Basic Amplifier Concepts

Voltage gain (non-inverting):

\[ v_o(t) = A_v v_i(t) \]

Inverting and non-inverting amplifiers: Inverting amplifiers have negative voltage gain, and the output waveform is an inverted version of the input waveform. Non-inverting amplifiers have positive voltage gain.

Voltage amplifier model:

\[ A_v = \frac{v_o}{v_i} = A_v \frac{R_o}{R_i} \]

Note the Thevenin equivalents

Current gain:

\[ A_i = \frac{i_o}{i_i} = \frac{v_o/R_o}{v_i/R_i} = A_v \frac{R_o}{R_i} \]

Power gain:

\[ G = \frac{P_o}{P_i} = \frac{v_o I_o}{v_i I_i} = A_v A_i \left( A_v \frac{R_o}{R_i} \right) \]
Root Mean Square (RMS) values:

\[
\langle P \rangle_{\text{Average}} = \frac{1}{T} \int_0^T p \, dt = \frac{1}{T} \int_0^T \frac{V_m^2 \cos^2(\omega t + \vartheta)}{R} \, dt = \frac{1}{R} \left[ \frac{1}{T} \int_0^T V_m^2 \cos^2(\omega t + \vartheta) \, dt \right]
\]

\[
\frac{V_{\text{rms}}^2}{R} = \frac{V_m^2}{2R} = \frac{(0.707V_m)^2}{R}
\]

In general

\[
V_{\text{rms}} = \sqrt{\frac{1}{T} \int_0^T v^2(t) \, dt} \quad I_{\text{rms}} = \sqrt{\frac{1}{T} \int_0^T i^2(t) \, dt}
\]

For a sinusoidal voltage: \(V_{\text{rms}} = 0.707 \, V_m\)  
(rms = 0.707 x amplitude)

Example for voltage, current and power gain.

![Diagram](image)

Impedance match for max power into load

![Diagram](image)
Cascaded Amplifiers

The overall voltage gain of cascaded amplifiers is the product of the gain of the individual stages. This is also true for the current and power gains.

Example

Simplified model
Power Supplies and Efficiency

Figure 11.8 The power supply delivers power to the amplifier from several dc voltage sources.

Find the input power, output power, supply power and the power dissipated in the amplifier. Also find the efficiency of the amplifier.

Figure 11.30 Amplifier of Example 11.4.