
BENHA UNIVERSITY
FACULTY OF ENGINEERING AT SHOUBRA

# ELC301
# Electronic Engineering

## Lecture #2
## Diode Applications & Special Diodes

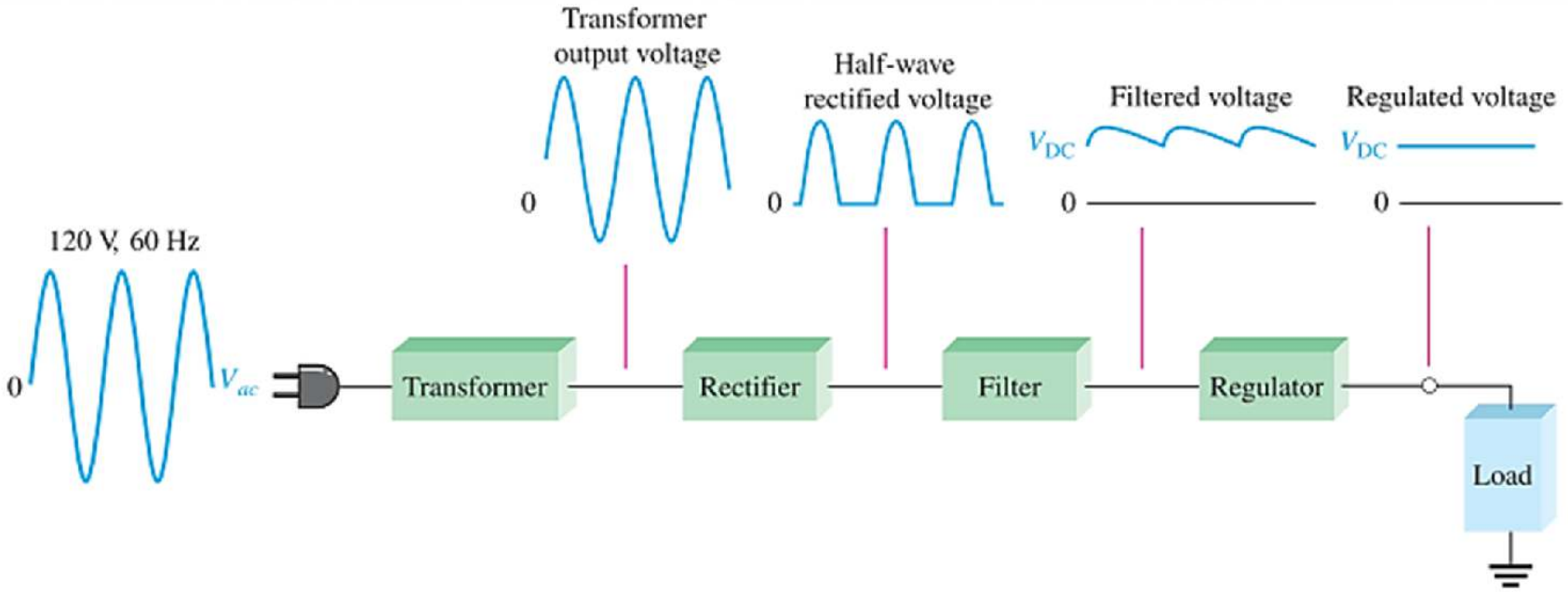
**Instructor:**
**Dr. Moataz Elsherbini**

# Agenda

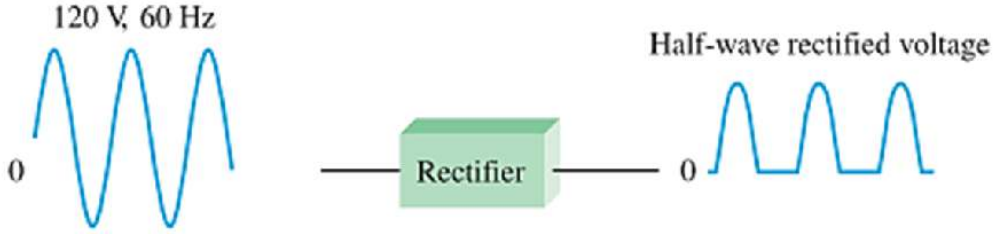
- Half-wave Rectifier
- Full-wave Rectifier
- Power Supply Filters
- Power Supply Regulators

# Diode Applications

# Rectifiers Half-wave Rectifiers

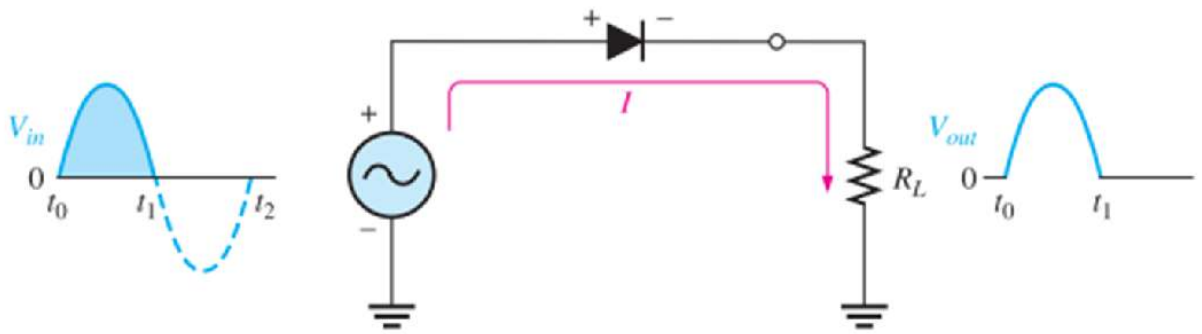



(a) Complete power supply with transformer, rectifier, filter, and regulator

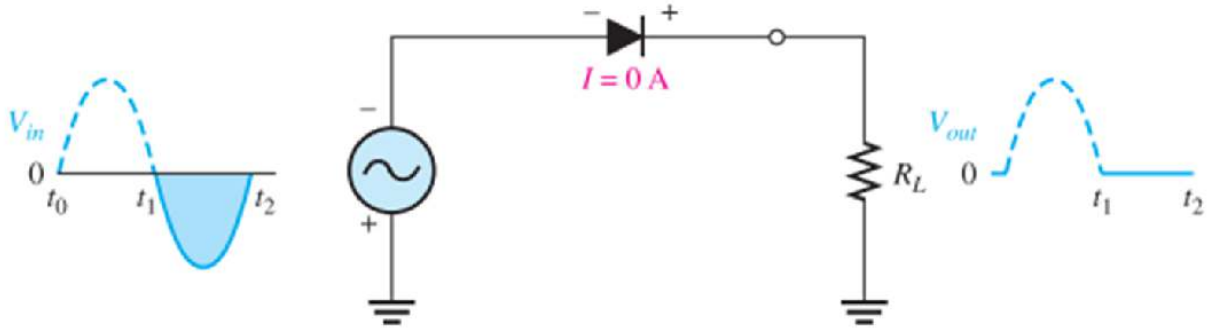



(b) Half-wave rectifier

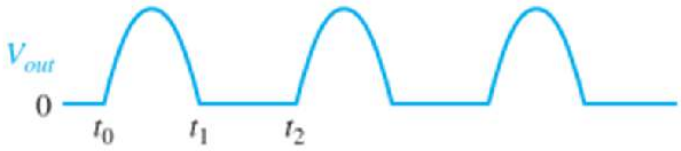
# Half-wave Rectifier Operation




(a) During the positive alternation of the 60 Hz input voltage, the output voltage looks like the positive half of the input voltage. The current path is through ground back to the source.




(b) During the negative alternation of the input voltage, the current is 0, so the output voltage is also 0.

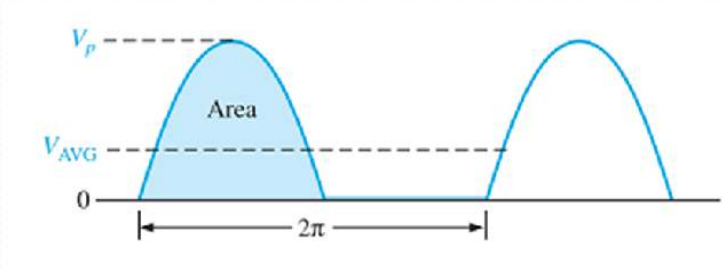



(c) 60 Hz half-wave output voltage for three input cycles

# Average Voltage & PIV

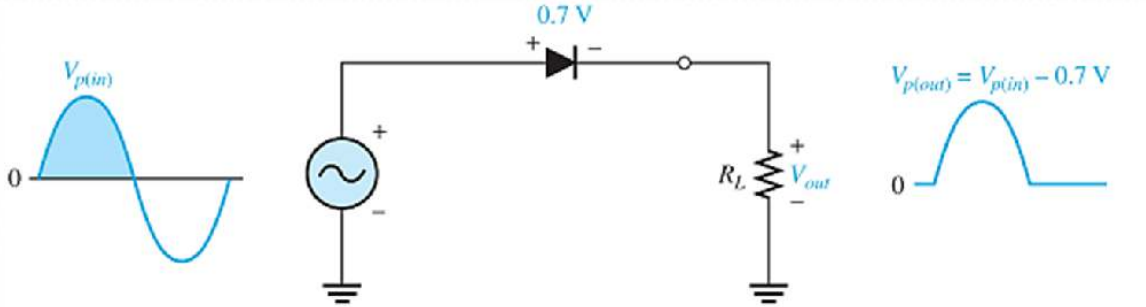
- Average Value of the Half-Wave Output Voltage

$$V_{AVG} = \frac{V_p}{\pi}$$



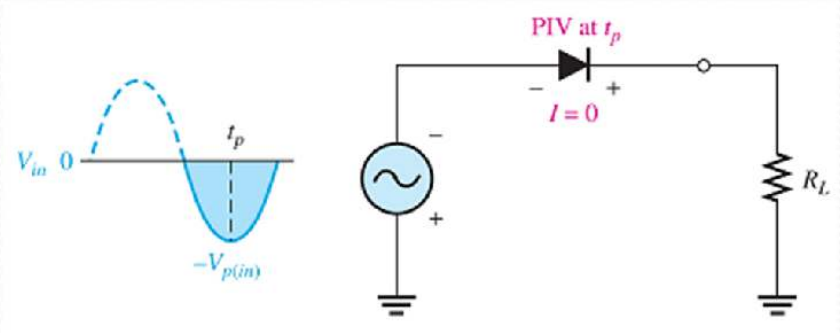

- Effect of the Barrier Potential

$$V_{p(out)} = V_{p(in)} - 0.7\text{ V}$$




- The peak inverse voltage (**PIV**) equals the peak value of the input voltage

$$\text{PIV} = V_{p(in)}$$

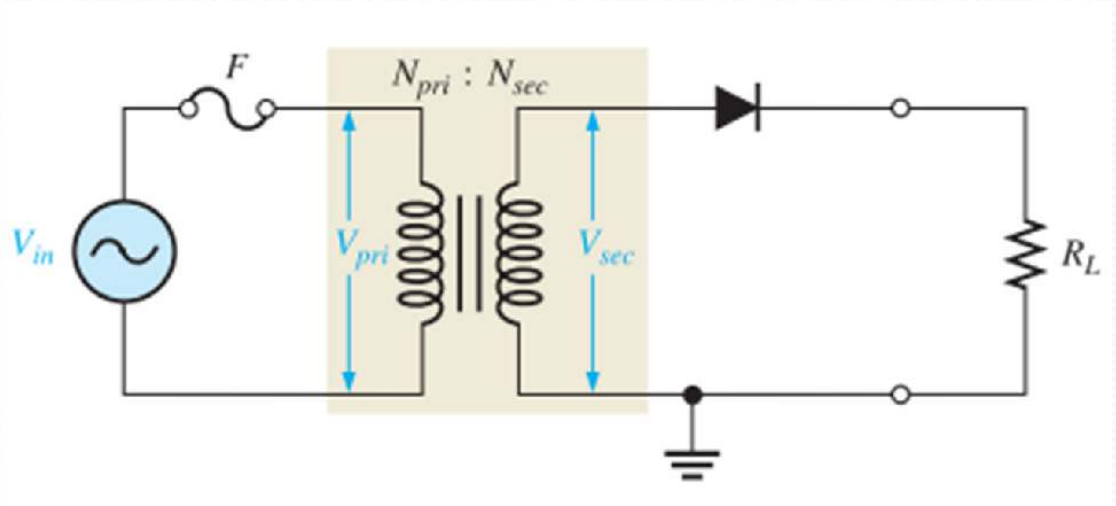



The diode must be capable of withstanding this amount of repetitive reverse voltage

# Transformer Coupling

$$V_{sec} = nV_{pri}$$

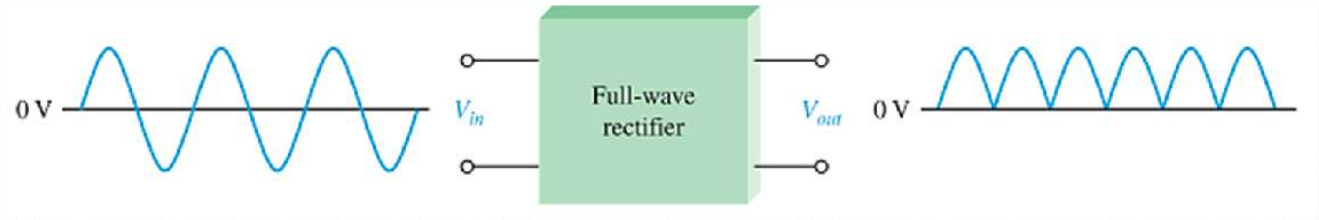
$n$ : turns ratio
$V_{sec}$: secondary voltage
$V_{pri}$ : primary voltage




$$V_{p(out)} = V_{p(sec)} - 0.7\,\text{V}$$

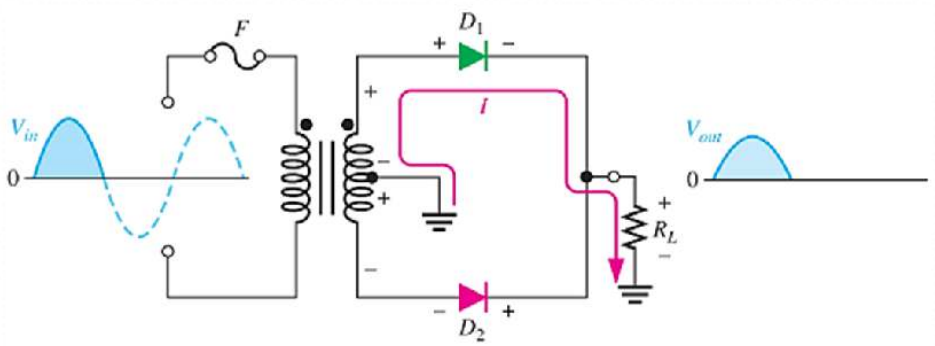
$$\text{PIV} = V_{p(sec)}$$

# Rectifiers
# Full-wave Rectifiers

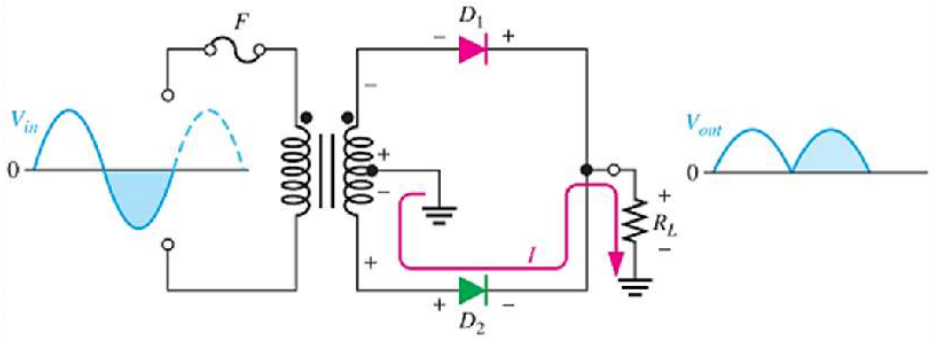



$$V_{AVG} = \frac{2V_p}{\pi}$$

- **Center-tapped Full-wave Rectifier**



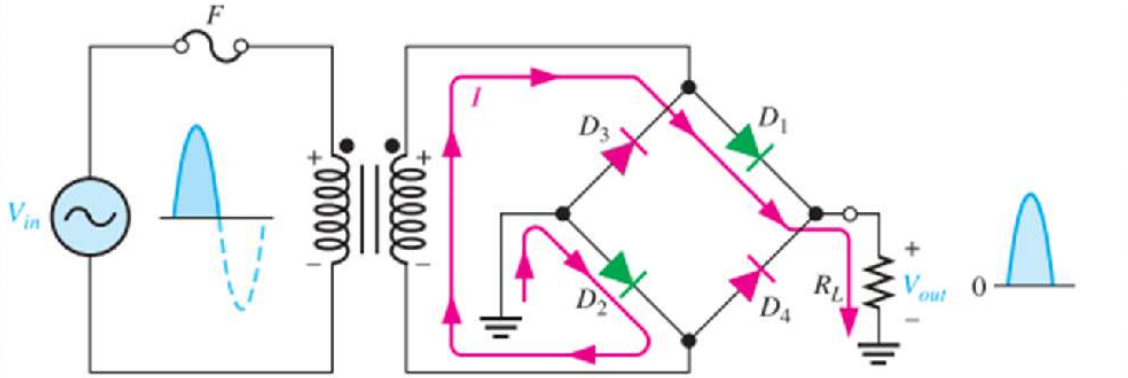

(a) During positive half-cycles, $D_1$ is forward-biased and $D_2$ is reverse-biased.



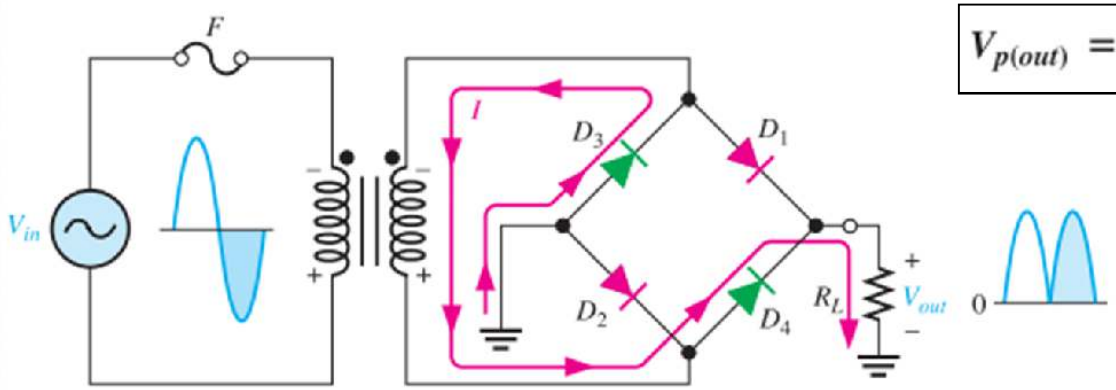

(b) During negative half-cycles, $D_2$ is forward-biased and $D_1$ is reverse-biased.

$$V_{out} = \frac{V_{sec}}{2} - 0.7\,\text{V}$$

# Bridge Full-Wave Rectifier Operation



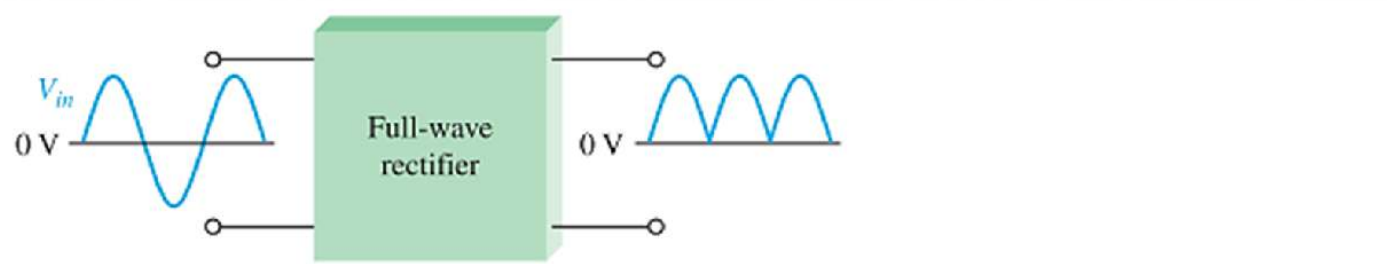

(a) During the positive half-cycle of the input, $D_1$ and $D_2$ are forward-biased and conduct current. $D_3$ and $D_4$ are reverse-biased.



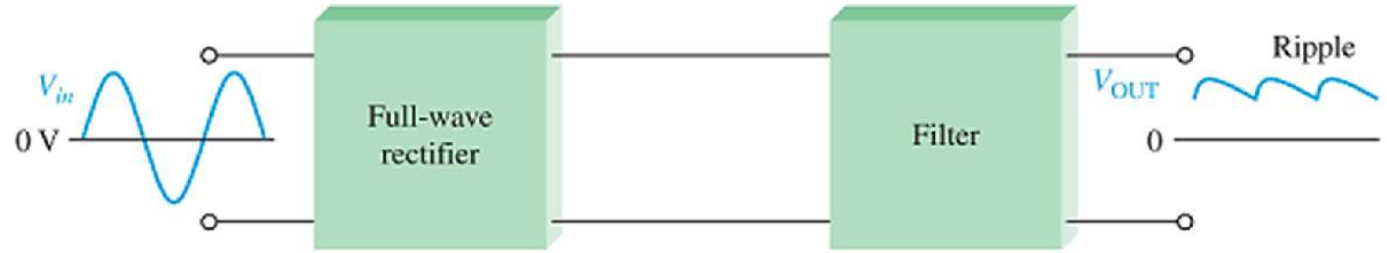

(b) During the negative half-cycle of the input, $D_3$ and $D_4$ are forward-biased and conduct current. $D_1$ and $D_2$ are reverse-biased.

$$V_{p(out)} = V_{p(sec)} - 1.4\,\text{V}$$

# POWER SUPPLY FILTERS

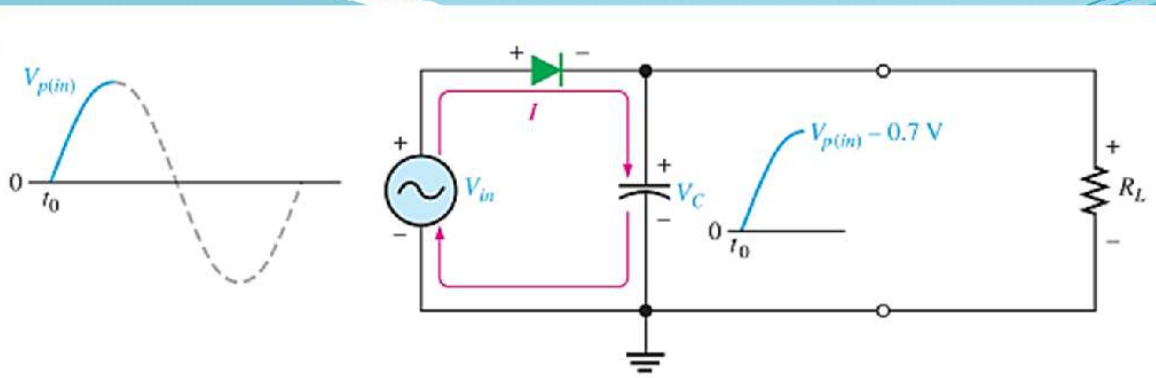



(a) Rectifier without a filter

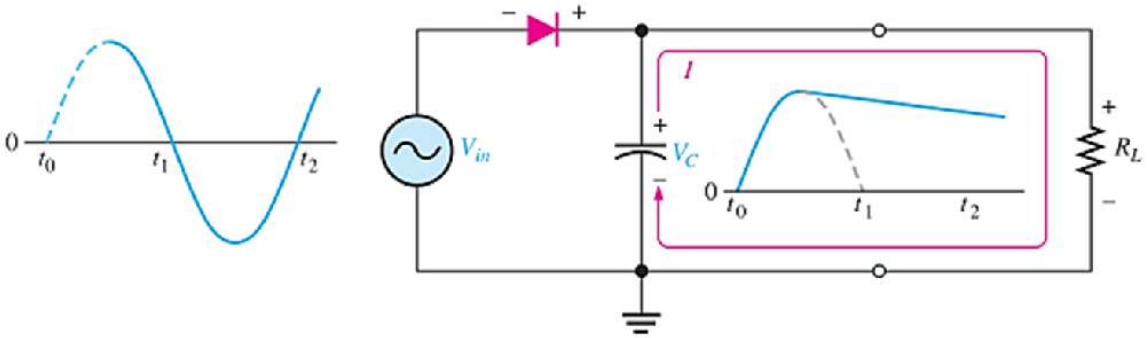



(b) Rectifier with a filter (output ripple is exaggerated)

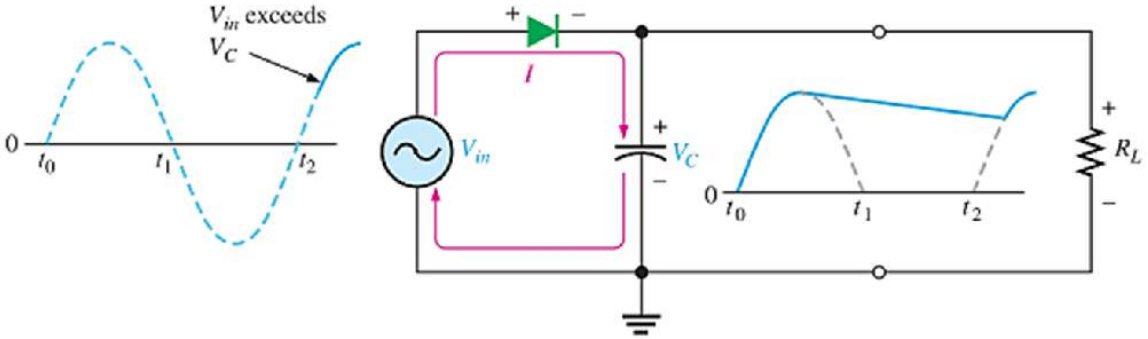
# Capacitor Input Filter




(a) Initial charging of the capacitor (diode is forward-biased) happens only once when power is turned on.




(b) The capacitor discharges through $R_L$ after peak of positive alternation when the diode is reverse-biased. This discharging occurs during the portion of the input voltage indicated by the solid dark blue curve.

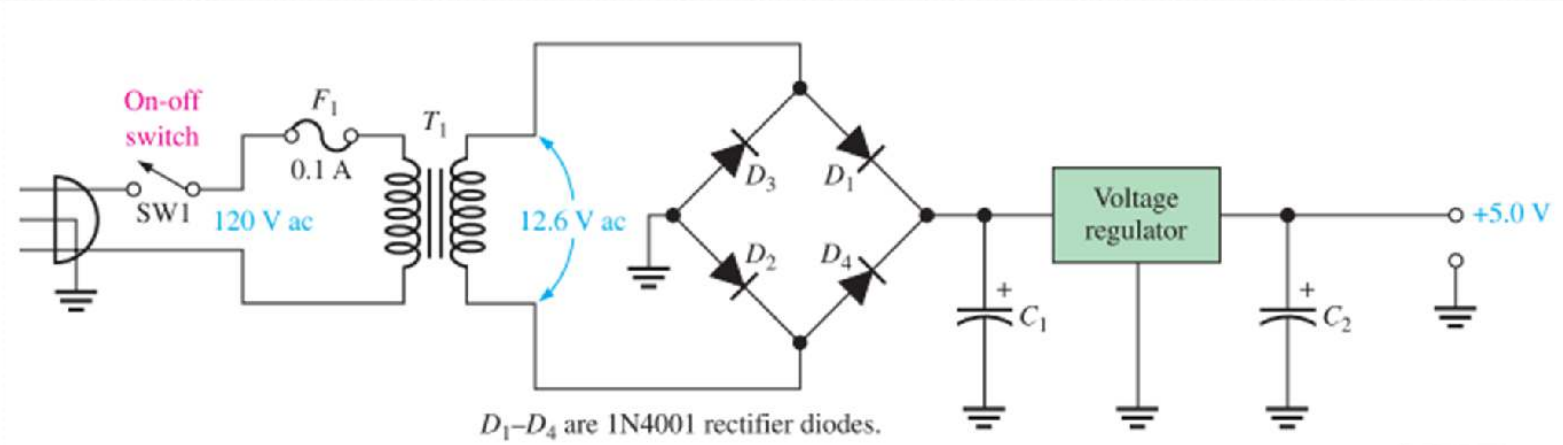



(c) The capacitor charges back to peak of input when the diode becomes forward-biased. This charging occurs during the portion of the input voltage indicated by the solid dark blue curve.

# POWER SUPPLY REGULATORS

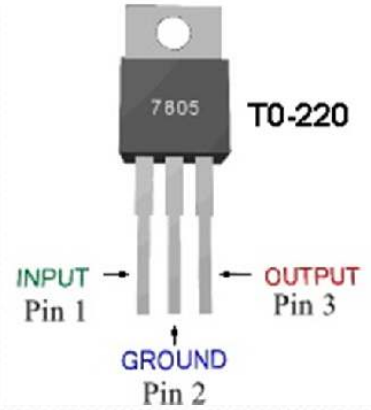
- While filters can reduce the ripple from power supplies to a low value, the most effective approach is a combination of a capacitor-input filter used with a voltage regulator.

**A basic +5.0 V regulated power supply**




$D_1$–$D_4$ are 1N4001 rectifier diodes.

7805 Voltage Regulator IC →



- For more details, refer to:
  - Chapter 2,3, T. Floyd, **Electronic Devices and Circuit Theory**, 11th edition, Prentice Hall.
- The lecture is available online at:
  - *http://bu.edu.eg/staff/motazali3-courses/14630*
- For inquires, send to:
  - Motaz.ali@feng.bu.edu.eg