BJT Fundamental relations for DC and AC Analysis
ECE 352 - Spring 2007

**DC analysis**

\[ I_E = I_B + I_C \]
\[ I_C = \alpha I_E = \beta I_B \]
\[ I_E = (\beta + 1) I_B \]
\[ \beta = \frac{\alpha}{1-\alpha} \quad \alpha = \frac{\beta}{\beta+1} \]

**AC analysis**

<table>
<thead>
<tr>
<th>( r_{th} )</th>
<th>( r_E )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{V_T}{I_B} )</td>
<td>( \frac{V_T}{I_E} )</td>
</tr>
<tr>
<td>( r_{th} = (\beta+1) r_E )</td>
<td></td>
</tr>
<tr>
<td>( g_m = \frac{I_C}{V_T} )</td>
<td></td>
</tr>
<tr>
<td>( r_{th} g_m = \beta \quad r_{egm} = \alpha )</td>
<td></td>
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<tr>
<td>( r_o = \frac{V_A}{I_C} )</td>
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\( V_T = 26 \text{ meV} \)

\( V_A = [50-100] \text{ V} \)

Early Voltage

**Hybrid \( h \) model**

Typically, \( 100-200 \Omega \)

\( C_u \) - Miller capacitance
Basic Types of Feedback Amplifiers

Fig. 8.4 The four basic feedback topologies: (a) voltage-sampling series-mixing (series-shunt) topology; (b) current-sampling shunt-mixing (shunt-series) topology; (c) current-sampling series-mixing (series-series) topology; (d) voltage-sampling shunt-mixing (shunt-shunt) topology.
First Order Filter Functions

* First order filter functions are of the form

\[ T(s) = \frac{a_1 s + a_0}{s + \omega_0} = \frac{a_1 \left( s + \frac{a_0}{a_1} \right)}{s + \omega_0} \]

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(c) General

**General**

**All Pass**

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Fig. 11.14 First-order all-pass filter.

ECE 352 Electronics II Spring 2000

Ch. 11 Active Filters
Second-Order Filter Functions

\[ T(s) = \frac{a_2 s^2 + a_1 s + a_0}{s^2 + \omega_0^2 s + \omega_0^2} \]

**Notch**
\[ a_1 = 0 \]

**Low Pass Notch**
\[ a_1 = 0 \]

**High Pass Notch**
\[ a_1 = 0 \]

**All-Pass**