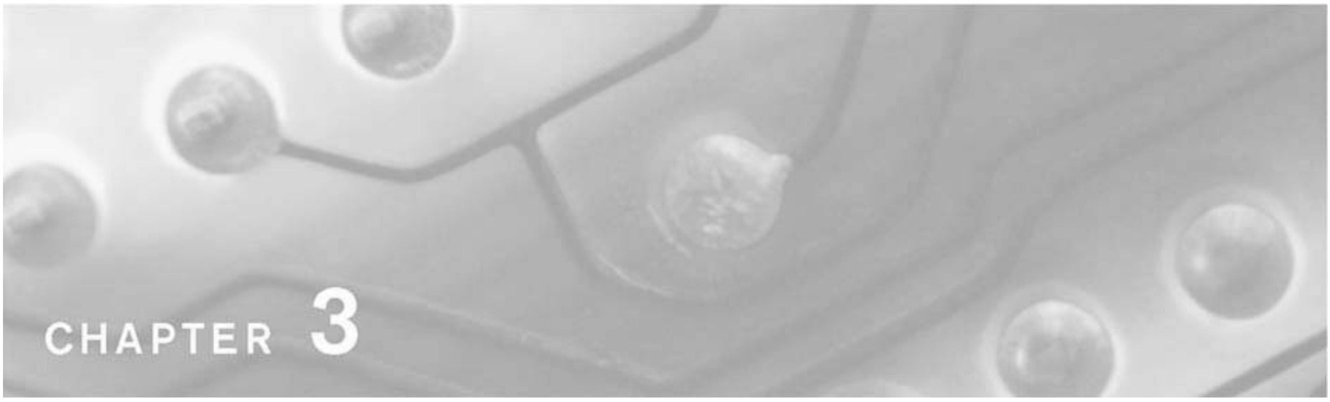


Diodes

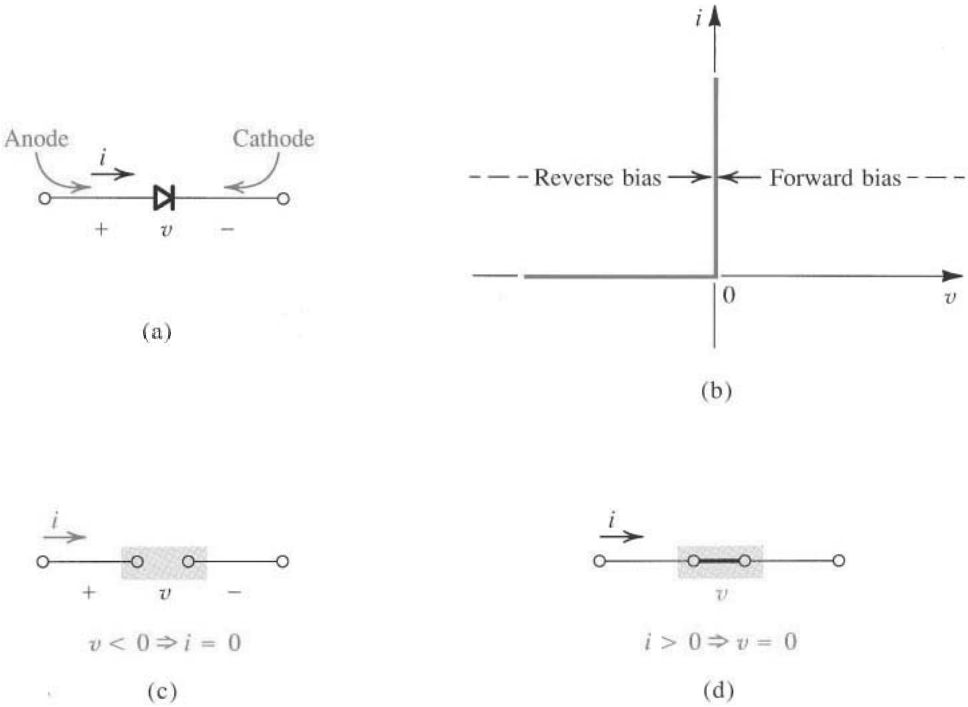


Figure 3.1 The ideal diode: **(a)** diode circuit symbol; **(b)** *i*–*v* characteristic; **(c)** equivalent circuit in the reverse direction; **(d)** equivalent circuit in the forward direction.

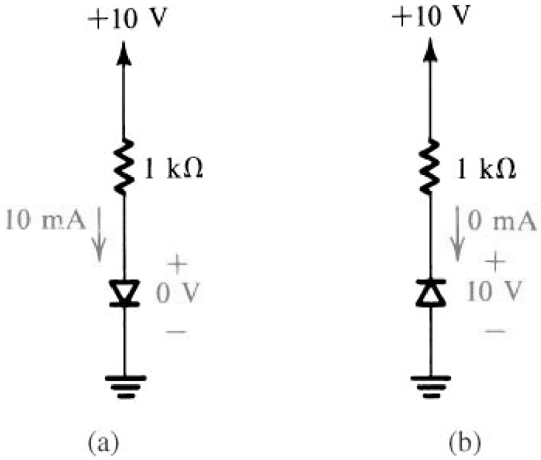


Figure 3.2 The two modes of operation of ideal diodes and the use of an external circuit to limit the forward current **(a)** and the reverse voltage **(b)**.

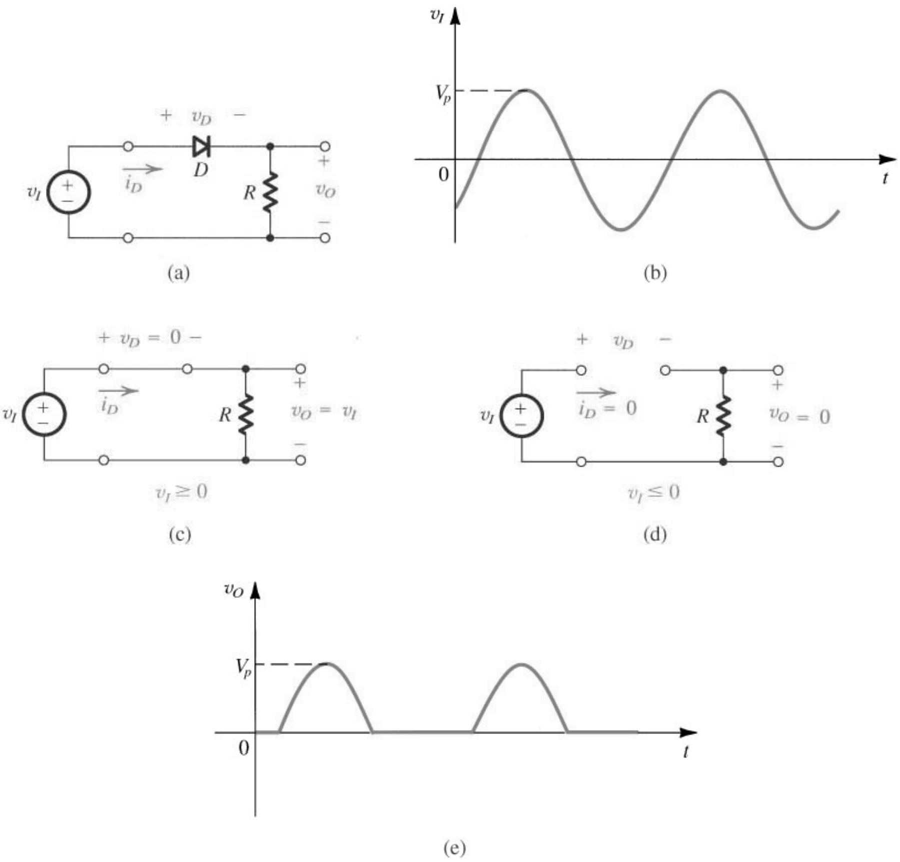


Figure 3.3 **(a)** Rectifier circuit. **(b)** Input waveform. **(c)** Equivalent circuit when $v_I \geq 0$. **(d)** Equivalent circuit when v_I ✧ 0. **(e)** Output waveform.

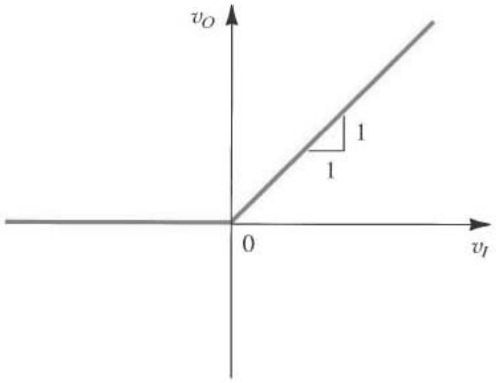


Figure E3.1

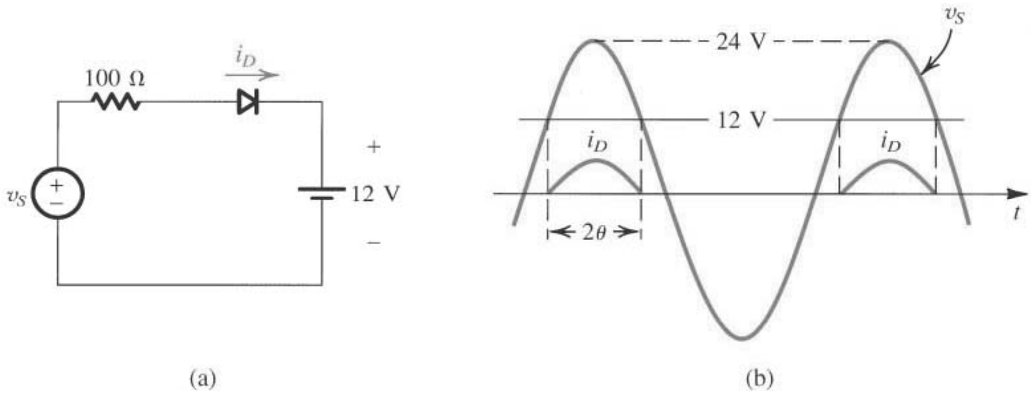


Figure 3.4 Circuit and waveforms for Example 3.1.

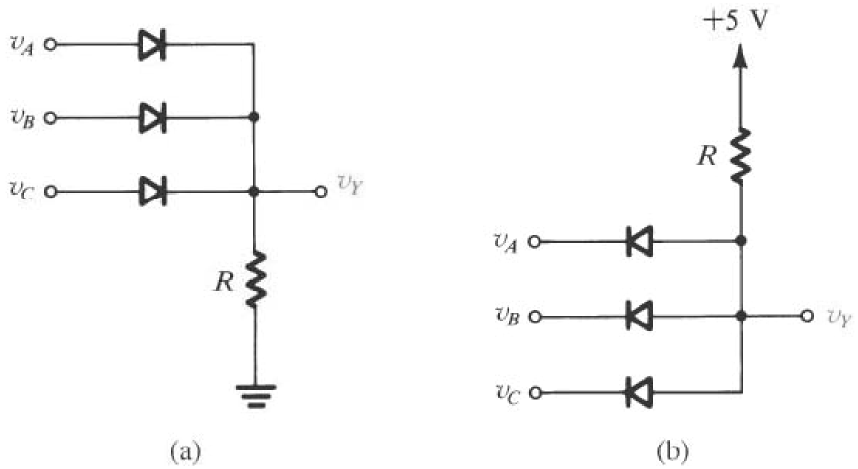


Figure 3.5 Diode logic gates: **(a)** OR gate; **(b)** AND gate (in a positive-logic system).

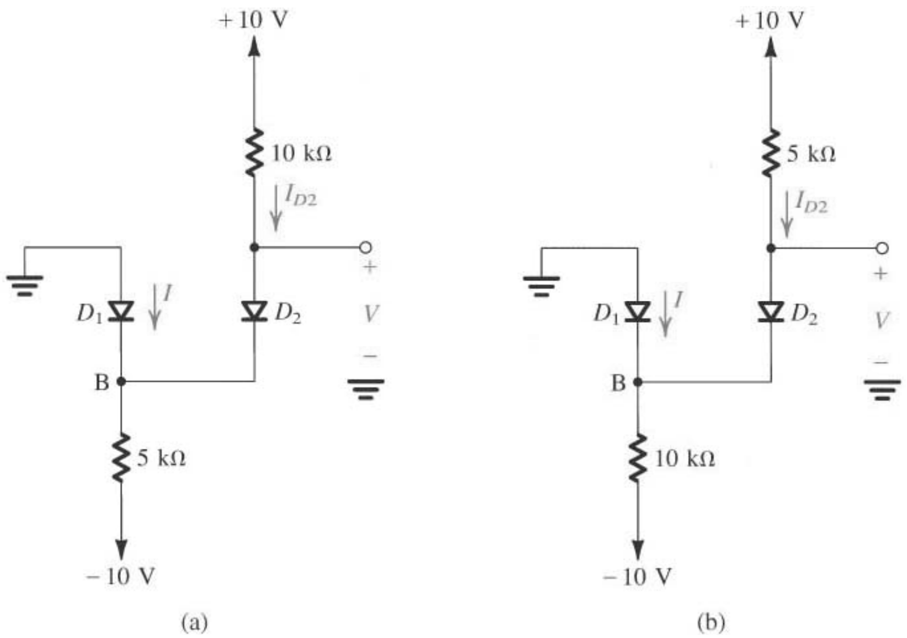


Figure 3.6 Circuits for Example 3.2.

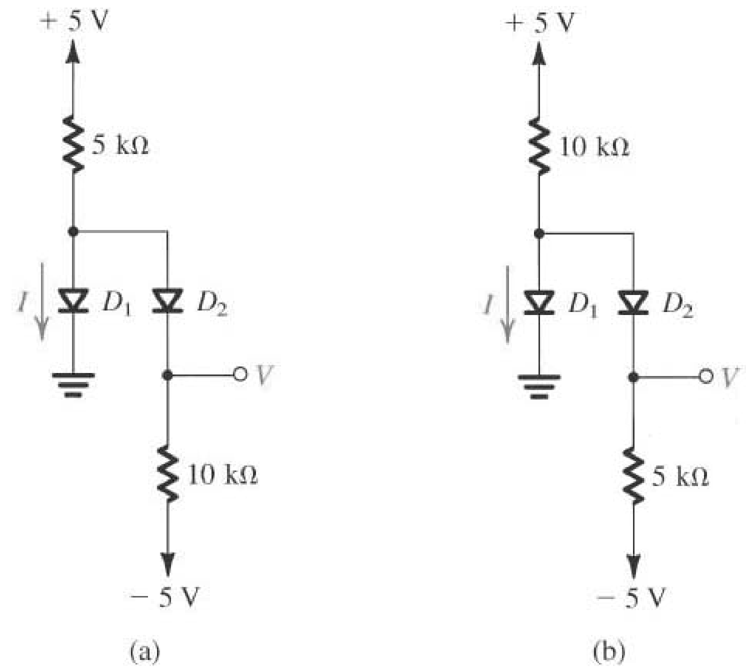


Figure P3.9

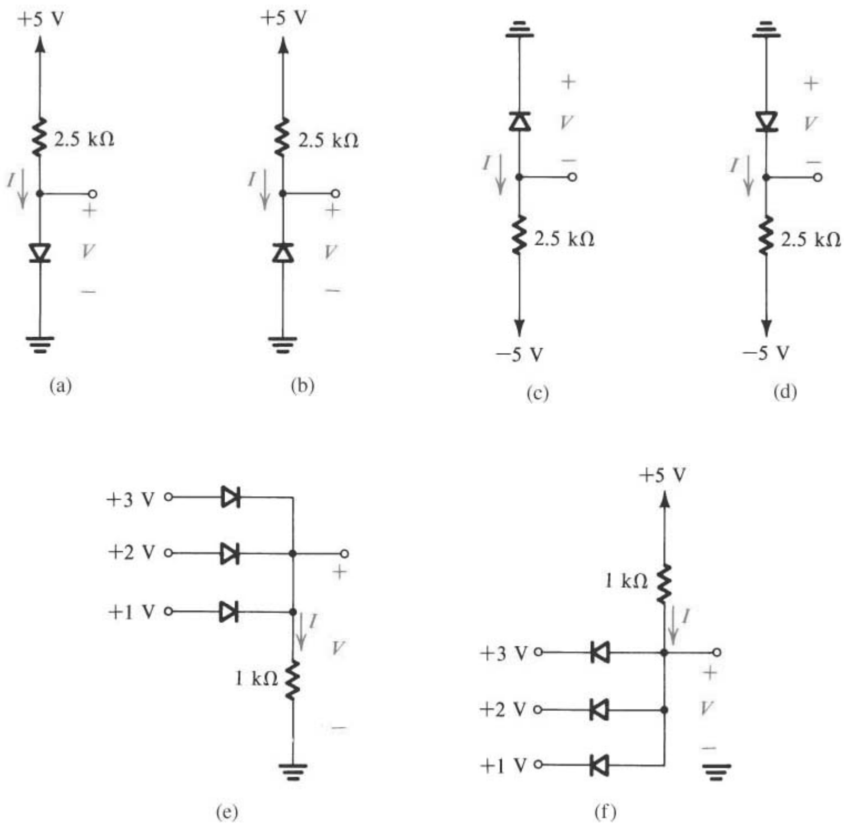


Figure E3.4

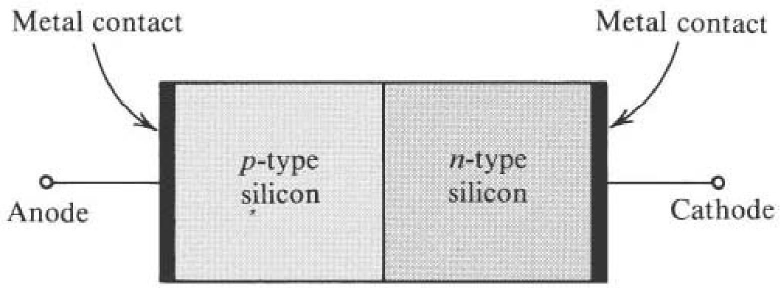


Figure 3.39 Simplified physical structure of the junction diode. (Actual geometries are given in Appendix A.)

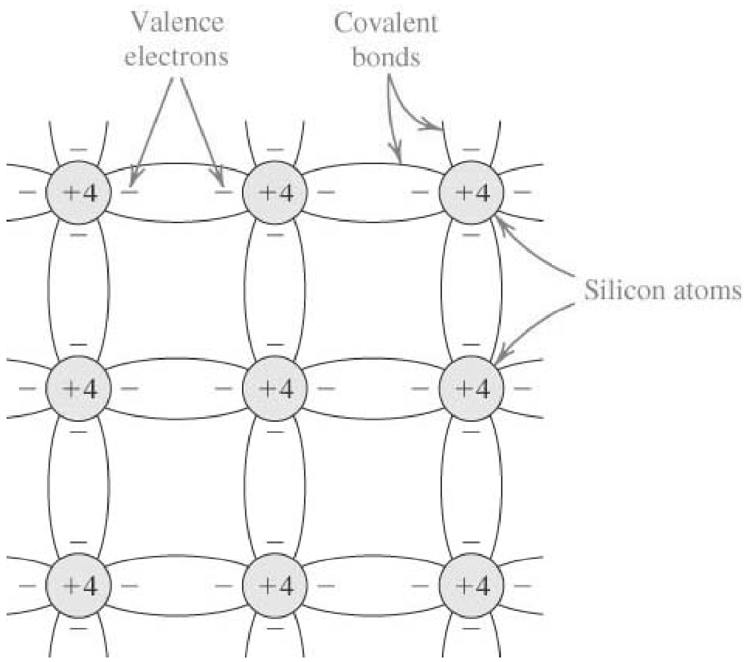


Figure 3.40 Two-dimensional representation of the silicon crystal. The circles represent the inner core of silicon atoms, with +4 indicating its positive charge of +4q, which is neutralized by the charge of the four valence electrons. Observe how the covalent bonds are formed by sharing of the valence electrons. At 0 K, all bonds are intact and no free electrons are available for current conduction.

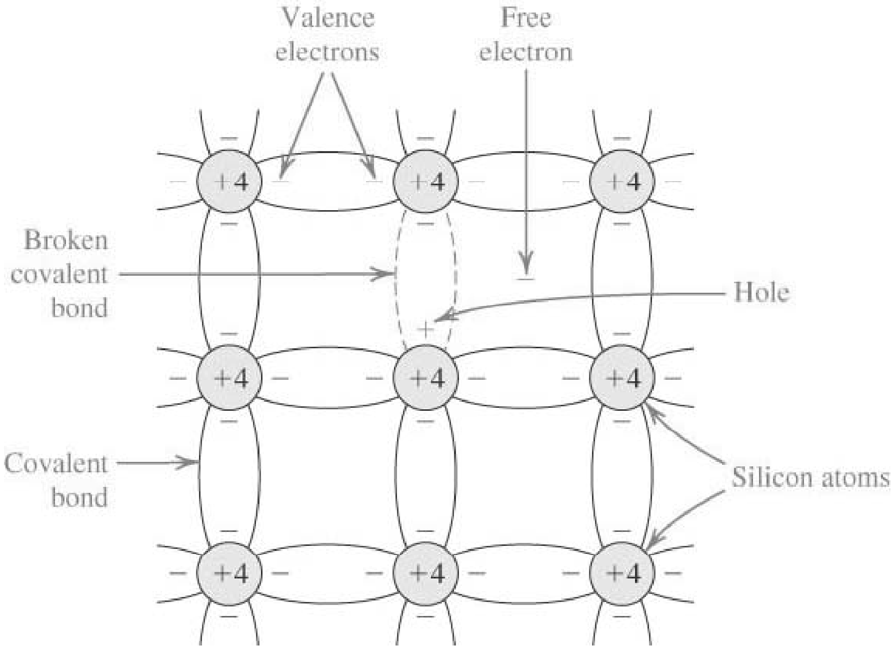


Figure 3.41 At room temperature, some of the covalent bonds are broken by thermal ionization. Each broken bond gives rise to a free electron and a hole, both of which become available for current conduction.

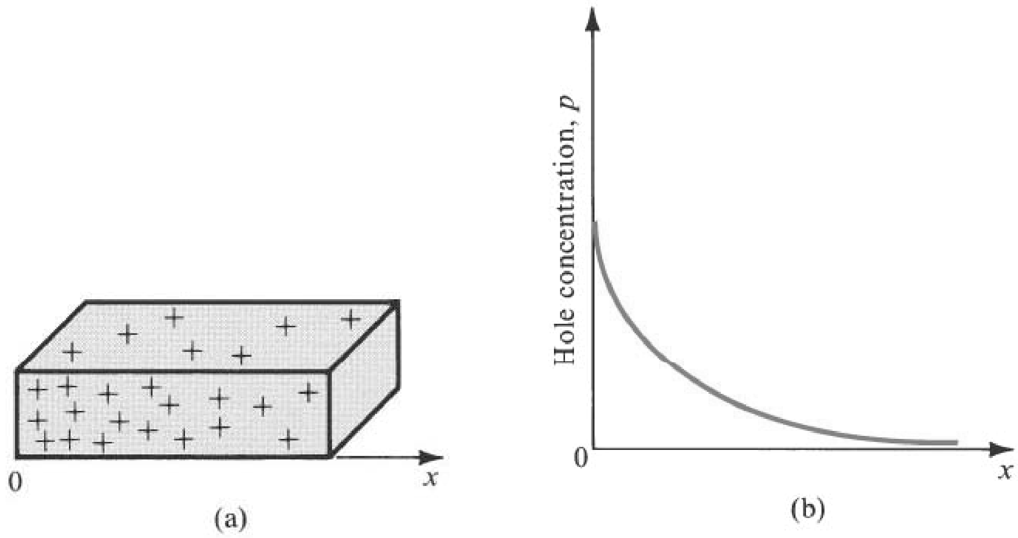


Figure 3.42 A bar of intrinsic silicon **(a)** in which the hole concentration profile shown in **(b)** has been created along the *x*-axis by some unspecified mechanism.

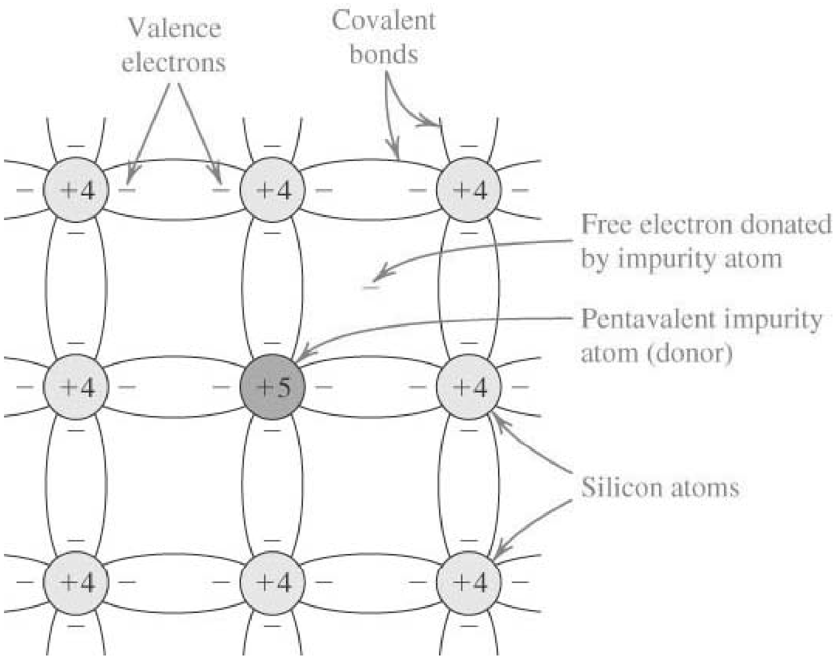


Figure 3.43 A silicon crystal doped by a pentavalent element. Each dopant atom donates a free electron and is thus called a donor. The doped semiconductor becomes *n* type.

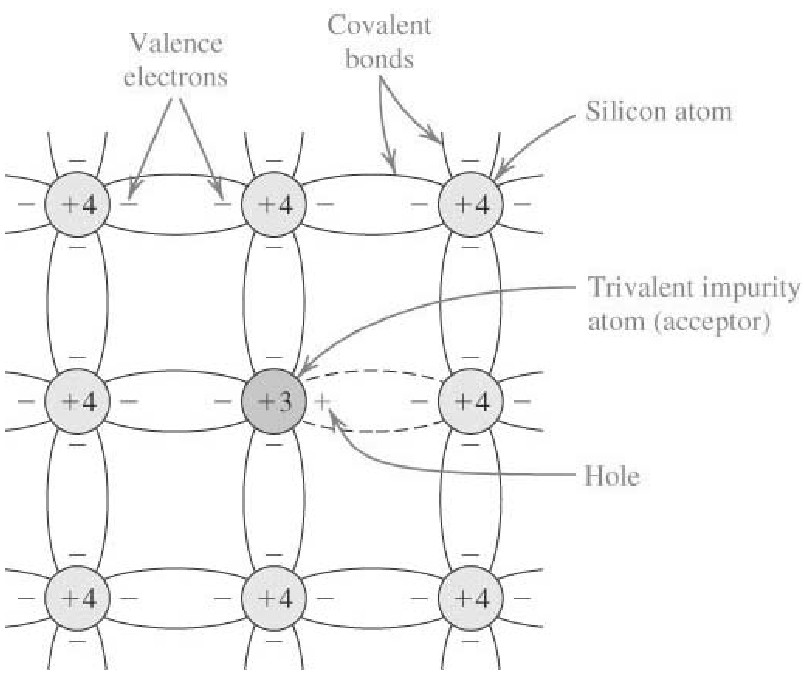


Figure 3.44 A silicon crystal doped with a trivalent impurity. Each dopant atom gives rise to a hole, and the semiconductor becomes *p* type.

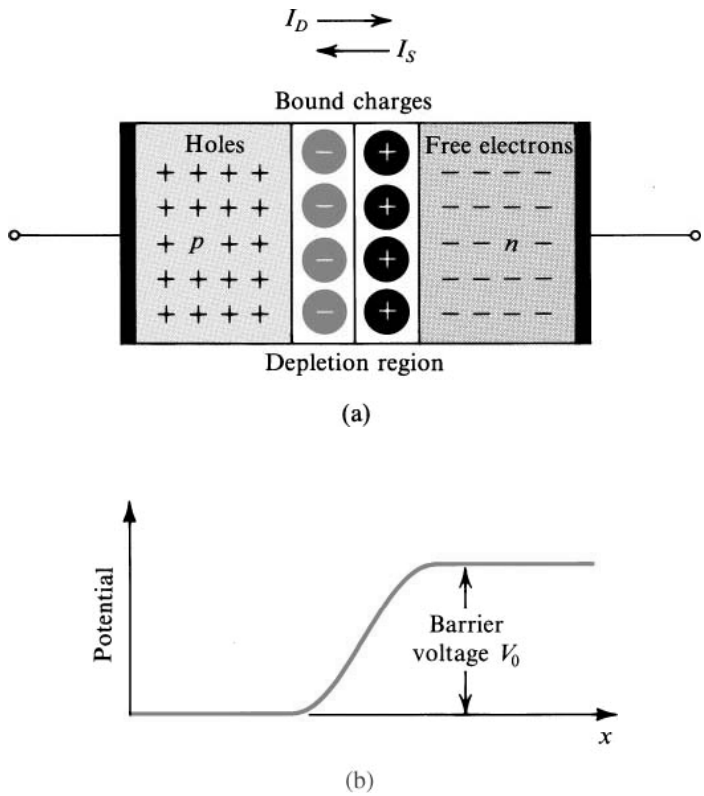


Figure 3.45 **(a)** The *pn* junction with no applied voltage (open-circuited terminals). **(b)** The potential distribution along an axis perpendicular to the junction.

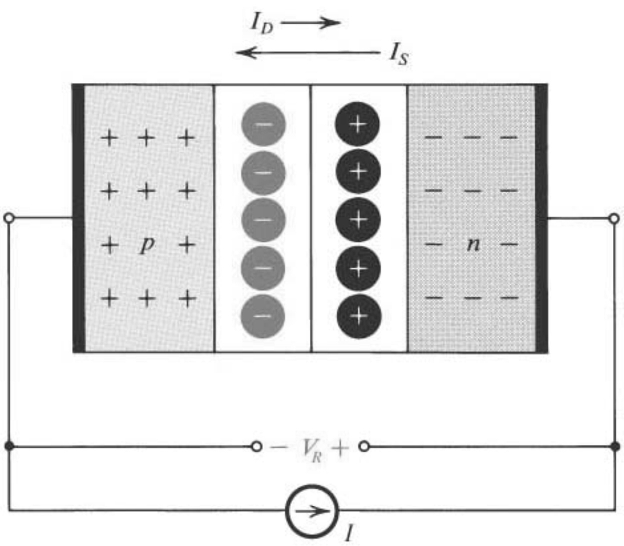


Figure 3.46 The *pn* junction excited by a constant-current source I in the reverse direction. To avoid breakdown, I is kept smaller than I_S. Note that the depletion layer widens and the barrier voltage increases by V_R volts, which appears between the terminals as a reverse voltage.

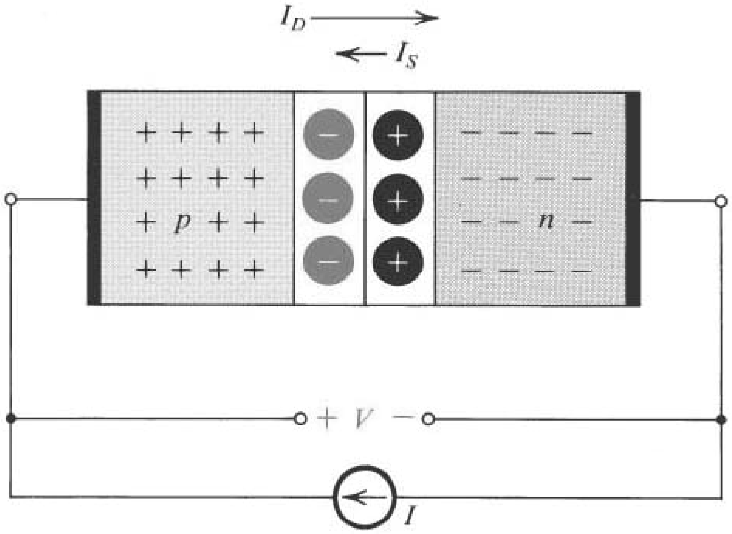


Figure 3.49 The *pn* junction excited by a constant-current source supplying a current *I* in the forward direction. The depletion layer narrows and the barrier voltage decreases by *V* volts, which appears as an external voltage in the forward direction.

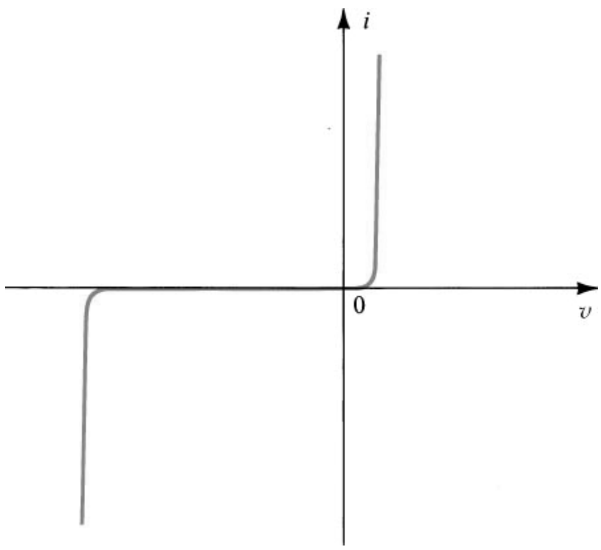


Figure 3.7 The *i*–*v* characteristic of a silicon junction diode.

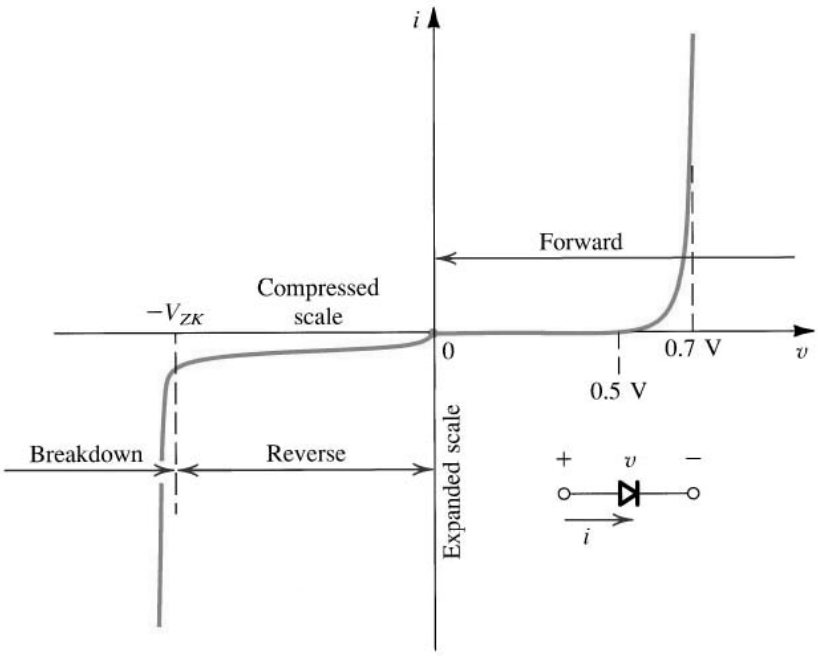


Figure 3.8 The diode *i–v* relationship with some scales expanded and others compressed in order to reveal details.

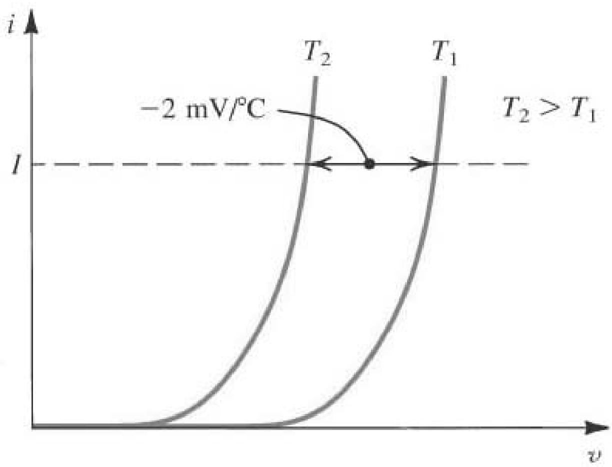


Figure 3.9 Illustrating the temperature dependence of the diode forward characteristic. At a constant current, the voltage drop decreases by approximately 2 mV for every 1°C increase in temperature.

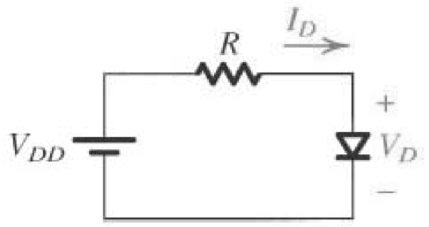


Figure 3.10 A simple circuit used to illustrate the analysis of circuits in which the diode is forward conducting.

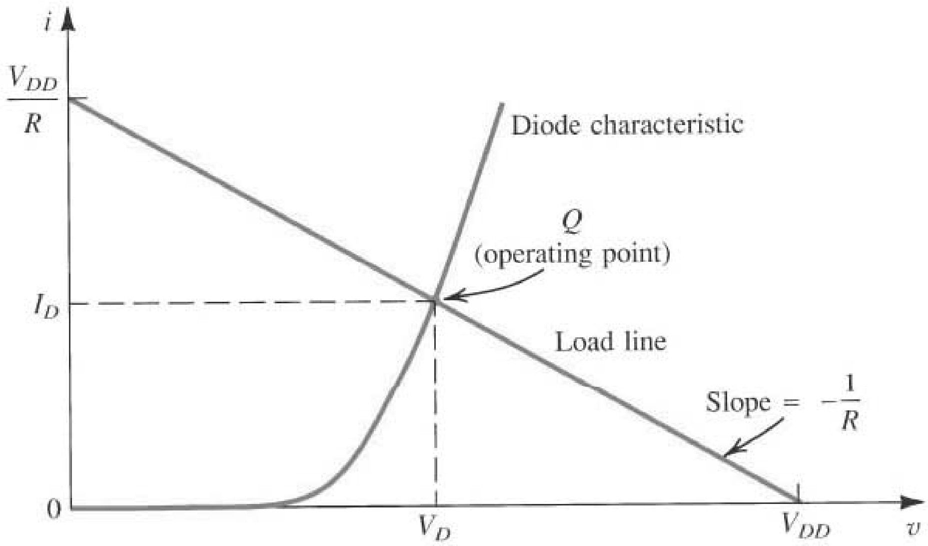


Figure 3.11 Graphical analysis of the circuit in Fig. 3.10 using the exponential diode model.

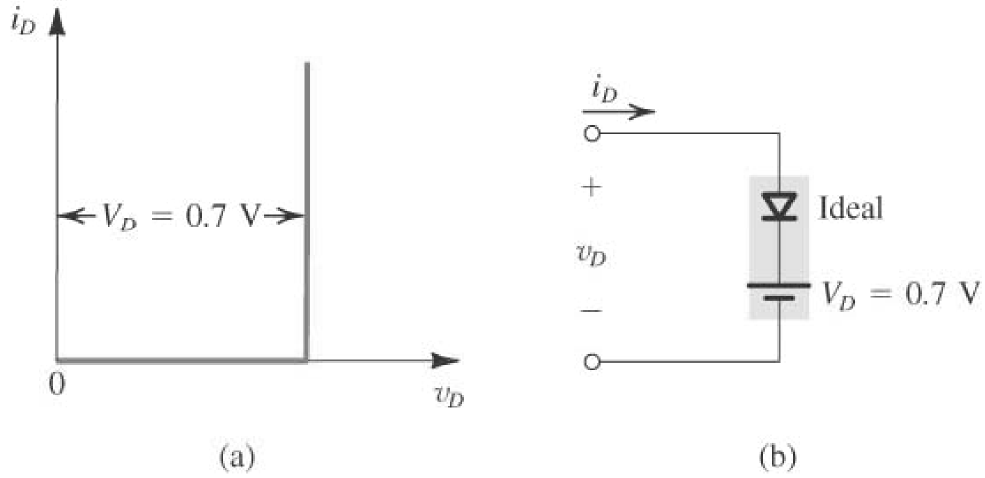


Figure 3.16 The constant-voltage-drop model of the diode forward characteristics and its equivalent-circuit representation.

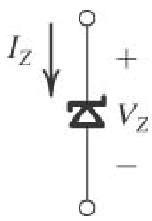


Figure 3.20 Circuit symbol for a zener diode.

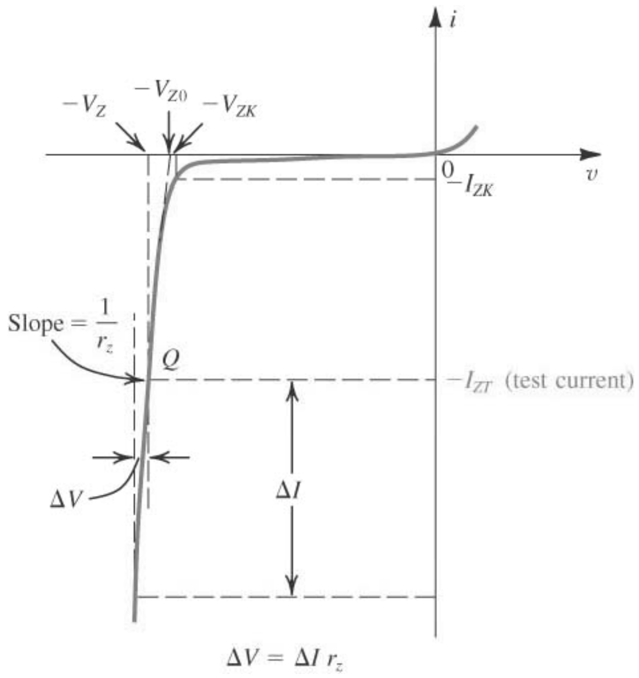


Figure 3.21 The diode *i–v* characteristic with the breakdown region shown in some detail.

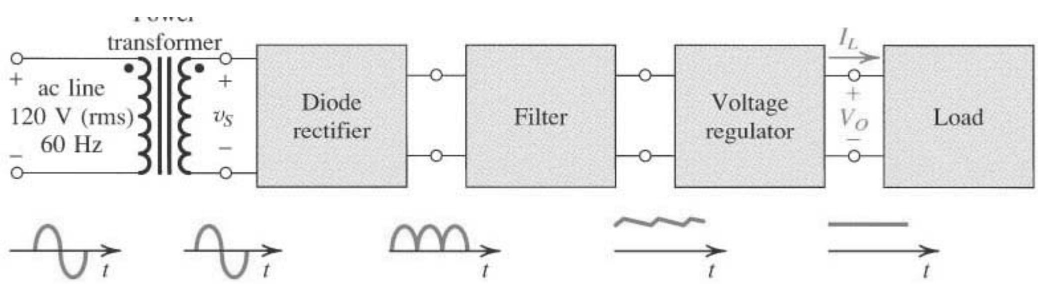


Figure 3.24 Block diagram of a dc power supply.

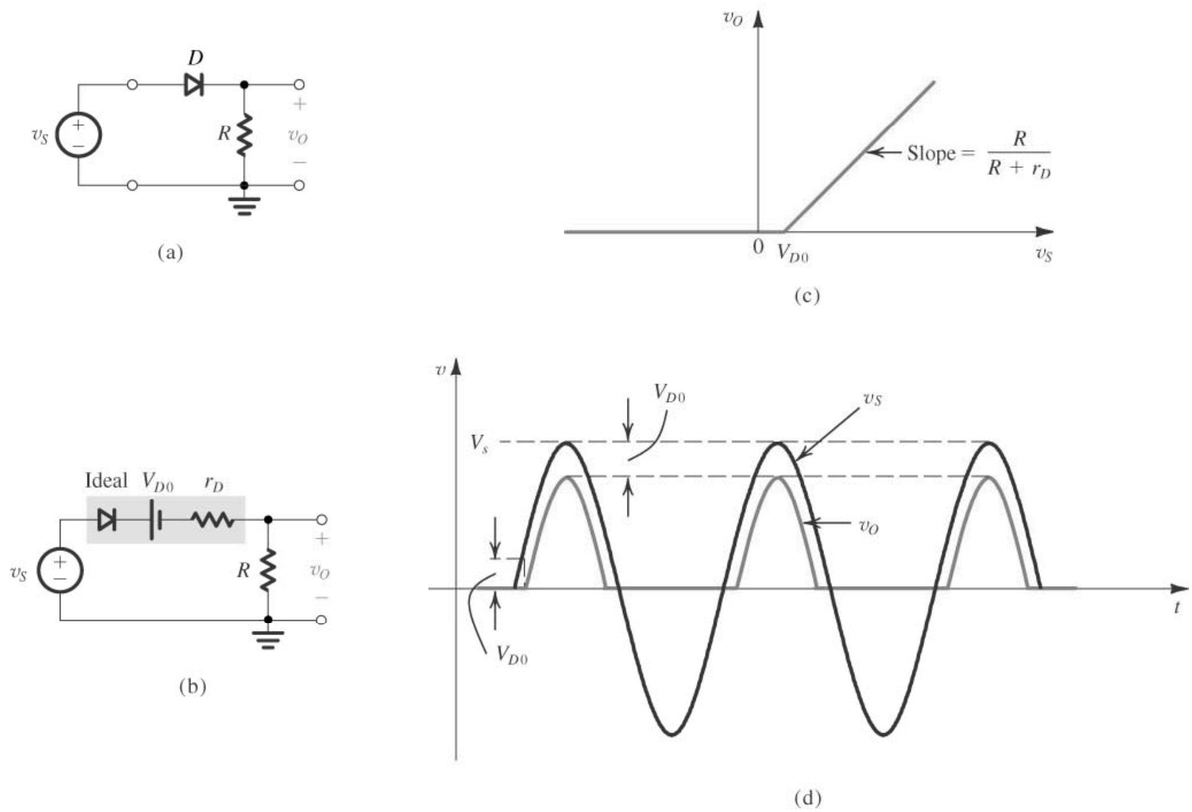


Figure 3.25 **(a)** Half-wave rectifier. **(b)** Equivalent circuit of the half-wave rectifier with the diode replaced with its battery-plus-resistance model. **(c)** Transfer characteristic of the rectifier circuit. **(d)** Input and output waveforms, assuming that $r_D \ll R$.

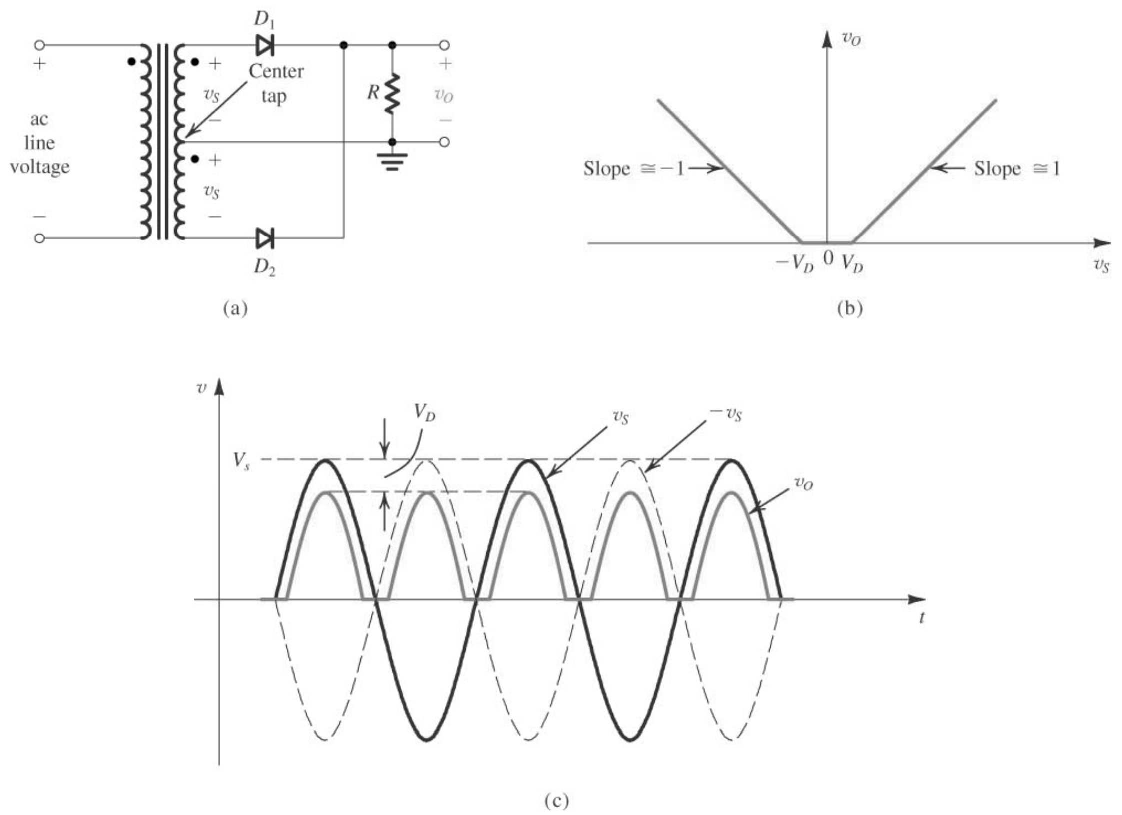


Figure 3.26 Full-wave rectifier utilizing a transformer with a center-tapped secondary winding: **(a)** circuit; **(b)** transfer characteristic assuming a constant-voltage-drop model for the diodes; **(c)** input and output waveforms.

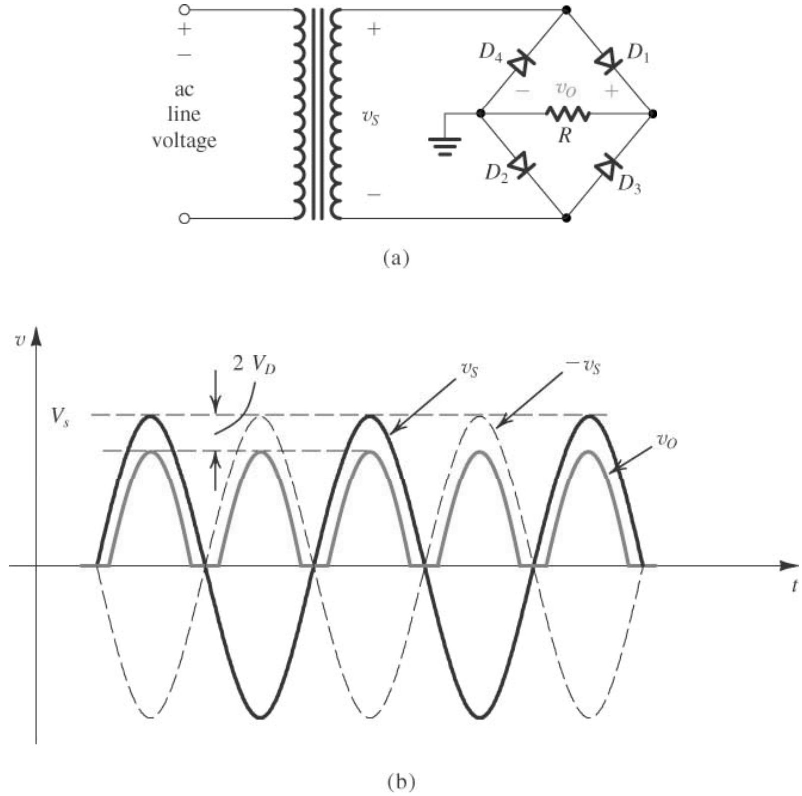


Figure 3.27 The bridge rectifier: **(a)** circuit; **(b)** input and output waveforms.

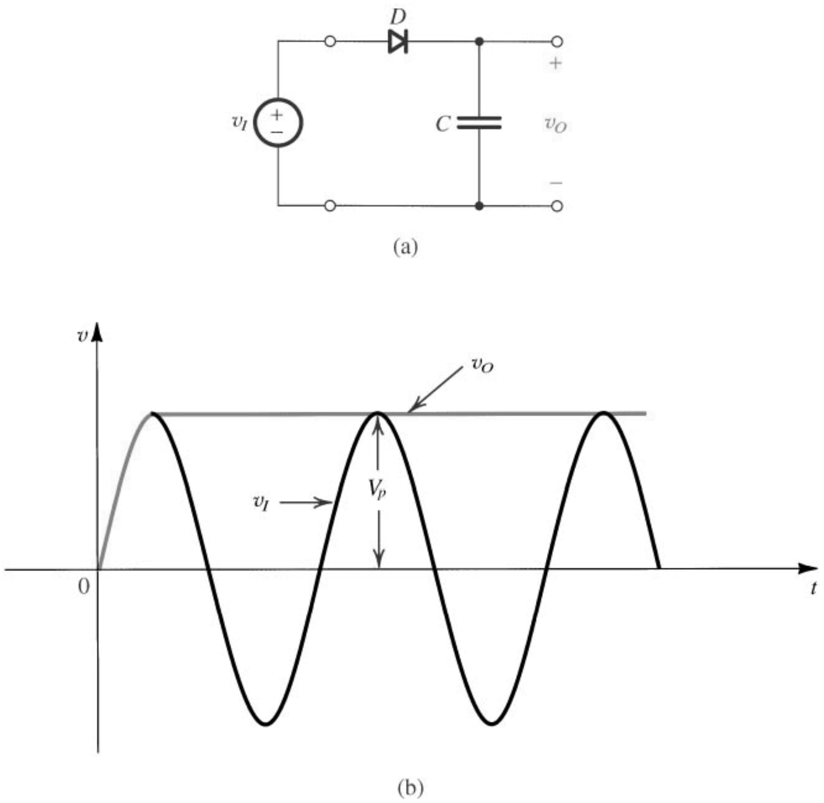


Figure 3.28 **(a)** A simple circuit used to illustrate the effect of a filter capacitor. **(b)** Input and output waveforms assuming an ideal diode. Note that the circuit provides a dc voltage equal to the peak of the input sine wave. The circuit is therefore known as a peak rectifier or a peak detector.

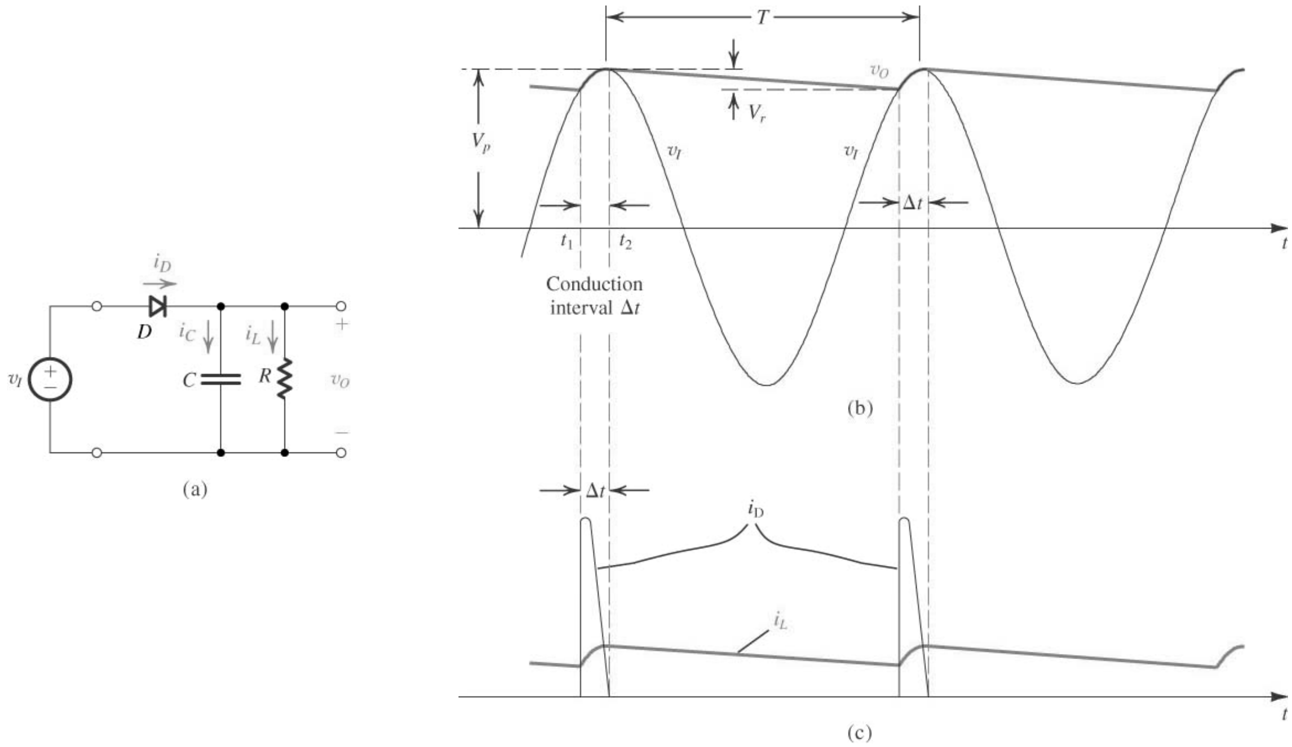


Figure 3.29 Voltage and current waveforms in the peak rectifier circuit with *CR* @ *T*. The diode is assumed ideal.

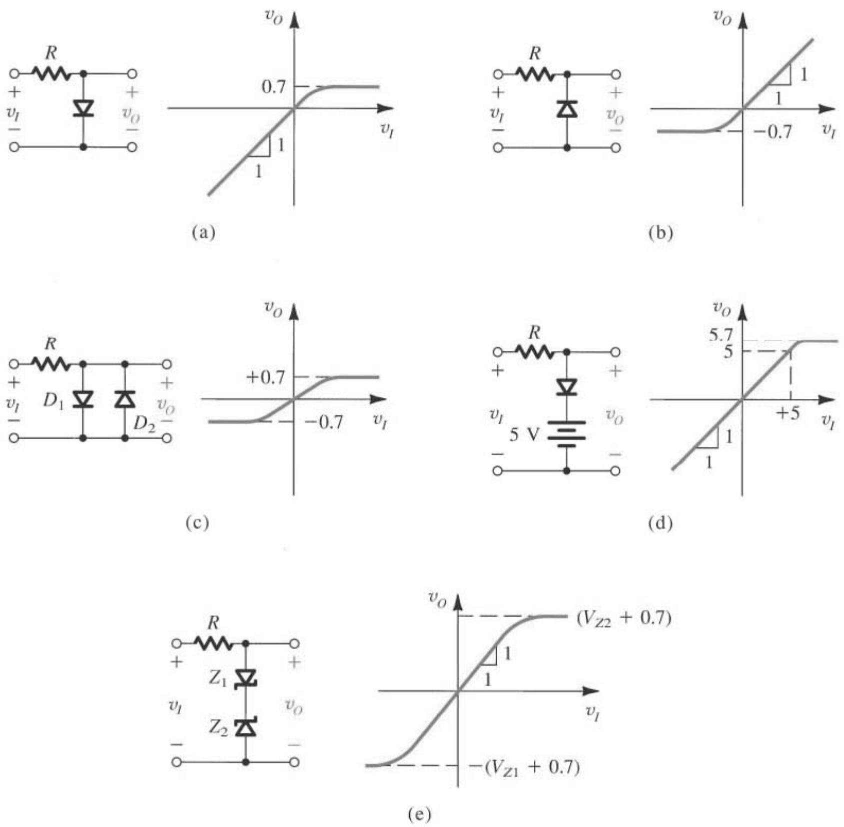


Figure 3.35 A variety of basic limiting circuits.

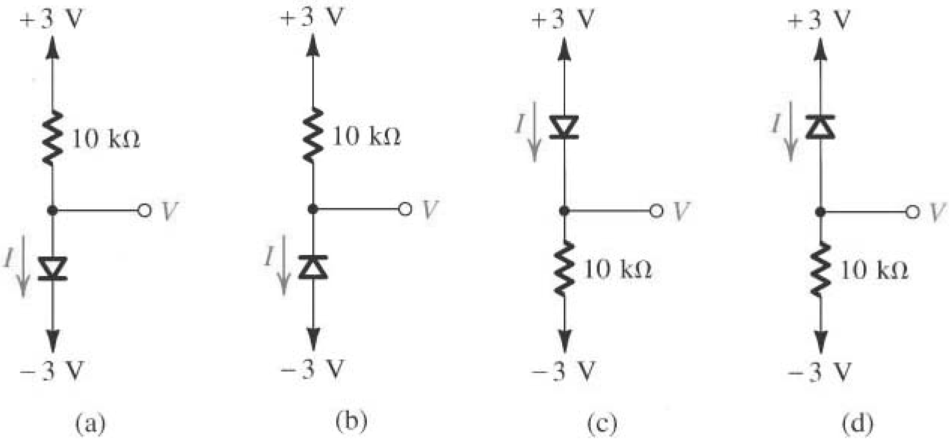


Figure P3.2

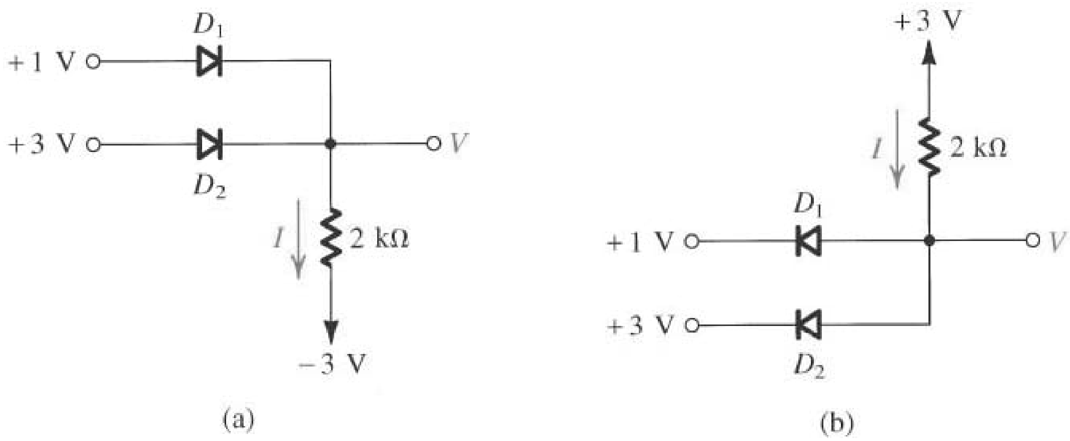
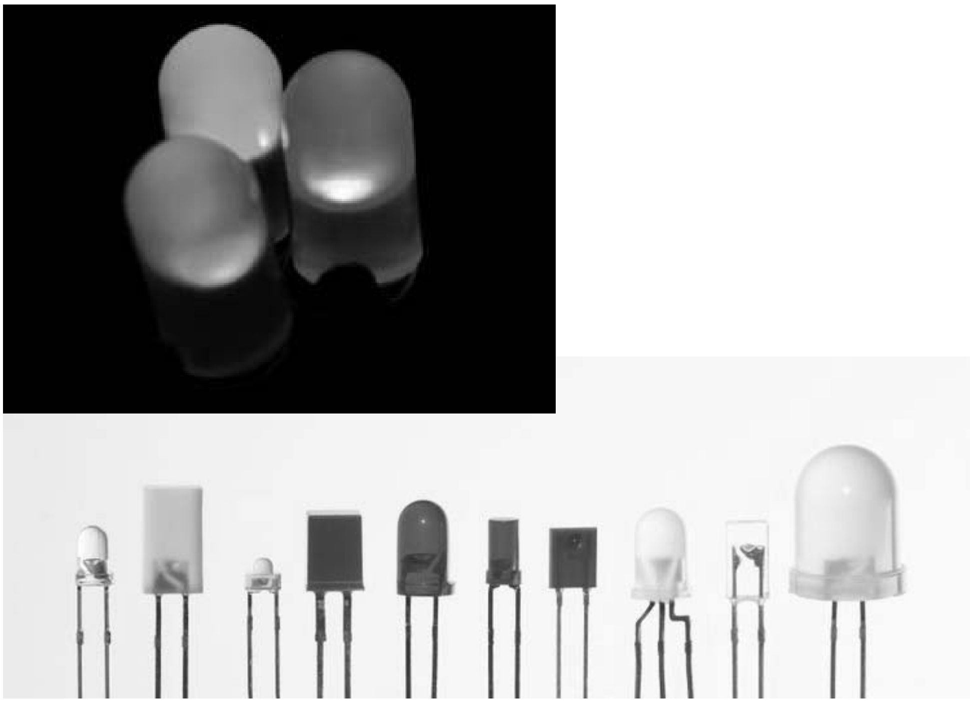


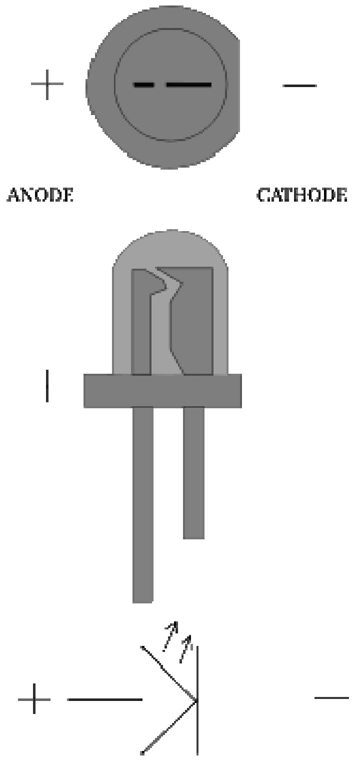
Figure P3.3

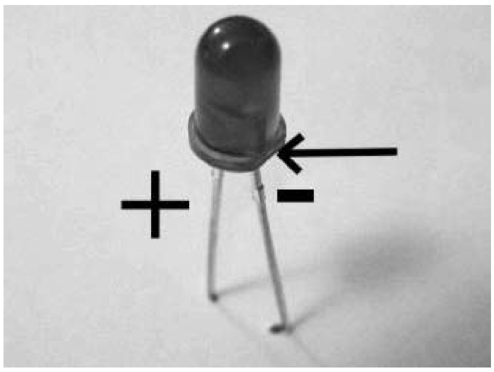
Light Emitting Diodes (LEDs)



Images are from www.wikidepia.com

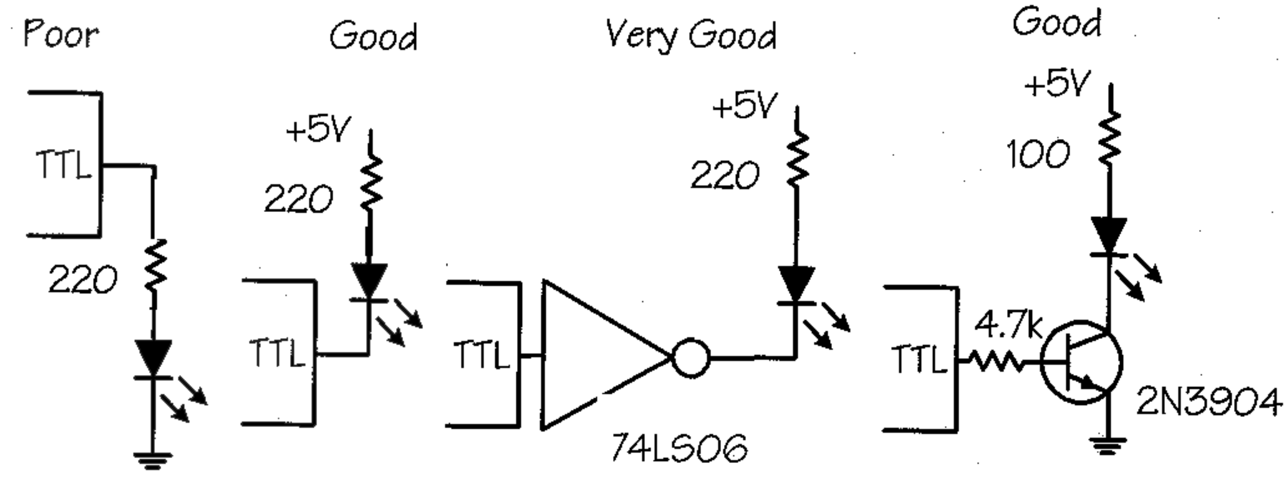
LEDs





Images are from www.wikipedia.com

Connecting LED to microprocessor



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