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A Novel Technique (Trick) to Determine the Output and Draw its Waveform of Diode Clamper Circuits

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Abstract: This paper describes a unique approach to draw the output waveform of the diode clamper circuits. This method does not require solving the problem using conventional method, without solving or applying numerical approach, the output of the clamper circuit can be found and output waveform can be drawn accurately. That means, without solving the diode clipper circuits we can find the output waveform as well as output voltage of the diode clamper circuits. This unique approach is based on practical observation (trick) and verified by using conventional method by applying KVL to the given circuits. This method is applicable for solving and finding the output waveform of all types of clamper circuits (biased and unbiased). This technique can also be used to solve the biased Clamper circuit which uses practical diode like Silicon or Germanium diode. The waveform and the output of the diode clamper circuit obtained is exactly same which was obtained using conventional method with 100% accuracy.

Keywords: Diode Clamper, Electronics Device, Kirchhoff's Voltage Law, Unbiased clamper, Biased Clamper, Output Waveform.

INTRODUCTION

- It is an Electronic Device which used to "Clamp Up" or "Clamp down" the input sinusoidal waveform. That means the waveform either move up or down depending upon the application of diode[1-3].
- It is constructed using a capacitor, diode, resistance and a battery (only in case of biased clipper).
- The Peak to Peak value of waveform never gets changes.
- Shape and size of the waveform remains same.
- Capacitor is always connected in series with the applied input, hence diode is always connected in shunt (parallel) with the output

It is basically divided into two types:

a) Unbiased Clamper (No external battery)

b) Biased Clamper (External battery is applied)

1. Unbiased Clamper: in this type of clamper, the output waveform is shifted completely downwards or upwards from "Zero Axis" (origin) and there is no external battery is applied, it consists of only capacitor, diode and resister. In figure 1, the typical unbiased clamper circuit is shown which consists of one capacitor in series with the input, an ideal diode shunt with the output and a load resister. Sinusoidal waveform (AC) is applied as the input and the shifted waveform will be obtained in sinusoidal form in output. The voltage across the capacitor is denoted by "Vc", idea diode is represented by "D", load resistor is denoted by "R_L" Input and output voltages are denoted by "Vin" and "Vo" respectively [4-5].

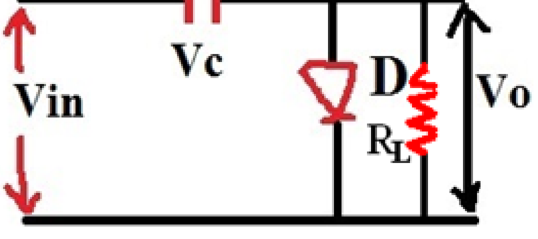


Fig.1: Unbiased clamper circuit

2. Biased Clamper: in this type of clamper, the output waveform is shifted completely downwards or upwards depending upon the diode direction and the polarity of battery. In biased clamper, the external source of DC (battery is compulsory). In figure 2, the biased clamper circuit has been visualized, which consists of one external battery in series with the diode, a capacitor in series with the input, an ideal diode shunt with the output and a load resister [6-8].

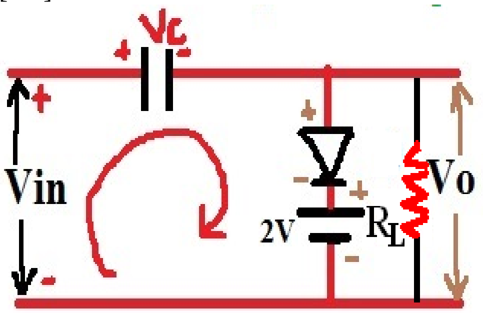


Fig.2: Unbiased clamper circuit

PROPOSED METHODOLOGY

The method proposed here to find the output of the clamper circuit by direct method is demonstrated in the Flow chart given below, shown in figure 7.

1. First of all start with the given clamper circuit.
2. Check that battery is applied or not? If there is no battery is applied then it is the unbiased clamper otherwise biased clamper.
3. Now, we will see the polarity of the battery, it will be checked from bottom to up, if the negative sign is first then it is considered as positive otherwise negative, shown in the figure 3.

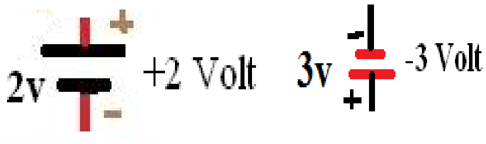


Fig.3: Battery polarity and voltage measurement

4. In next step is to check the type of diode that means ideal or practical diode. If it is ideal then no extra voltage is added or subtracted.
5. When the practical diode is applied, then we know that the knee voltage of Si diode is 0.7 and Ge is 0.3.
6. When the battery and the diode polarity is same then add 0.7 in case of Si diode and 0.3 in case of Ge diode otherwise subtract these values.

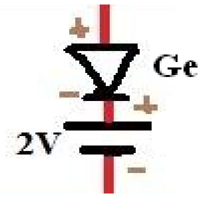


Fig.4: Same direction of Ge diode and battery

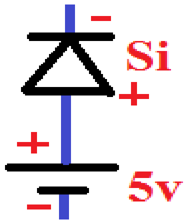


Fig.5: Opposite direction of Si diode and battery

7. In a figure 4, from bottom to up, battery and diode have same direction; hence the equivalent voltage will be +2 + 0.7 = 2.7 volt. But in case of figure 5, battery polarity is positive to negative and Ge diode polarity is positive to negative; hence the equivalent voltage will be 5-0.3 = 4.7 volt.
8. This equivalent voltage obtained from the step no. 7 will be marked as starting point of the output waveform on Y-axis.
9. The polarity of diode will be checked as shown in the figure 6. If the cathode of the diode (Negative sign or arrow direction) is in upside, it will shift the output waveform in upward otherwise downward.

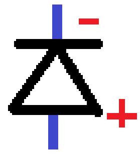
 O/P waveform will be shift downward from the starting point	 O/P waveform will be shift upwards from the starting point

Fig.6: Diode Direction with polarity

10. As we know that peak to peak value of the waveform never changes in case of the clamper circuit, that means the input and output waveform will have same peak to peak value. So, if we have determined the starting point in step no. 8, then end point will be easily determined.

11. Because input and output waveforms are sinusoidal value, hence it will have some positive cycle value and negative cycle value from the origin. So, we can easily determine the origin point of the output waveform.
12. The output value in case of starting point is equal to the positive half cycle peak value and the end point value is equal to the negative cycle peak value.
13. As we know that peak to peak value of the waveform never changes in case of the clamper circuit, that means the input and output waveform will have same peak to peak value. So, if we have determined the starting point in step no. 8, then end point will be easily determined [9].
14. Because input and output waveforms are sinusoidal value, hence it will have some positive cycle value and negative cycle value from the origin, shown in figure 8. So, we can easily determine the origin point of the output waveform.
15. The starting point is equal to the output of the positive half cycle peak value and the end point value is equal to the negative cycle peak value.
16. To verify the accuracy of this proposed method, we have verified it through conventional Kirchhoff's Voltage Law (KVL) method.
17. This method is used to plot the output waveform directly without solving the given circuit is named as direct method.
18. The accuracy of the direct method is 100% as compared with respect to any other method.

Flow Chart of Proposed Method:

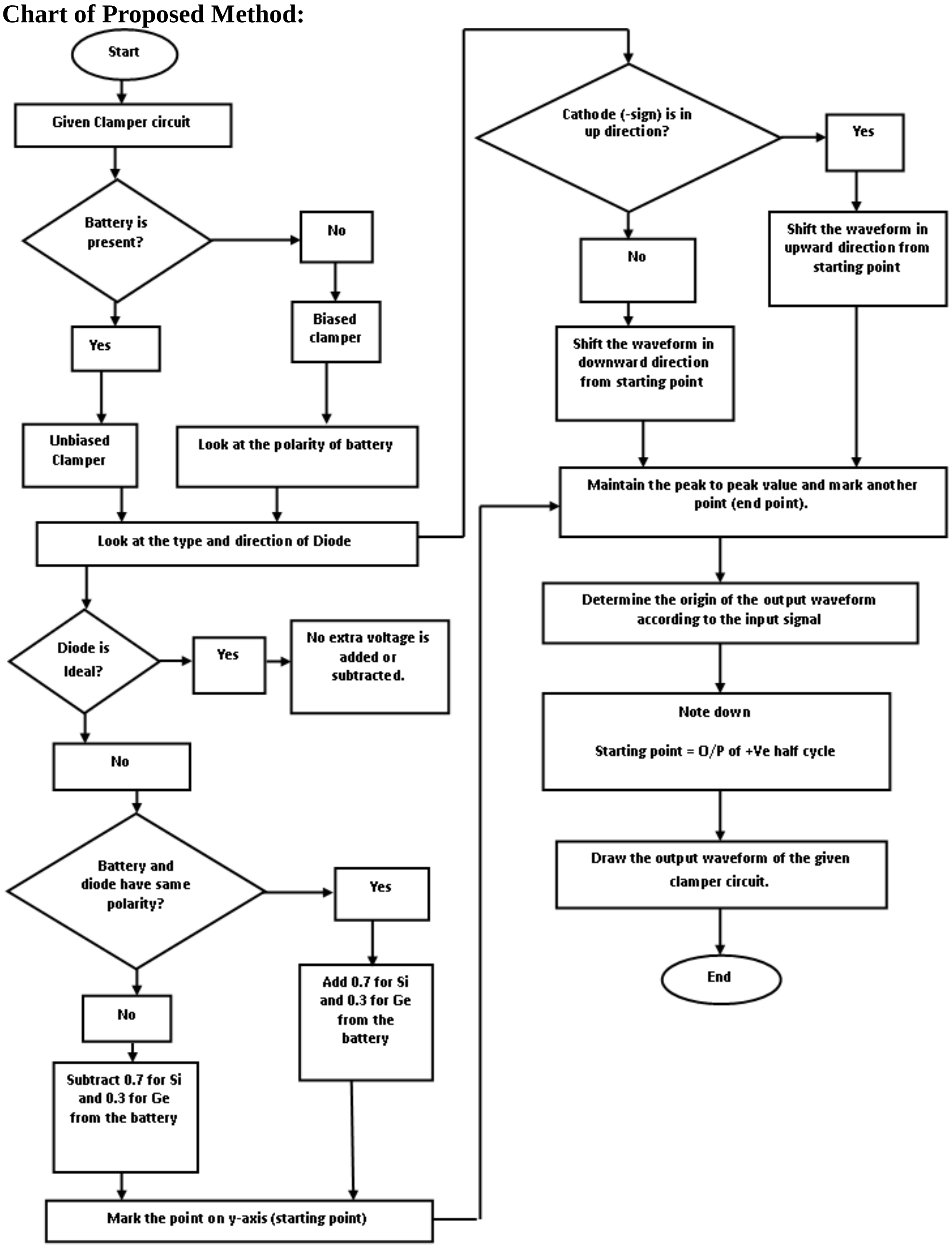


Fig. 7: Flow Chart of Proposed Method (Direct Method) to determine output of clamper circuit

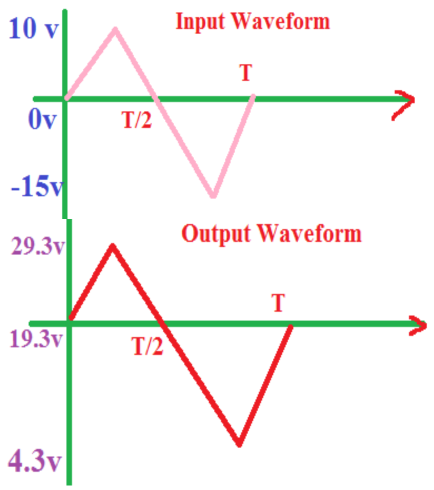


Fig.8: Input and Output waveform of clamper circuit

RESULT AND ANALYSIS:

1. **Unbiased clamper:**

The proposed method is applied to the unbiased diode clamper circuit given in the figure 9.

By using Proposed direct method approach [10], it is clear from the figure 9, that there is no battery is applied hence it is unbiased clipper. The diode applied is ideal because it is not mentioned any label (Si or Ge). The diode cathode (negative sign) is in downward direction; hence the waveform will be shifted downwards from the 0 line. Peak to peak value of the input waveform is 2Vin (from +Vin to -Vin). So, the output waveform will also maintain the same peak to peak and it will start from 0 line and go till -2Vin, as shown in the figure 9. [11]

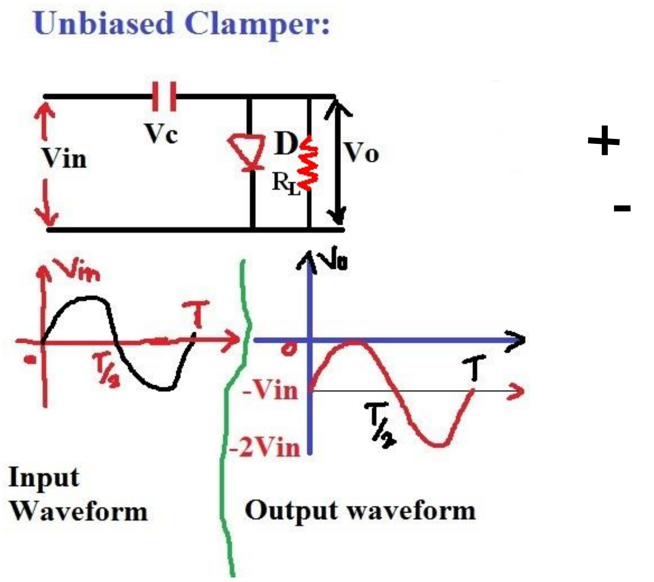


Fig.9: Unbiased clipper with I/P and O/P waveform using direct method

2. **Biased clamper with Ideal diode**

The output of the given circuit is 1st determined using direct method [11] and then it is verified using conventional KVL approach.

From the given figure 10, since battery is connected in the circuit, hence it is a biased clamper circuit. The diode applied is ideal diode; hence no addition or subtraction of battery is needed. The polarity of battery is negative to positive from bottom to top, equivalent voltage will be + 2v, it will be the starting point of the output waveform. The diode negative sign is in downward direction, the waveform will be shifted towards downward. Input waveform varies from +5v to -5v, hence peak to peak value is equal to (5-(-5)=10) 10v. Since the input waveform peak to peak value is 10v hence output waveform will also have peak to peak value 10v. The starting point of the output waveform is already determined i.e. 2v. Maintaining peak to peak value 10v from 2v towards downward will be -8v. Hence the output waveform will vary from +2v to -8v. The origin of the input waveform is -5v below the minimum value, so the origin of the output waveform will be (-8-(-5)=-3) at -3v.

Biased clamper using KVL:

The direct method is then verified using KVL:

To solve the clamper circuit, 1st start with the cycle, which makes diode forward bias? In this case, the positive half cycle will make the diode forward bias hence we will start with the positive half cycle [12-13].

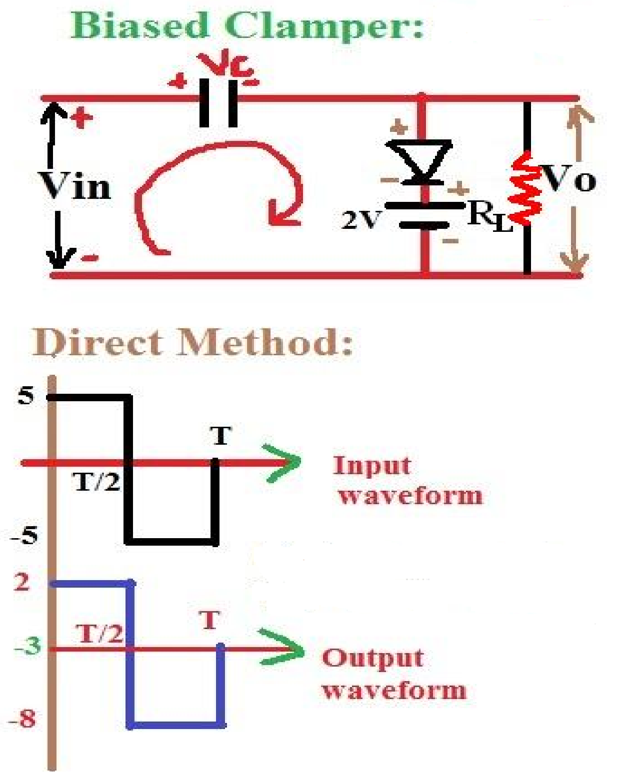


Fig.10: Biased clipper with I/P and O/P waveform using direct method

1st find the charge across capacitor apply positive half cycle.
Apply KVL for Vc, in 1st loop:
Vin -Vc-2 = 0
Vc = Vin - 2
Vc= 5 - 2 = 3v
Vc = 3v----------------------------------(1)
Apply KVL for O/P
Applying KVl in the 1st loop again to find the output.
Vin + Vc -Vo = 0
Vo = Vin - Vc--------------------------(2)
Now, substitute the peak value of positive half cycle of input to obtain the O/P peak for positive half cycle.
Vo = Vin - Vc from equation (2)
Vo = 5 - 3 = 2v --------------------------(3)
the value of Vc is 3v from equation (1)
Positive peak of the output is equal to 2v.
Now, substitute the peak value of negative half cycle of input to obtain the O/P peak for Negative half cycle.
Vo = Vin -Vc
Vo = -5 - 3v = -8v --------------------------(4)
Negative peak of the output is equal to -8v
To obtain the origin, substitute 0 at the place of Vin in equation (2).
Vo = Vin -Vc
Vo = 0 - 3 = -3v--------------------------(5)
Origin will be at -3v.

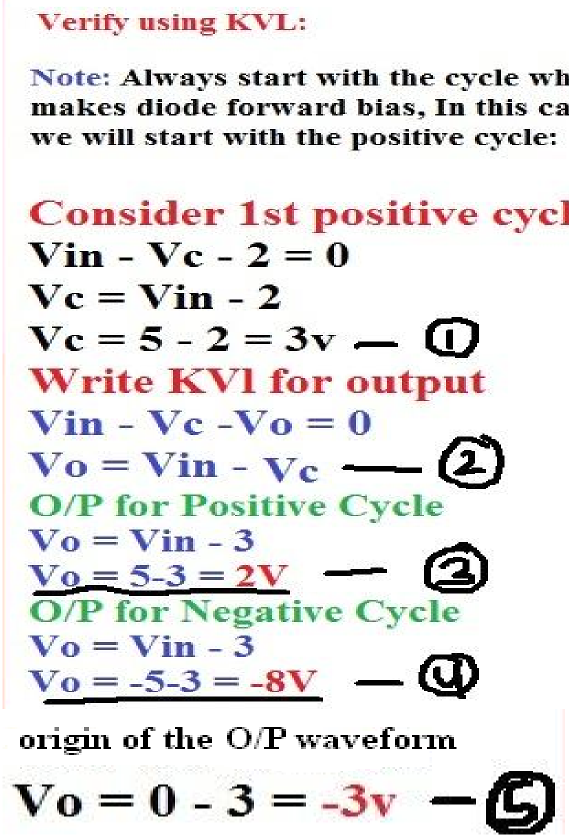


Fig.11: Verification of direct method using KVL

Hence, we found that the output value of direct method approach and KVL are exactly same. The verification of direct method using KVL has been shown in figure 11.

The comparative analysis of direct method and KVL method for biased clipper with ideal diode is tabulated in table 1. It is observed the peak to peak value for Input and output are same. It is also found that the positive peak value and negative peak value using direct method and KVL are exactly same. The shift of origin point, positive peak and negative peak are also with value.

Table -1: Comparison between direct method and KVL of biased clipper with ideal diode

Values/Methods	Direct Method	KVL Method
I/P Positive Peak value	+5v	+5v
I/P Positive Peak value	-5v	-5v
I/P Origin point	0v	0v
I/P peak to peak value	10v	10v
O/P Positive Peak value	+2v	+2v
O/P Positive Peak value	-8v	-8v
O/P Origin point	-3v	-3v
O/P peak to peak value	10v	10v

Biased clamper with practical diode:

Figure 12 shows the biased clipper with +5v external battery, a Silicon diode and a capacitor in series with the input.

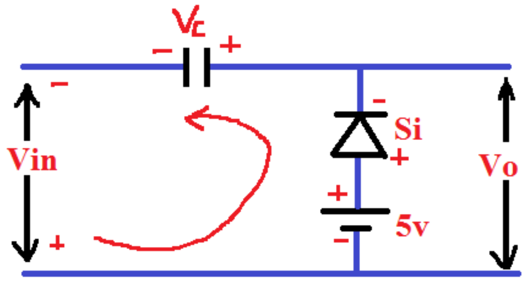


Fig.12: Biased clamper with practical diode

The output waveform using direct method has been drawn in figure 13 and output for each cycle has been determined. The comparison between input and output waveform has been also visualized in the figure.

The peak value for positive half cycle in O/P = +29.3v.
The peak value for negative half cycle in O/P = +4.3v.
Origin point of the O/P = +19.3v
Peak to peak O/P voltage = (29.3 - 4.3) = 25v

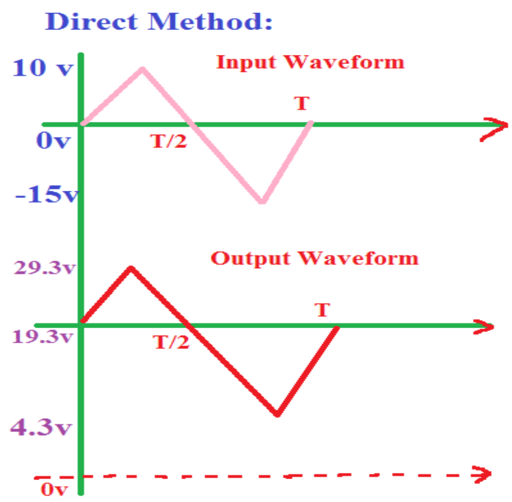


Fig.13: Biased clipper with practical diode and I/P O/P waveform using direct method

Verification of direct method using KVL:
In figure, the diode will be forward bias for negative half cycle, hence we will write the KVL equation for negative half cycle.
Find The charge across capacitor, 1st negative half cycle:

Apply KVL for Vc:
Vin + 5 - 0.7 -Vc = 0
Vc = Vin + 4.3
Vc = 15 + 4.3 = 19.3v --------------------------(1)

Apply KVL for O/P
Vin + Vc -Vo = 0
Vo = Vin + Vc -----------------------------------(2)

O/P for positive half cycle
Vo = Vin + Vc
Vo = 10 + 19.3 = 29.3v -----------------------(3)

O/P for Negative half cycle
Vo = Vin + Vc

Vo = -15 + 19.3v = 4.3v--------------------------(4)

O/P for the origin
Vo = Vin + Vc
Vo = 0 + 19.3 = 19.3v --------------------------(5)

Hence Using KVL, the output of the given clamper circuit is same as proposed method (direct method)

Table -2: Comparison between direct method and KVL of biased clipper with practical diode

Values/Methods	Direct Method	KVL Method
I/P Positive Peak value	+10v	+10v
I/P Positive Peak value	-15v	-15v
I/P Origin point	0v	0v
I/P peak to peak value	25v	25v
O/P Positive Peak value	+29.3v	+29.3v
O/P Positive Peak value	+4.3v	+4.3v
O/P Origin point	+19.3v	+19.3v
O/P peak to peak value	25v	25v

The comparative analysis of direct method and KVL method for biased clipper with practical diode is tabulated in table 2. It is observed the peak to peak value for Input and output are same (25 v). The obtained value of origin point, positive peak and negative peak using KVL is same as direct method.

The line graph between Input and Output Values using direct method is shown in figure 14. From the graph, it is visualized that the peak to peak value, origin to positive peak value and origin to negative peak values are same. It means that the shift of output waveform only shifts the origin point and corresponding positive peak and negative peak value.

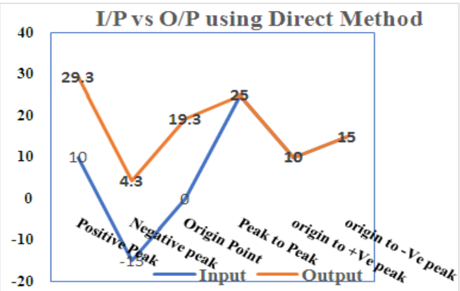


Fig.14: Line graph of Input and Output voltages using

CONCLUSION:

The proposed method (Direct method) to determine the output and draw the waveform of diode clamper circuit has been successfully implemented and verified in this paper. A novel approach is observation based, proposed to directly determine the output voltage of biased and unbiased clipper with 100% of accuracy. The accuracy of the direct method is verified using conventional KVL method. This paper also proposed that this method to determine the output voltage of clamper circuit is novel, unique and 100% accurate.

REFERENCES

[1]. Monssen, Franz, and Robert L. Boylestad. Electronic Devices and Circuit Theory, Eleventh Edition, Robert Boylestad, Louis Nashelsky. Upper Saddle River, NJ: Prentice Hall, 2012.

[2]. Paynter, Robert T. Introductory Electronic Devices And Circuits. 1st ed. Upper Saddle River, N.J.: Pearson Prentice Hall, 2006. Print.

[3]. LaLond, David, and John A Ross. Principles Of Electronic Devices And Circuits. 1st ed. Albany, NY: Delmar Publishers, 1994. Print.

[4]. Paynter, Robert T. Introductory Electronic Devices And Circuits. 1st ed. Upper Saddle River, N.J.: Pearson Prentice Hall, 2006. Print.

[5]. Rosenstein, Milton, and Paul Morris. Modern Electronic Devices. 1st ed. Reston: Reston Publishing Company, 1985. Print.

[6]. Herrick, Robert J. DC/AC Circuits And Electronics. 1st ed. Clifton Park, N.Y.: Thomson/Delmar Learning, 2003. Print.

[7]. "Diode Clamping Circuits-Positive And Negative Clamper,Circuit,Waveform". Electronic Circuits and Diagram-Electronics Projects and Design. N.p., 2017. Web. 16 May 2017.

[8]. "Positive Negative And Biased Clamper". Visionics.co.in. N.p., 2017. Web. 16 May 2017.

[9]. "Waveform Clamping: Positive & Negative Clamping Circuit Design". Engineersgarage.com. N.p., 2017. Web. 16 May 2017.

[10]. Hari Mohan Rai, (2016, October15). Part 4-(Hindi)Trick to draw output waveform of Clamper circuits. https://youtu.be/2BvmxxZbp5I

[11]. Hari Mohan Rai, (2017, May 19). (Trick) Simplest method to find the output and draw the waveform of clamper circuit-1. https://youtu.be/F8pkgNH8jIU

[12]. Hari Mohan Rai, (2017, May 19). (Trick)Simplest method to find the output and draw the waveform of clamper circuit-2. https://youtu.be/K3_xT-M4bS8

[13]. Vishal Phaugat, Hari Mohan Rai, Subham Gupta, Rohit Thakran, " Effect of Binder on Viscosity with Shear Rate", (IJETEE–ISSN: 2320-9569), Vol. 9, Issue 1, Nov. 2013.