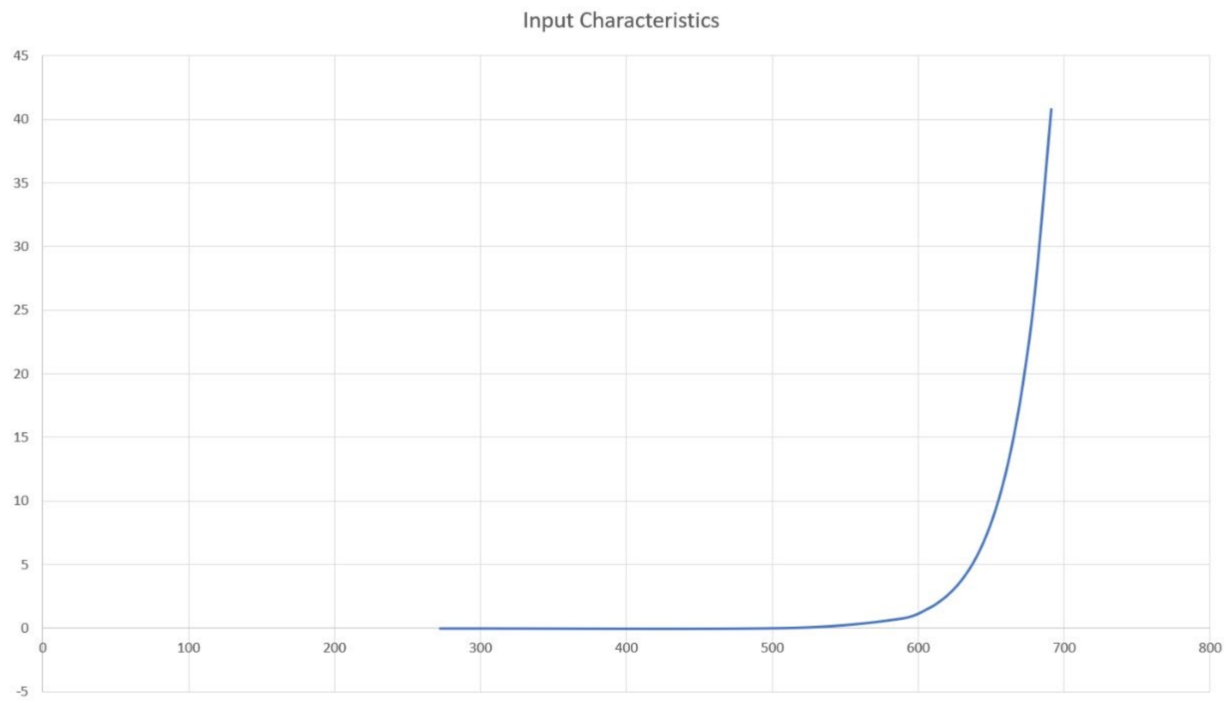
b)

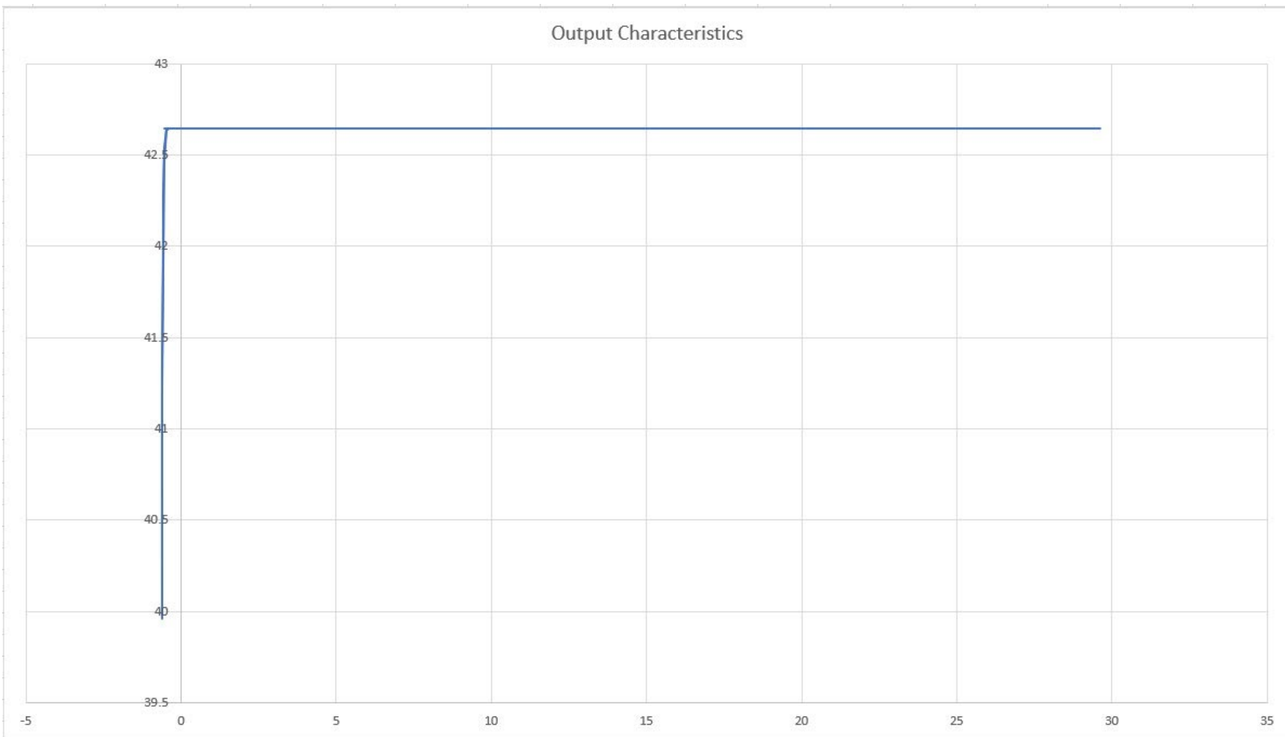
- Take an NPN transistor, and ground the base terminal.
- Give a forward bias to the base – emitter junction and reverse bias to the base – collector.
- Use a potentiometer on either sides to change the output voltage and input current
- Note the input and output characteristics using ammeter and voltmeter.



Components used:
NPN - transistor, ammeter, voltmeter, potentiometer, 2 terminal DC voltage source, resistor.

c) Graphs:
Input Characteristics





- D)
- Dynamic input resistance
- Δv_{be}= 0.034
- Δi_e=0.138
- $\frac{\Delta v_{be}}{\Delta i_e}$=0.248
- Dynamic output resistance
- Δv_{cb}=0.681
- Δi_c=0.137
- $\frac{\Delta v_{cb}}{\Delta i_c}$=4.934
- Common base current gain
- $\frac{\Delta \mathrm{i_c}}{\Delta i_\mathrm{b}}$=0.9927

e)

The dynamic output resistance is high because the collector base junction is in reverse bias.

The current gain factor is almost 1 signifying that nearly all the emitter current is passed to collector junction.

THANK YOU!!