BJT: Fundamental relations for DC and AC analyses
ECE352 - 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

$V_T \simeq 26\,mV$

$V_A \sim [50 - 100\,V]$

Early voltage

$$r_\pi = \frac{V_T}{I_B} \qquad r_e = \frac{V_T}{I_E}$$

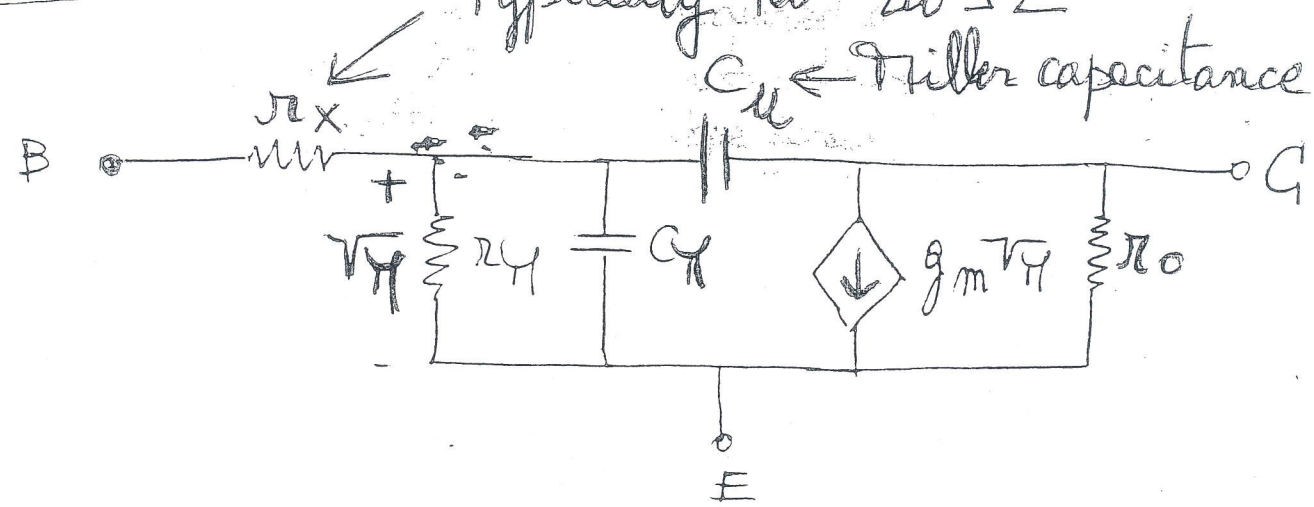
$$r_\pi = (\beta+1)\, r_e$$

$$g_m = I_C / V_T$$

$$r_\pi g_m = \beta \; ; \quad r_e g_m = \alpha$$

$$r_o = V_A / I_C$$

Hybrid-π model



Basic Types of Feedback Amplifiers

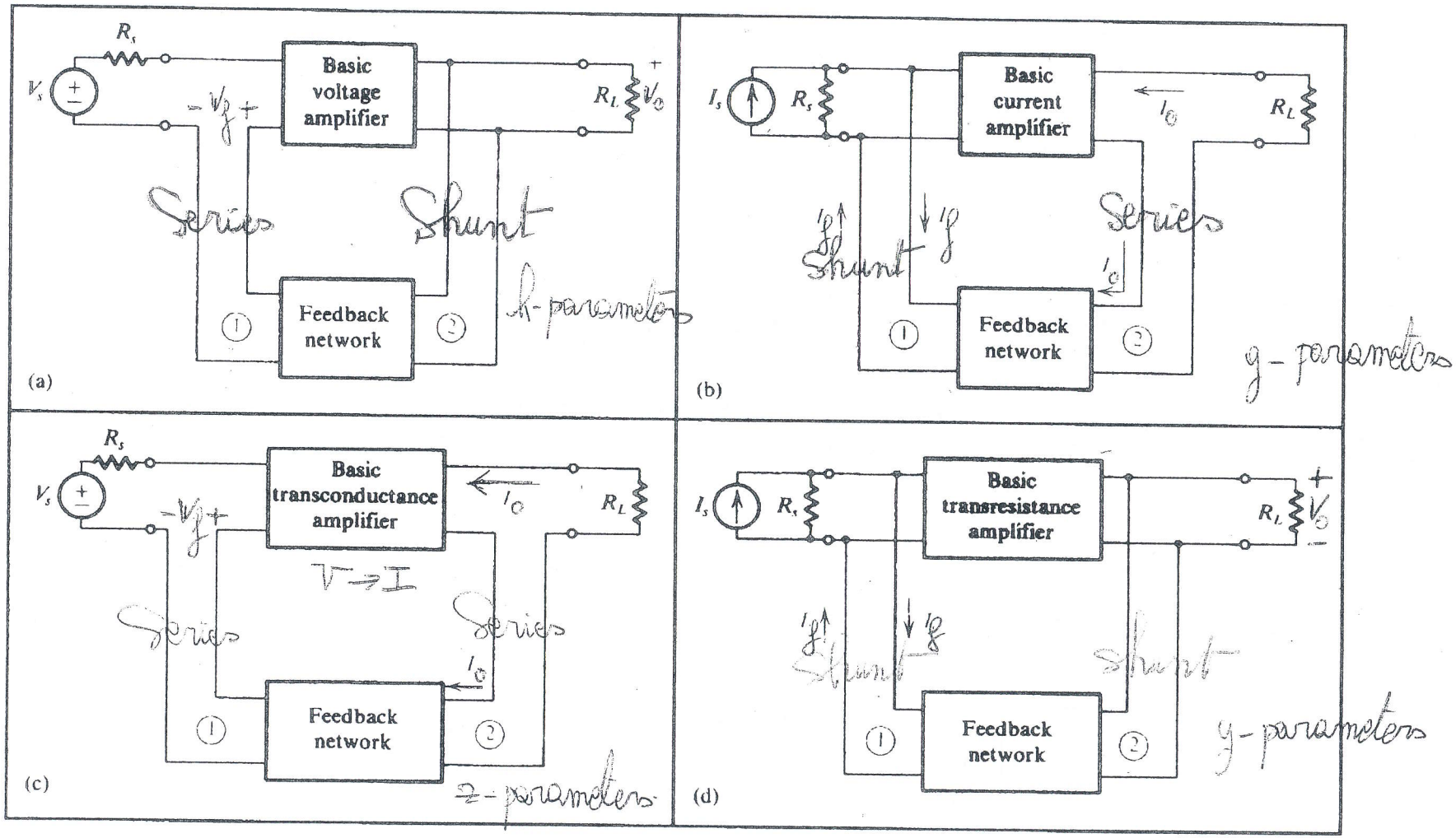
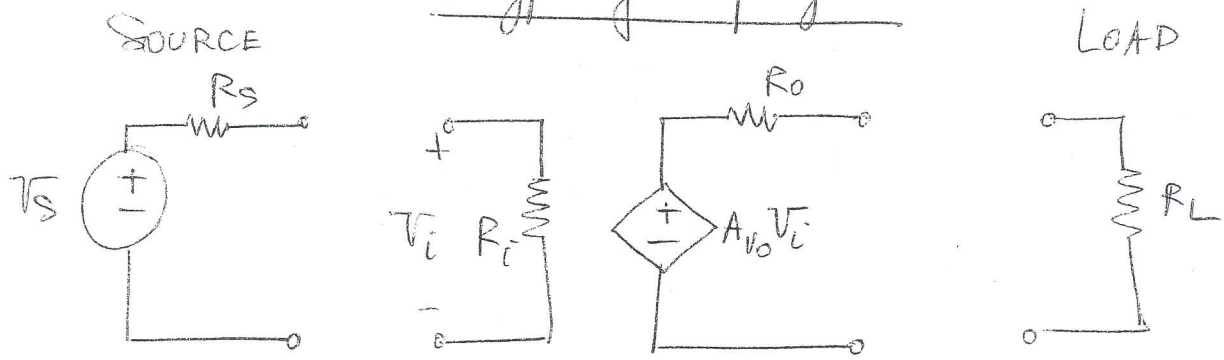
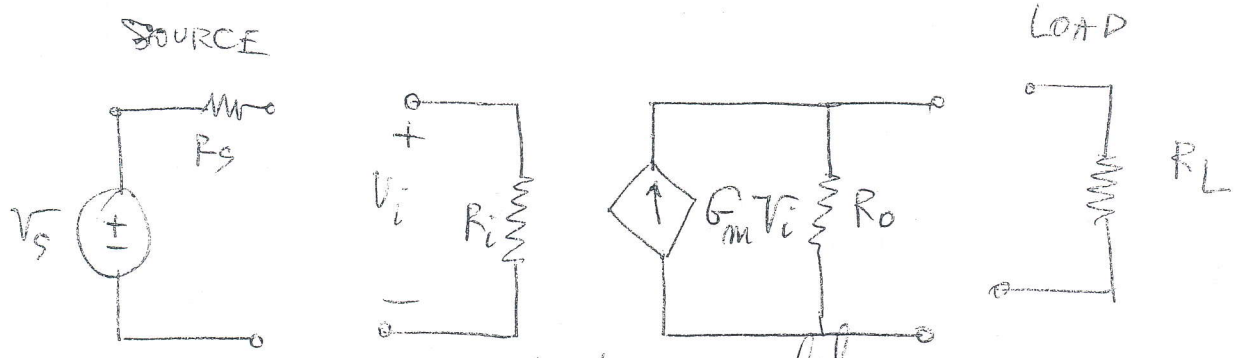


Fig. 8.4 The four basic feedback topologies: **(a)** voltage-sampling series-mixing (series–shunt) topology; **(b)** current-sampling shunt-mixing (shunt–series) topology; **(c)** current-sampling series-mixing (series–series) topology; **(d)** voltage-sampling shunt-mixing (shunt–shunt) topology.

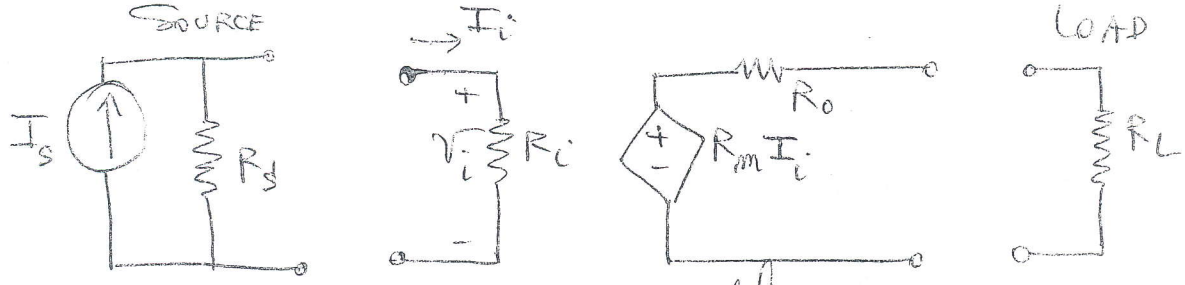
4 Types of amplifiers



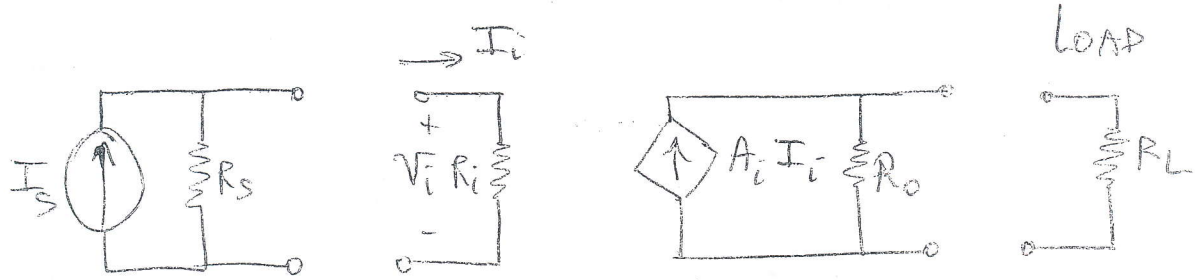
Basic Voltage amplifier



Basic Transconductance amplifier



Basic Transresistance amplifier



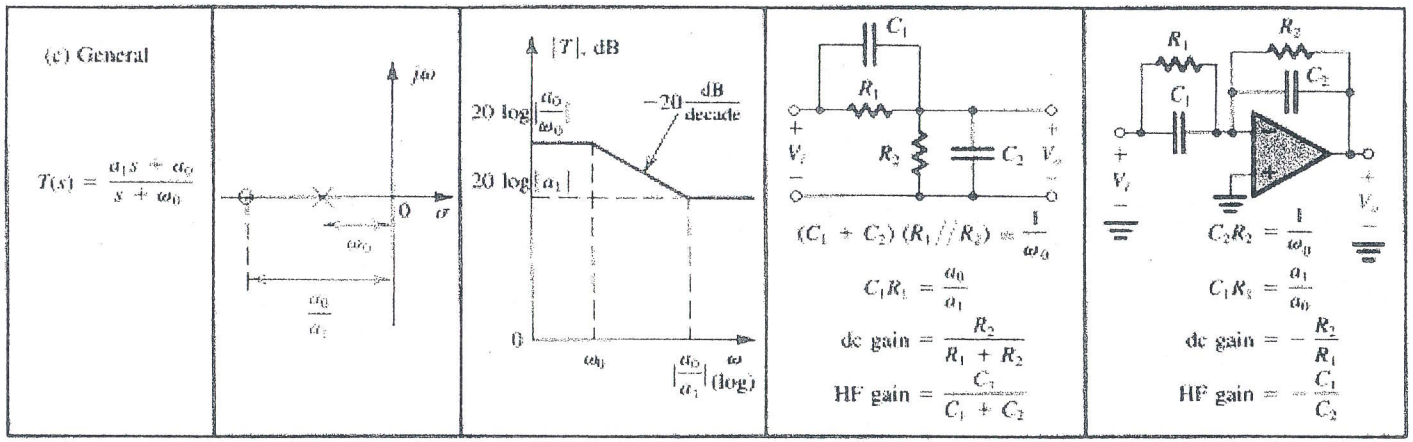
Basic current amplifier

First Order Filter Functions

* **First order filter functions are of the form**

$$T(s) = \frac{a_1 s + a_o}{s + \omega_0} = \frac{a_1\left(s + \dfrac{a_o}{a_1}\right)}{s + \omega_0}$$

General



All Pass

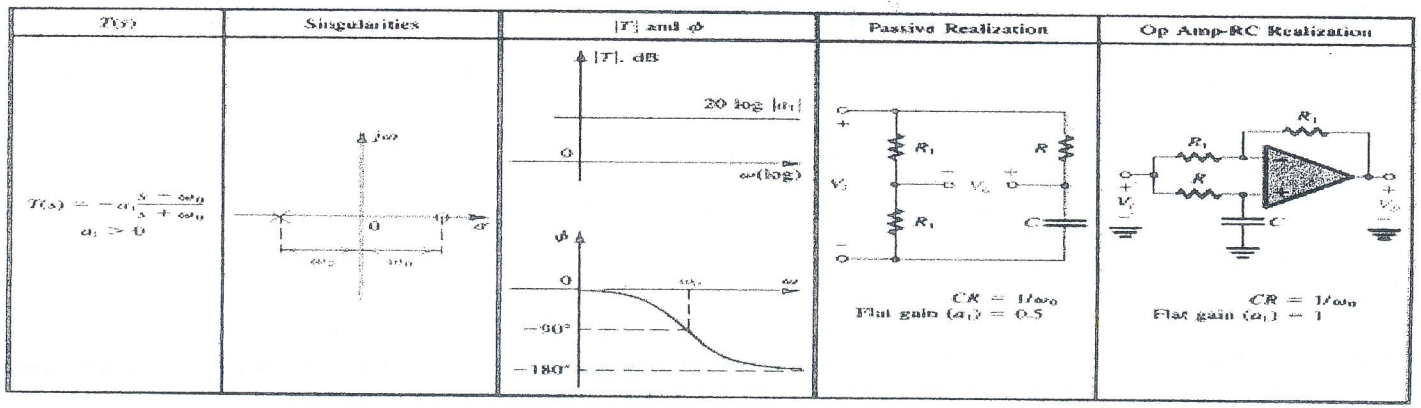


Fig. 11.14 First-order all-pass filter.

Second-Order Filter Functions

$$T(s) = \frac{a_2 s^2 + a_1 s + a_o}{s^2 + \frac{\omega_0}{Q} s + \omega_0^2}$$

Notch

a_1=0

Low Pass Notch

a_1=0

High Pass Notch

a_1=0

All-Pass