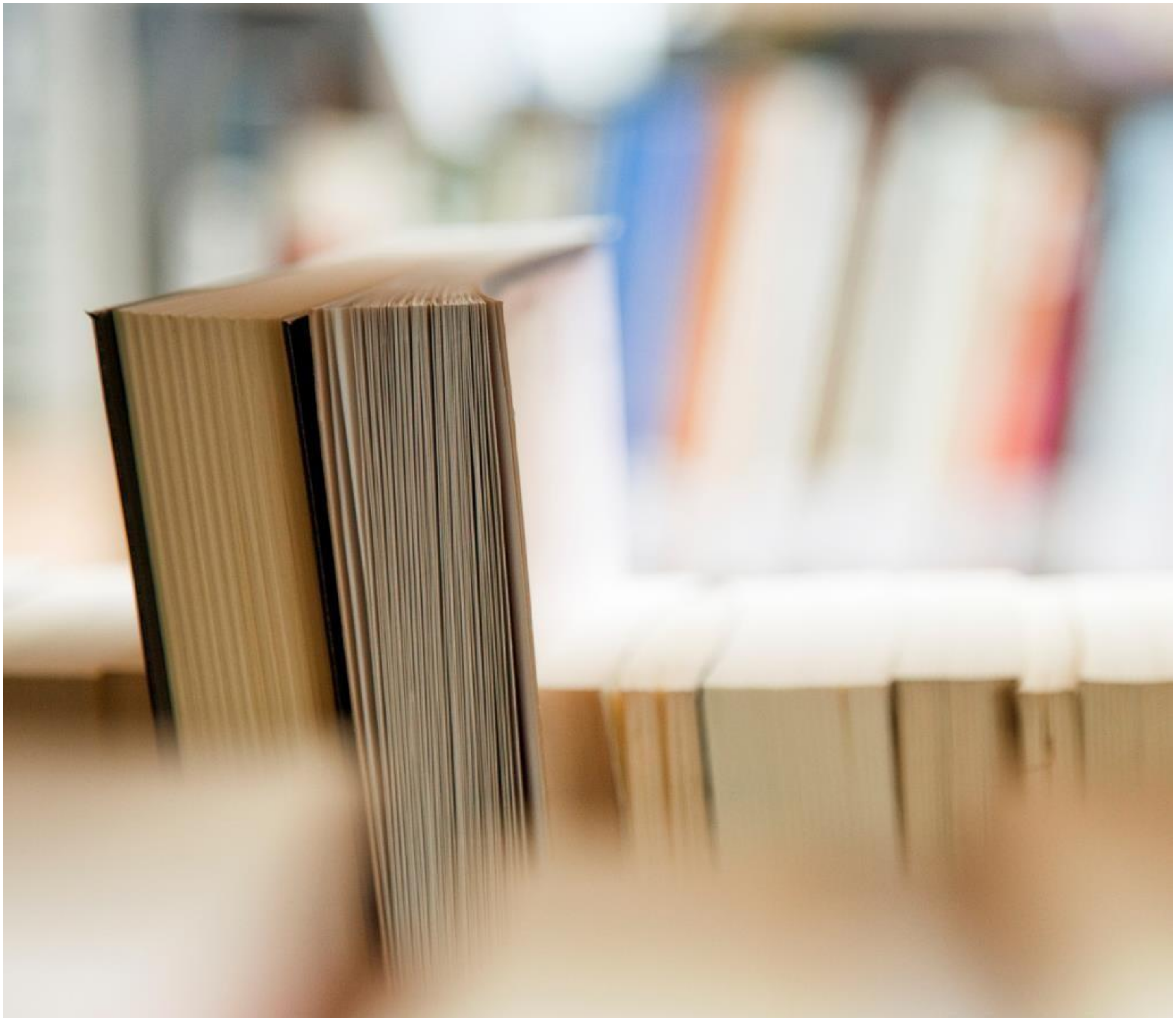

Electronic devices & circuit

Second Stage

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Lecture Five

First Course

Lecture Five

Half Wave Rectifier

1. Sinusoidal Input (Half Wave Rectifier)

The diode analysis will now be expanded to include time-varying functions such as the sinusoidal waveform and the square wave. For the moment we will use the ideal model (note the absence of the Si or Ge label to denote ideal diode) to ensure that the approach is not clouded by additional mathematical complexity.

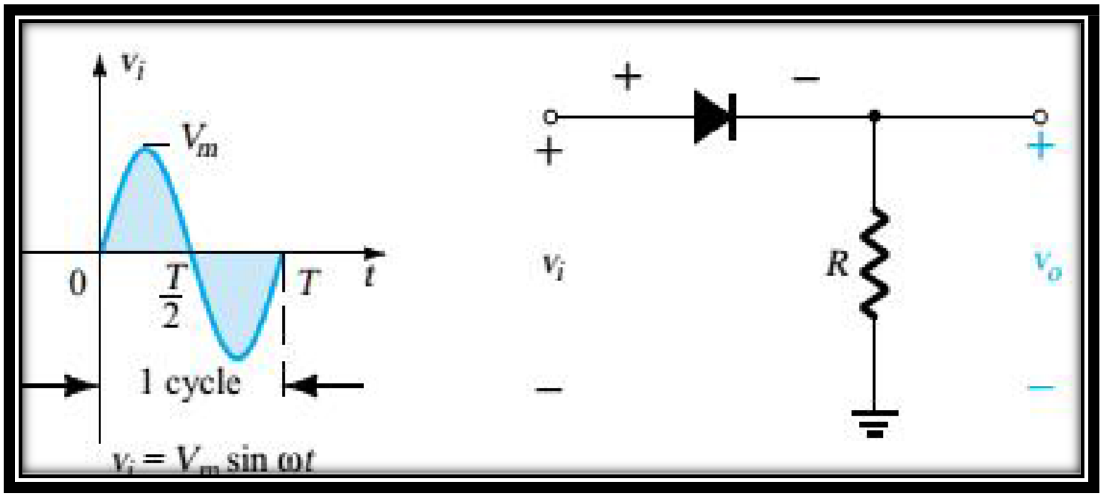


Figure (15) Half-Wave Rectifier

Over one full cycle, defined by the period T of Fig. (15), the average value (the algebraic sum of the areas above and below the axis) is zero.

The circuit of Fig. (15) called a half-wave rectifier will generate a waveform *vo* that will have an average value of particular, use in the ac to dc conversion process.

During the interval t = 0 → T/2 in Fig. (15). the polarity of the applied voltage *vi* is such as to establish "pressure" in the direction indicated and turn on the diode with the polarity appearing above the diode, see Fig. (16).

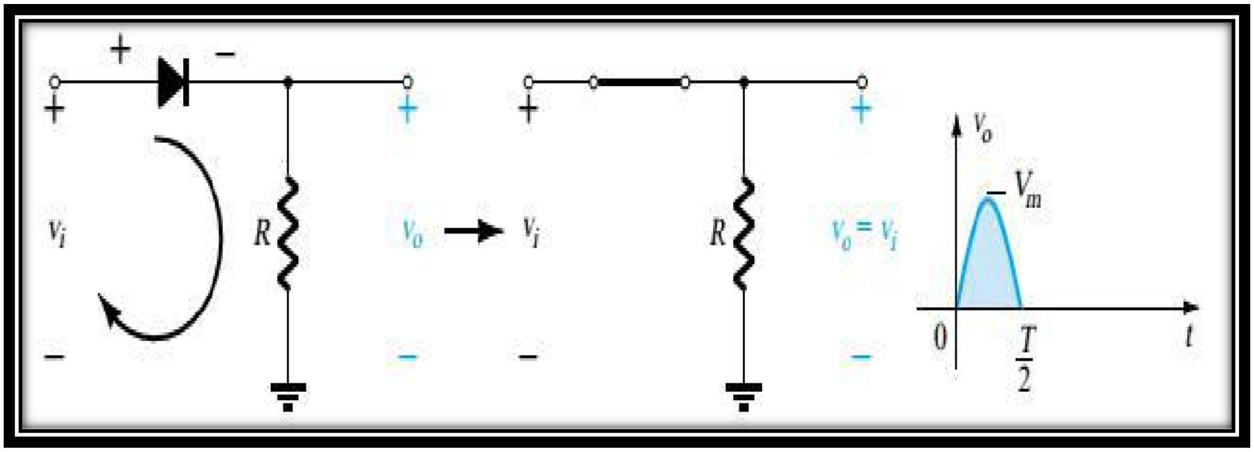


Figure (16) Sinusoidal Inputs; Half-Wave Rectification

For the period T/2 → T, the polarity of the input *vi* is as shown in Fig. (17) and the resulting polarity across the ideal diode produces an "off" state with an open-circuit equivalent. The result is the absence of a path for charge to flow and [*vo* = I * R = (0) * R = 0 V] for period T/2 → T.

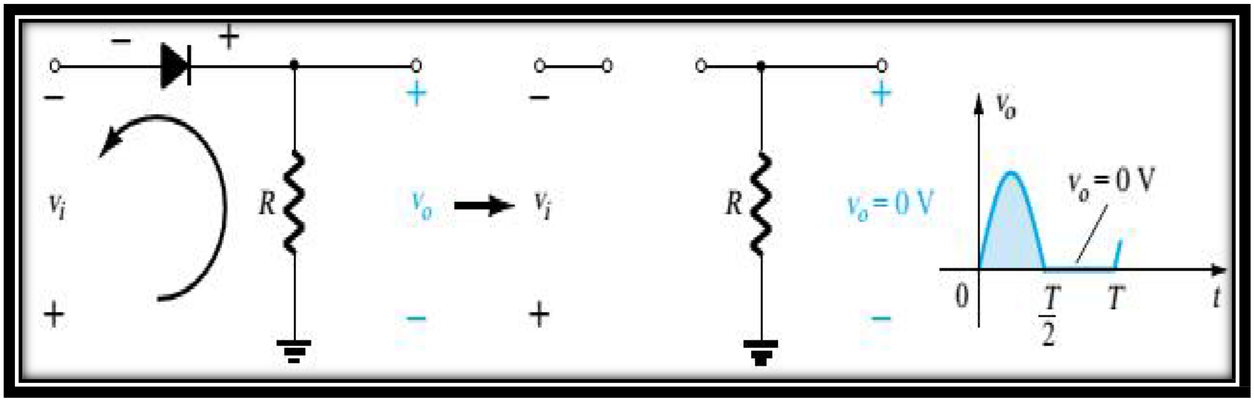


Figure (17) Nonconduction region (T/2 → T).

The input *vi* and the output *vo* were sketched together in Fig. (18) for comparison purposes. The output signal *vo* now has a net positive area above the axis over a full period and an average value determined by:

$\mathbf{V_{dc}=0.318\ Vm}$ (half-wave)

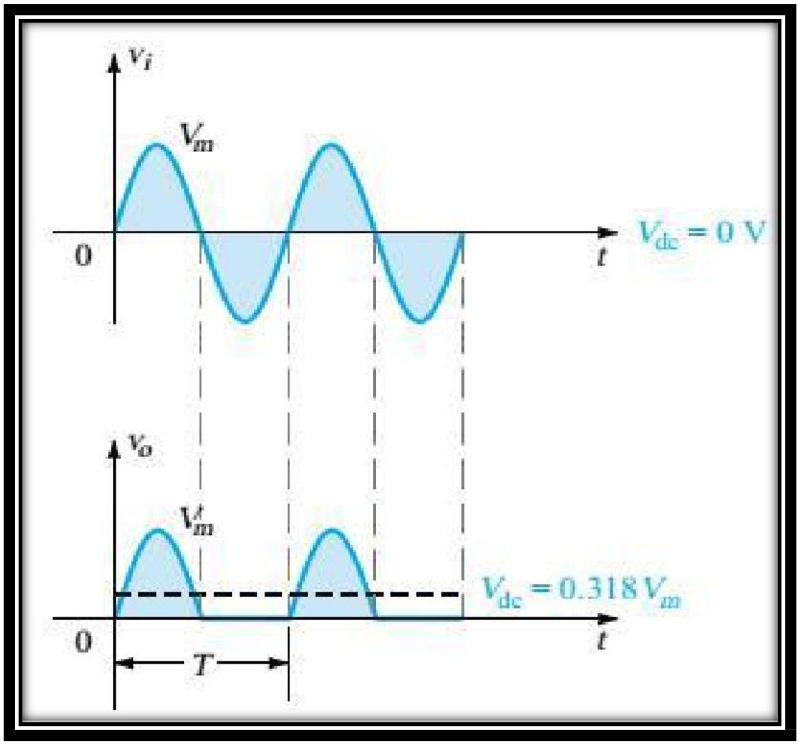


Figure (18) Half-Wave Rectified Signal

The effect of using a silicon diode with VT = 0.7 V is demonstrated in Fig. (19) for the forward-bias region. The applied signal must now be at least 0.7 V before the diode can turn “on” For levels of *vi* less than 0.7V, the diode is still in an open circuit state and *vo* = 0 V as shown in the same figure. The difference between *vo* and *vi* is a fixed level of VT=0.7V and *vo* = *vi* - *VT*, as shown in the figure. The net effect is a reduction in area above the axis, which naturally reduces the resulting dc voltage level. For situations where Vm >> VT, so we can determine the average value with a relatively high level of accuracy.

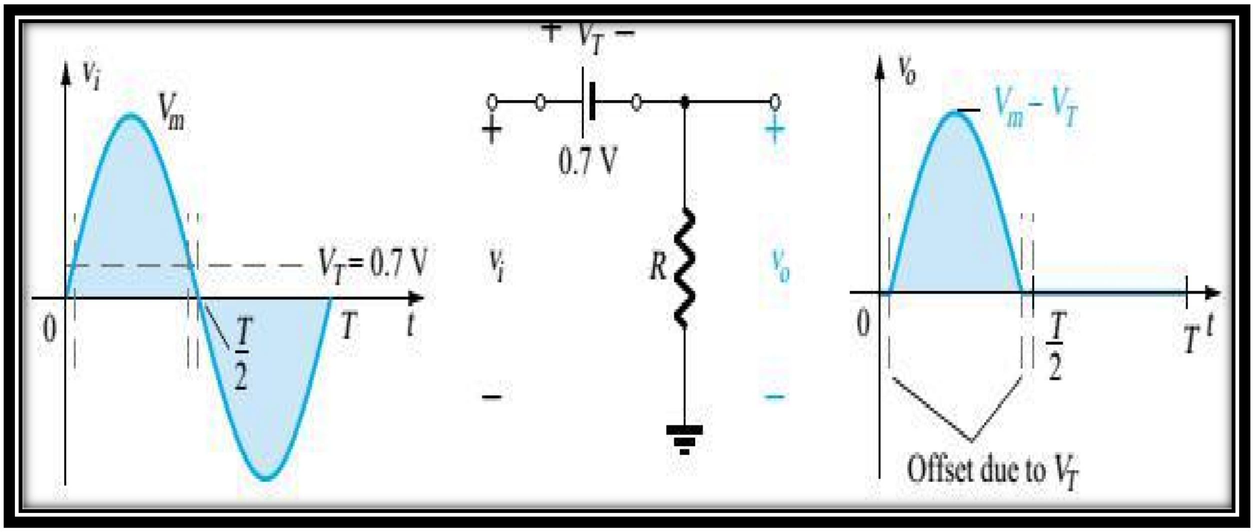


Figure (19) Effect of VT on Half-Wave Rectified Signal

$$V_{dc}=0.318\ (Vm - V_T)$$

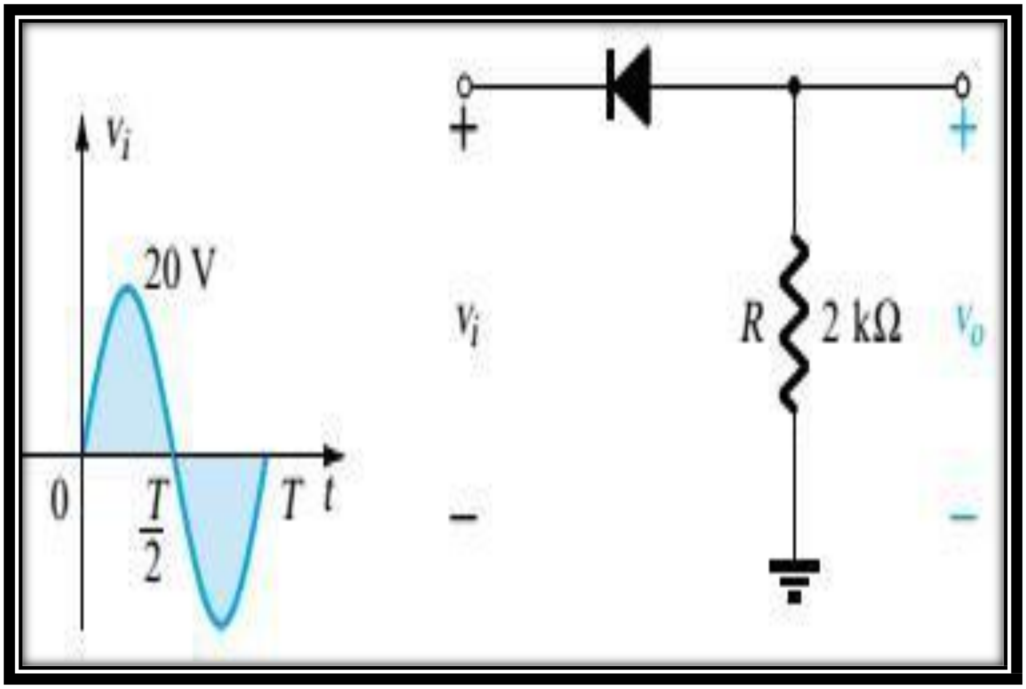
In fact, if Vm is sufficiently greater than VT, (Vdc = 0.318 Vm) is often applied as a first approximation for Vdc.

Example1

(a) Sketch the output *vo* and determine the dc level of the output for the network of Fig. below.

(b) Repeat part (a) if the ideal diode is replaced by a silicon diode.

(c) Repeat parts (a) and (b) if Vm is increased to 200 V and compare solutions using exact and approximation method.



(a) In this situation the diode will conduct during the negative part of the input:

$$V_{dc} = -0.318V_m = -0.318 \times 20 = -6.36V$$

(b) Using a silicon diode:

$$V_{dc} \cong -0.318(V_m - V_T) \cong -0.318(20 - 0.7) = -0.318 \times 19.3$$

$$\cong -6.14V$$

(c) $V_{dc} = -0.318V_m = -0.318 \times 200 = -63.6V$

$$V_{dc} = -0.318(V_m - V_T) = -0.318(200 - 0.7)$$

$$= -0.318 \times 190.3 = -63.38V$$