IRE 105 ELECTRONICS DEVICES AND APPLICATIONS

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CLIPPER CIRCUIT

- The rectification concept gives us the information that diode can change/rectify the shape of a waveform

CLIPPER CIRCUIT: Clippers are network that employ diodes to clip away a portion of input signal without distorting the remaining part of the applied waveform.

POSITIVE DIODE CLIPPING CIRCUITS

- In this diode clipping circuit, the diode is forward biased (anode more positive than cathode) during the positive half cycle of the sinusoidal input waveform. For the diode to become forward biased, it must have the input voltage magnitude greater than +0.7 volts (0.3 volts for a germanium diode).

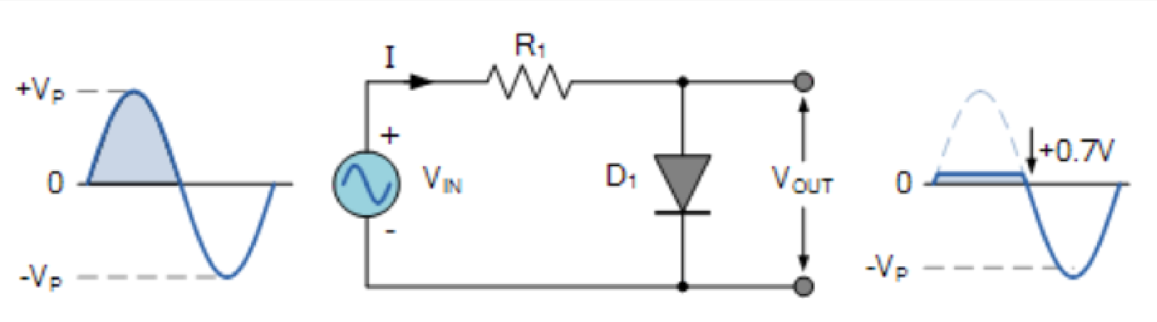
Si

(+) $V_i < 0.7$ $V_o = V_i$

$V_i > 0.7$ $V_o = 0.7$

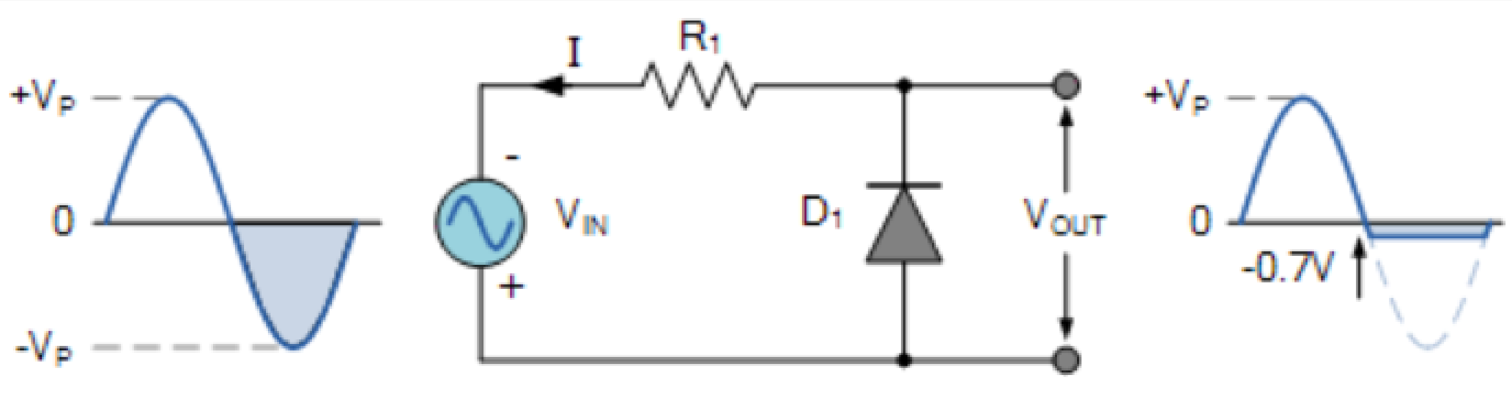
(−) $V_o = V_i$

- When this happens the diodes begins to conduct and holds the voltage across itself constant at 0.7V until the sinusoidal waveform falls below this value. Thus the output voltage which is taken across the diode can never exceed 0.7 volts during the positive half cycle.
- During the negative half cycle, the diode is reverse biased (cathode more positive than anode) blocking current flow through itself and as a result has no effect on the negative half of the sinusoidal voltage which passes to the load unaltered. Thus the diode limits the positive half of the input waveform and is known as a positive clipper circuit.



NEGATIVE DIODE CLIPPING CIRCUIT

- Here the reverse is true. The diode is forward biased during the negative half cycle of the sinusoidal waveform and limits or clips it to –0.7 volts while allowing the positive half cycle to pass unaltered when reverse biased. As the diode limits the negative half cycle of the input voltage it is therefore called a negative clipper circuit. (+): $V_o = V_i$

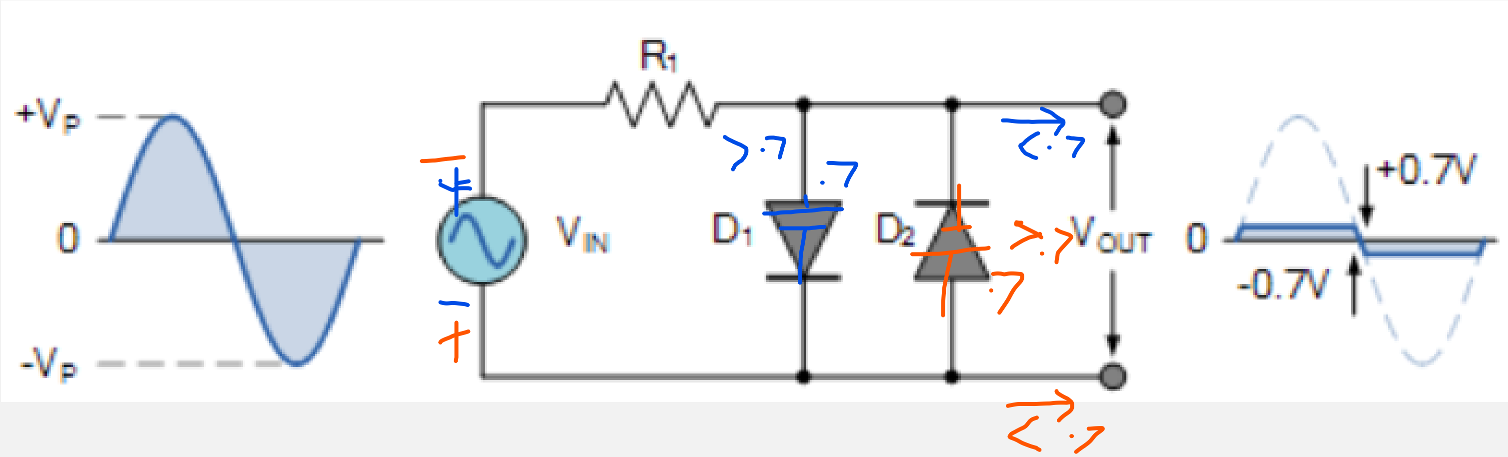


(-) $V_i < .7$ $V_o = V_i$

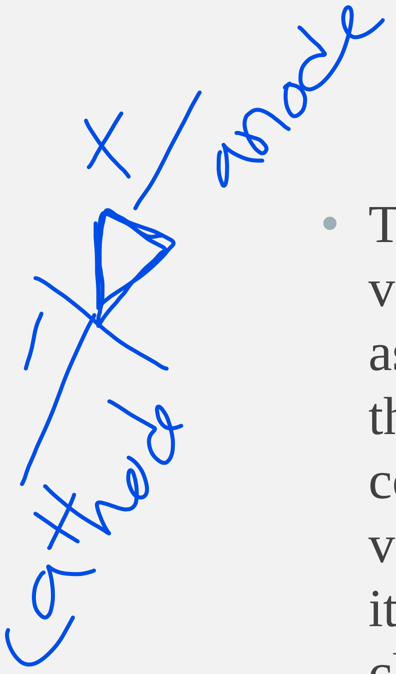
$V_i > .7$ $V_o = .7$

CLIPPING OF BOTH HALF CYCLES

- If we connected two diodes in inverse parallel as shown, then both the positive and negative half cycles would be clipped as diode D_1 clips the positive half cycle of the sinusoidal input waveform while diode D_2 clips the negative half cycle. Then diode clipping circuits can be used to clip the positive half cycle, the negative half cycle or both.
- For ideal diodes the output waveform above would be zero. However, due to the forward bias voltage drop across the diodes the actual clipping point occurs at +0.7 volts and –0.7 volts respectively. But we can increase this ±0.7V threshold to any value we want up to the maximum value, (V_{PEAK}) of the sinusoidal waveform either by connecting together more diodes in series creating multiples of 0.7 volts, or by adding a voltage bias to the diodes.

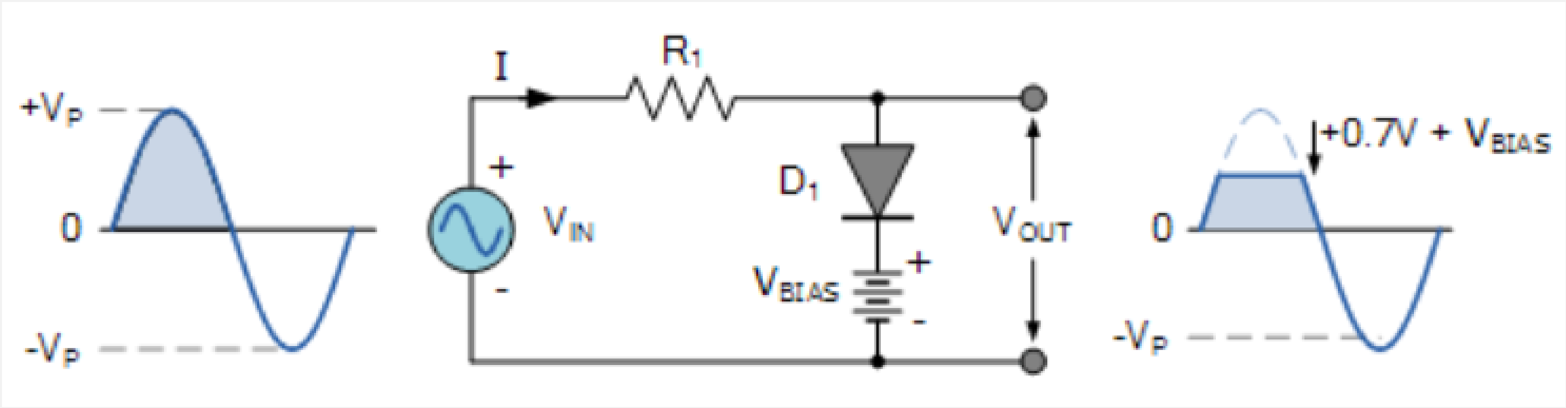


BIASED DIODE CLIPPING CIRCUITS



- 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.

POSITIVE BIAS DIODE



(+) $V_i < .7 + V_B$

$V_o = V_i$

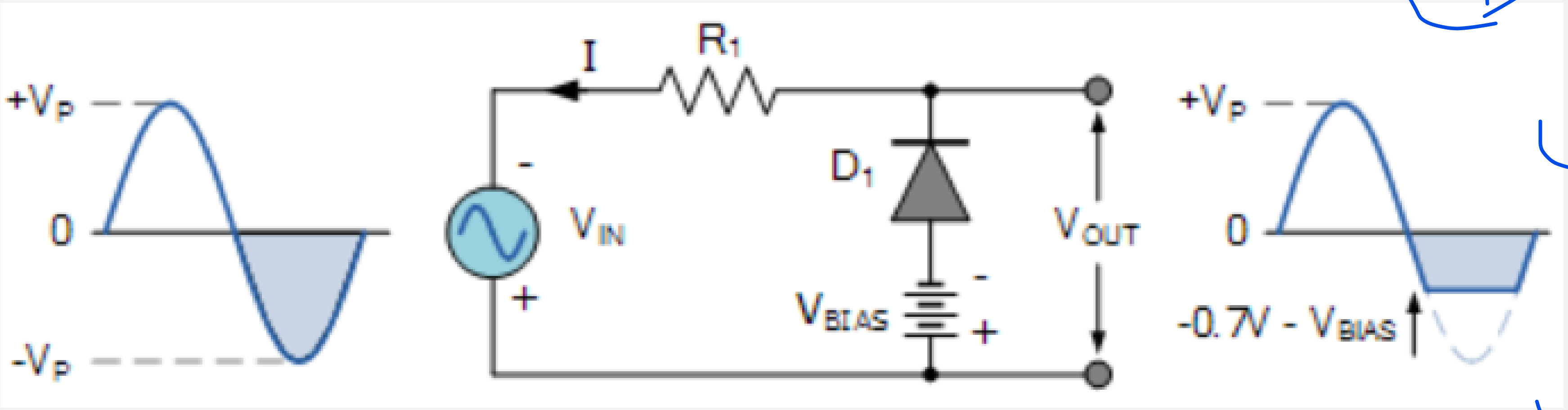
$V_i > .7 + V_B$

$V_o = .7 + V_B$

(−) $V_o = V_i$

NEGATIVE BIAS DIODE

- A variable diode clipping or diode limiting level can be achieved by varying the bias voltage of the diodes. If both the positive and the negative half cycles are to be clipped, then two biased clipping diodes are used. But for both positive and negative diode clipping, the bias voltage need not be the same. The positive bias voltage could be at one level, for example 4 volts, and the negative bias voltage at another, for example 6 volts as shown.



(+) $V_o = V_i$

(−) $V_i < -.7 - V_B$

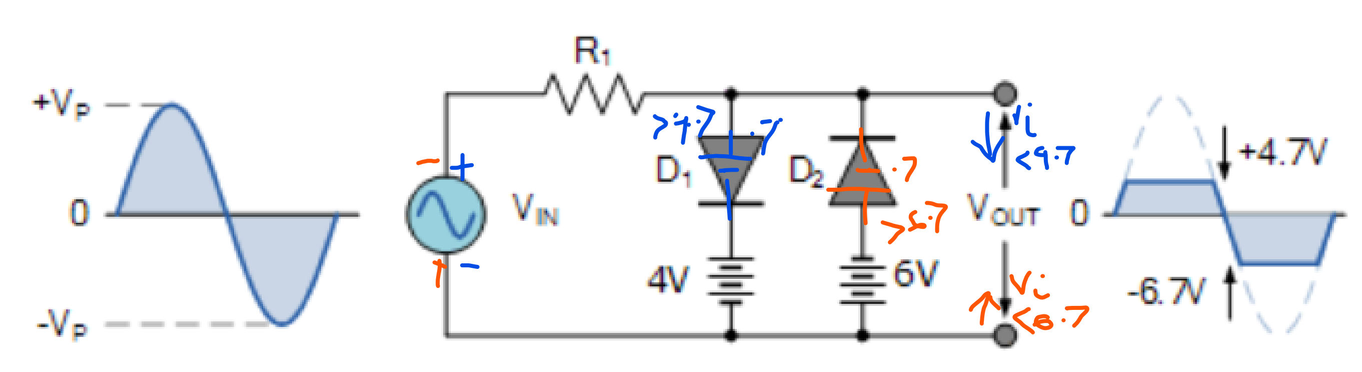
$V_o = V_i$

$V_i > \rightarrow +V_p$

$V_i = \rightarrow -V_B$

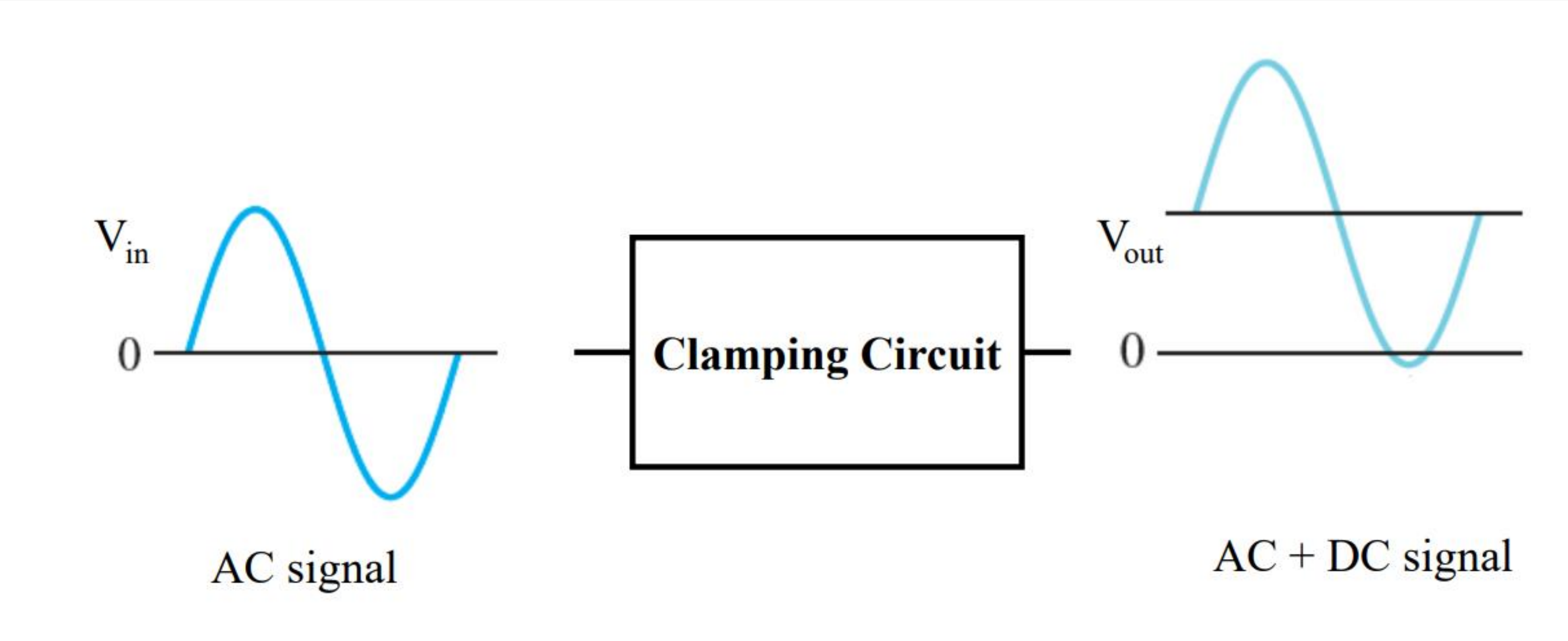
DIODE CLIPPING OF DIFFERENT BIAS LEVELS

- When the voltage of the positive half cycle reaches +4.7 V, diode D_1 conducts and limits the waveform at +4.7 V. Diode D_2 does not conduct until the voltage reaches –6.7 V. Therefore, all positive voltages above +4.7 V and negative voltages below –6.7 V are automatically clipped.
- The advantage of biased diode clipping circuits is that it prevents the output signal from exceeding preset voltage limits for both half cycles of the input waveform, which could be an input from a noisy sensor or the positive and negative supply rails of a power supply.
- If the diode clipping levels are set too low or the input waveform is too great then the elimination of both waveform peaks could end up with a square-wave shaped waveform.



CLAMPER CIRCUIT

- **CLAMPER CIRCUIT:** A clamper is a network constructed of a diode, a resistor, a capacitor that shifts a waveform to a different dc level without changing the waveshape.



1. for the capacitor to store voltage, the diode must be in forward bias.
2. Input polarity = capacitor polarity [closer]
    2.1. then it will get charged to the peak value of input (if no bias voltage)
        or, peak value + V_{bias} (if bias voltage)

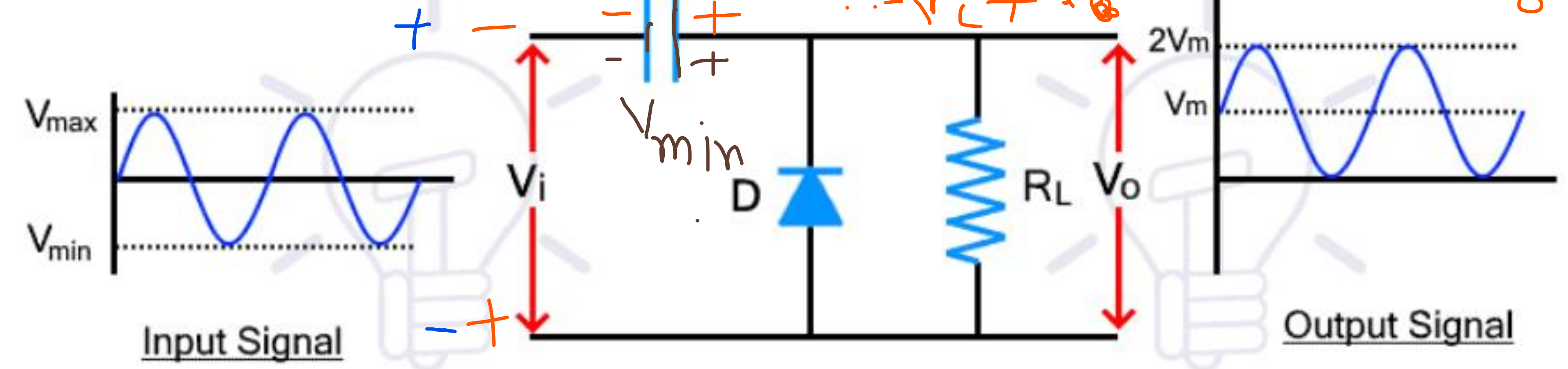
POSITIVE CLAMPER

(+) $-V_i - V_c + V_o$

$\therefore V_o = V_i + V_c$

(−) $V_i + V_c = 0$ $\therefore V_c = V_{min}$

$\therefore -V_i + V_o + V_c = 0$ $\therefore V_o = V_i - V_c$



Positive Clamper

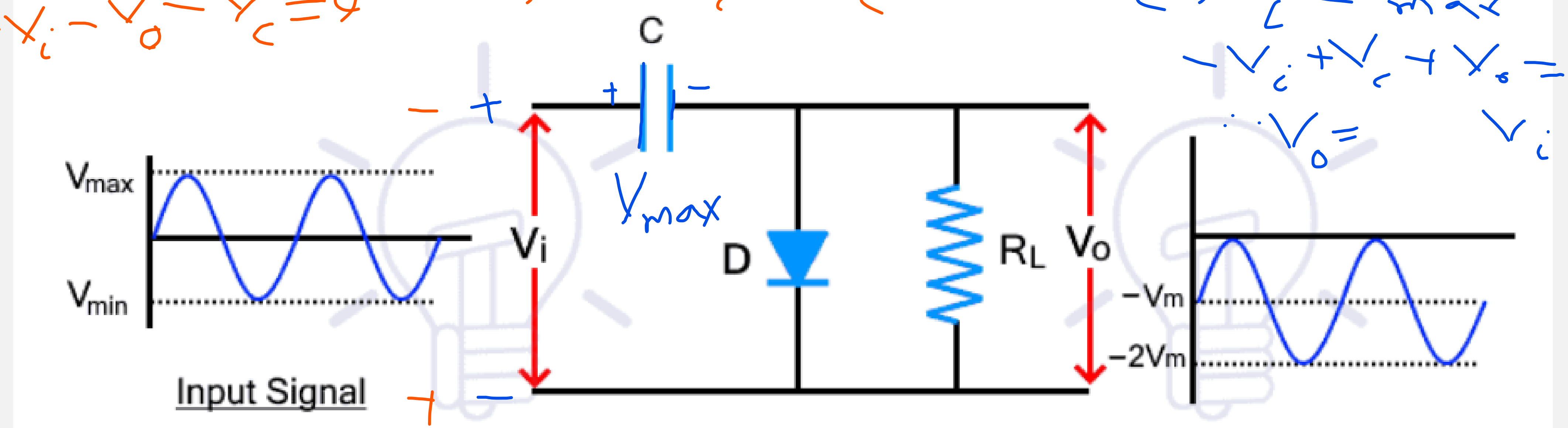
NEGATIVE CLAMPER

(−) $-V_i - V_o - V_c = 0$ $\therefore V_o = -V_i - V_c$

(+) $V_c = V_{max}$

$-V_i + V_c + V_o = 0$

$\therefore V_o = V_i - V_c$



Negative Clamper

CLIPPER CIRCUIT

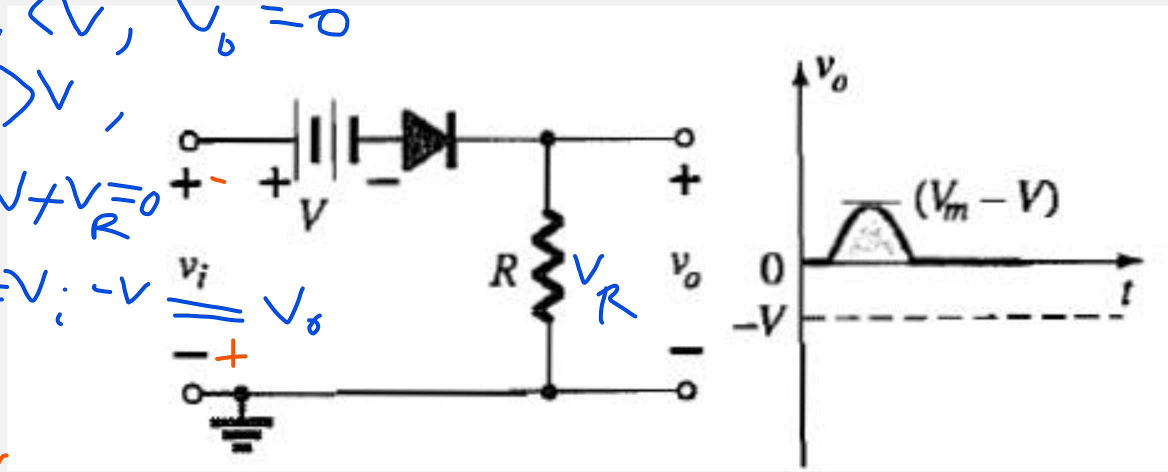
(+) $V_i < V$, $V_o = 0$

$V_i > V$,

$-V_i + V + V_R = 0$

$\therefore V_R = V_i - V = V_o$

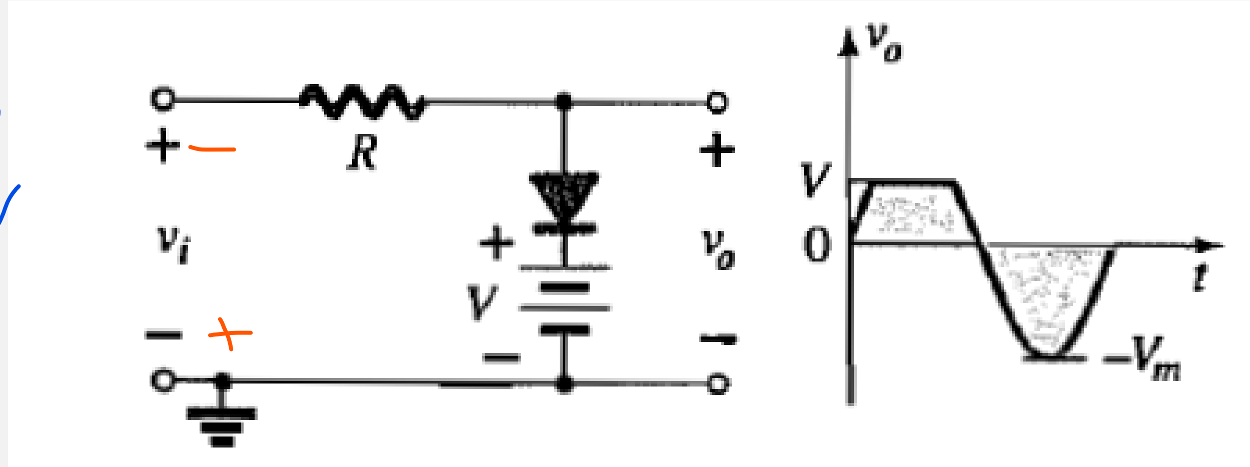
(−) $V_o = 0$



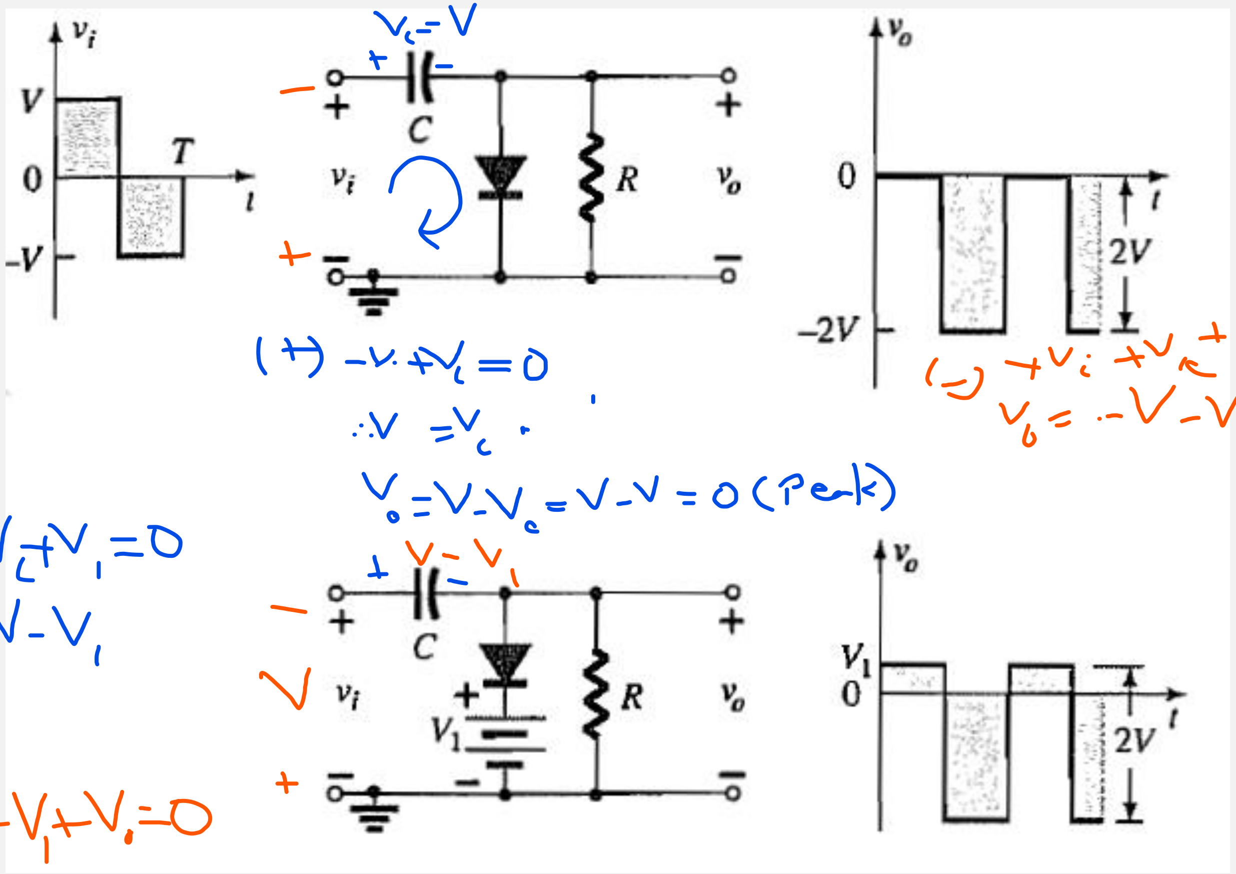
(+) $V_i < V$, $V_i = V_o$

$V_i > V$, $V_o = V$

(−) $V_o = V_i$



CLAMPER CIRCUIT



$V_c = V$

$(+)\ -V_i + V_c = 0$

$\therefore V = V_c$

$V_o = V - V_c = V - V = 0$ (Peak)

$(-)\ +V_i + V_c + V_o = 0$

$V_o = -V - V = -2V$

$V_c = V - V_1$

$(+)\ -V + V_c + V_1 = 0$

$\therefore V_c = V - V_1$

$V_o = V_1$

$(-)\ V + V - V_1 + V_o = 0$

$\therefore V_o = -2V + V_1$

VOLTAGE MULTIPLIER/ DOUBLER CIRCUIT