Capacitors

- The voltage/current relationship for a capacitor is
  \[ i = C \frac{dv}{dt} \]
- That's right, capacitors know calculus!
- The units for capacitance (C) are Farads (F), but a 1 F cap is huge. Typical values in electronic applications are 1 μF \((10^{-6} \text{ F})\) or 1 pF \((10^{-12} \text{ F})\).
- Capacitors can be used to build differentiators and integrators.

Capacitors

- Schematic symbol: \[\text{−} \left\| \text{−}\right\] \]
- Some types of capacitors are polarized and must be connected properly or they can explode.
- The units for capacitance (C) are Farads (F), but a 1 F capacitor is huge. Typical values for electronics applications are 1 μF \((10^{-6} \text{ F})\) or 1 pF \((10^{-12} \text{ F})\).
- Capacitors can be used to build differentiators and integrators and filters.

Inductors

- Schematic symbol: \[\text{−} \left\| \text{−}\right\] \]
- Current/voltage relationship: \[ v = L \frac{di}{dt} \]
- The units for inductance (L) are Henrys (H). Typical values for electronics applications are 1 mH \((10^{-3} \text{ H})\) or 1 μH \((10^{-6} \text{ H})\).
- Not as common as capacitors in electronics except at radio frequencies.

Filters

- A low pass filter passes through low frequency voltages while blocking high frequencies.

\[\begin{array}{c}
\text{−} \left\| \text{−}\right\]
\end{array}\]

\[v_{\text{IN}}\]

\[v_{\text{OUT}}\]

Filters

- A high pass filter passes through high frequency voltages while blocking low frequencies.

\[\begin{array}{c}
\text{−} \left\| \text{−}\right\]
\end{array}\]

\[v_{\text{IN}}\]

\[v_{\text{OUT}}\]
Diodes

- Diodes only allow current to flow in one direction. They act like open circuits when current tries to low the wrong way.
- There are some special purpose diodes. Light emitting diodes (LEDs) give off light.

Transistors

- Transistors, when used as voltage controlled switches, are the fundamental component in digital and computer systems.
- Transistors, when used as amplifiers, are the fundamental component in communication systems.

Integrated Circuits

- Integrated circuits (ICs or chips) contain miniature resistor, diode, and transistor circuits.
- Modern microprocessors are ICs with over a million transistors in a single circuits.
- ICs are available for both digital and analog applications.

 Operational Amplifiers

- Op amps are easy-to-use, off-the-shelf IC amplifiers. A typical op amp contains about 40 transistors.