Transistor Amplifiers and Oscillators

Amplifiers require *negative feedback* (180º out-of-phase) for circuit stability, high fidelity, wide bandwidth
Oscillators require *positive feedback* (in-phase) in order to sustain operation
Oscillators convert DC supply voltages to AC signals
  Piezoelectric Effect (Crystal Control)
    Vibrates when immersed in an electric field and generates current when physically deformed
Common Emitter (BJT) Amplifiers
  Low frequency cut-off due to coupling capacitors and by-pass capacitors
  High frequency cut-off due internal junction capacitance and frequency dependence of β
Amplifier Gain (Generally expressed as Gain = Output / Input)
  Gain Factors are defined for Voltage, Current, and Power
  Voltage Gain is often expressed using slightly different symbology (α, A, A_0, A_v).
  Current Gain A_i
  Power Gain A_p

Operational Amplifiers (Op-Amps)

Series of cascaded amplifiers:
  differential amplifier, high gain voltage amplifier, low impedance output amplifier.
Characteristics of input and output impedance, voltage gain, bandwidth for an ideal op-amp:
  high input impedance, low output impedance, high gain, wide bandwidth.
$V_{sat} = V_{CC} \pm 2$ volts $+V_{sat}$ (Max V_{out}) = +Vcc - 2 V $-V_{sat}$ (Max V_{out}) = -Vcc + 2 V
Basic Rule for Input Currents: $i^- = i^+ = 0$

Closed Loop (negative feedback)
  Basic Rule for Input Voltages: $v^- = v^+$
  Gain:
    Inverting (input to v_- terminal) = $-Z_f / Z_i$
    Non-Inverting (input to v_+ terminal) = $1 + Z_f / Z_i$
  Commonly used as summers, multipliers, differentiators, integrators; hence the name *operational amplifiers* (analog computers). Can also be configured as log and anti-log (exponentiation) amplifiers, active filters, unity buffers, comparators, Schmitt triggers, oscillators.