Electronic Devices

Course Teacher
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Prepared By
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Reference book:

Electronic Devices and Circuit Theory (Chapter-2)

Robert L. Boylestad and L. Nashelsky , (11th Edition)

Department of Electrical and Electronics Engineering
American International University-Bangladesh(AIUB)

Objectives

- Diodes application : AND/OR gates
- Understand the process of rectification to establish a dc level from a sinusoidal ac input.

Logic OR gates

EXAMPLE 2.14 Determine V_o for the network of Fig. 2.39.

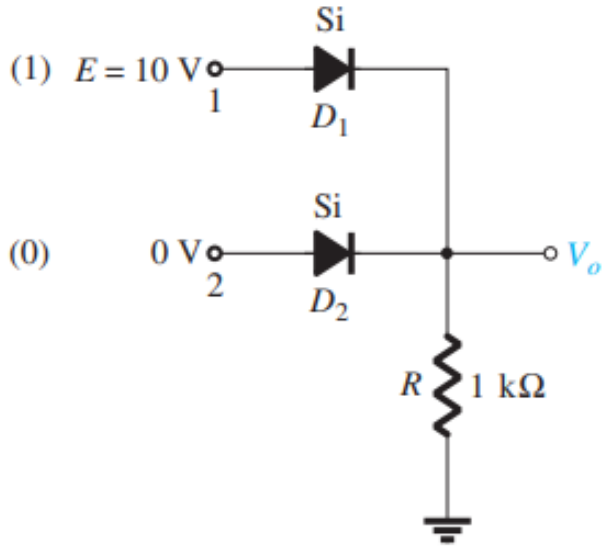


FIG. 2.39
Positive logic OR gate.

Inputs of Diode, D1 and D2 are 1 (10 V) and 0 (0 V), respectively (Fig 2.39)

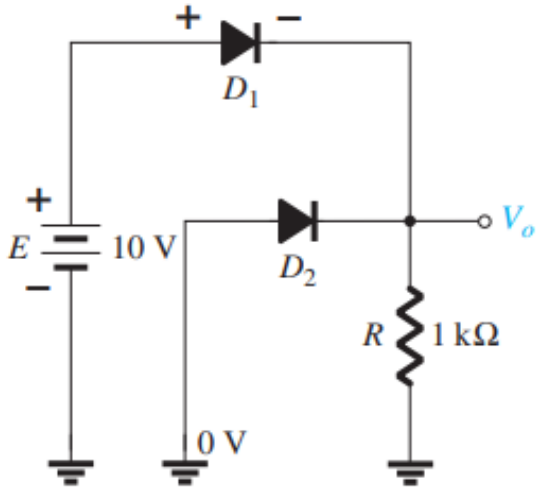


FIG. 2.40
Redrawn network of Fig. 2.39.

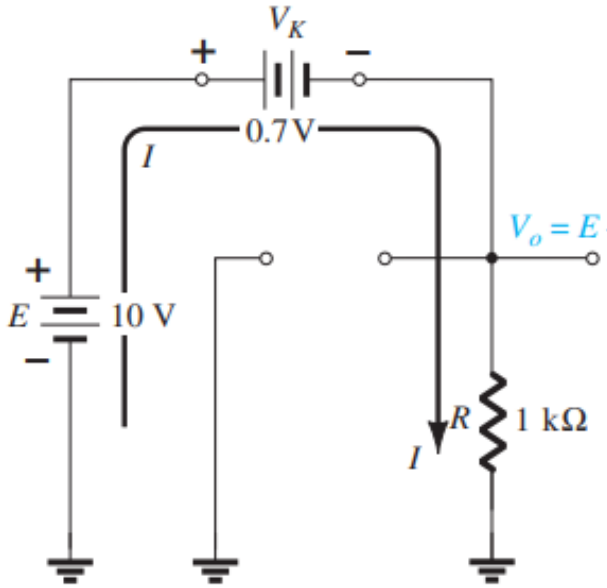


FIG. 2.41
Assumed diode states for Fig. 2.40.

Output across the resistor is 9.3 V (1 level) Fig. 2.41

For AND gates see the Example 2.15

SINUSOIDAL INPUTS; HALF-WAVE

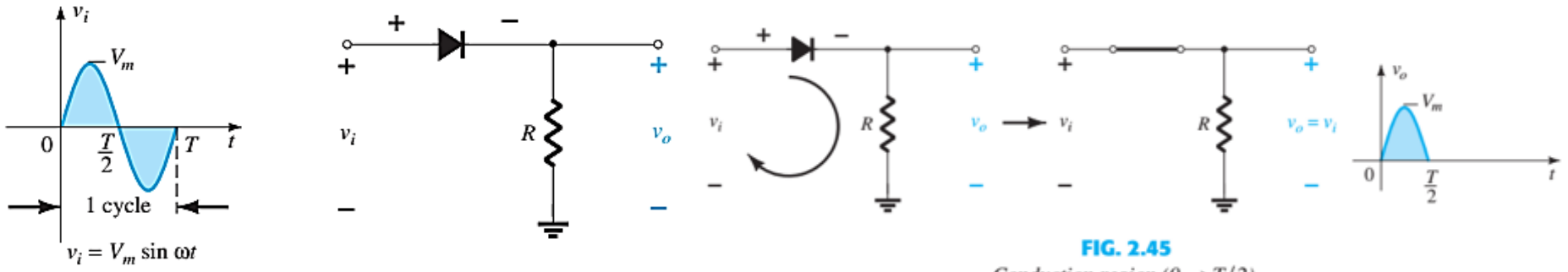


FIG. 2.44
Half-wave rectifier.

FIG. 2.45
Conduction region ($0 \rightarrow T/2$).

FIG. 2.46
Nonconduction region ($T/2 \rightarrow T$).

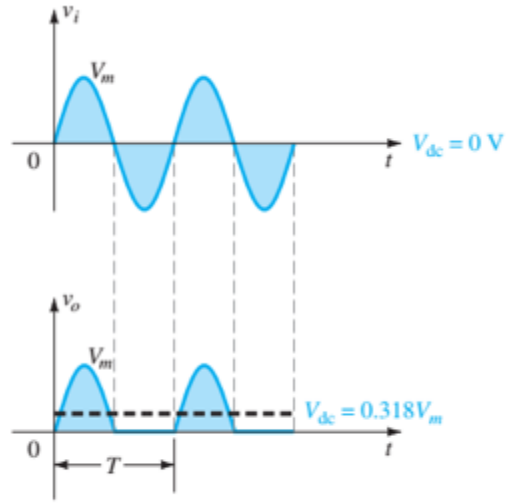


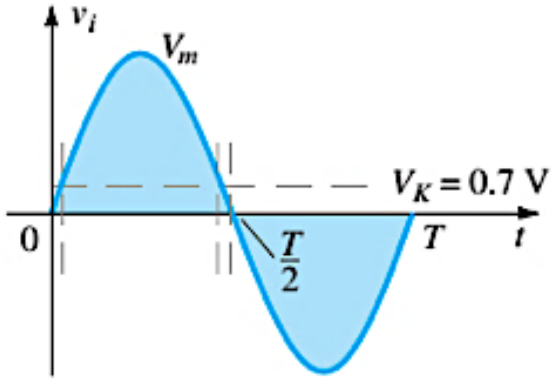
FIG. 2.47
Half-wave rectified signal.

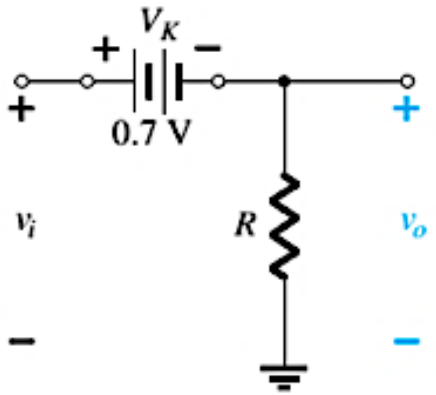
$$V_{dc} = 0.318\, V_m$$ half-wave

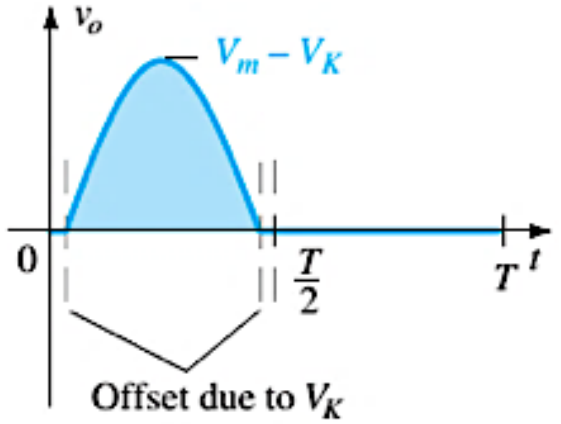
HALF-WAVE RECTIFICATION

- The process of removing one-half the input signal to establish a dc level is called ***halfwave rectification.***

- The effect of using a silicon diode with V_K = 0.7 V is demonstrated in below Figure for the forward-bias region. The applied signal must now be at least 0.7 V before the diode can turn "on."





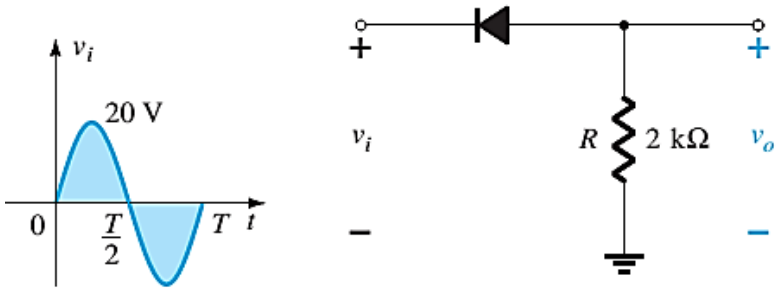


$$V_{dc} \cong 0.318(V_m - V_K)$$

HALF-WAVE RECTIFICATION

EXAMPLE 2.16

a. Sketch the output v_o and determine the dc level of the output for the network of Fig. 2.49.
b. Repeat part (a) if the ideal diode is replaced by a silicon diode.
c. Repeat parts (a) and (b) if V_m is increased to 200 V, and compare solutions using Eqs. (2.7) and (2.8).



$$V_{dc} = -0.318V_m = -0.318(20\text{ V}) = \mathbf{-6.36\text{ V}}$$

FIG. 2.49
Network for Example 2.16.

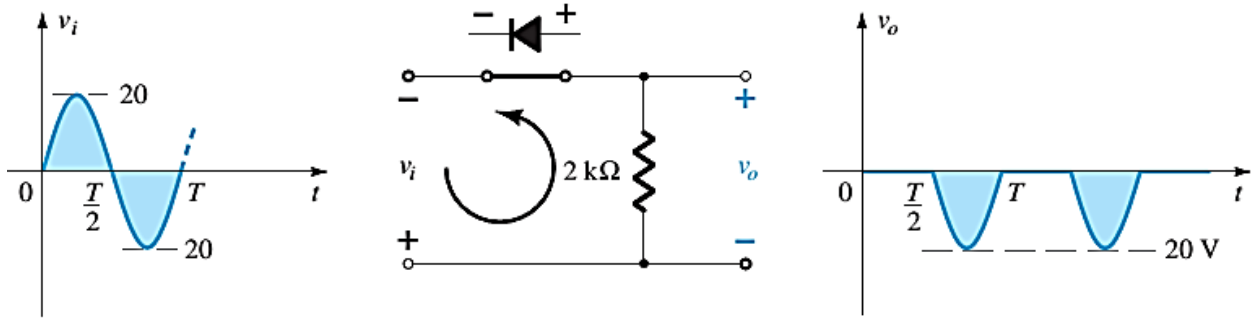


FIG. 2.50
Resulting v_o for the circuit of Example 2.16.

HALF-WAVE RECTIFICATION

b. For a silicon diode, the output has the appearance of Fig. 2.51, and

$$V_{dc} \cong -0.318(V_m - 0.7\text{ V}) = -0.318(19.3\text{ V}) \cong \mathbf{-6.14\text{ V}}$$

The resulting drop in dc level is 0.22 V, or about 3.5%.

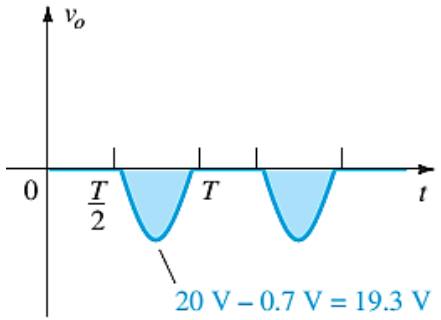


FIG. 2.51
Effect of V_K on output of Fig. 2.50.

c. Eq. (2.7): $V_{dc} = -0.318\,V_m = -0.318(200\text{ V}) = \mathbf{-63.6\text{ V}}$

Eq. (2.8): $V_{dc} = -0.318(V_m - V_K) = -0.318(200\text{ V} - 0.7\text{ V})$

$= -(0.318)(199.3\text{ V}) = \mathbf{-63.38\text{ V}}$

PIV (PRV)

- It is the voltage rating that must not be exceeded in the reverse-bias region or the diode will enter the Zener avalanche region.
- Applying Kirchhoff's voltage law, it is fairly obvious that the PIV rating of the diode must equal or exceed the peak value of the applied voltage.

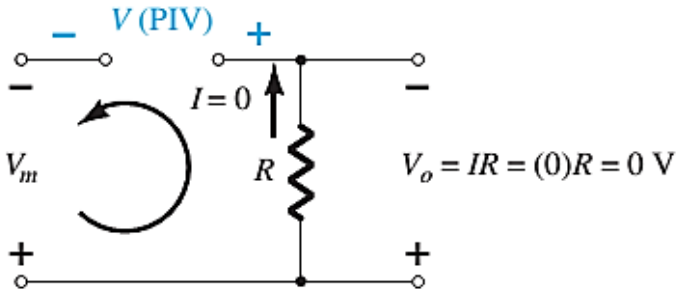


FIG. 2.52
Determining the required PIV rating for the half-wave rectifier.

$$\text{PIV rating} \geqq V_m$$ half-wave rectifier

FULL-WAVE RECTIFICATION: BRIDGE NETWORK

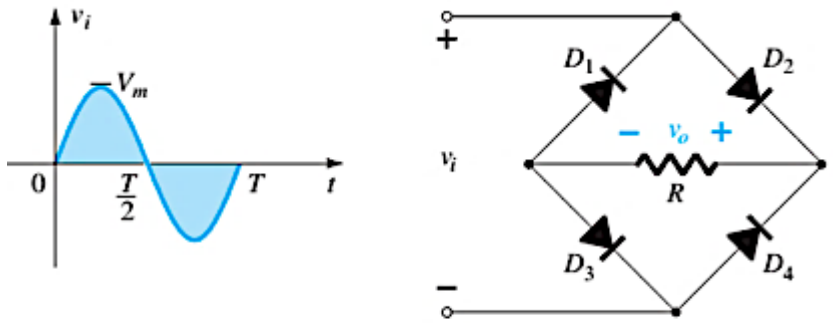


FIG. 2.53
Full-wave bridge rectifier.

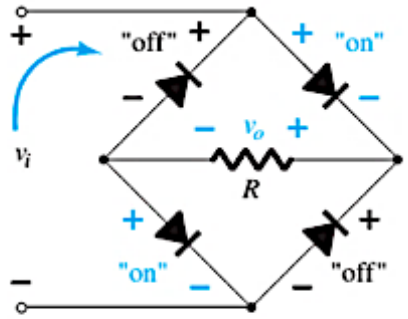


FIG. 2.54
Network of Fig. 2.53 for the period $0 \rightarrow T/2$ of the input voltage v_i.

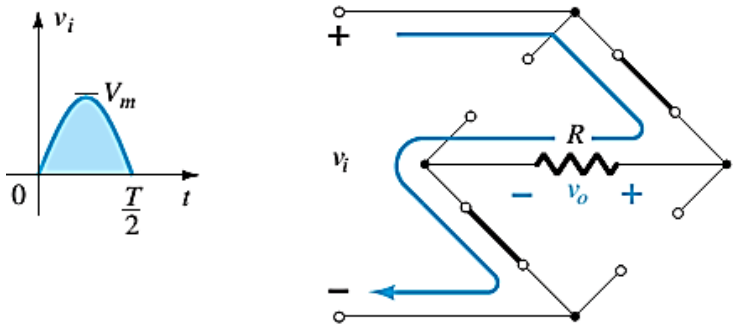


FIG. 2.55
Conduction path for the positive region of v_i.

BRIDGE NETWORK

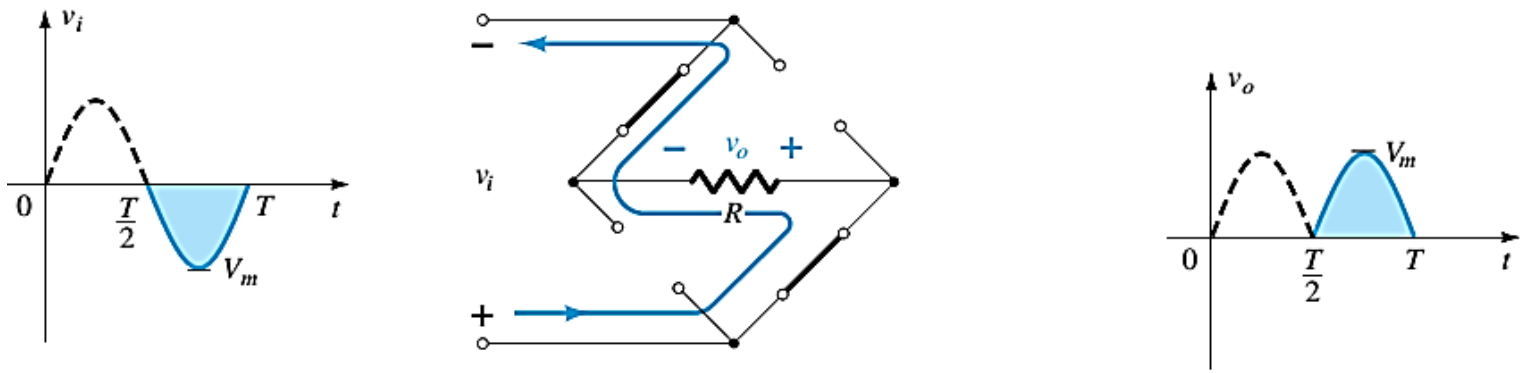


FIG. 2.56

Conduction path for the negative region of v_i.

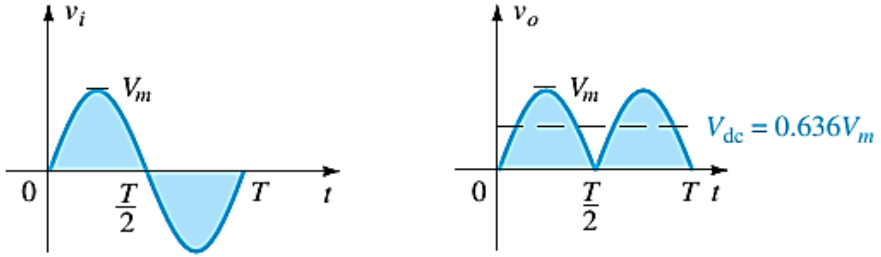
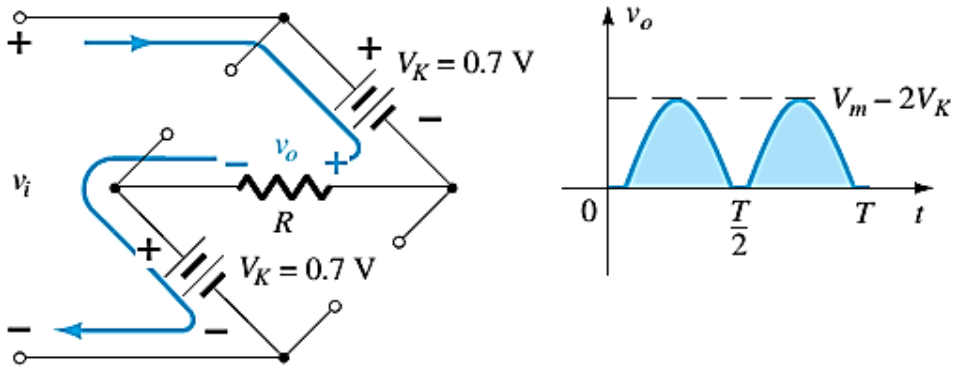


FIG. 2.57

Input and output waveforms for a full-wave rectifier.

BRIDGE NETWORK



$$V_{dc} \cong 0.636(V_m - 2V_K)$$

FIG. 2.58

Determining $V_{o_{max}}$ for silicon diodes in the bridge configuration.

$$PIV \cong V_m$$

full-wave bridge rectifier

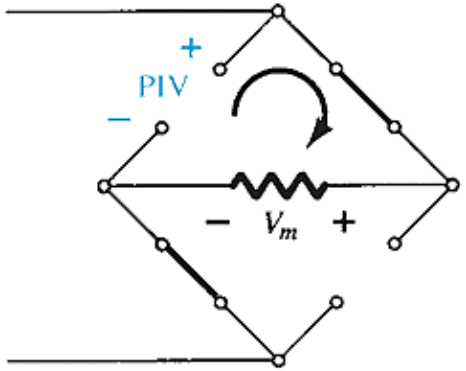


FIG. 2.59

Determining the required PIV for the bridge configuration.

CENTER-TAPPED TRANSFORMER

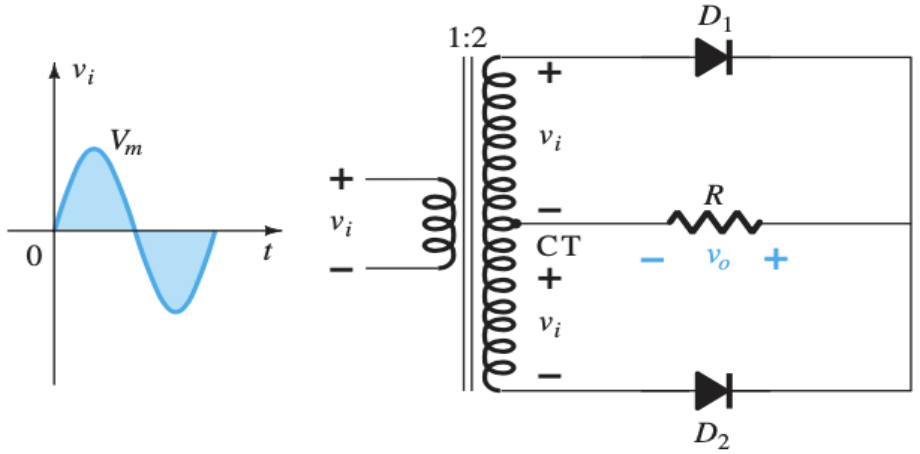
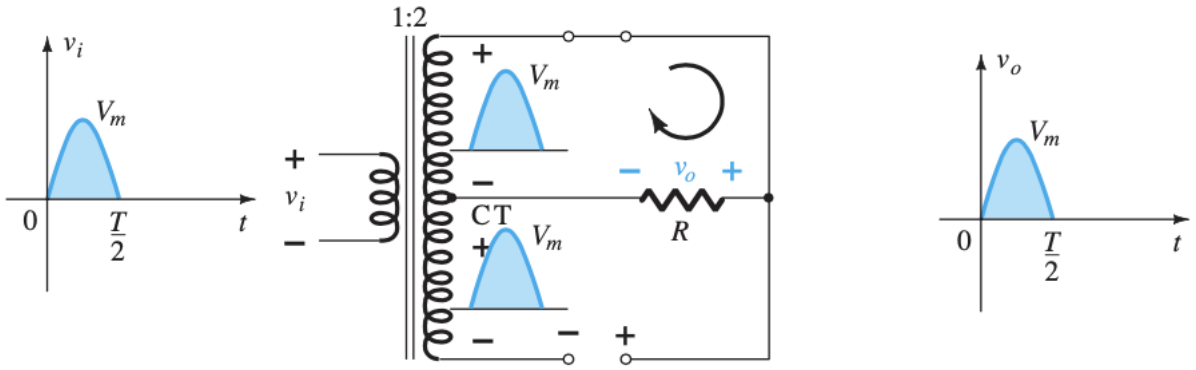


FIG. 2.60

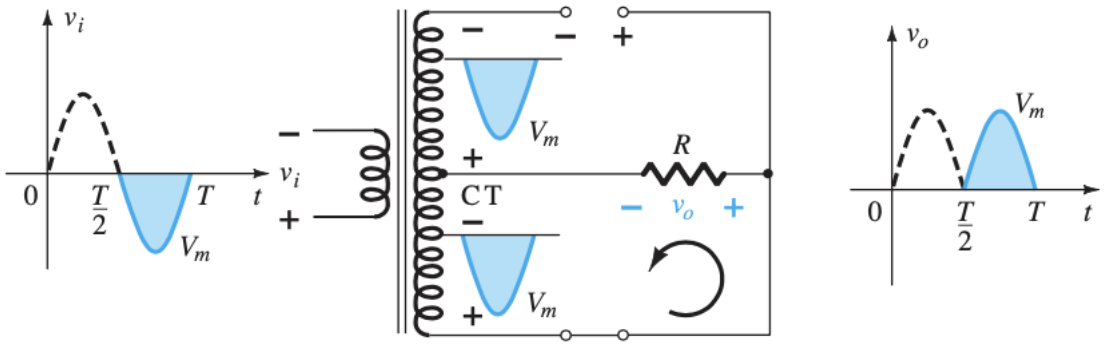
Center-tapped transformer full-wave rectifier.

Network conditions for the positive region of v_i



CENTER-TAPPED TRANSFORMER

Network conditions for the negative region of v_i



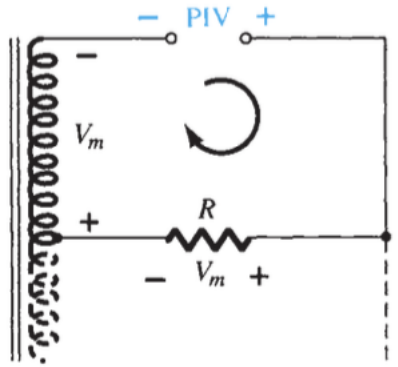


FIG. 2.63
Determining the PIV level for the diodes of the CT transformer full-wave rectifier.

$$\text{PIV} = V_{\text{secondary}} + V_R$$
$$= V_m + V_m$$

$$\boxed{\text{PIV} \geqq 2V_m}$$ CT transformer, full-wave rectifier

EXAMPLE 2.17 Determine the output waveform for the network of Fig. 2.64 and calculate the output dc level and the required PIV of each diode.

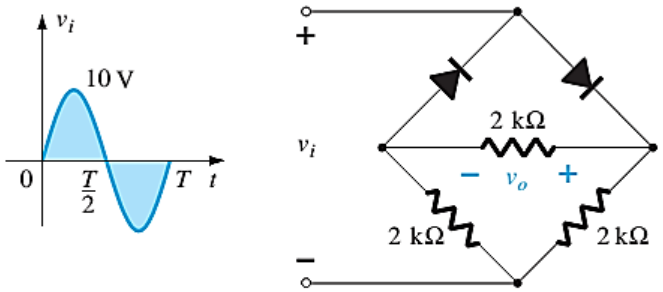


FIG. 2.64
Bridge network for Example 2.17.

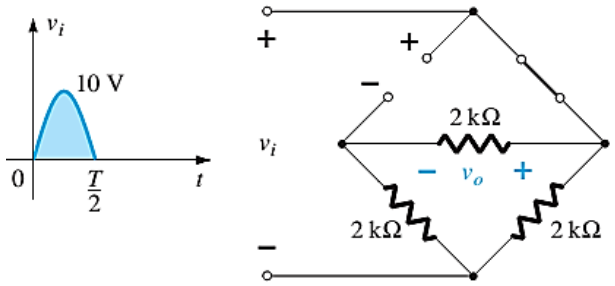


FIG. 2.65
Network of Fig. 2.64 for the positive region of v_i.

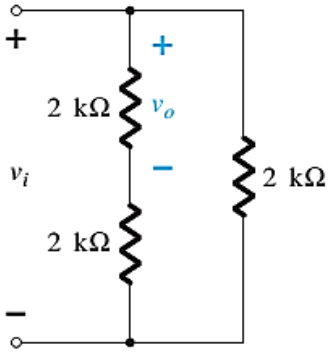
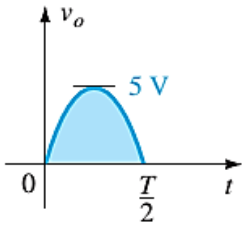


FIG. 2.66
Redrawn network of Fig. 2.65.



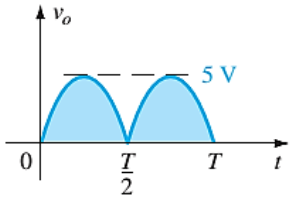


FIG. 2.67
Resulting output for Example 2.17.

***The PIV as determined from Fig. 2.59 is equal to the maximum voltage across R , which is 5 V, or half of that required for a half-wave rectifier with the same input.

$$V_{o_{max}} = \frac{1}{2}V_{i_{max}} = \frac{1}{2}(10\text{ V}) = 5\text{ V}. \qquad V_{dc} = 0.636(5\text{ V}) = \mathbf{3.18\text{ V}}$$

Thank You