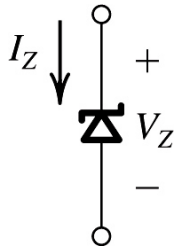
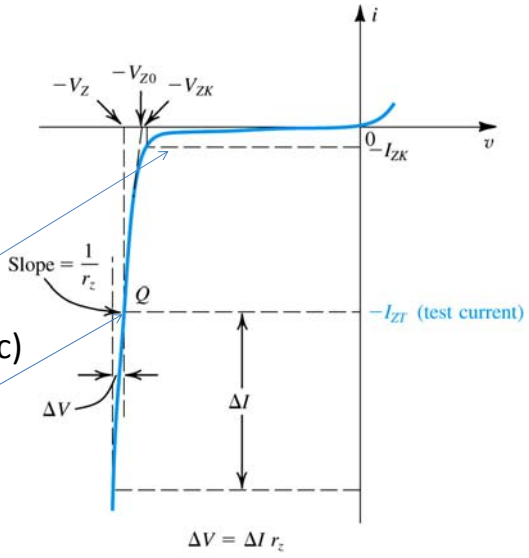
Zener Diode

- Diodes that are designed to operate in the reverse breakdown region.
- Used for low current regulators (although regulators chips are widely used now).



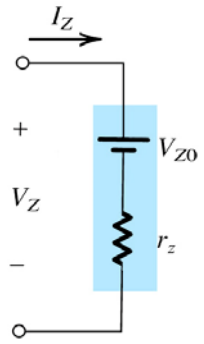
Zener diodes

- Characterized by
  - V_z at a specified test current I_{ZT}
  - Maximum power
  - Knee current I_{KZ}
  - Incremental (dynamic) resistance $r_z=\Delta V/\Delta I$



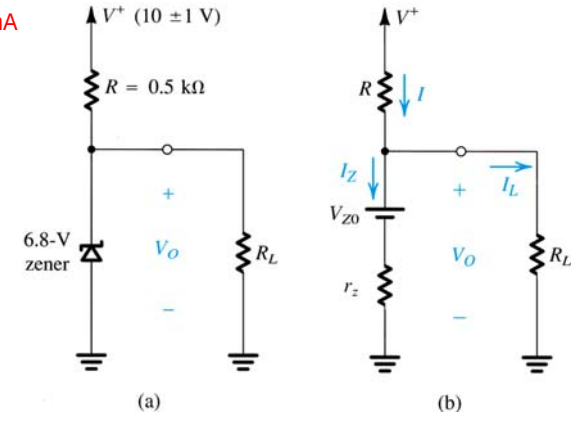
Zener Diodes

- Equivalent circuit
- VZ0 in practice is the same as the knee voltage



Assume a 6.8-V Zener diode with V_Z=6.8 at I_z=5mA, r_z=20 Ω, I_{ZK} = 0.2 mA, V^+ =10V± 1V

- Find VO and the line regulation at no load
- Find the load regulation when the load current is 1mA
- Find VO for R=2 KΩ, 0.5KΩ
- Find the minimum load for the diode to operate in the breakdown region



Changing amplitude and ***Electrical isolation***

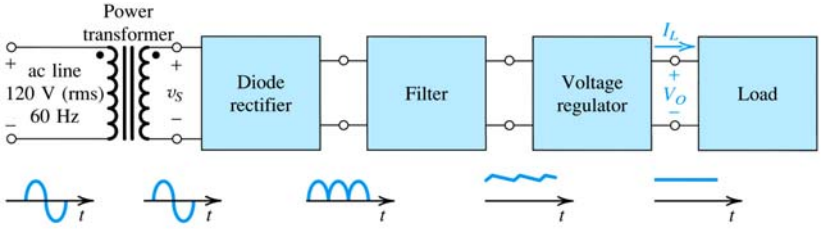
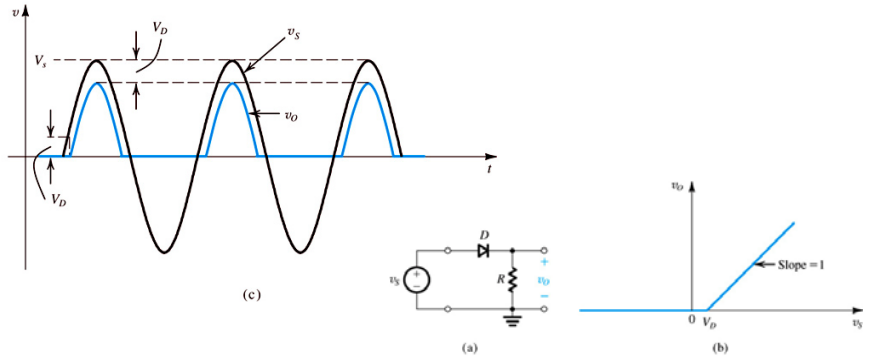


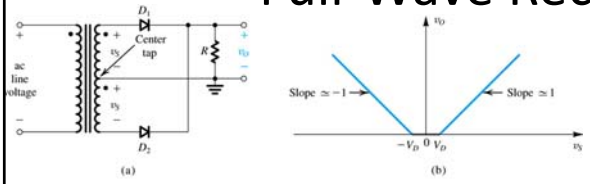
Figure 4.20 Block diagram of a dc power supply.

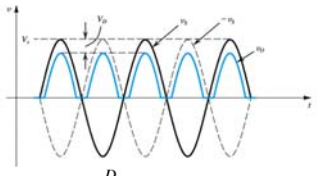
Half-Wave Rectifier

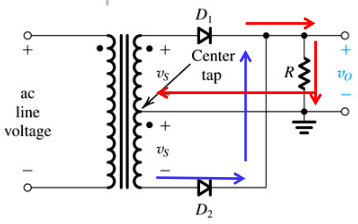
- Removes the negative voltage half cycle
- Peak inverse voltage < breakdown voltage

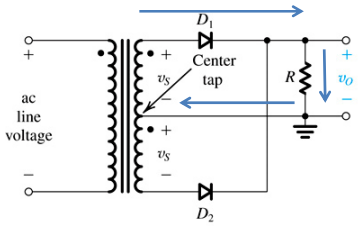


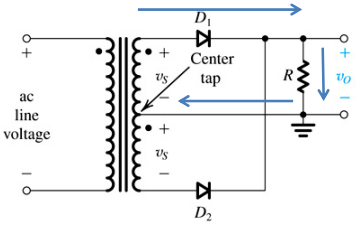
Full-Wave Rectifier

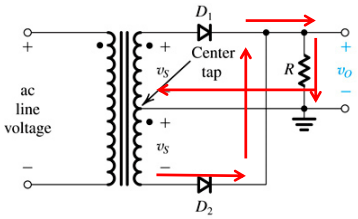




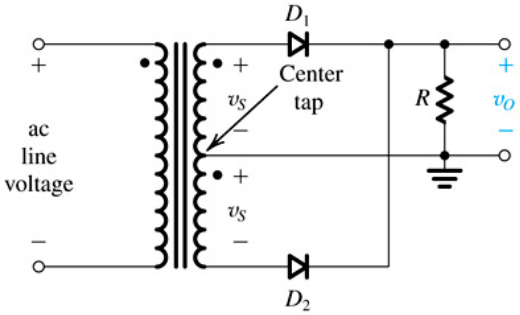








PIV ?



Bridge Rectifier

PIV ?

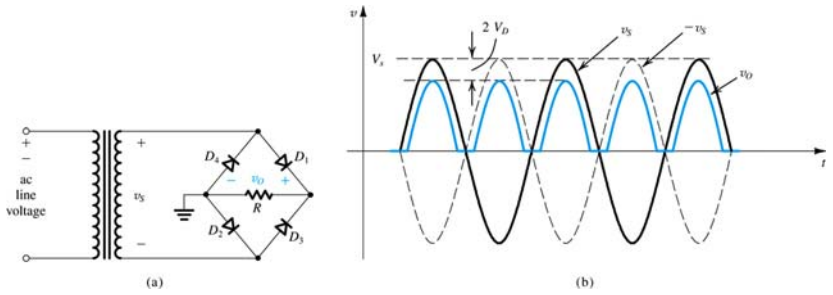


Figure 4.23 The bridge rectifier: (a) circuit; (b) input and output waveforms.

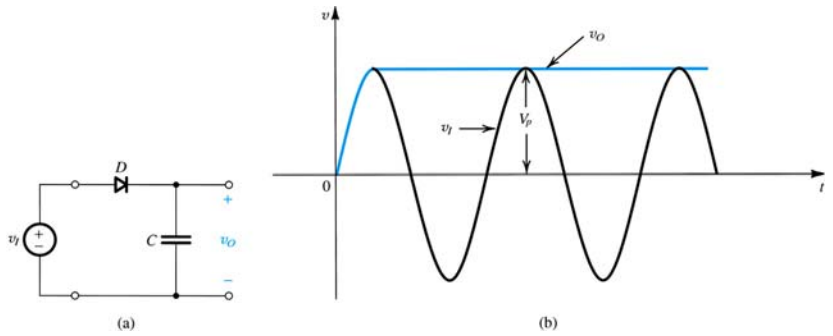


Figure 4.24 (a) A simple circuit used to illustrate the effect of a filter capacitor. (b) Input and output waveforms assuming an ideal diode. Note that the circuit provides a dc voltage equal to the peak of the input sine wave. The circuit is therefore known as a *peak rectifier* or a *peak detector*.

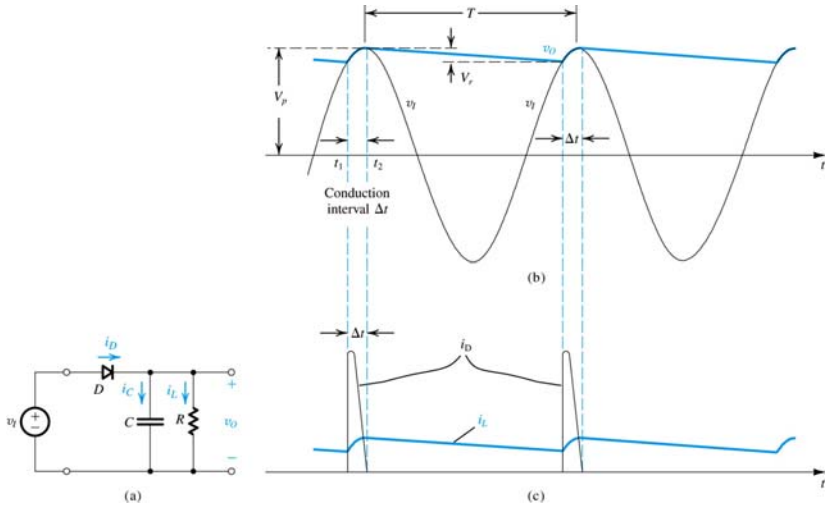


Figure 4.25 Voltage and current waveforms in the peak rectifier circuit with $CR \gg T$. The diode is assumed ideal.

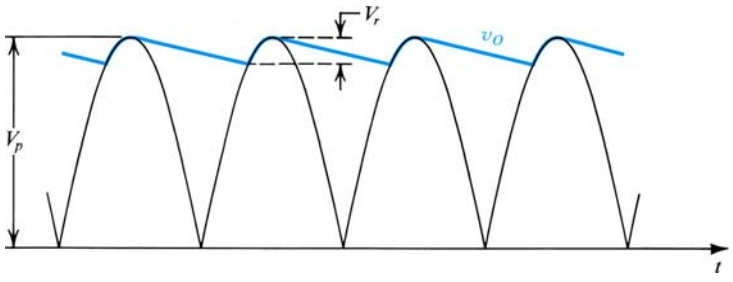


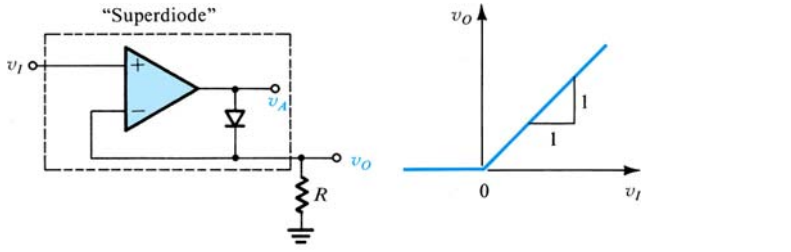
Figure 4.26 Waveforms in the full-wave peak rectifier.

Superdiode

- There is one or 2 diode voltage drops in the rectifier circuits we studied.
- That is O.K. when we are designing a DC power supply.
- Can not be used to rectify a small voltage signal (100 mV).

Superdiode

- When v_I is positive, v_A is positive, the diode conducts providing the –ve feed back and $v_O = v_I$
- When v_I is –ve v_A is negative diode is reverse biased, no current in R no drop on R, $v_O = 0$



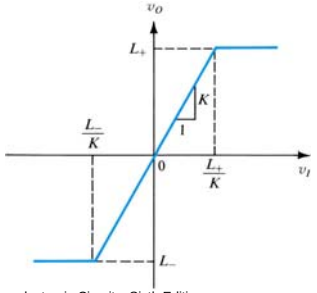
Microele (a) (b) ord University Press, Inc.

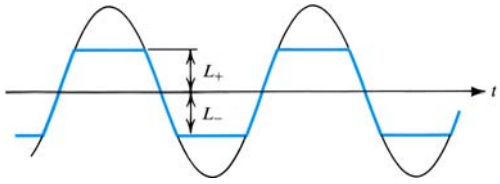
Diode Circuits

- Limiter circuits
- Clamped capacitor or DC restorer
- Voltage doubler

Limiter Circuits

- K could be > 1, but we concentrate of k<=1 (passive limiter)
- Also known as clippers
- Soft limiting vs. hard limiting





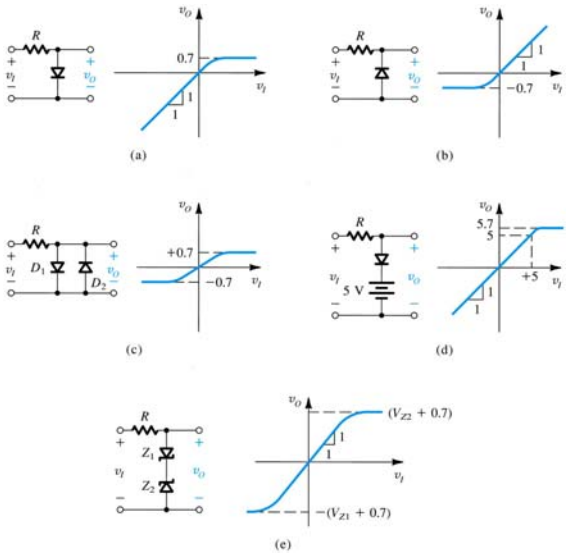


Figure 4.31 A variety of basic limiting circuits.

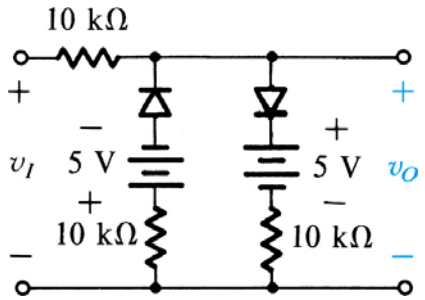
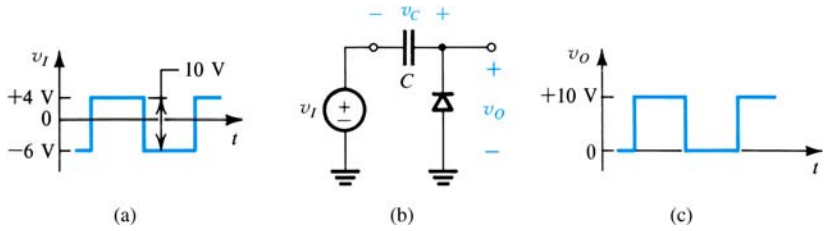


Figure E4.26

Clamped Capacitor (DC restorer)

- Shifts the input signal by a specific amount
- When v_I is -6, v_C = 6 V as shown
- When v_I is +4, diode is off and capacitor does not discharge
- $v_O = v_I + v_C$



Clamped Capacitor with a Load

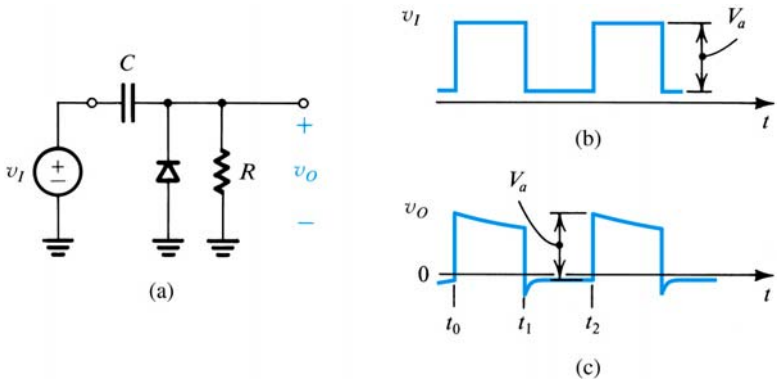


Figure 4.33 The clamped capacitor with a load resistance *R*.

Voltage Doubler

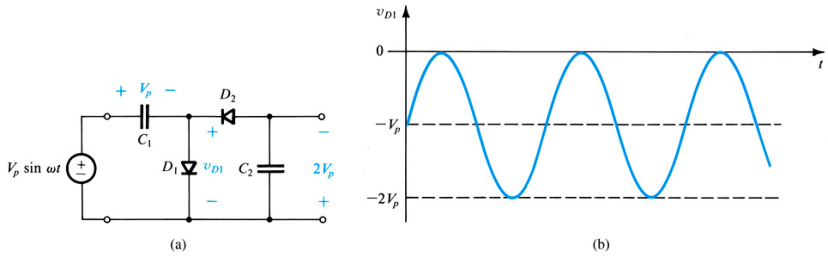


Figure 4.34 Voltage doubler: (a) circuit; (b) waveform of the voltage across D_1.

