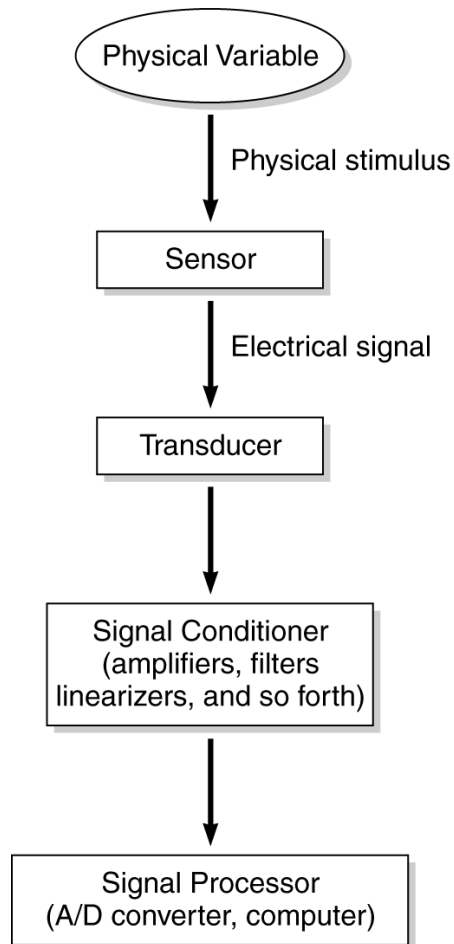


# Amplifiers and Filters



Temperature, pressure, strain, length, and so forth.

*Temperature*

Temperature  $\gg$  resistance:  
 $R = R_0 (1 + \alpha [T - T_0])$

*Resistance*

Resistance  $\gg$  voltage  
(using Wheatstone Bridge)

*Signal typically a voltage*

Signal filtered and gained to proper frequency, range and magnitude.

Analog signal sampled and converted to digital signal with proper resolution. Digital signal stored and possibly analyzed.

# Amplifiers

- An *amplifier* is an electronic component that scales the magnitude of a signal from its input value,  $E_i$ , to its output value,  $E_o$ .

# Operational Amplifiers

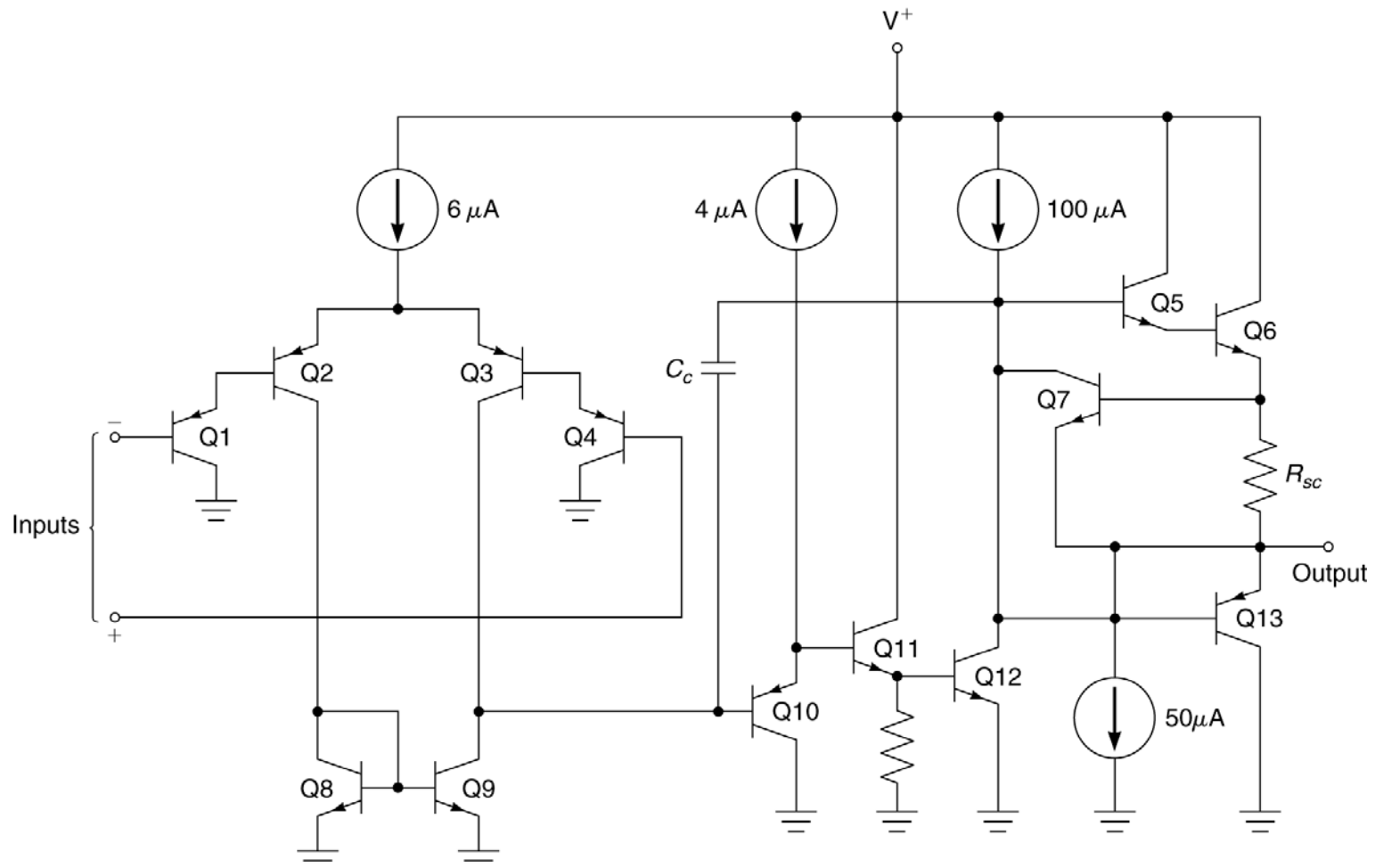
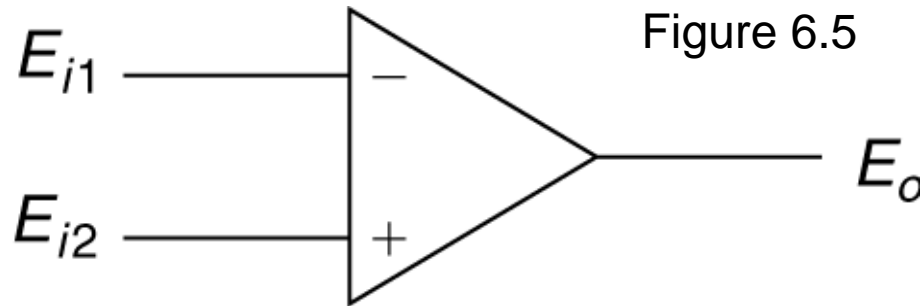


Figure 6.4: The LM124 Series Op Amp

# Operational Amplifiers

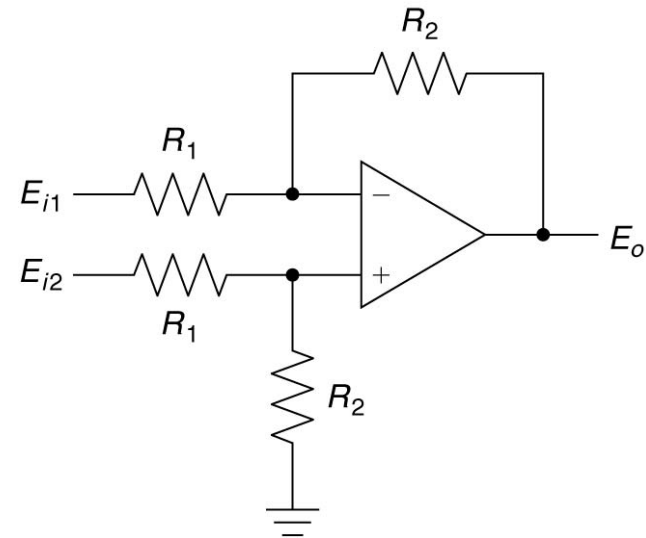
- The complex circuit of the op amp can be modeled as a 'black box' having two voltage inputs and one voltage output.



- Its major attributes are:

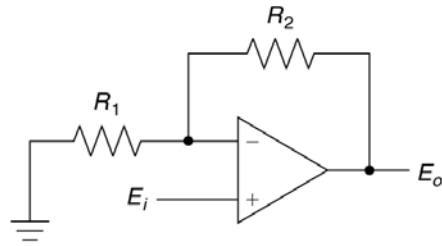
# Differential Op Amp Equation

- Kirchoff's First Law can be applied to determine the amplification factor for this configuration.



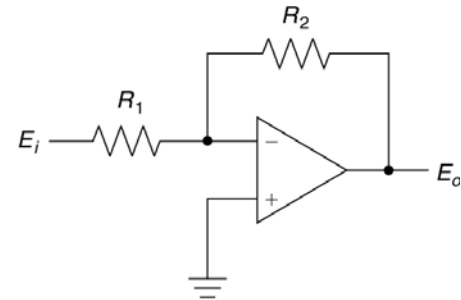
$$E_o = (E_{i2} - E_{i1})[R_2/R_1]$$

Differential Amplifier



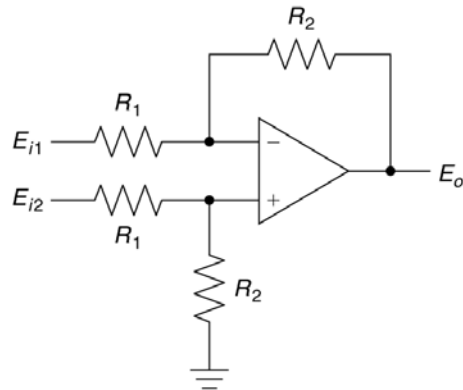
$$E_o = E_i[R_1 + R_2]/R_1$$

Noninverting Amplifier



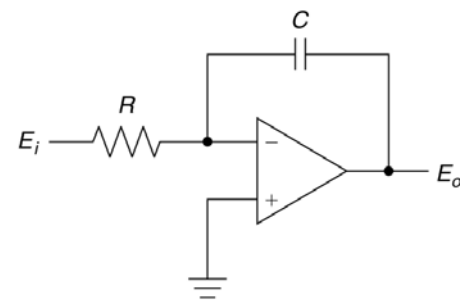
$$E_o = -E_i[R_2/R_1]$$

Inverting Amplifier



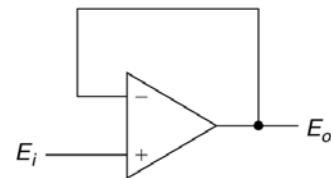
$$E_o = (E_{i2} - E_{i1})[R_2/R_1]$$

Differential Amplifier



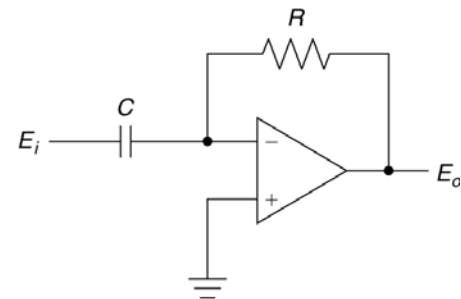
$$E_o = [1/RC] \int E_i(t) dt + \text{const.}$$

Integrator



$$E_o = E_i$$

Voltage Follower



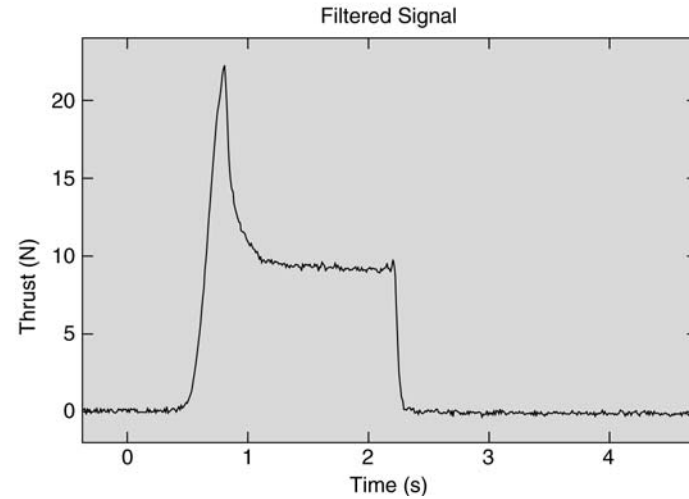
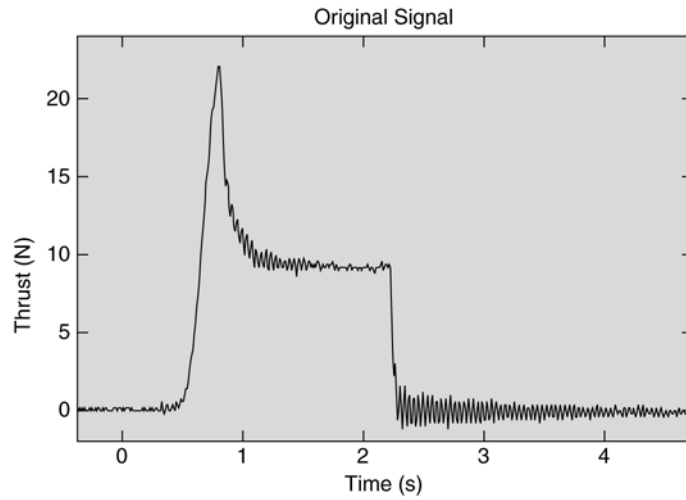
$$E_o = -RC[dE_i(t)/dt]$$

Differentiator

Figure 6.7

# Filters

- A filter removes a signal's unwanted frequency components.



# Filter Terminology

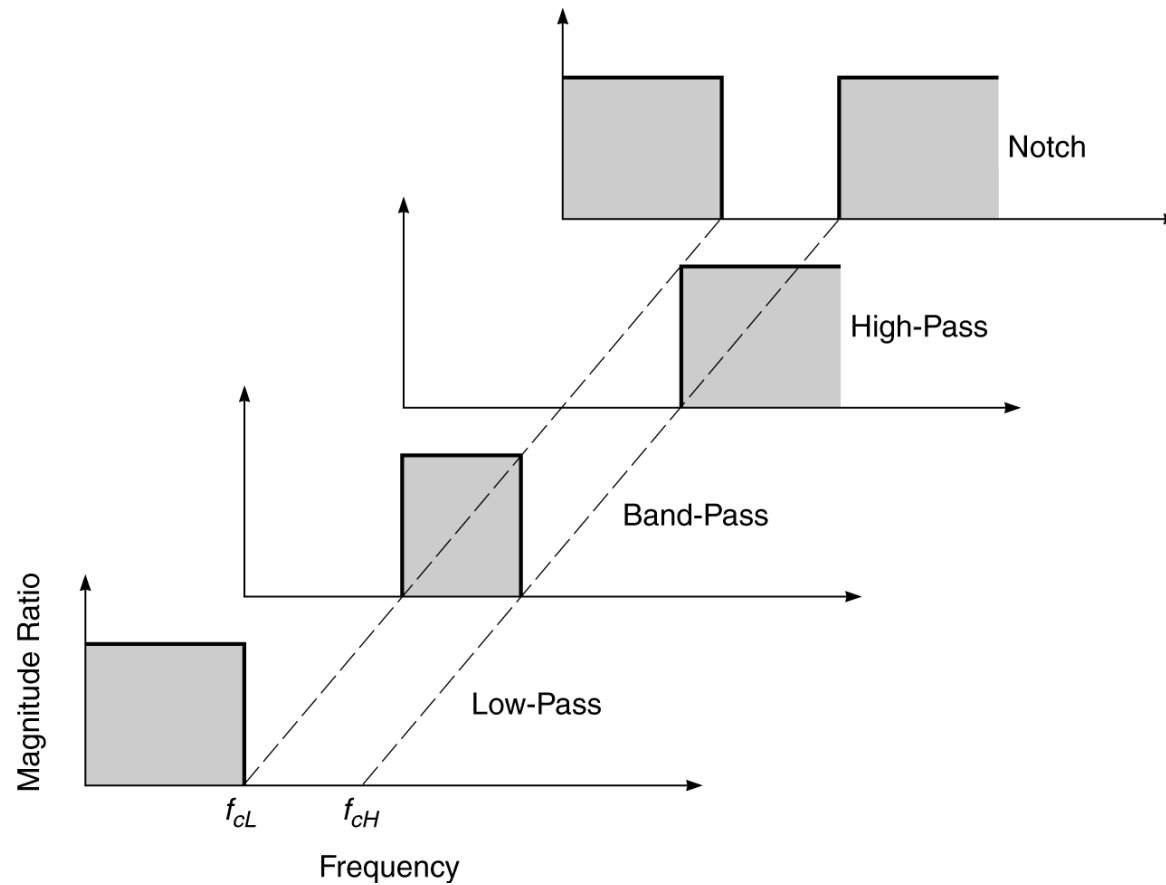


Figure 6.9



# Simple RC Filters

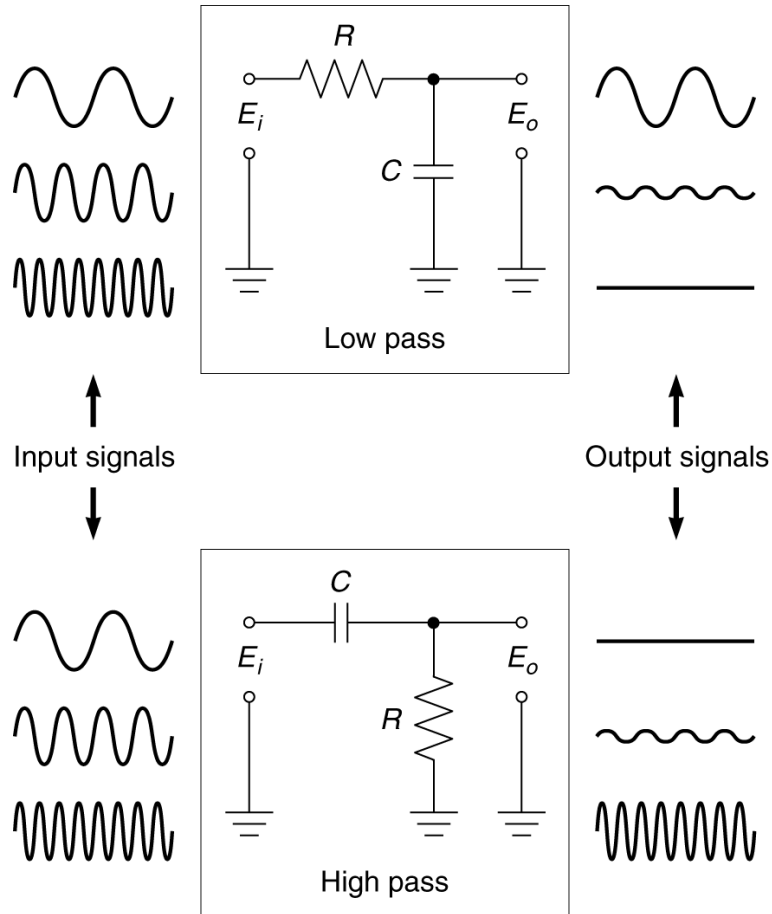


Figure 6.10

# Filter Distortion of Signal

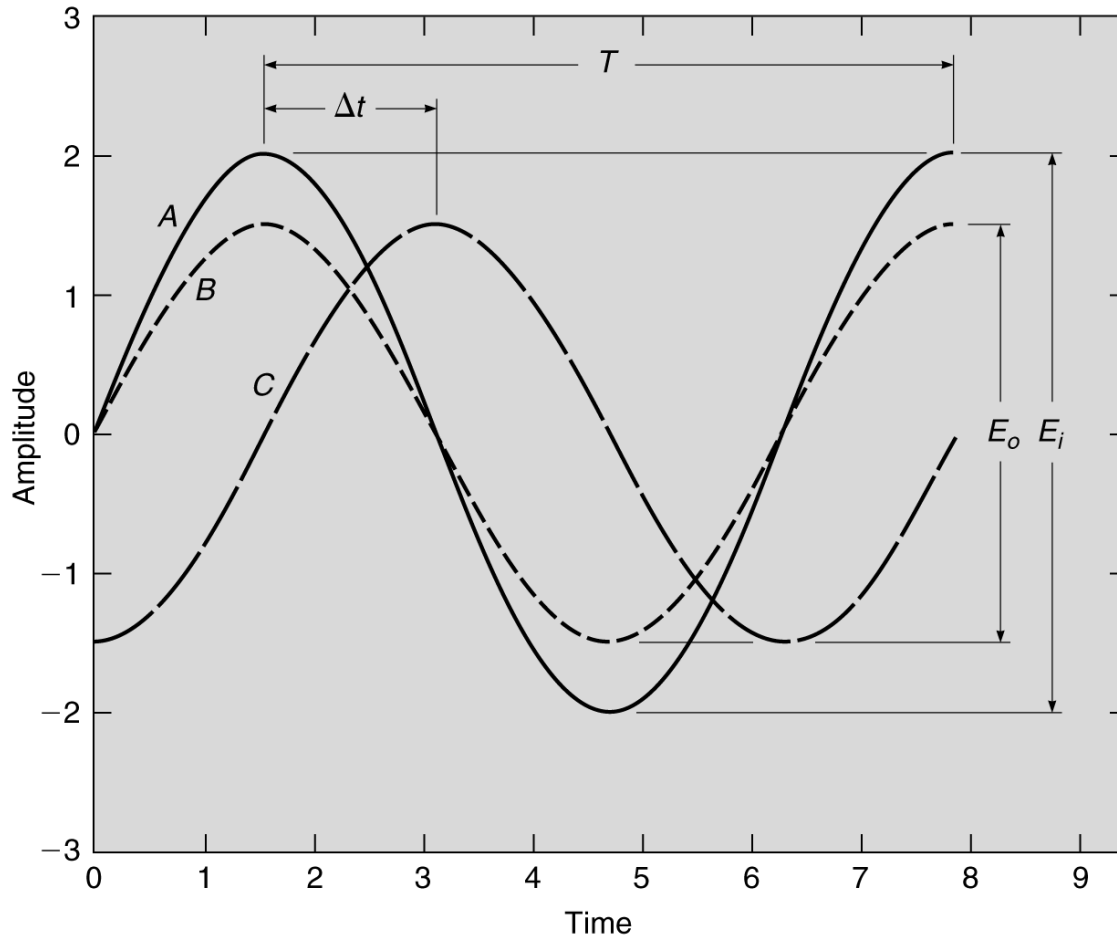


Figure 6.11

cyclic frequency for this signal =  
circular frequency for this signal =