ESE112 Engineering Lab

Protoboard
Resistor Code
Ground
Op-Amp

Resistor Color Coding

Source: www.pc-control.co.uk/images/resistor_code2.gif

- Resistors can be 4 band or 5 band
- In 4 band resistors
  - 4th band is tolerance band (gold or silver)
  - 3rd band is multiplier

Ground

- Ground is the reference point in an electrical circuit from which other voltages are measured
- A common return path for electric current (earth return or ground return), or a direct physical connection to the Earth.
Operational Amplifier (Op-Amp)

- Complex Arrangement of resistors, capacitors and transistors
- Active element
  - Needs to be powered
  - $-V_{ss} \leq V_o \leq V_{ss}$
  - -Input: Inverting terminal
  - +Input: Non-inverting terminal
- Uses
  - Comparator, Differentiator, Integrated, Voltage Amplifier

Rules for Op-amp

1. The output attempts to do whatever is necessary to make the voltage difference between inputs zero
   - $V_1 - V_2 \sim 0 \rightarrow V_1 = V_2$
2. The inputs draw no current
   - Due to infinite resistance between the input terminals

Inverting

\[
\frac{V_{in} - V_a}{R_1} = \frac{V_a - V_{out}}{R_f} \quad \text{(from rule 2)}
\]

$V_a = 0$, from Rule 1

Therefore: $V_{out} = -\frac{R_f}{R_1} V_{in}$