INDIAN INSTITUTE OF TECHNOLOGY
BHUBANESWAR

Introduction to Electronics Laboratory

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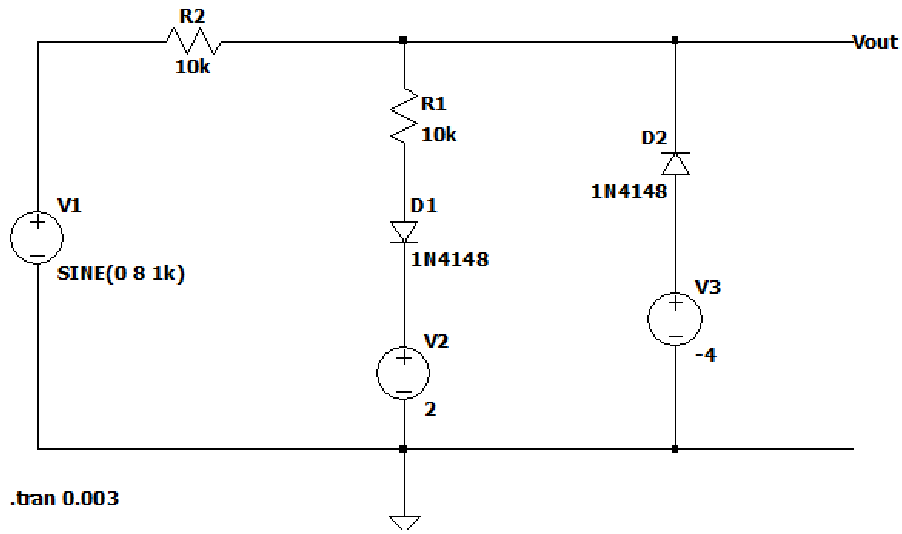
Objectives

- Build a shunt Clipper and measure its input-output characteristics
- Building a circuit from given output
- Build a Full Wave, bridge rectifier, and measure their characteristics
- Build a voltage doubler circuit, and observe its behavior
- Observing the output of below circuit.

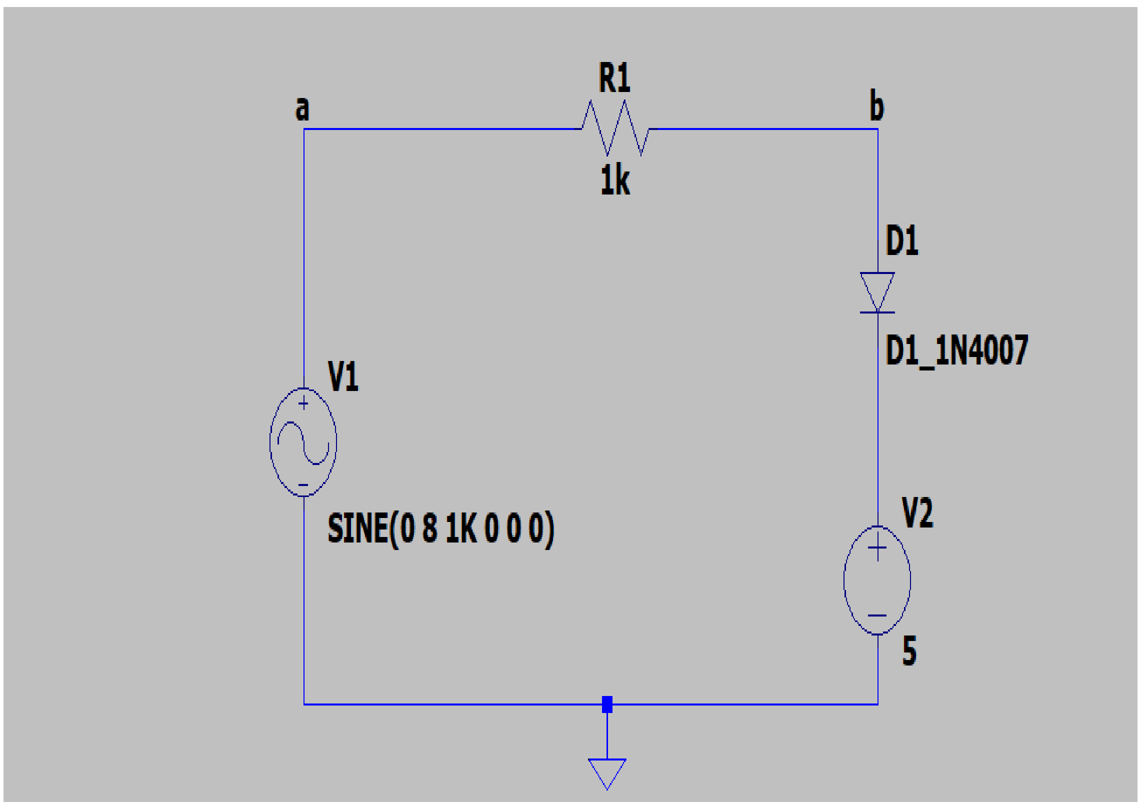


Part 1

Shunt Clippers using diodes

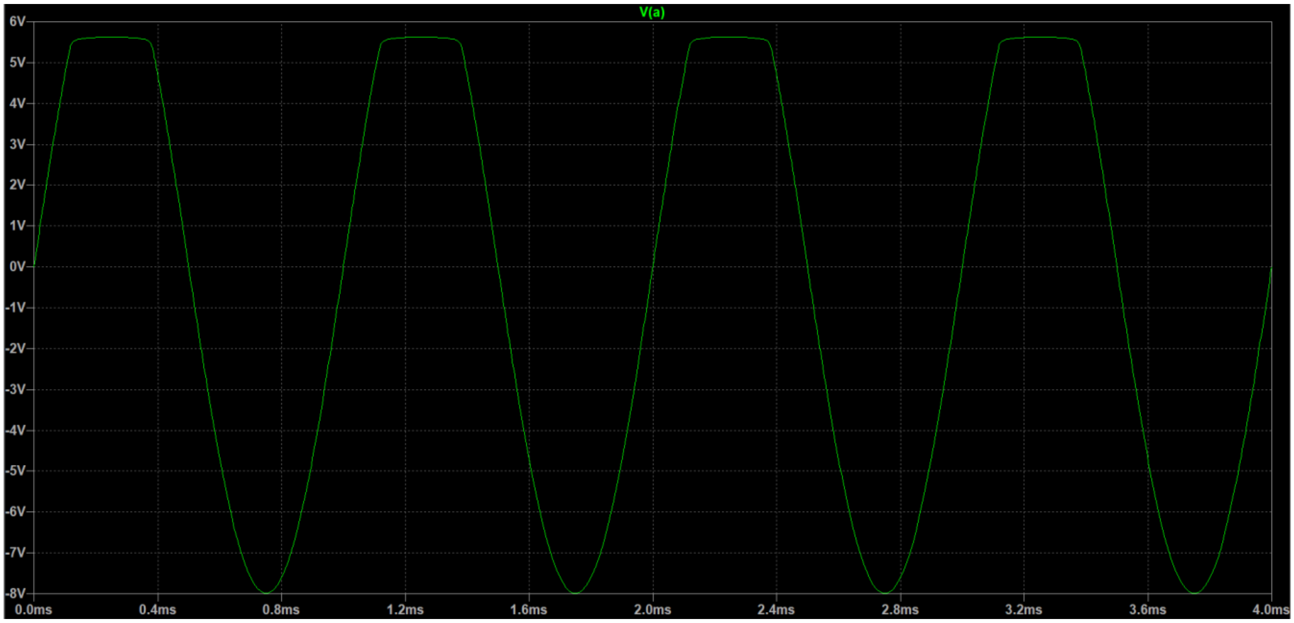
In normal mode

Ltspice circuit diagram

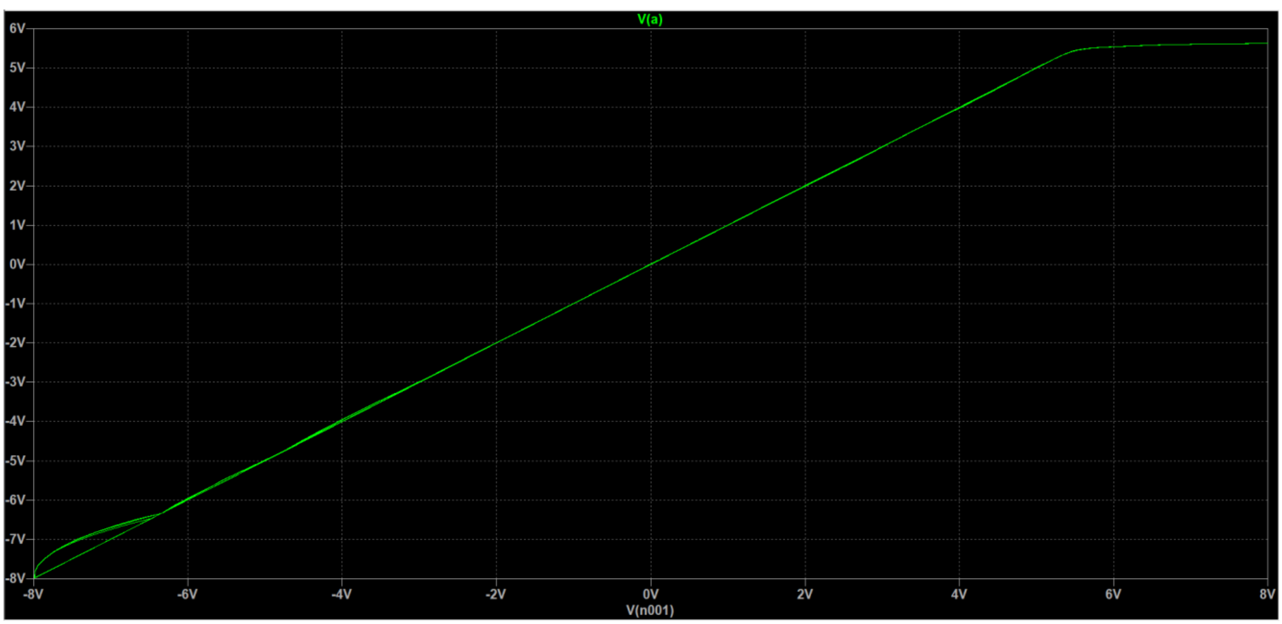


Ltspice output:

Plot between V_A and Time.



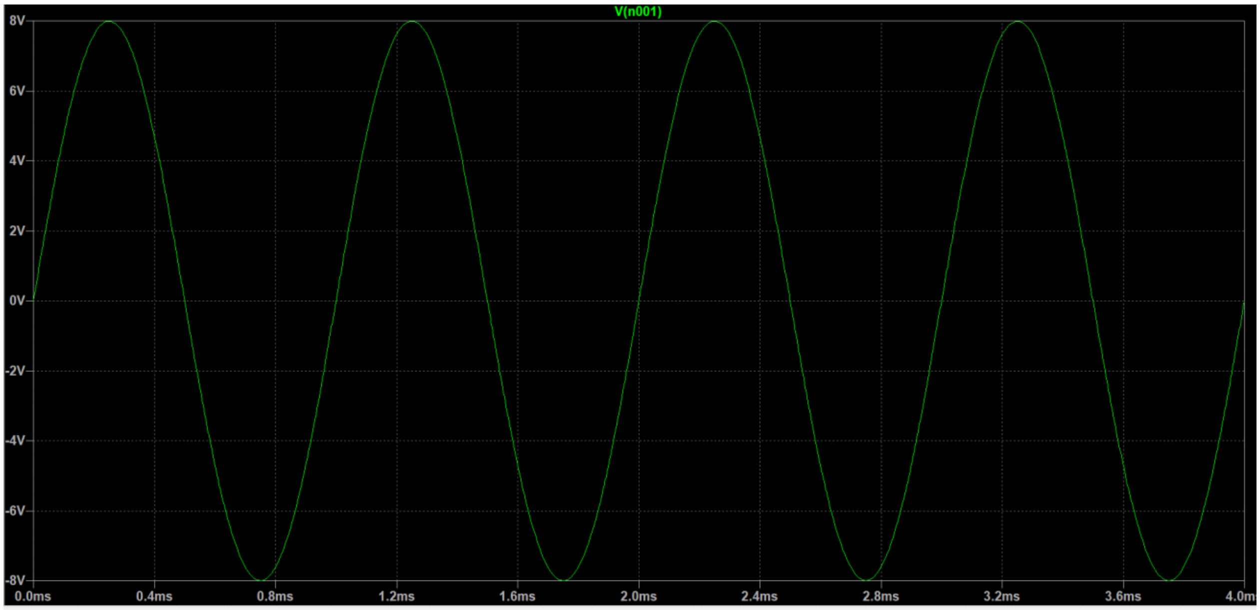
Plot between V_{in} vs V_A(Output)



Plot between V_A(Output) vs V_{in}

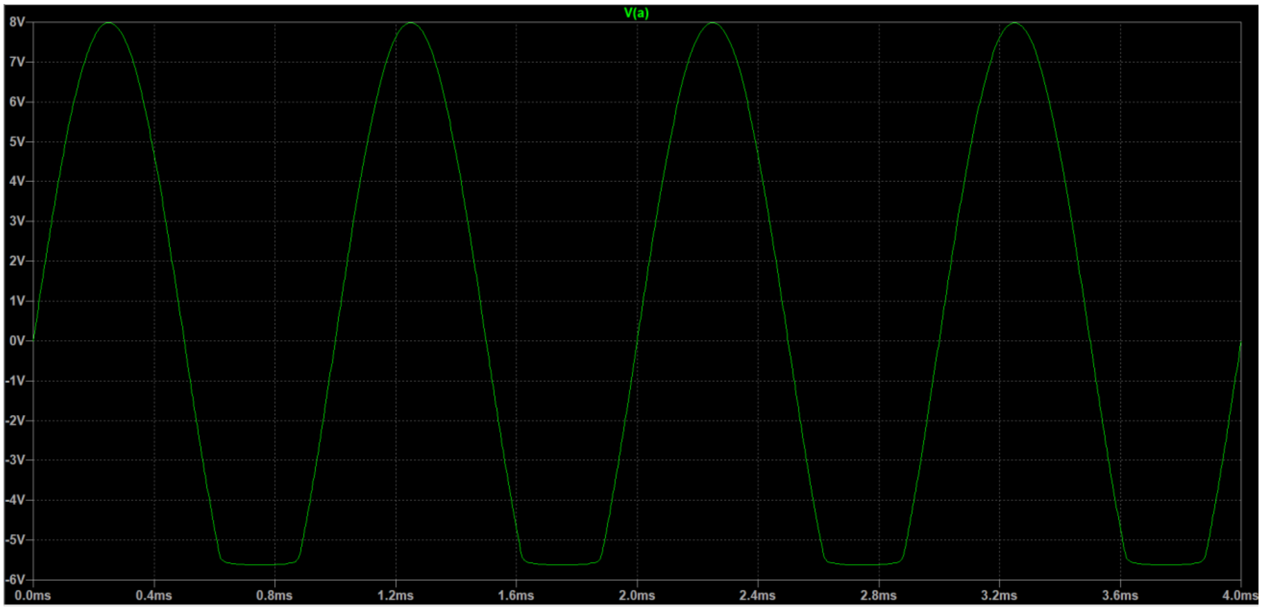
When diode and 5 volts are reversed

V_{input} vs time

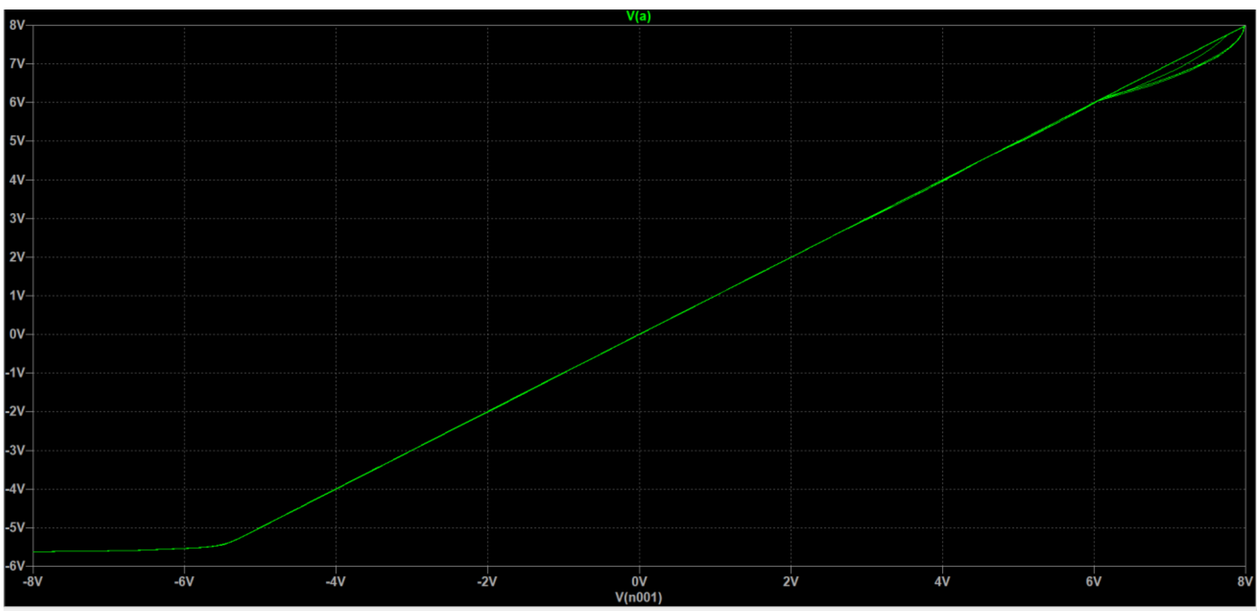


Ltspice Output:

Plot between V_A and time



Plot between V_{in} and V_A(Output)



Plot between V_A(Output) vs V_{in}

We can observe from graphs that if 5volts and diode are reversed then the clipping shifted to lower cycles.

And in normal mode from the plot between V_{in} vs V_A(Output) we can say that initially the graph is an increasing straight and in between 5-6volts it becomes constant this is the clipping region.

And when 5volts and diode are reversed the plot between V_{in} vs V_A(Output) we can say that initially the graph is a constant which means clipping in negative cycle and later it is increasing as a straight line.

Discussion:

A clipper is a device which limits, remove or prevents some portion of the wave form (input signal voltage) above or below a certain level In other words the circuit which limits positive or negative amplitude, or both is called chipping circuit.

Conclusion:

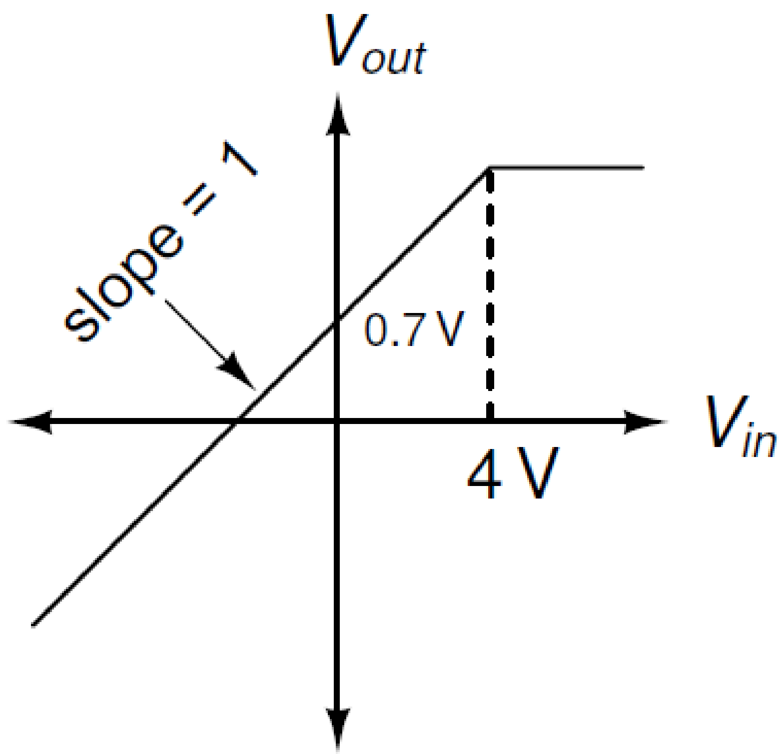
We successfully plotted Vout vs Vin of both the positive clipper and negative clipper and analyzed it.

Part 2

Designing a Circuit from the output graph

Now we are going to design a circuit based on a given plot in the Lab manual

Given graph in manual:

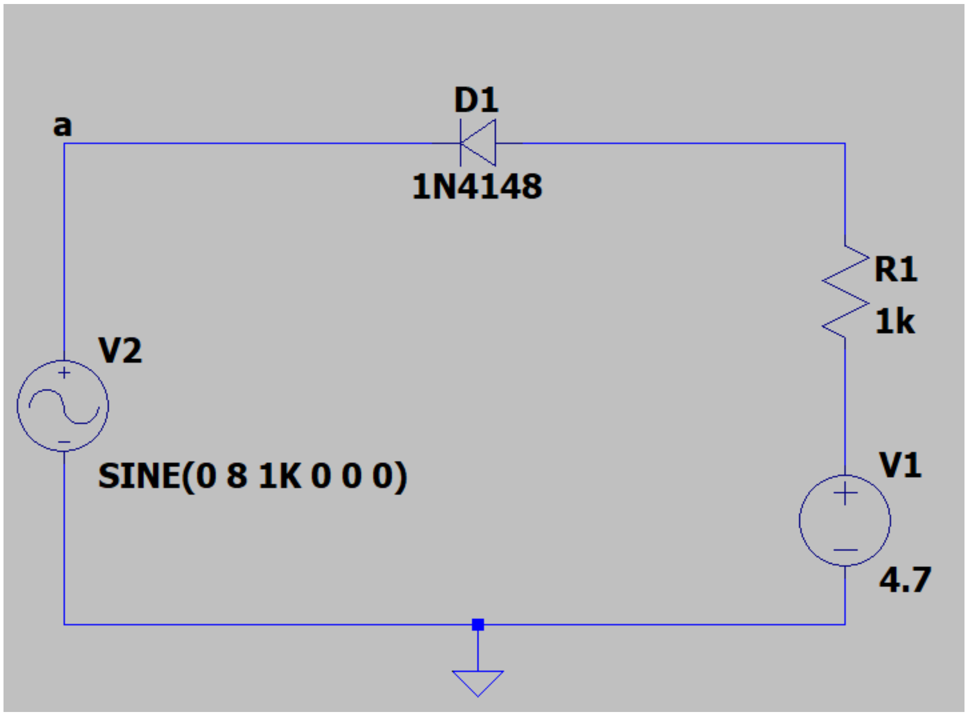


From the graph given in the manual we can see that when V_{in} is 0volts the output is 0.7volts that is equal to cut-in voltage of diode the slope is 1 is saying that in that region the diode is in forward bias and the constant V_{out} region is in Reverse bias.

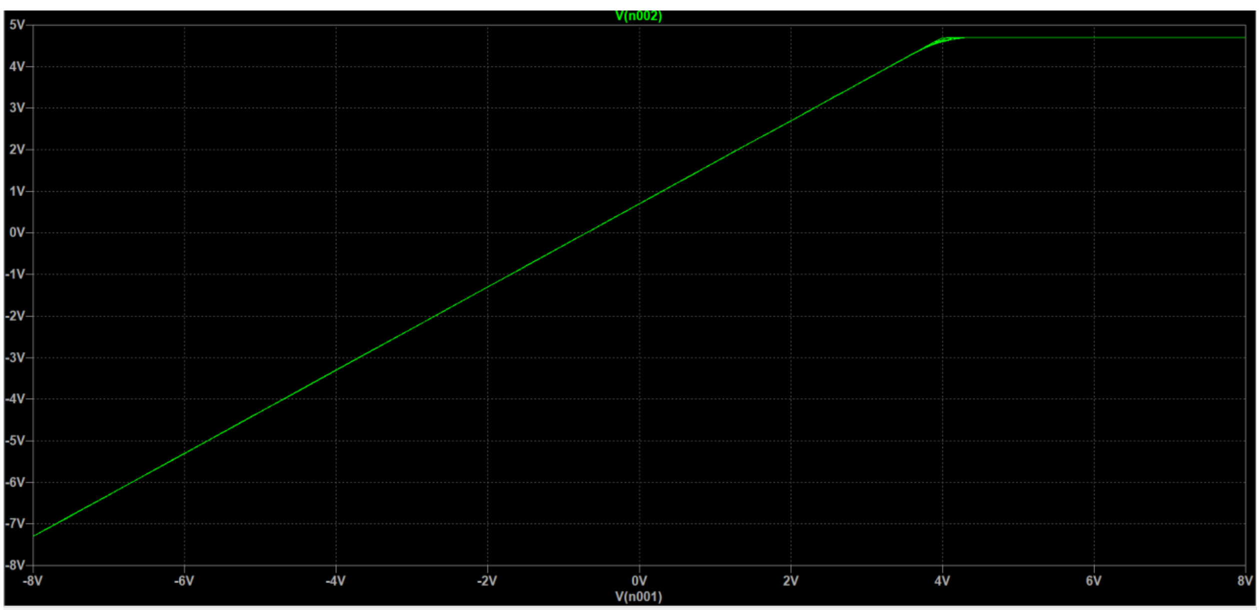
As the constant voltage is 4.7, we have to keep a DC source of 4.7volts as output.

Therefore, I am using an AC source, DC source, resistance, diode of 0.7 cut-in voltage.

From the observations I have designed the circuit in the following way i.e.;



Now let us check the output of the circuit and verify the requirements……

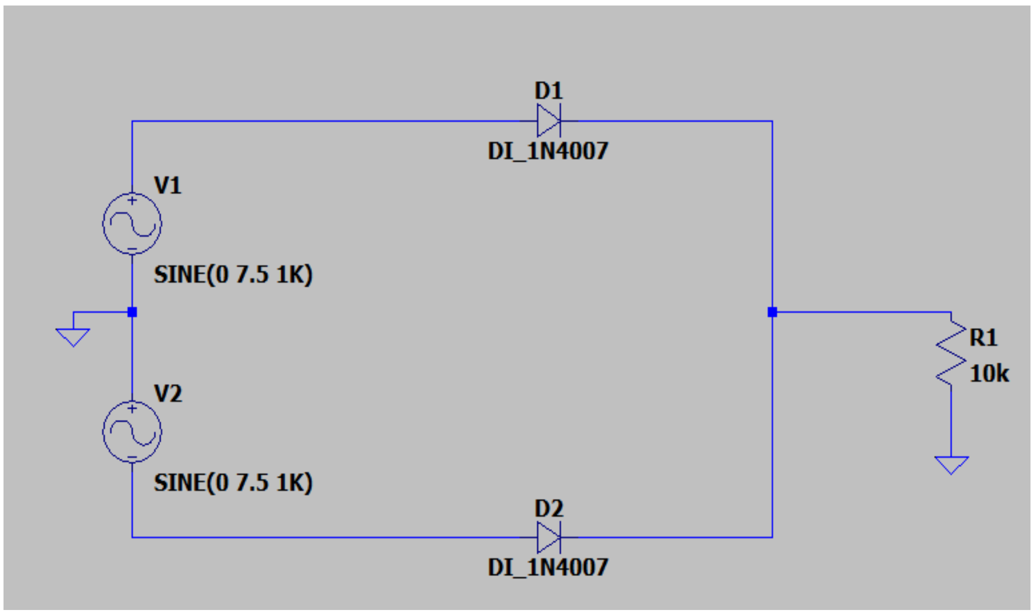


All the requirements are satisfied as mentioned in the graph.

Part 3

Full Wave Rectifier

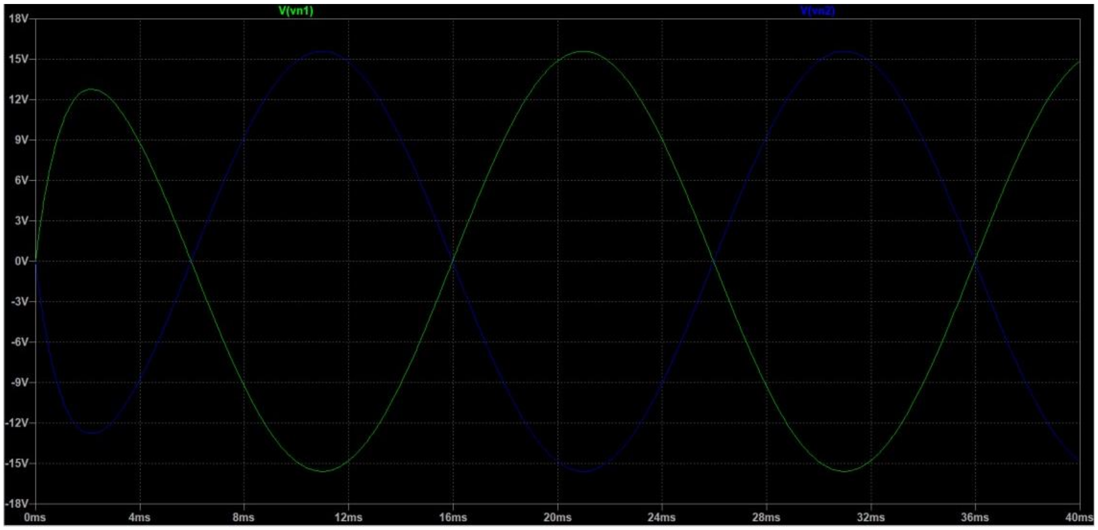
Ltspice circuit diagram



Here we used center tapping for a secondary winding to make the negative cycle as positive cycle.

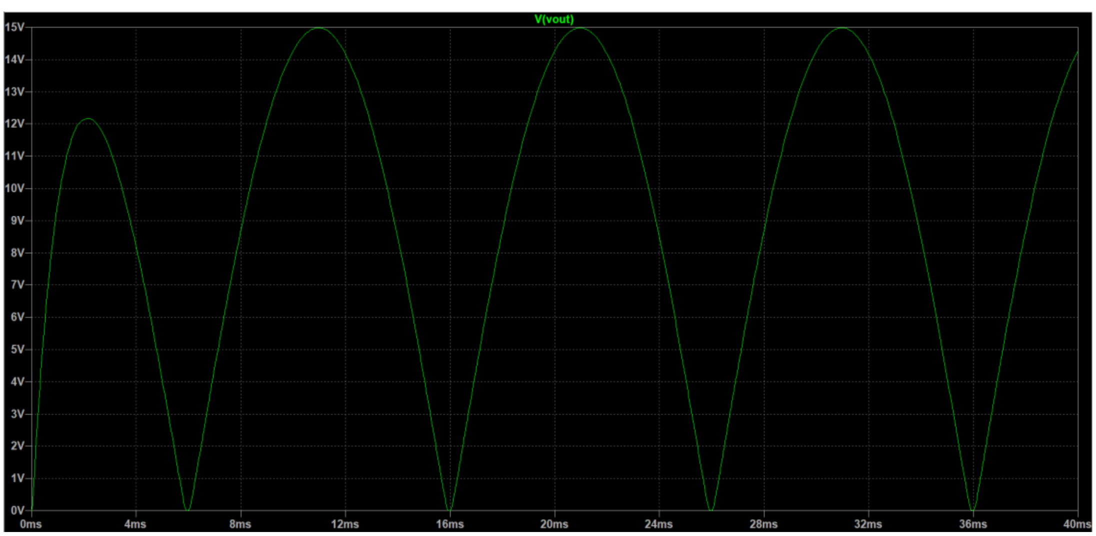
Ltspice Output:

Plot between $V_{secondary}$ with time



Here we can see that the output voltage from secondary winding is not perfectly sinusoidal in the first cycle the reason for this imperfection is some part of primary input energy is stored in the core (which consists of inductors) of transformer. In later cycles the energy is not deducted from the primary because the core has already consumed the energy from the first cycle.

Plot between V_{output} and time



Advantages:

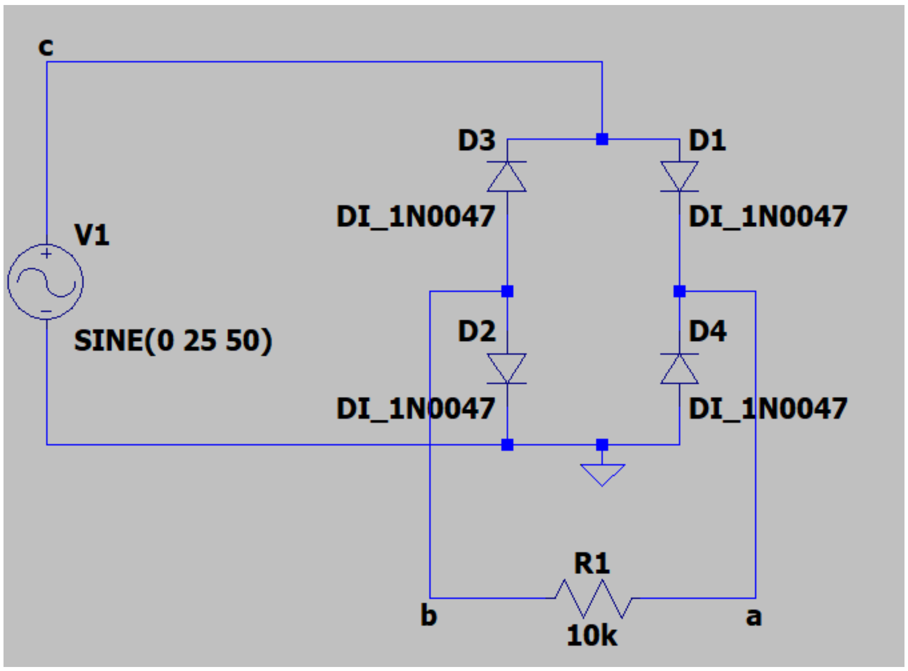
- The rectification efficiency is twice than that of a half wave rectifier. For a full wave rectifier, the maximum possible value of rectification efficiency is 81.2 % while that half wave rectifier is 40.6 %.
- The DC output voltage and DC load current values are twice than those of a half wave rectifier.
- The ripple factor is much less than that of half wave rectifier.

Disadvantages:

- The PIV (peak inverse voltage) of a diode used twice that of the diode used in the half wave rectifier, so the diodes used must have high PIV.
- It is expensive to manufacture a centre tapped transformer which produces equal voltage on each half of the secondary windings.
- The output voltage is half of the secondary voltage, as each diode utilizes only one half of the transformer secondary voltage.

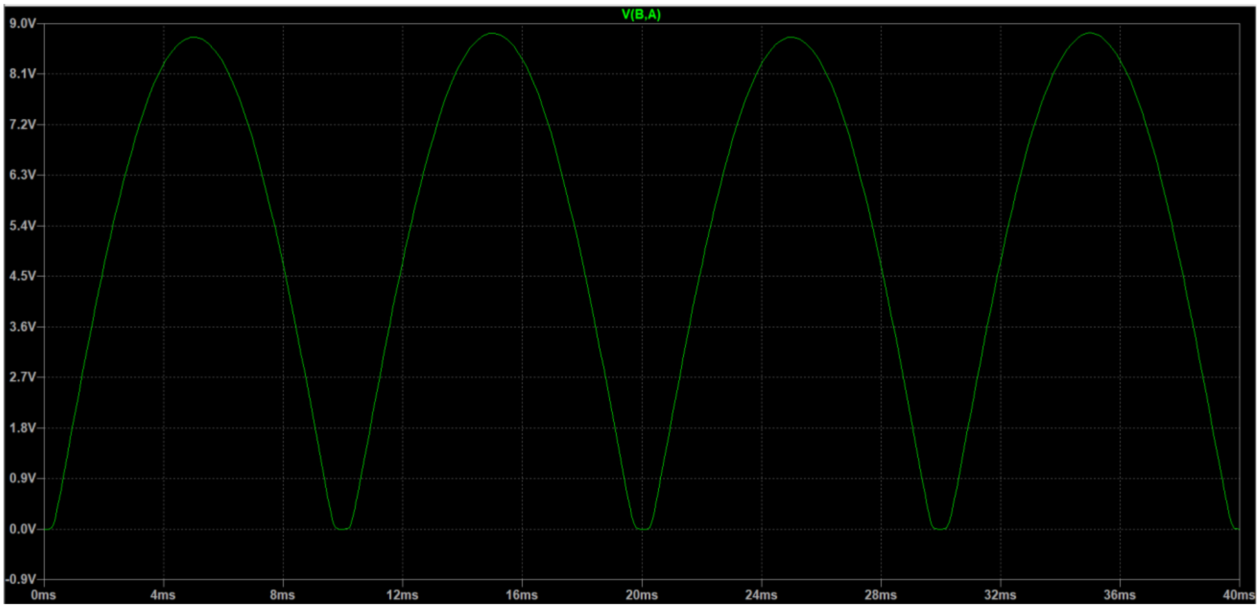
Bridge Rectifier

Ltspice circuit diagram



Ltspice Output:

Plot between V_{output} and time



Advantages:

- Transformer utilization factor, in case of a bridge rectifier, is higher than that of a centre-tap rectifier.
- It can be used in application allowing floating output terminals, i.e. no output terminal is grounded.
- The need for centre-tapped transformer is eliminated.
- The transformer is less costly as it is required to provide only half the voltage of an equivalent centre-tapped transformer used in a full wave rectifier.
- If stepping up or stepping down of AC voltage is not needed, and then it does not even require any transformer.
- The PIV is one half that of centre-tap rectifier. Hence bridge rectifier is highly suited for high voltage applications.

Disadvantages:

- Two diodes in series conduct at a time on alternate half cycles. This creates a problem when low DC voltages are required. This leads to poor voltage regulation.
- It requires four semiconducting diodes.

Difference Between the outputs

In case of Bridge rectifier, the diode drop is twice that of in case of Centre tapped full wave rectifier. The reason is in case of bridge rectifier we encounter two diodes in one half cycle whereas in Centre tapped full wave rectifier we encounter only a single diode.

Why is a Full Wave Bridge Rectifier better than a Full Wave Centre Tapped Rectifier?

Ans: A bridge rectifier does not require a bulky center tapped transformer, nowadays the center tapped transformers are costlier than diodes and a step-down transformer hence reduced size and cost.

The PIV (peak inverse voltage) ratings of the diodes in bridge rectifier is half than that of needed in a centre tapped full wave rectifiers. The diode used in bridge rectifier has capable of bearing high peak inverse voltage. Whereas in centre tapped rectifiers, the peak inverse voltage coming across each diode is double the maximum voltage across the half of the secondary winding.

The transformer utilization factor (TUF) also more in bridge rectifier as compared to the centre tapped full wave rectifier, Which makes it more advantageous.

Discussions:

A Full wave rectifier is a circuit arrangement which makes use of both half cycles of input alternating current (AC) and converts them to all positive cycles of AC.

Conclusion:

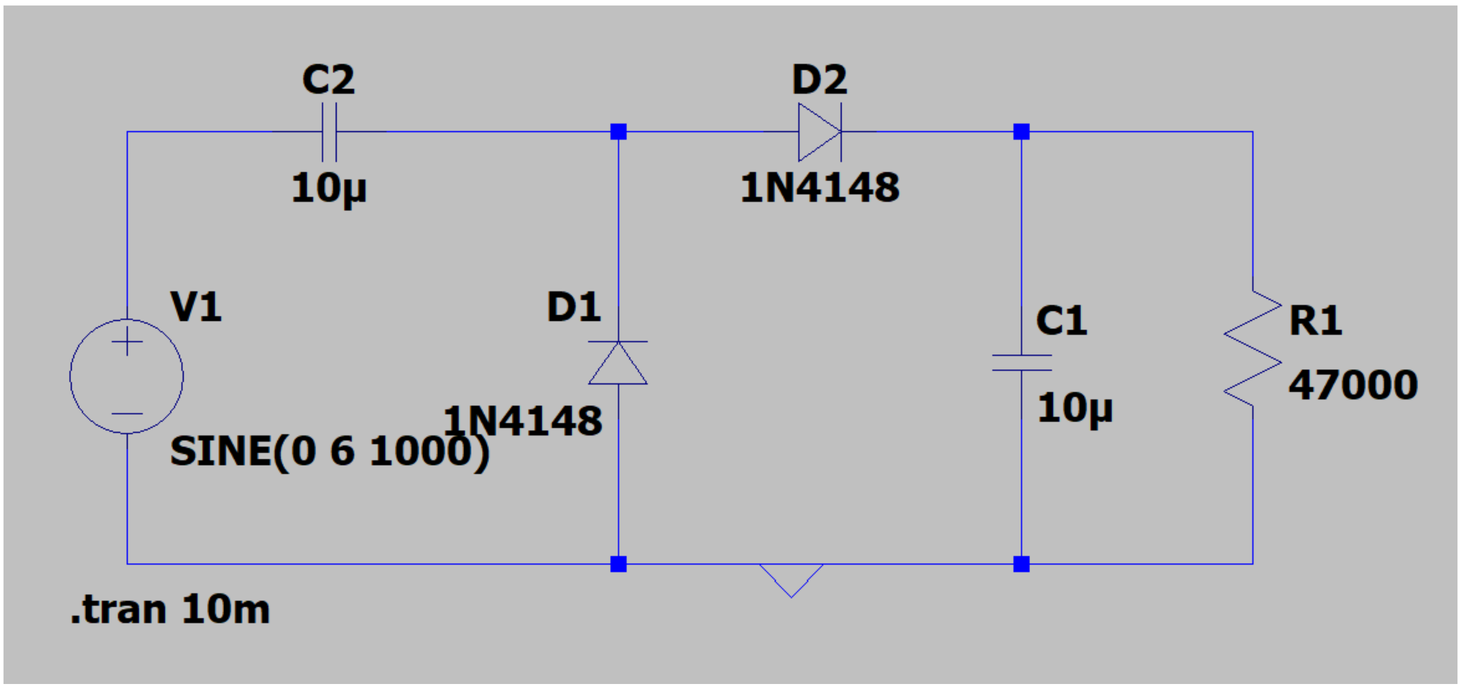
We analysed full wave and bridge rectifier and found the difference between them.

Part 4

Voltage Doubler Circuit

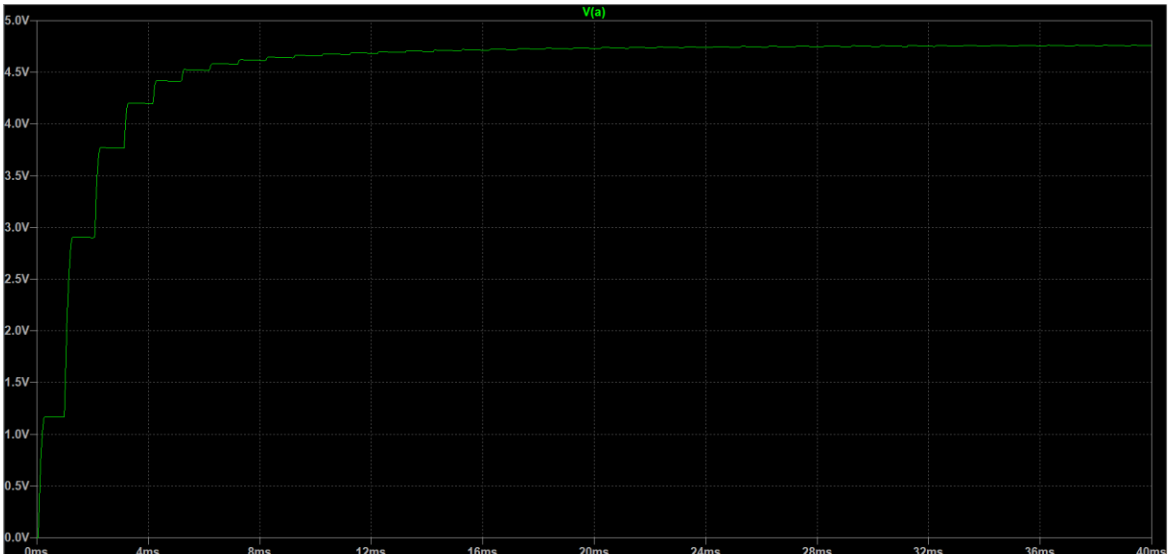
Circuit with 47Kohms resistance

Ltspice Circuit Diagram



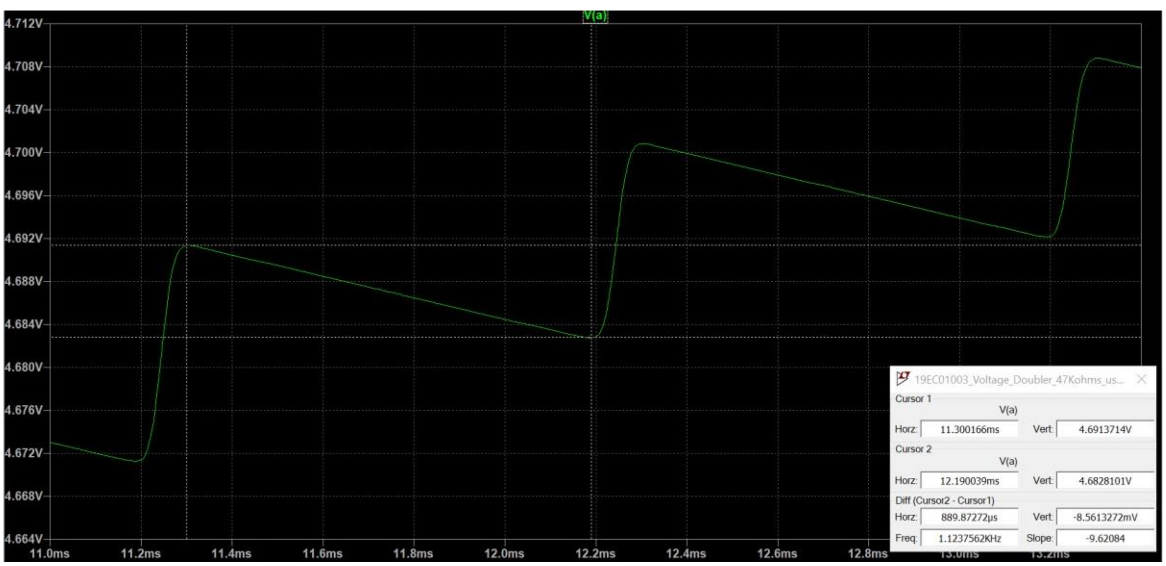
LTspice Output:

Plot of V_{out} vs time



Here we can clearly observe there are ripples which are obtains because of the capacitor discharging.

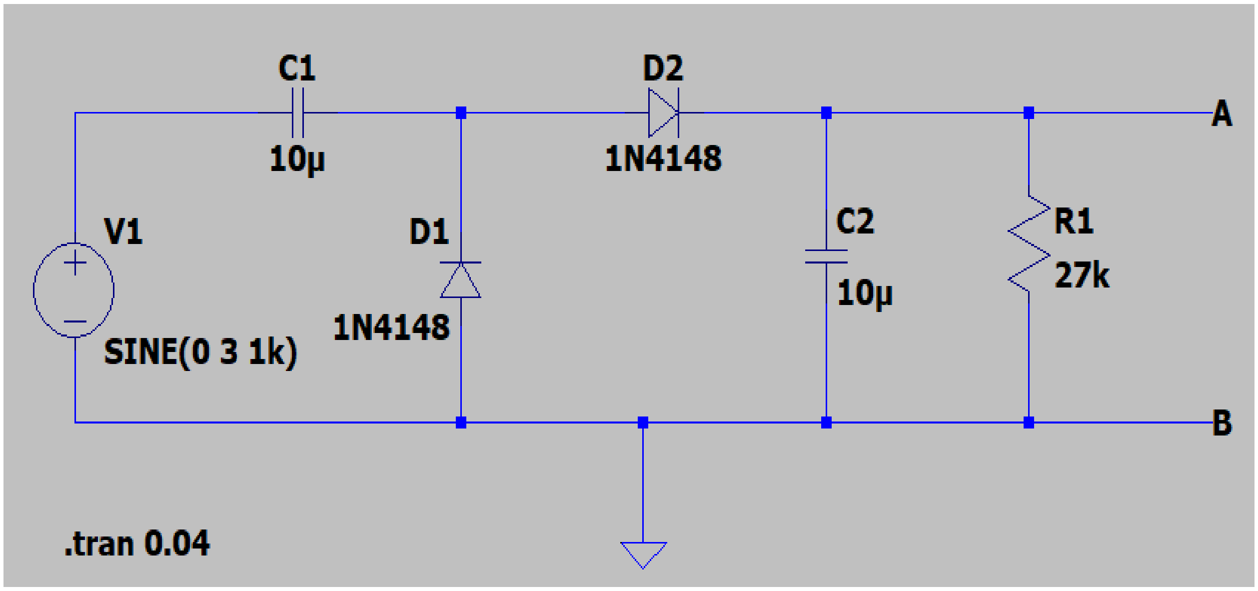
Now let us measure the ripple voltage.



After zooming the ripple voltage measured is 8.56mVolts = 0.00856volts.

Circuit with 27Kohms resistance

Ltspice Circuit Diagram

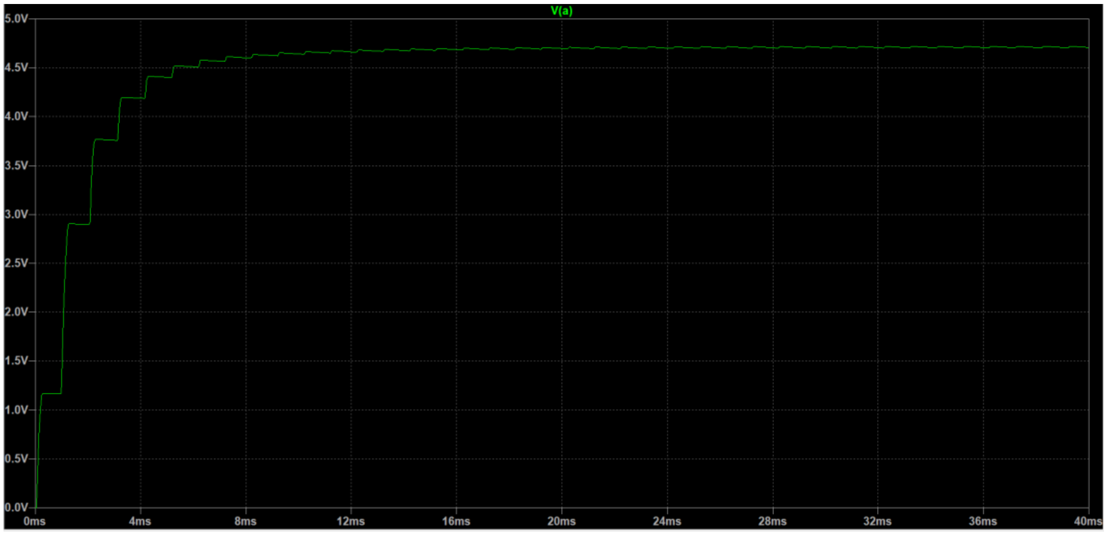


Here, I have used 1N4148 diode and an input with amplitude 3volts and frequency 1KHz.

As mentioned, the resistance used here is 27Kohms.

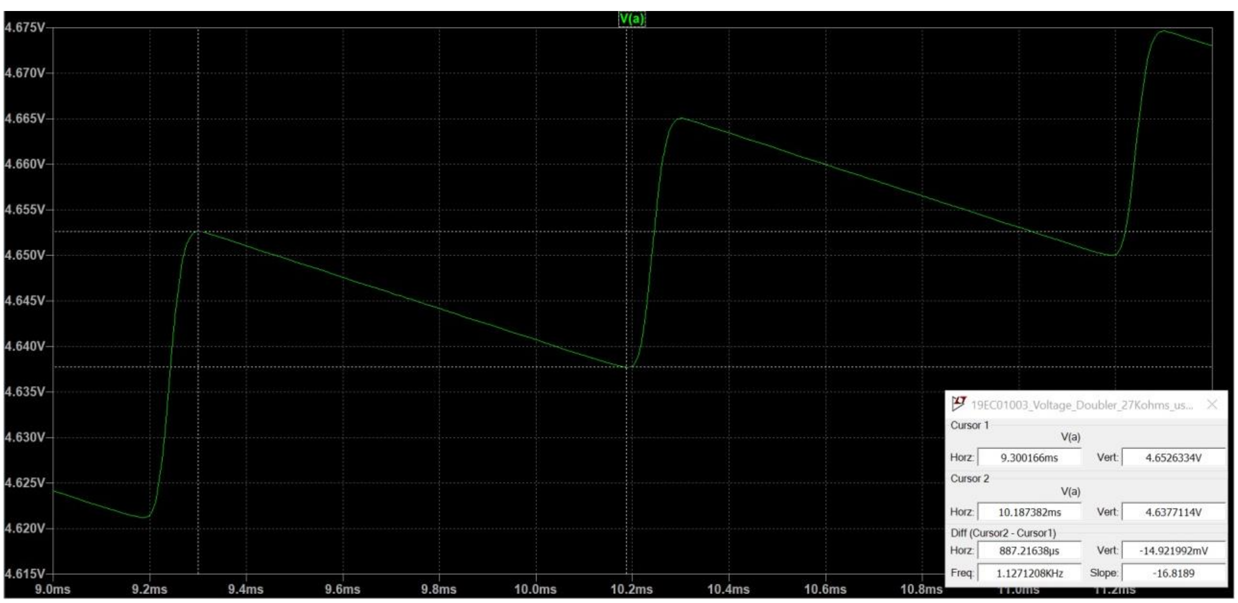
LTspice Output:

Plot of V_{out} vs time



Here we can clearly observe there are ripples which are obtains because of the capacitor discharging.

Now let us measure the ripple voltage.



After zooming the ripple voltage measured is 14.92mVolts = 0.01492volts.

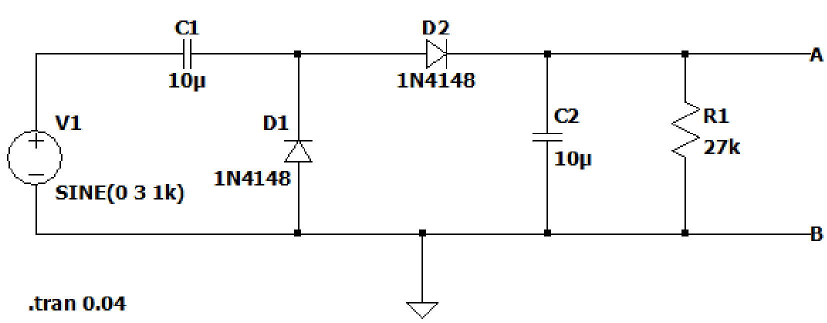
Variation of ripple voltage with load resistance:

In case of 47Kohms the ripple voltage is 8.56mV. Whereas in case of 27Kohms the ripple voltage becomes 14.92mV.

Which means as the load resistance increases the ripple voltage decreases.

Operation of voltage doubler circuit:

During the positive half cycle, diode D1 is forward biased and diode D2 is reverse biased, that will charge capacitor C1 to peak value of input voltage. During the negative half cycle, diode D2 is forward biased and diode D1 is reverse biased, that will charge capacitor C2 to the twice the peak value of input voltage because capacitor C1 (charged to Vp) and input voltage (Vp) now act as series aiding voltage source. When input voltage returns to its original polarity, diode D2 is again reverse biased (off), and then the capacitor C will be discharged through the load R_L. The time constant (R_LC_2) is so adjusted that C2 has little time to lose any of its charge before the input polarity reverses again. During the negative half cycle, diode D2 is turned on, capacitor C2 will be recharged again until voltage across it is again equal to 2Vp.



However, in case in practical case the output will not be the exact double but there is drop of voltage from two diodes.

Discussion:

A voltage doubler is an electronic circuit which charges capacitors from the input voltage and switches these charges in such a way that, in the ideal case, exactly twice the voltage is produced at the output as at its input.

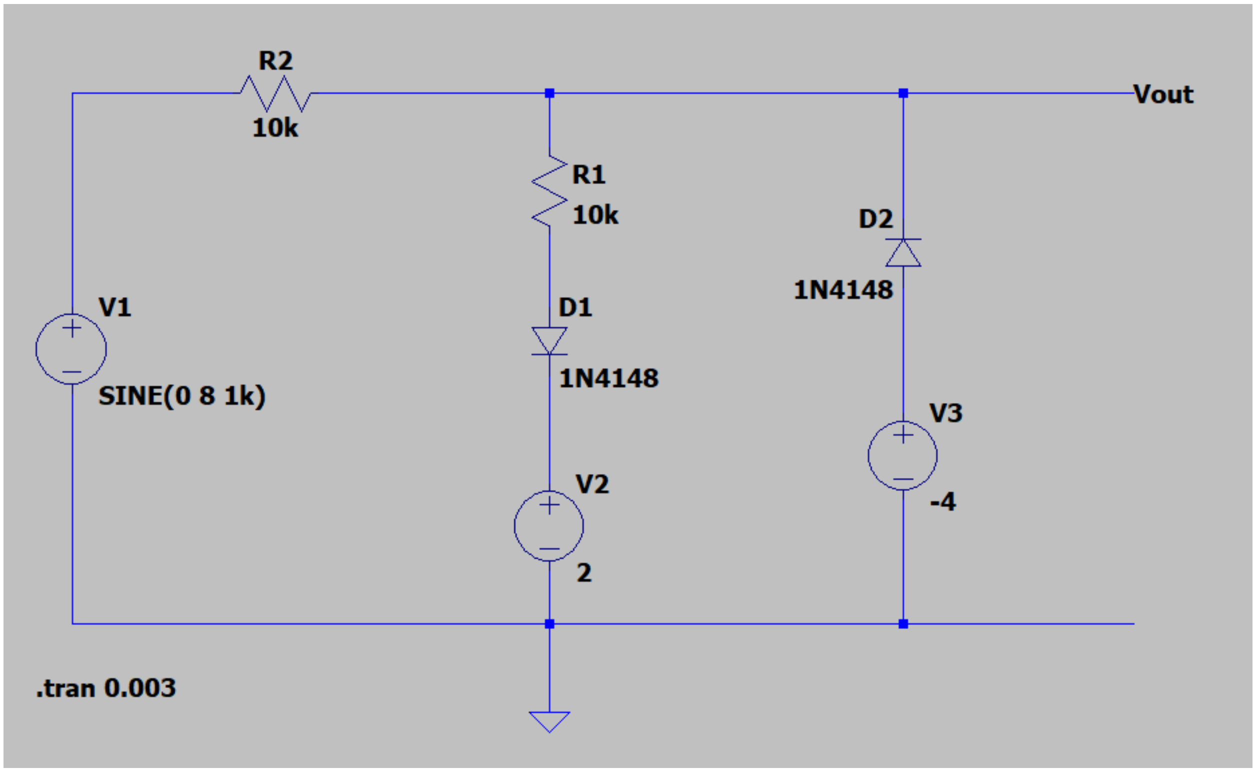
Conclusion:

We analyzed the voltage doubler circuit and also how it is functioning.

Part 5

Miscellaneous circuit

LTspice circuit diagram:



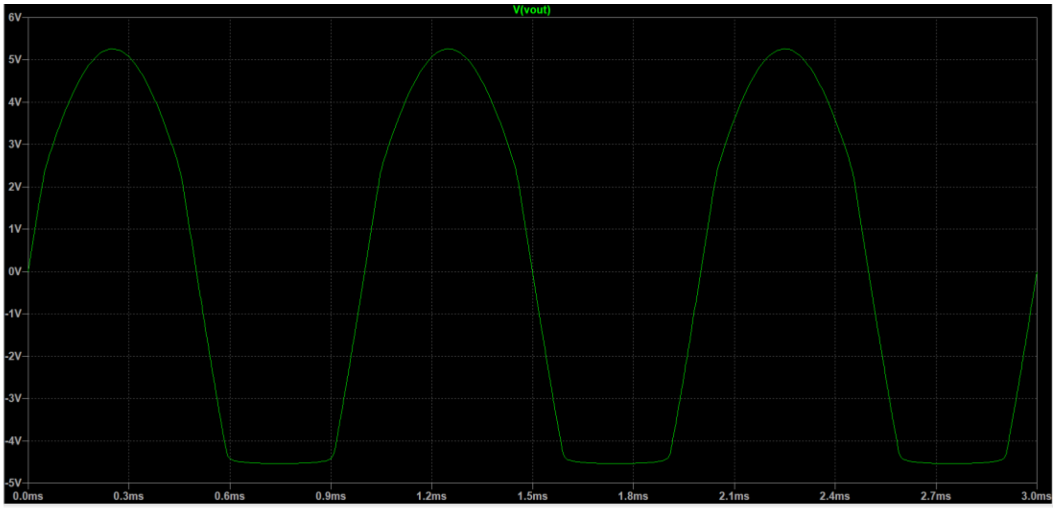
Here I have taken peak of input voltage as 8volts and its frequency as 1KHz

And, I have used 1N4148 diode in my circuit.

Now let us plot the LTspice output voltage.

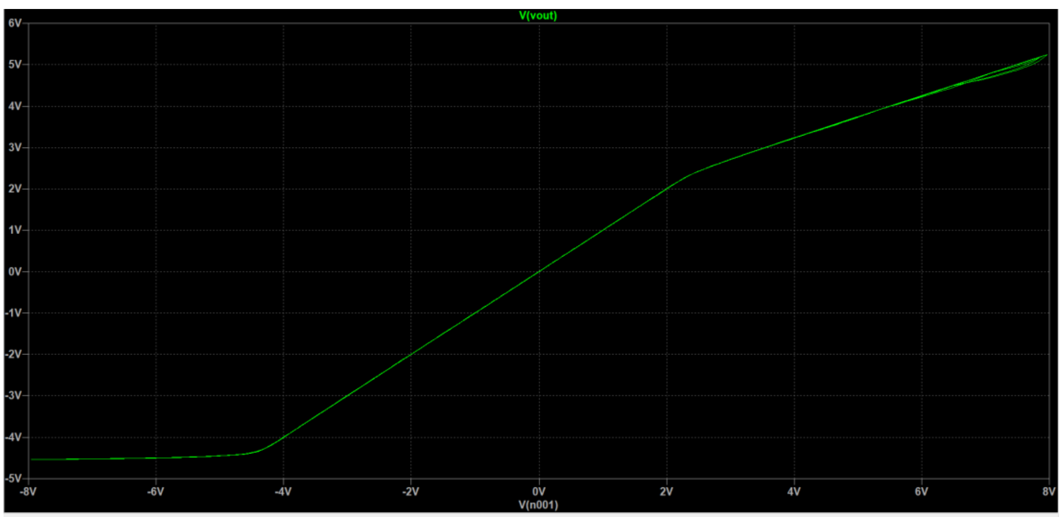
LTspice Output:

Plot of V_{out} vs time



Here we can see that this is a two-side clipper but as there is a resistor in action in case of positive cycle the voltage is not exactly clipped but it is like a manipulated output…

Let us observe V_{in} and V_{out} Plot.



Here we can see that in -ve half cycle the output is clipped but in +ve half cycle due to presence of resistor even in the clipping region the output is increasing linearly but with different slope which depends on resistor(R_1).