Diode Application

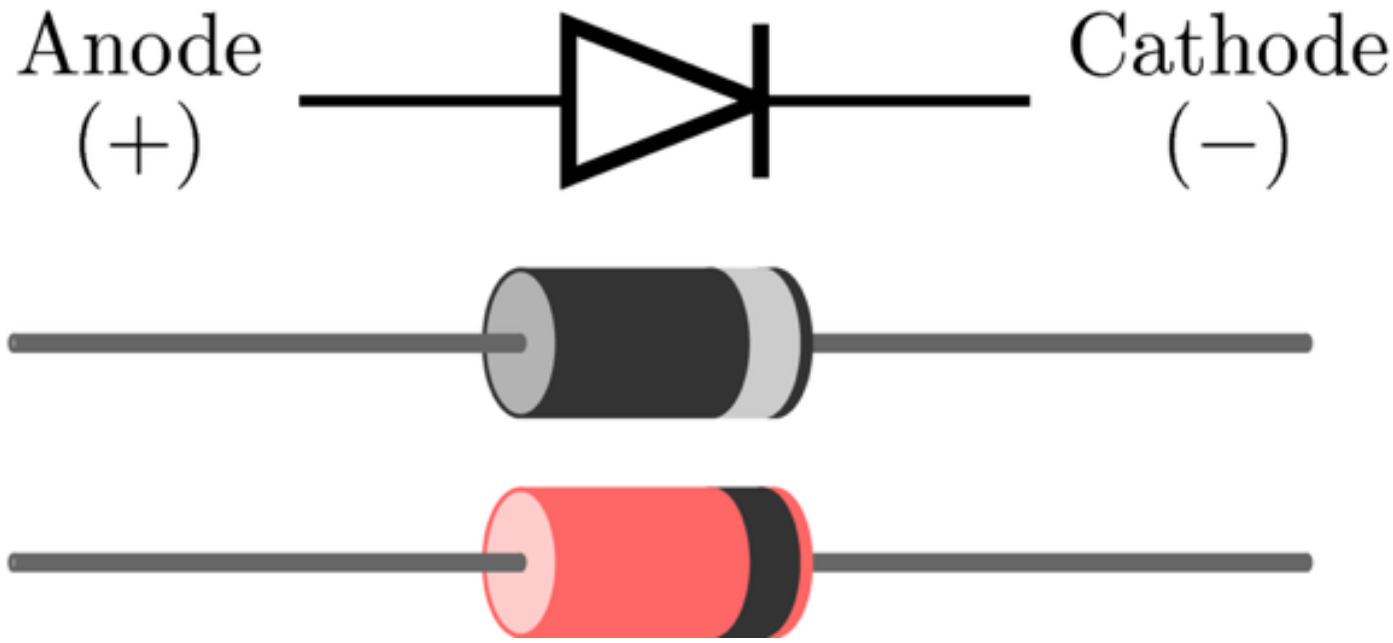
Dr Mohammad Abdur Rashid

Readings

Electronic Devices and Circuit Theory
– Boylestad, Nashelsky

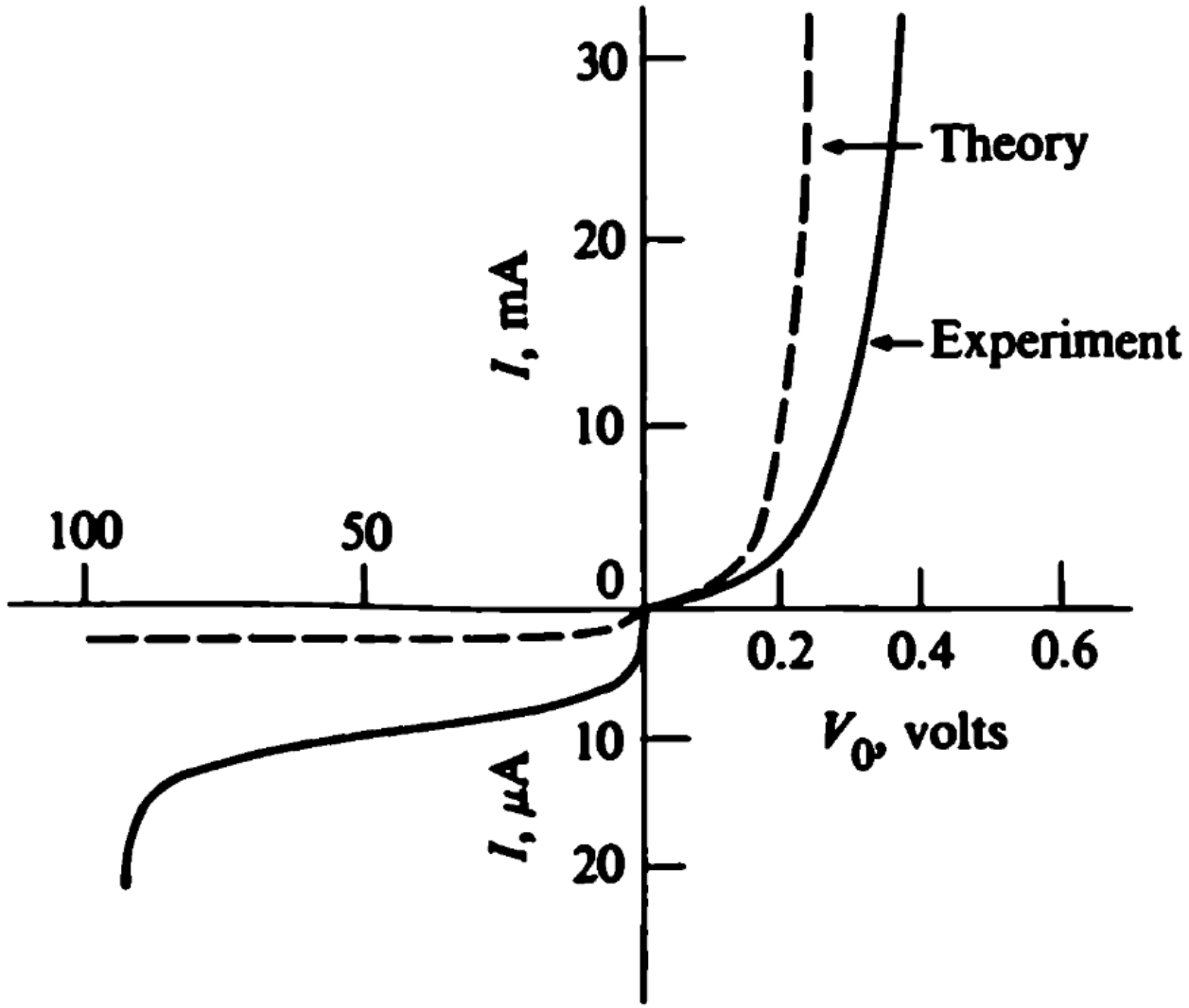
Chapter 2: Diode Applications

Diode



Current versus voltage characteristics

Elementary Solid State Physics – Ali Omar



LED residential and commercial lighting

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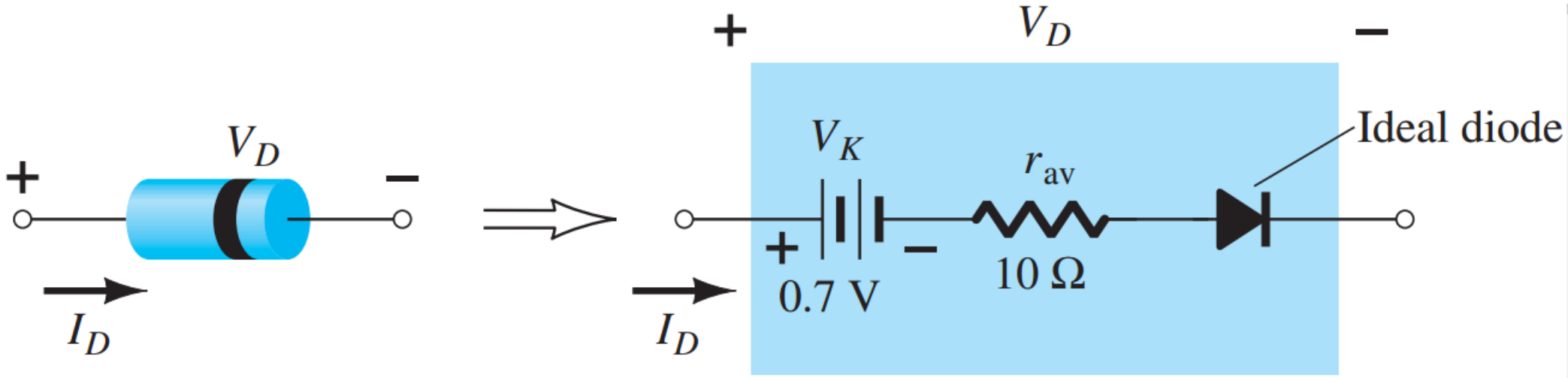
Diode symbol



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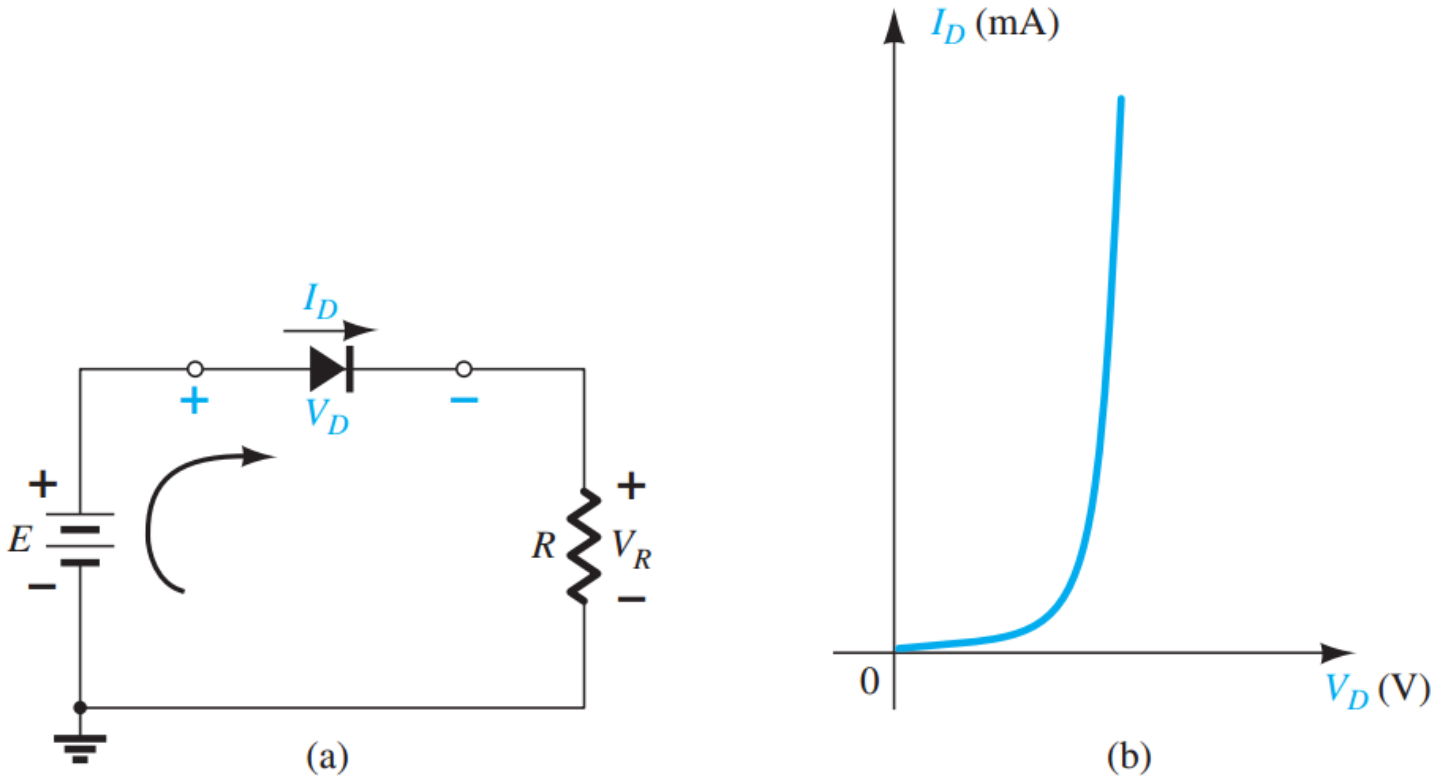
Load-line analysis



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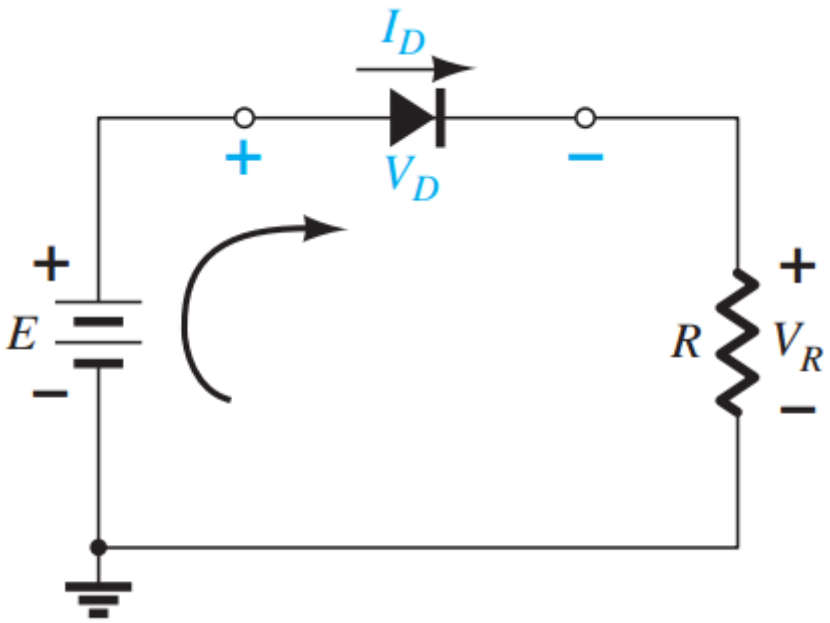
Series diode configuration: (a) circuit; (b) characteristics.

Note

In general, a diode is in the “on” state if the current established by the applied sources is such that its direction matches that of the arrow in the diode symbol, and $V_D \geq 0.7$ V for silicon, $V_D \geq 0.3$ V for germanium, and $V_D \geq 1.2$ V for gallium arsenide.

Applying Kirchhoff's voltage law

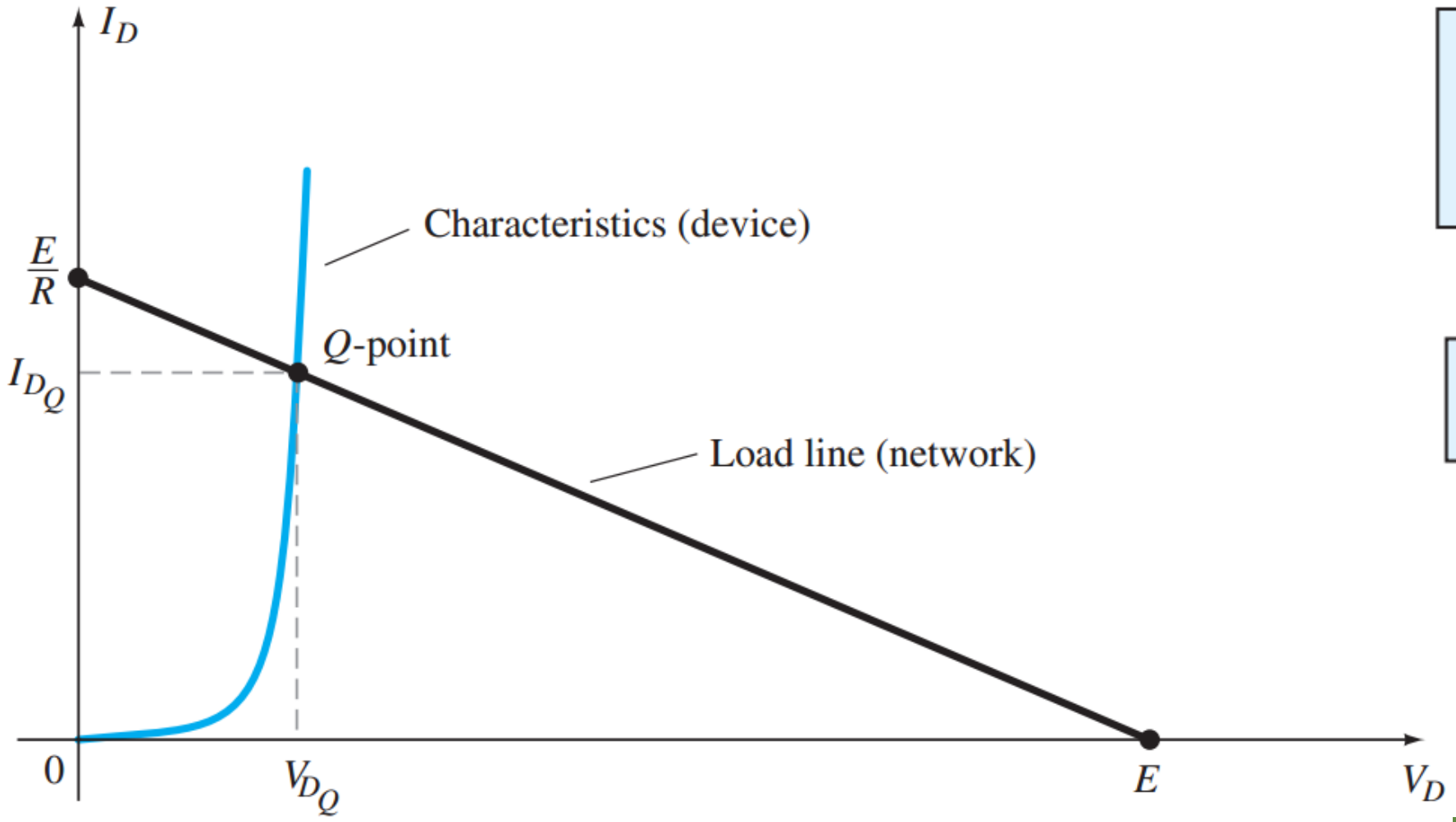


$$I_D = \left.\frac{E}{R}\right|_{V_D=0\text{ V}}$$

$$V_D = E\big|_{I_D=0\text{ A}}$$

$$E = V_D + I_D R$$

Load line and point of operation



$$I_D = \left.\frac{E}{R}\right|_{V_D=0\text{ V}}$$

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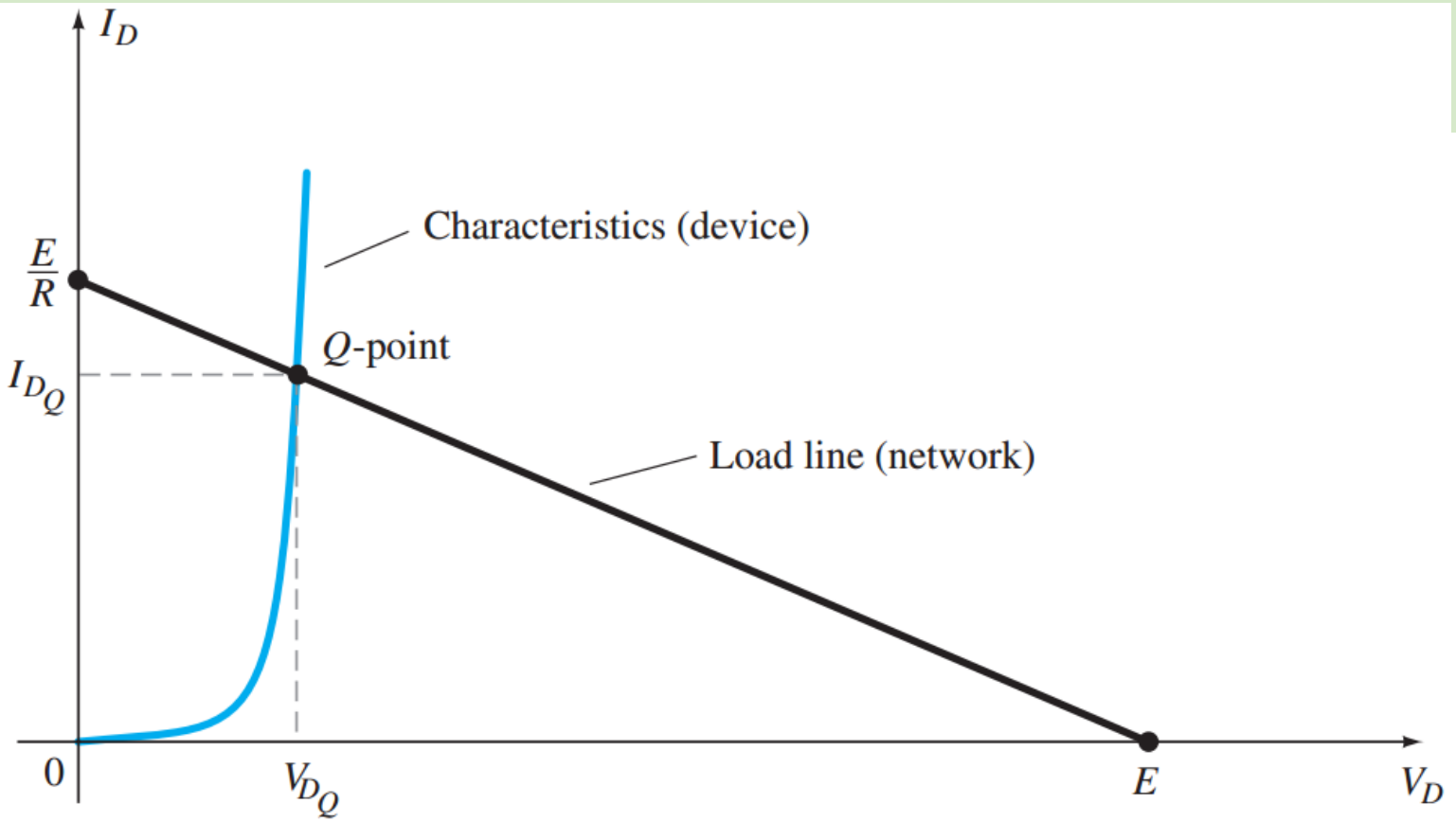
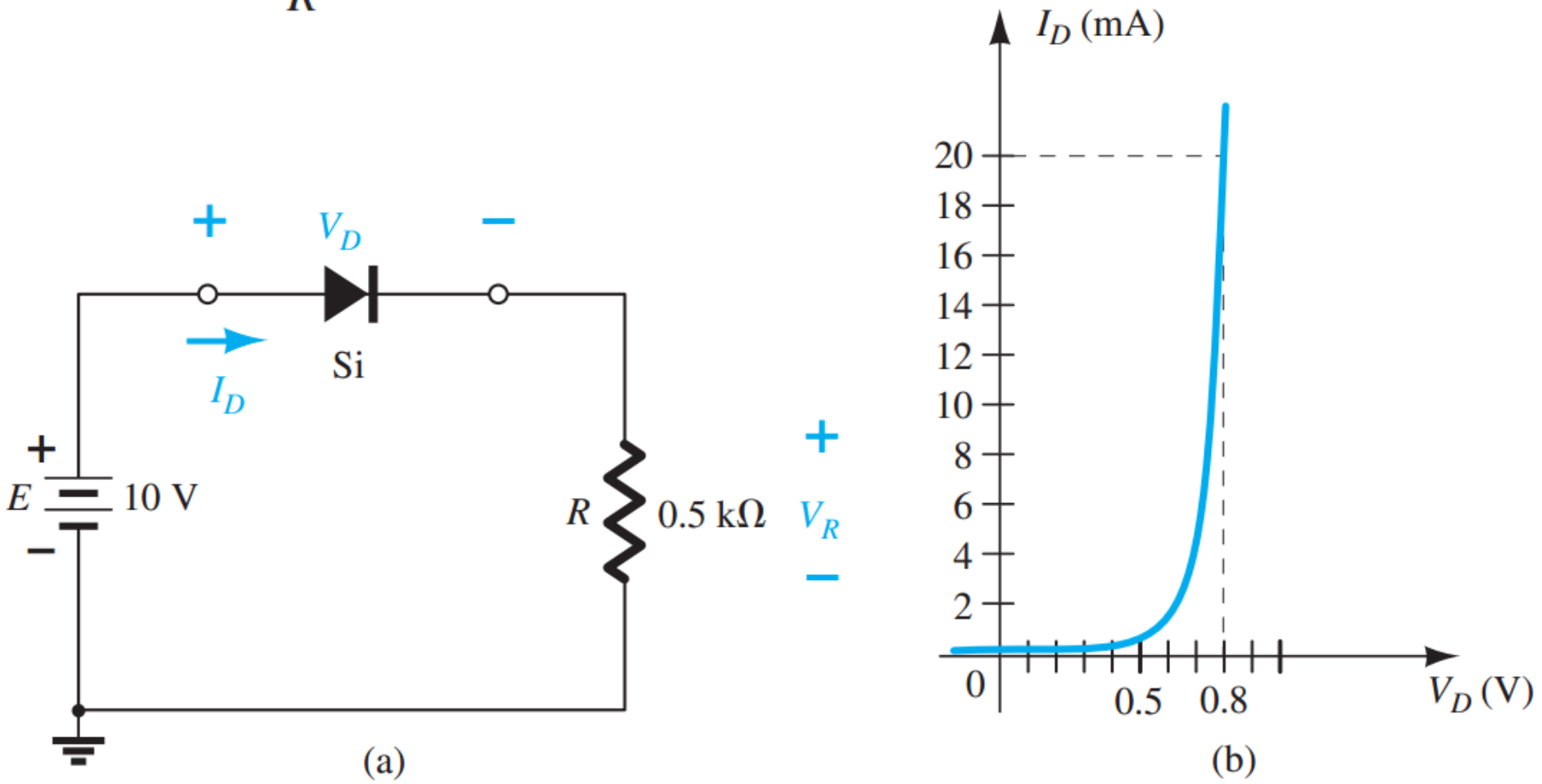


The point of operation is usually called the quiescent point (abbreviated " Q-point") to reflect its "still, unmoving" qualities as defined by a dc network.

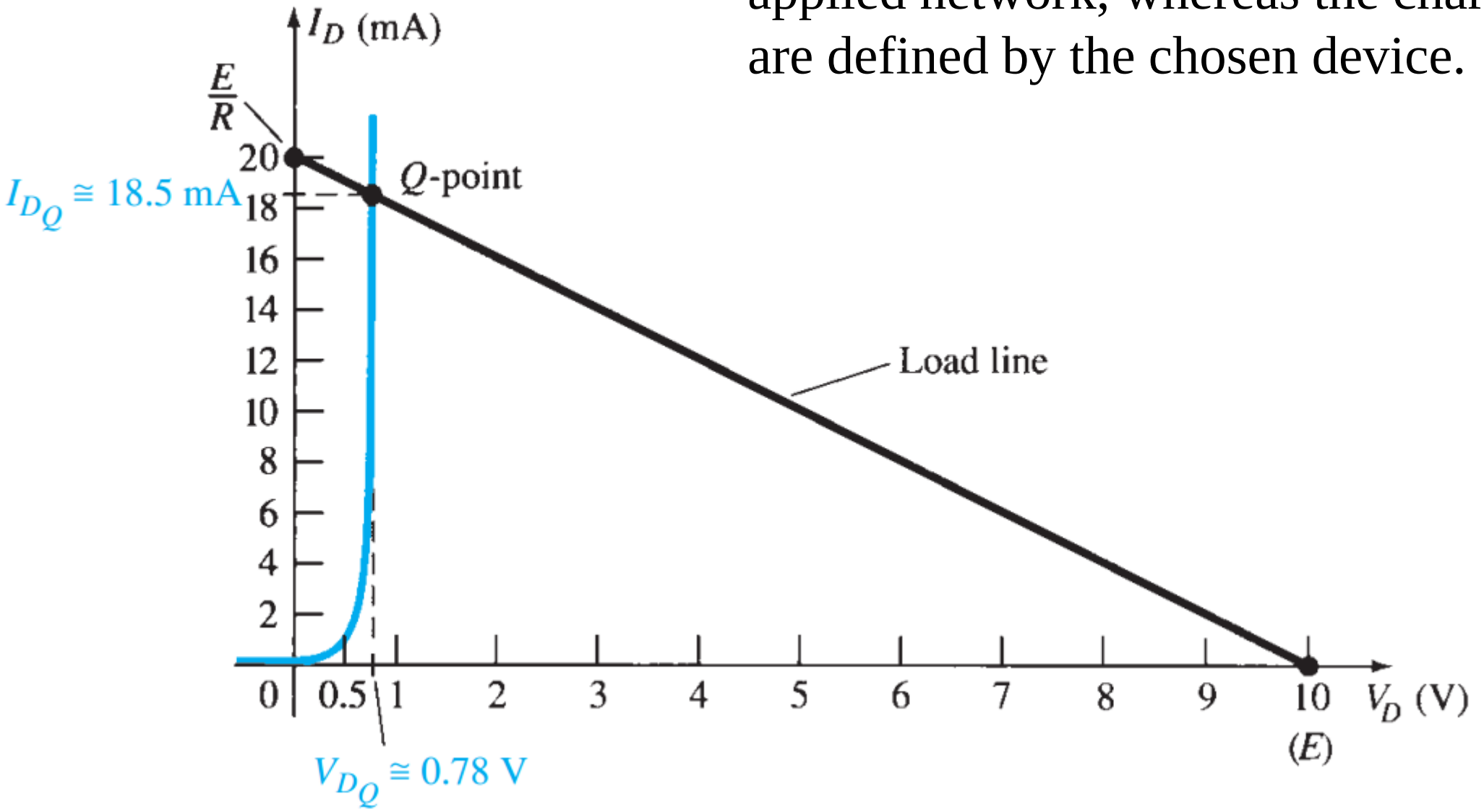
Determine:

a. V_{D_Q} and I_{D_Q}.
b. V_R.



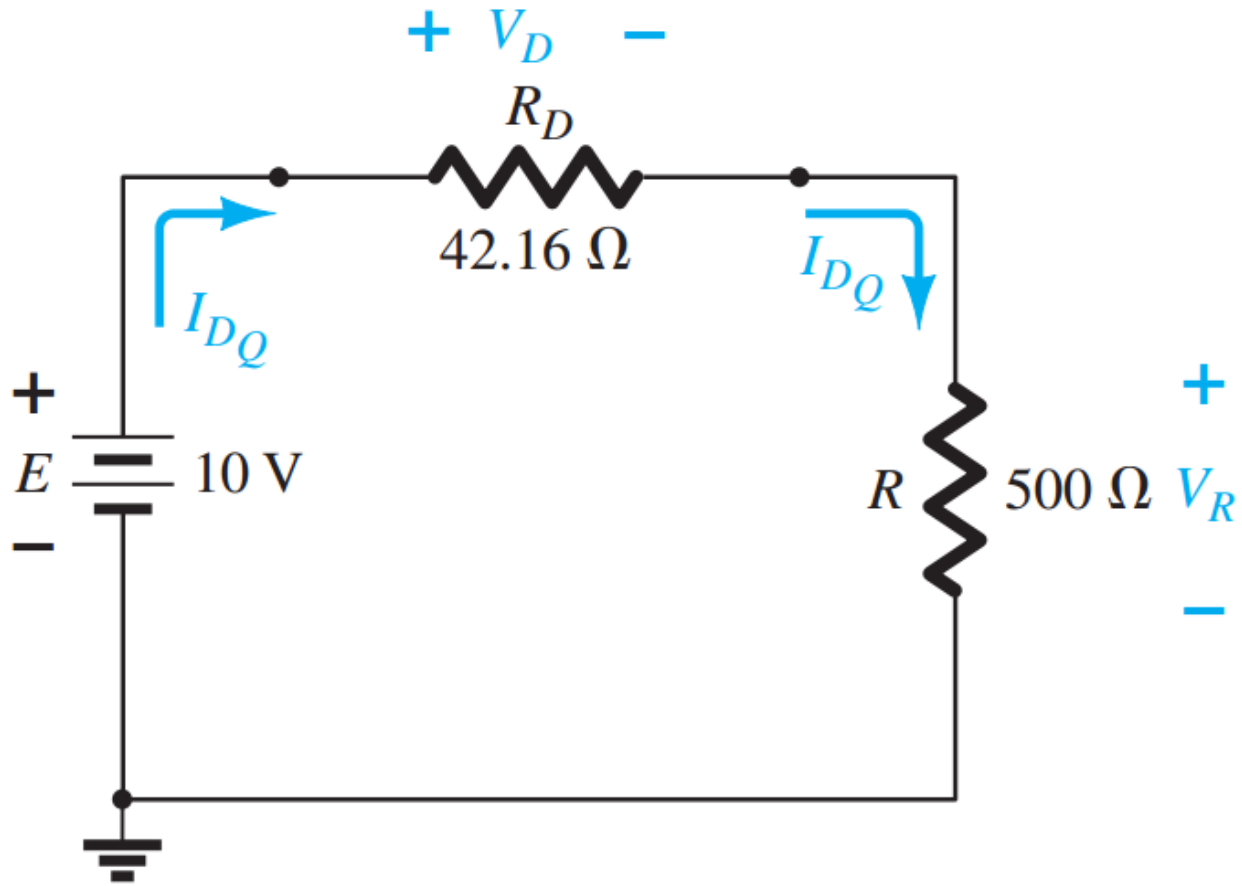
(a) Circuit; (b) characteristics.

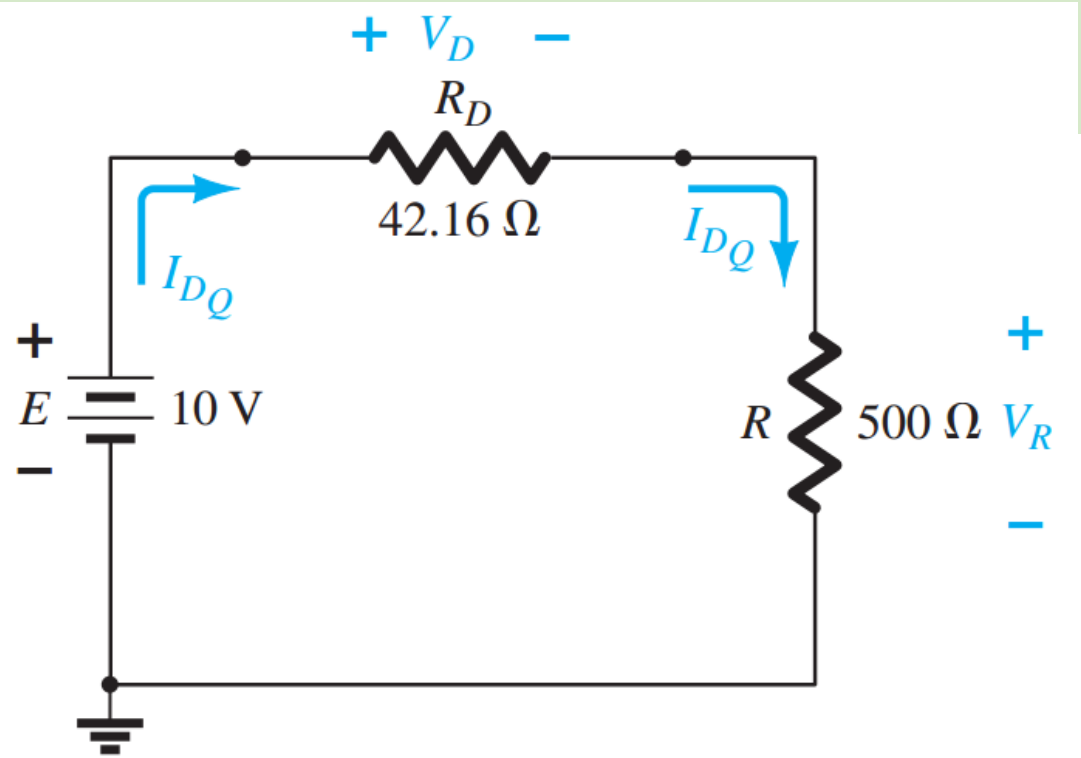
The load line is determined solely by the applied network, whereas the characteristics are defined by the chosen device.



Using the Q-point values, the dc resistance

$$R_D = \frac{V_{D_Q}}{I_{D_Q}} = \frac{0.78\ \text{V}}{18.5\ \text{mA}} = 42.16\ \Omega$$

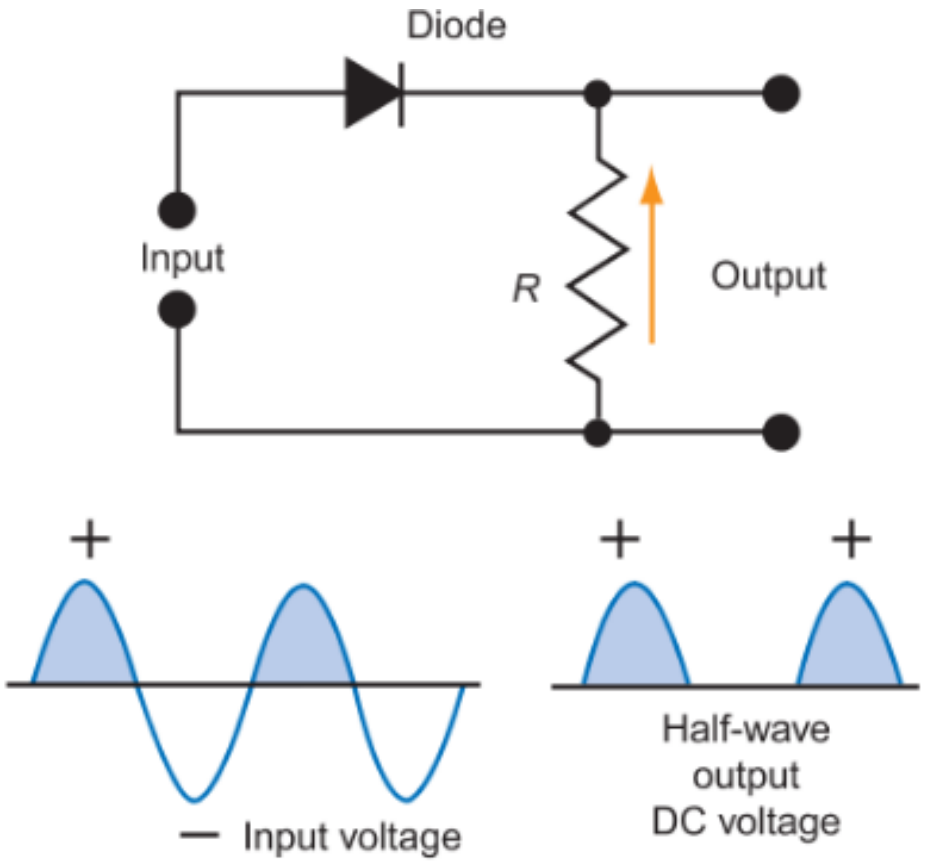




$$I_D = \frac{E}{R_D + R} = \frac{10\text{ V}}{42.16\ \Omega + 500\ \Omega} = \frac{10\text{ V}}{542.16\ \Omega} \cong \mathbf{18.5\ mA}$$

$$V_R = \frac{RE}{R_D + R} = \frac{(500\ \Omega)(10\text{ V})}{42.16\ \Omega + 500\ \Omega} = \mathbf{9.22\ V}$$

Half-wave rectifier



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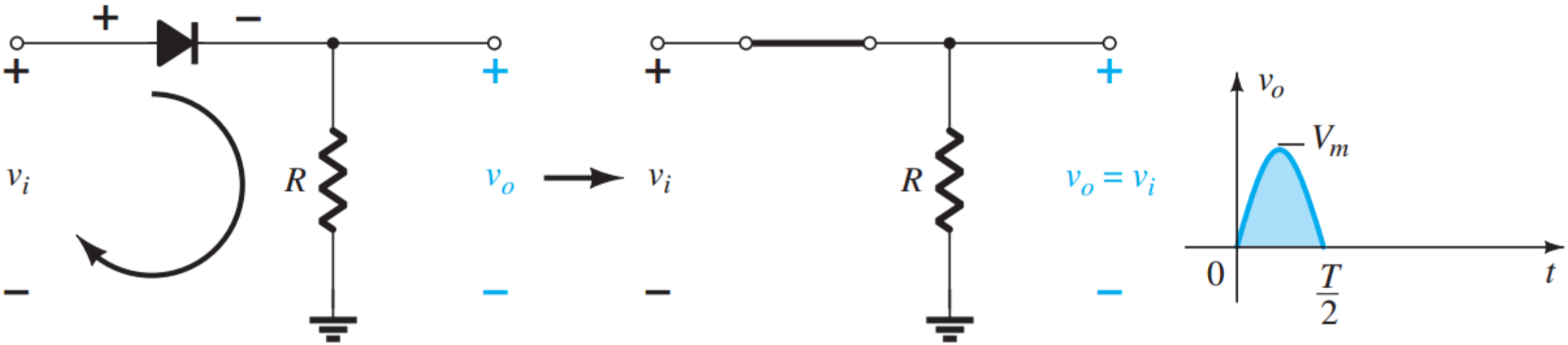
Half-wave rectifier



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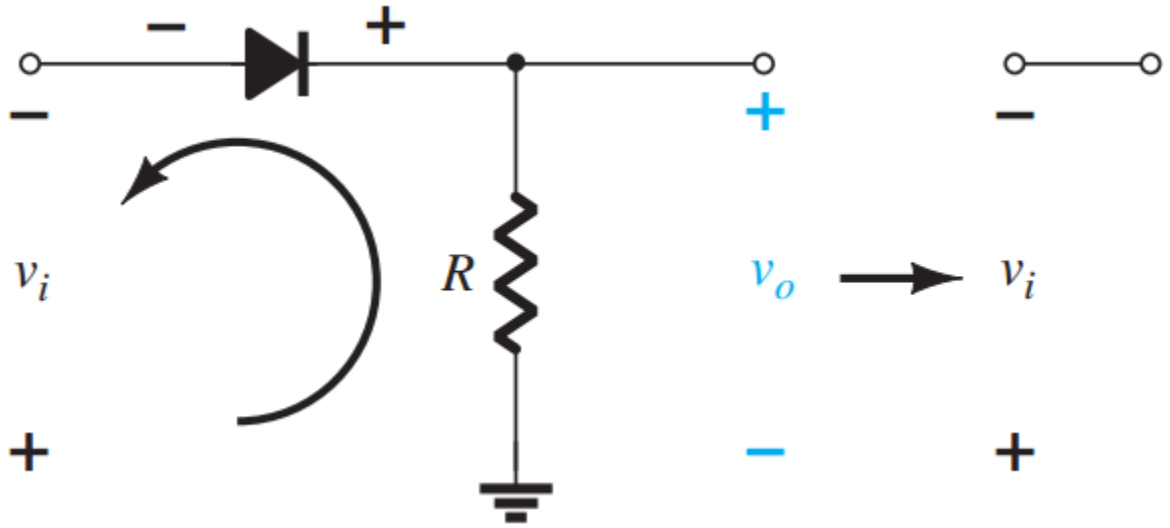
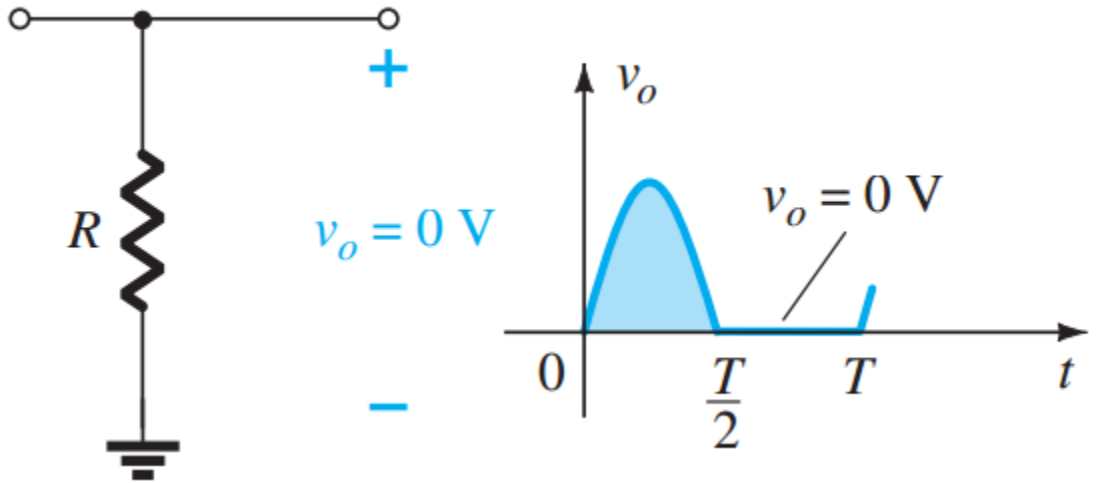
Half-wave rectifier





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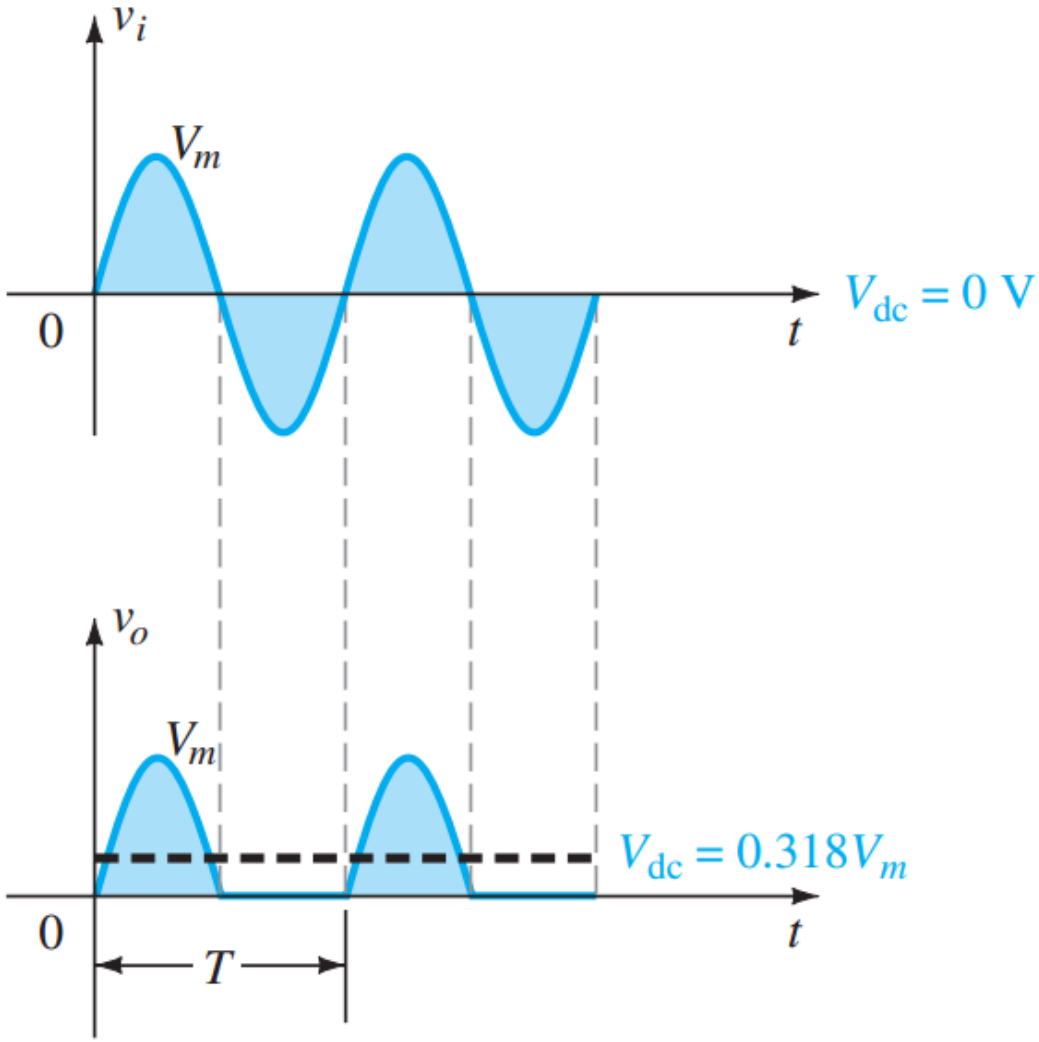
Half-wave rectified signal



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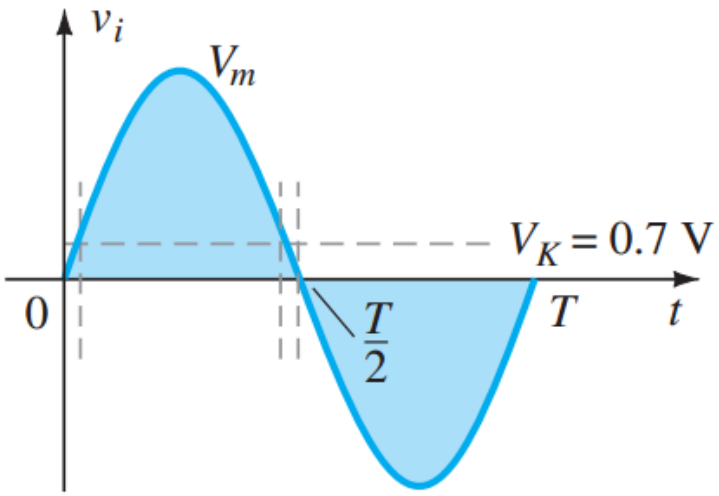

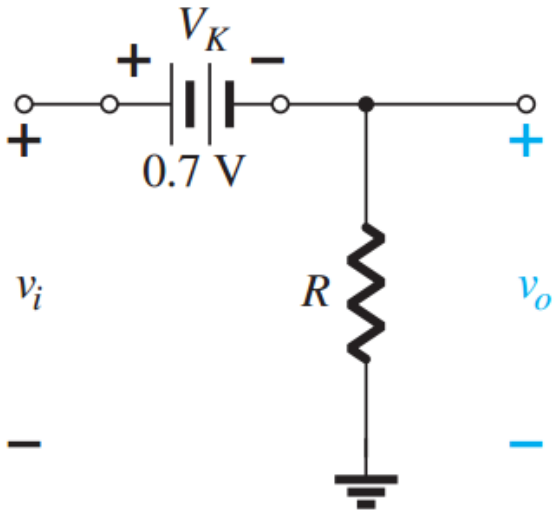

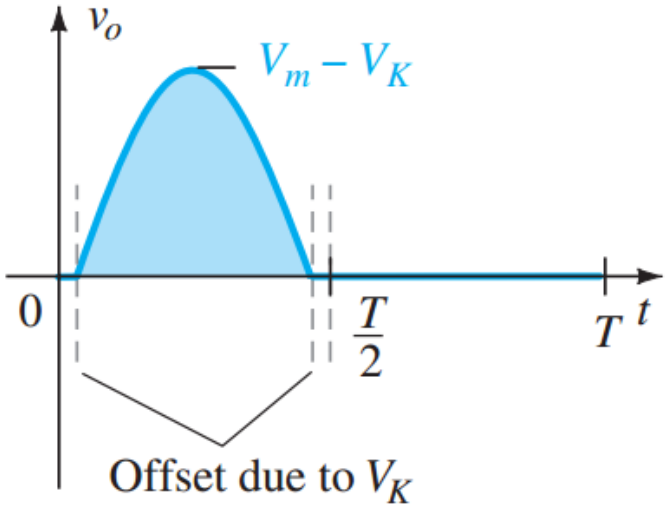

$$V_{dc} \cong 0.318(V_m - V_K)$$

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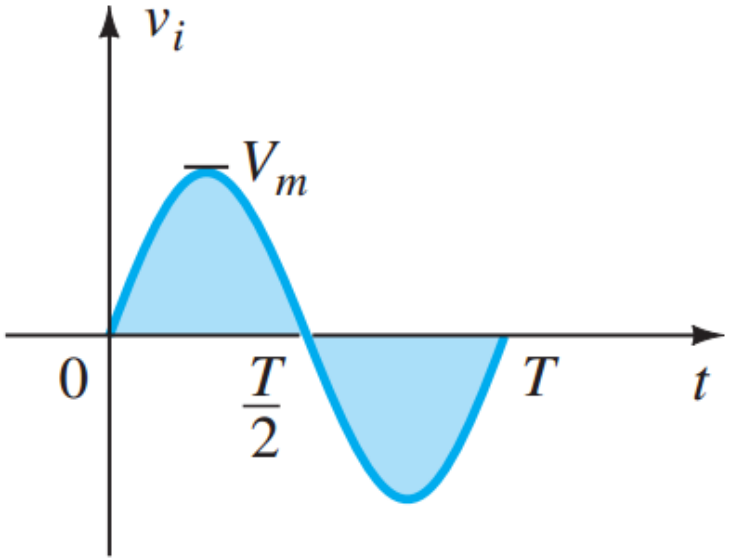
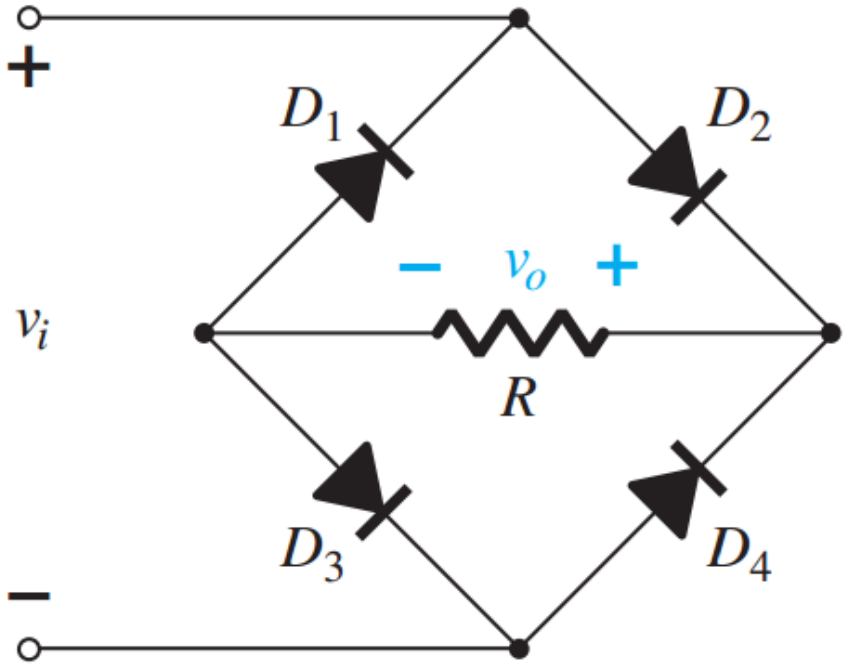
Full-wave rectified signal





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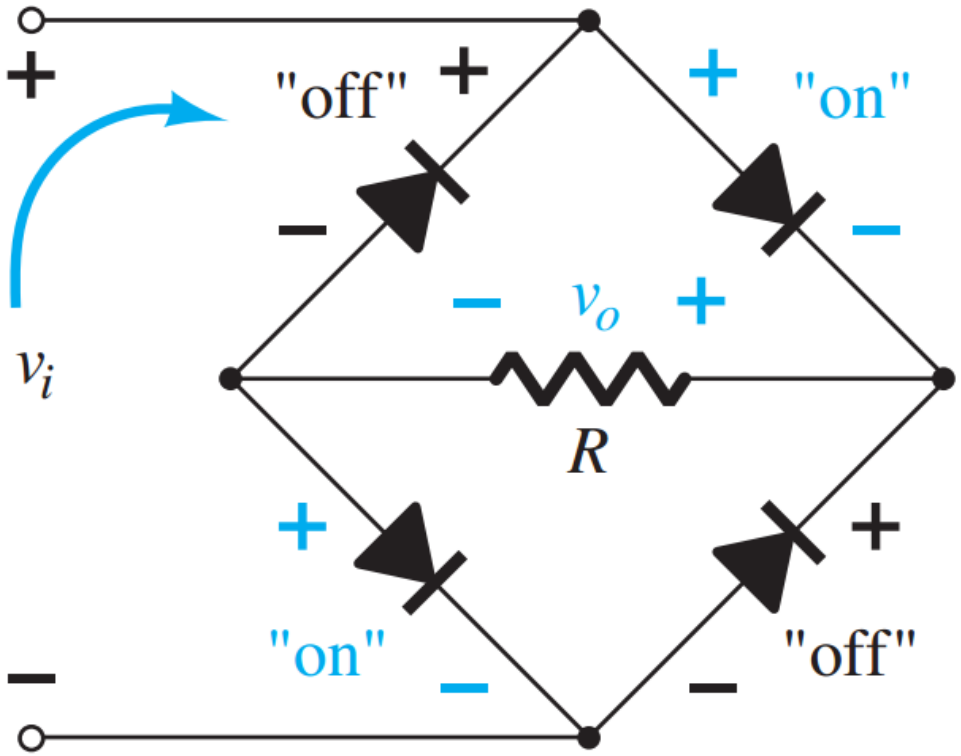
Full-wave rectified signal



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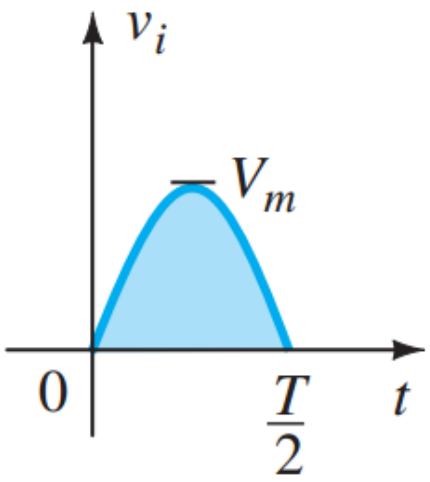
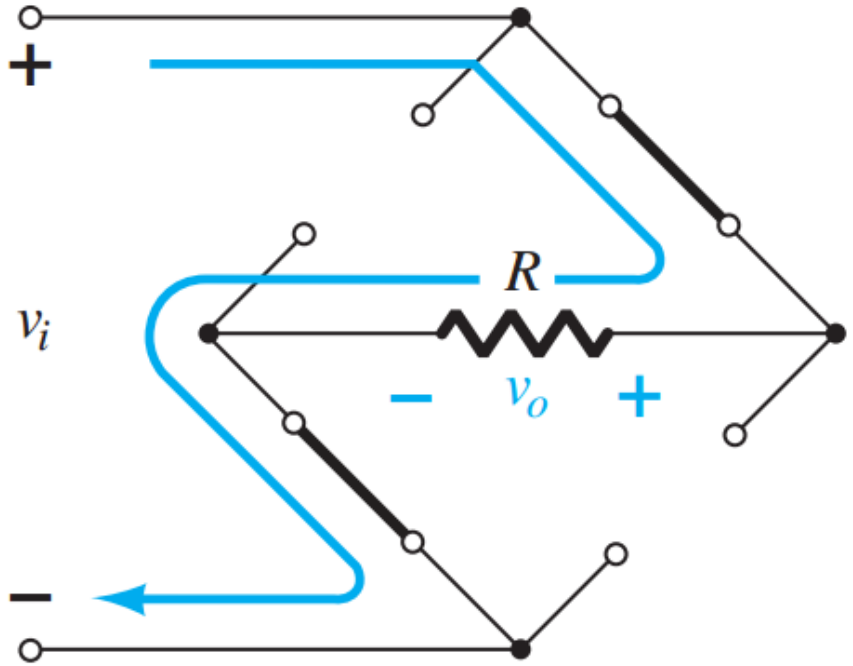
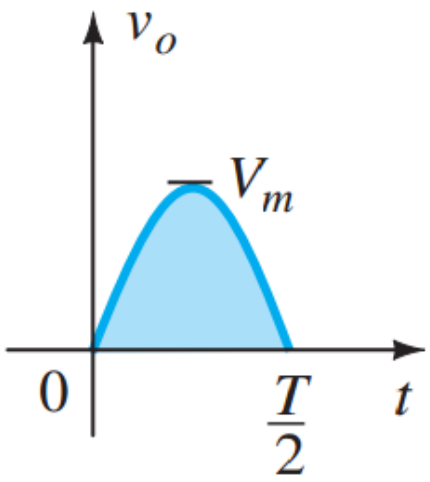
Full-wave rectified signal







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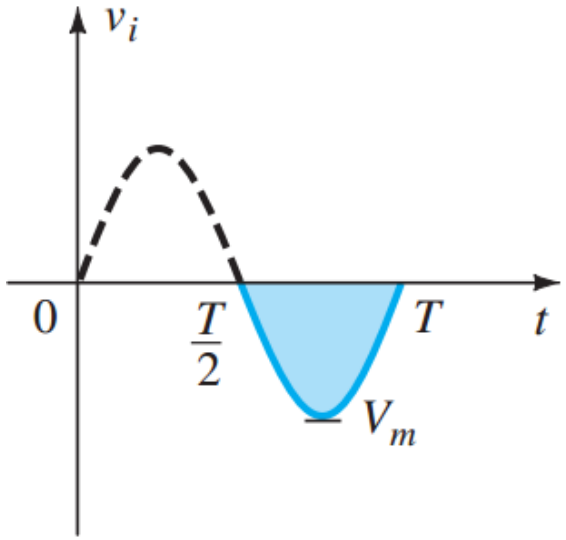
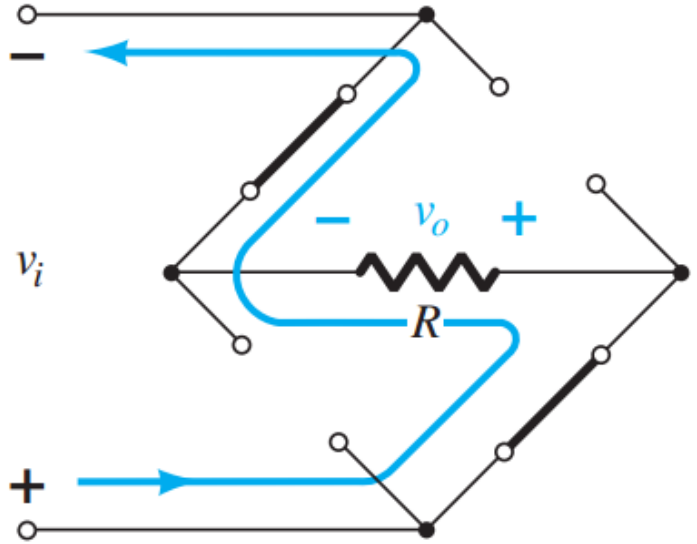
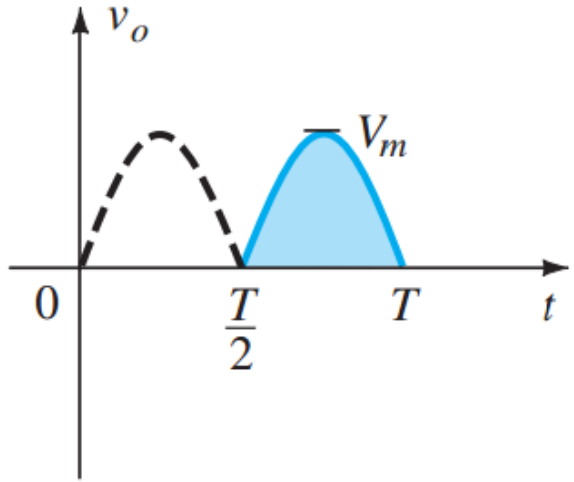
Full-wave rectified signal







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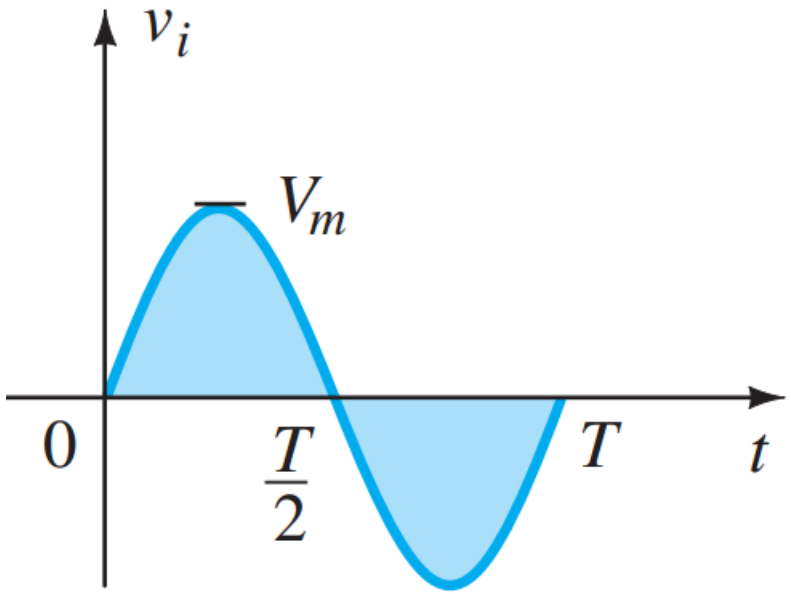
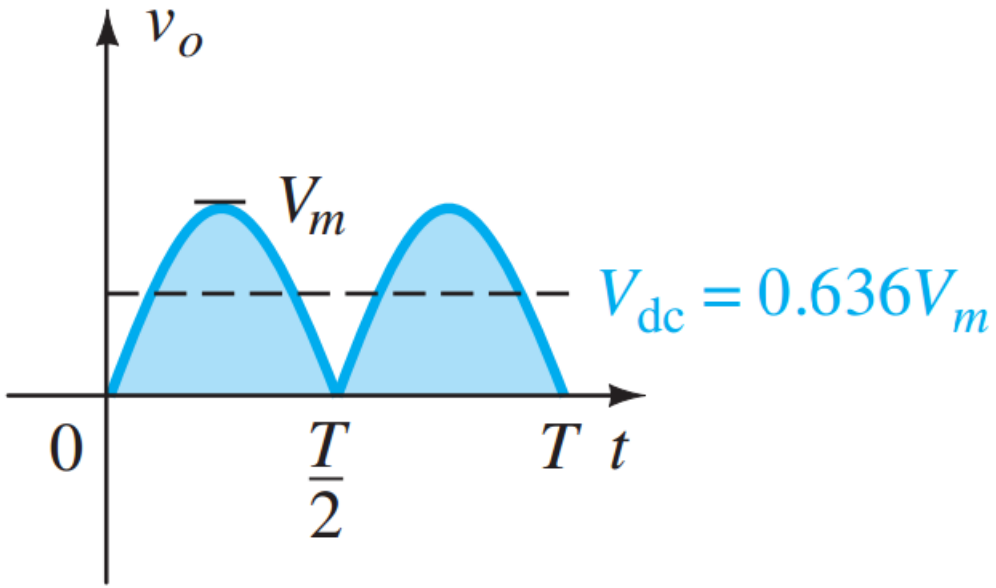
Full-wave rectified signal





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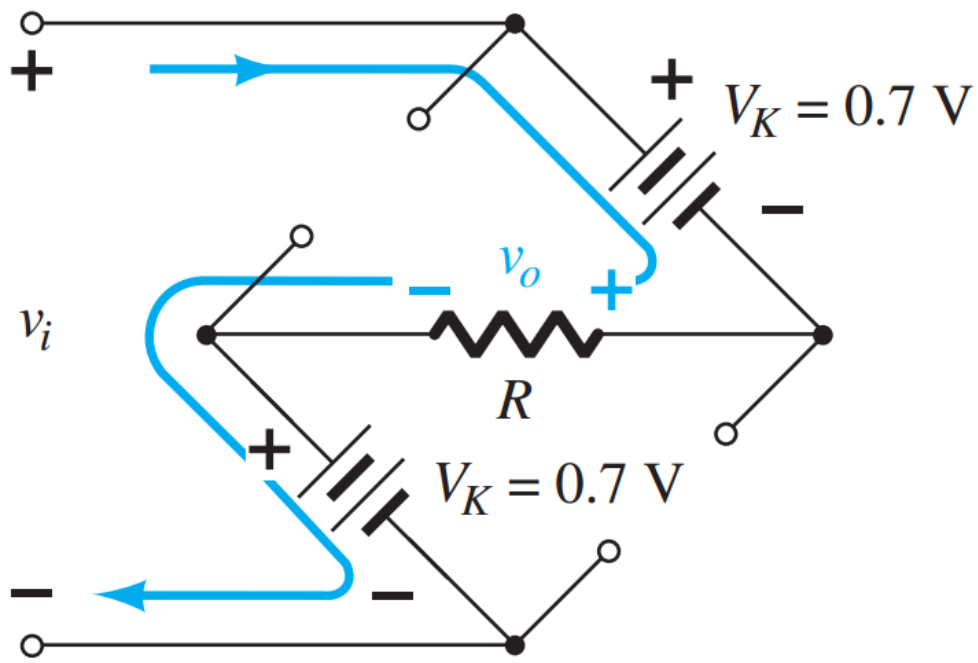
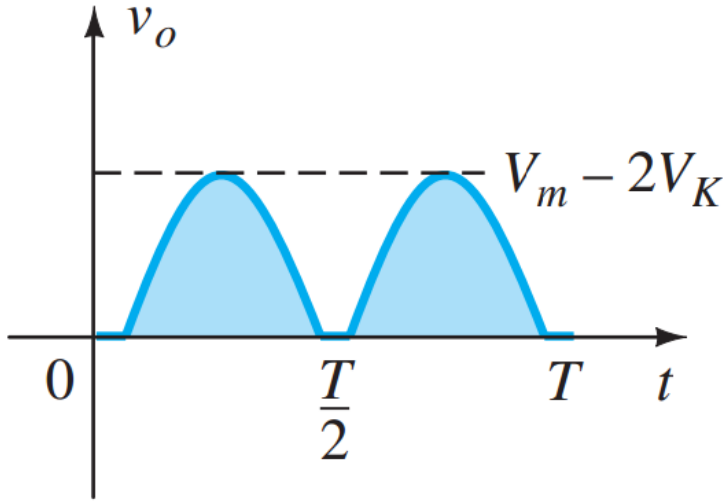
$$V_{dc} = 0.636\,V_m$$

full-wave

Full-wave rectified signal





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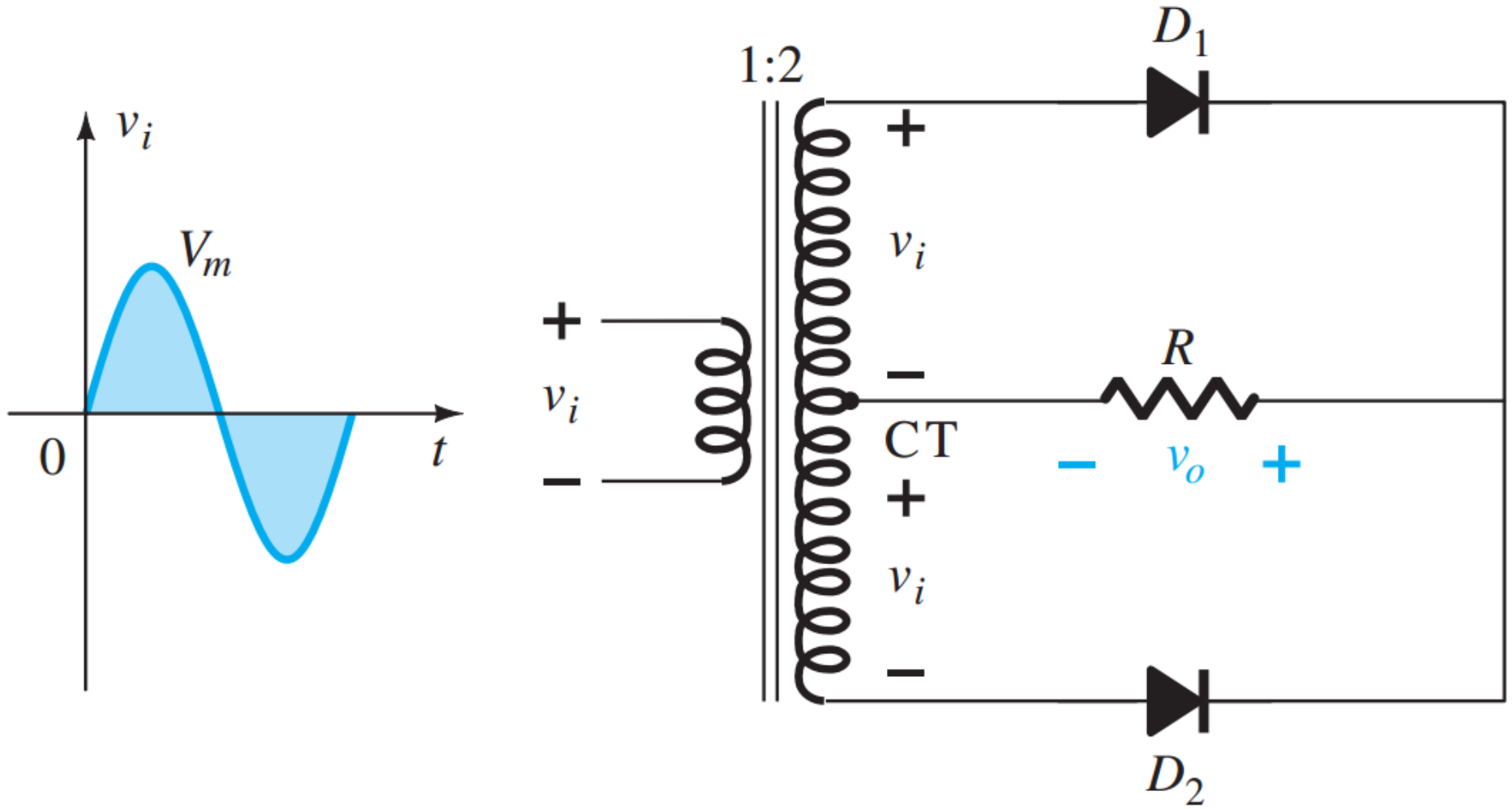
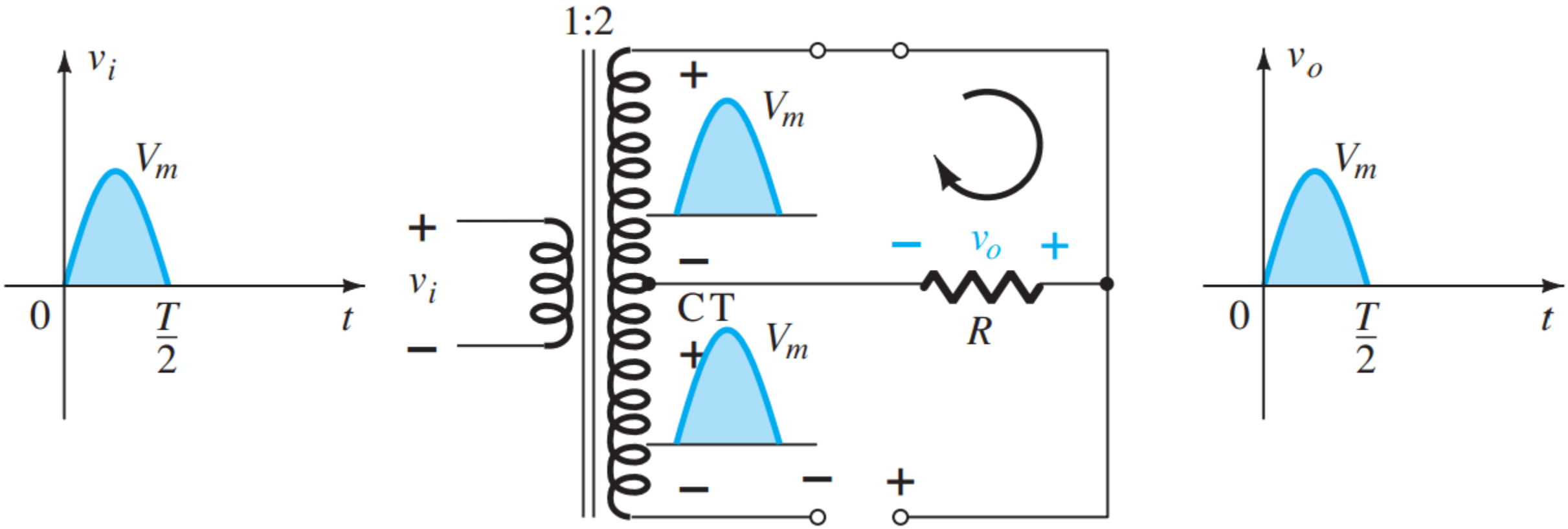
$$V_{dc} \cong 0.636(V_m - 2V_K)$$

Center-tapped transformer full-wave rectifier



Network conditions for the positive region of input voltage



Network conditions for the negative region of input voltage