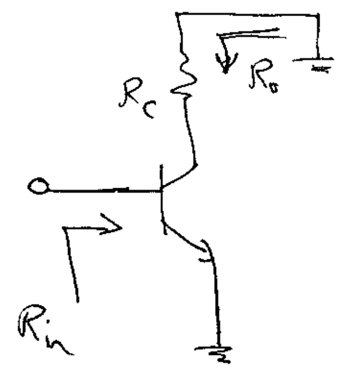
Common emitter

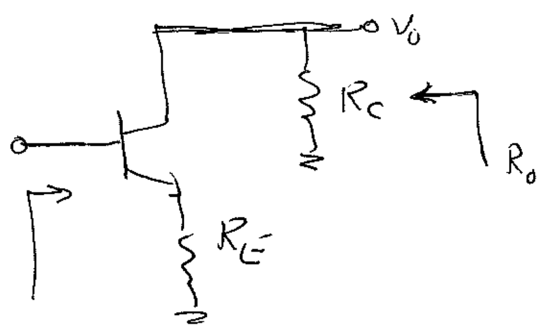
$R_{in} = r_\pi$

$A_{vo} = -g_m (R_C \| r_o) \simeq -g_m R_C$

$R_o = R_C \| r_o$



Common emitter with source resistance



$R_{in} = r_\pi + (\beta+1) R_E = (1+\beta)(r_e + R_E) = r_\pi (1 + g_m R_E)$

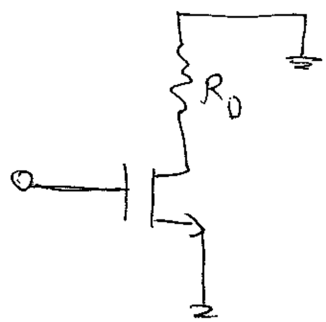
$$A_{vo} = -\frac{g_m R_C}{1 + g_m R_E}$$

$R_o = R_C$ (if $r_o = \infty$) or $R_o = R_C \| [r_o (1 + g_m R_E)]$ if r_o is taken into account

Common Source

$R_{in} = \infty \qquad A_{vo} = -g_m (R_D \| r_o) \simeq -g_m R_D$

$R_o = R_D \| r_o \simeq R_D$

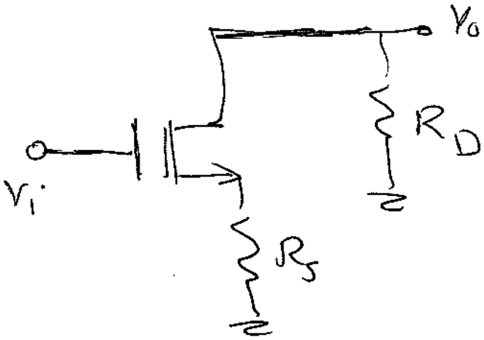


Common source with source resistance

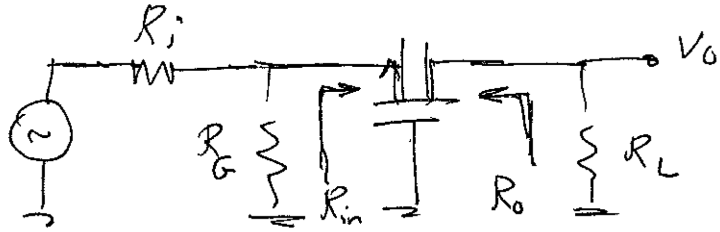
$$A_{vo} = -\frac{g_m R_D}{1 + g_m R_S} \simeq -\frac{R_D}{R_S} \qquad R_{in} = \infty$$

$R_o = R_D$ if $r_o = \infty$

if not $R_o = R_D \| \left[r_o (1 + g_m R_S) \right]$



Common Gate

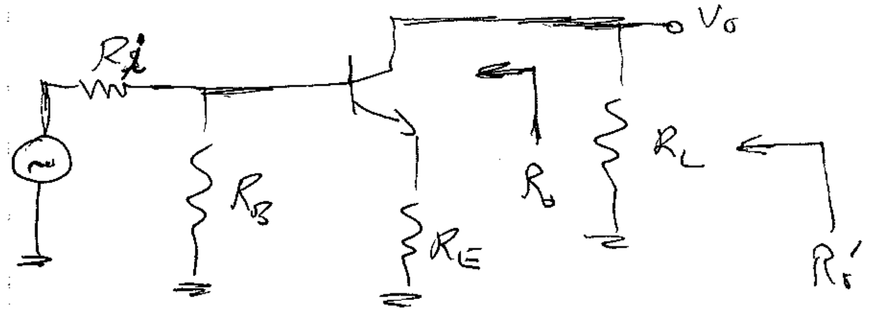


$$R_{in} = \frac{1}{g_m} \qquad A_{vo} = g_m R_D \ (r_o = \infty)$$

$$R_o = R_D \ (r_o = \infty) \quad \text{or} \quad R_L \| r_o \left[1 + g_m (R_i \| R_G) \right]$$

Common Base is similar

$$R_{in} = \frac{1}{g_m} \qquad A_{vo} = g_m R_D \qquad R_o = R_L \| r_o \left[1 + g_m (R_i \| R_B) \right]$$



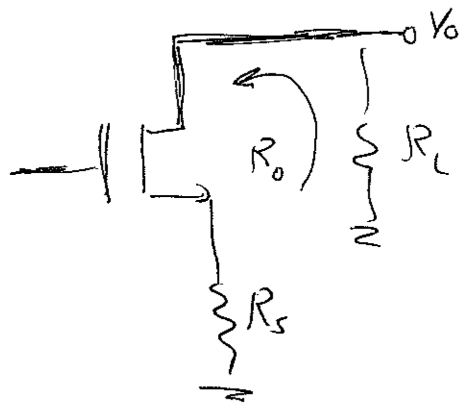
Common emitter

$R_o = r_o(1 + g_m R_E)$

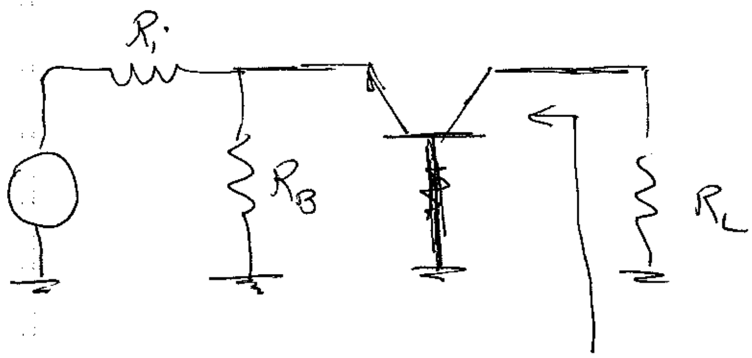
$R_o' = R_o \| R_L$ if ignore $r_o \Rightarrow R_L' = R_L$

Similar for common source with source resistance

$R_o = r_o(1 + g_m R_S)$



Common Base & Common Gate

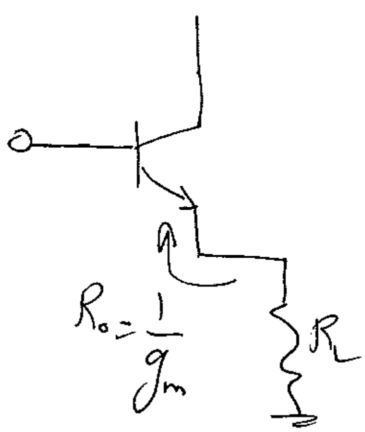


$$R_o = r_o \left[1 + g_m (R_i \| R_B) \right]$$

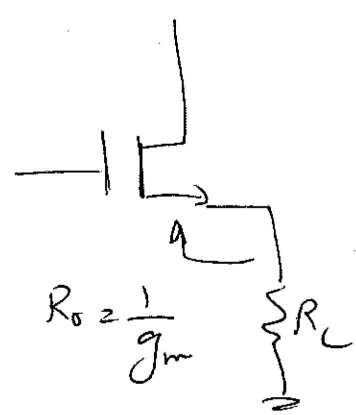
For common gate $R_o = r_o \left[1 + g_m (R_i \| R_G) \right]$

similar to CB

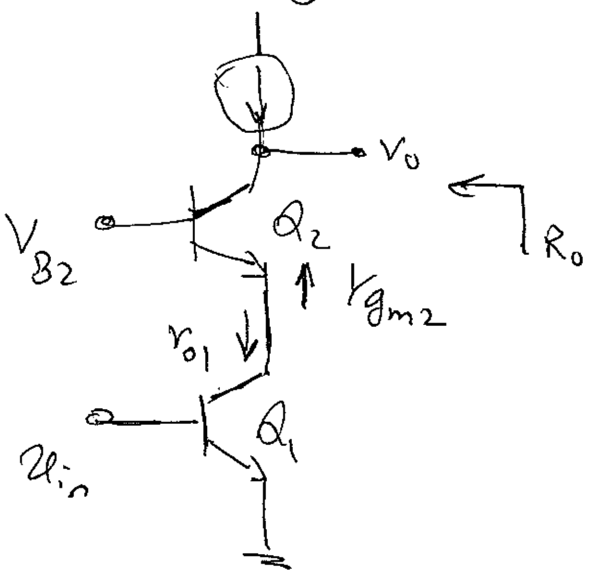
Common Collector



Common Drain



BJT Cascode



$$R_o = r_{o2}\left[1 + g_{m2}(r_{o1} \| r_{\pi 2})\right] \simeq g_{m2} r_{o2} (r_{o1} \| r_{\pi 2})$$
$$\simeq g_{m2} r_{o2} r_{\pi 2}$$

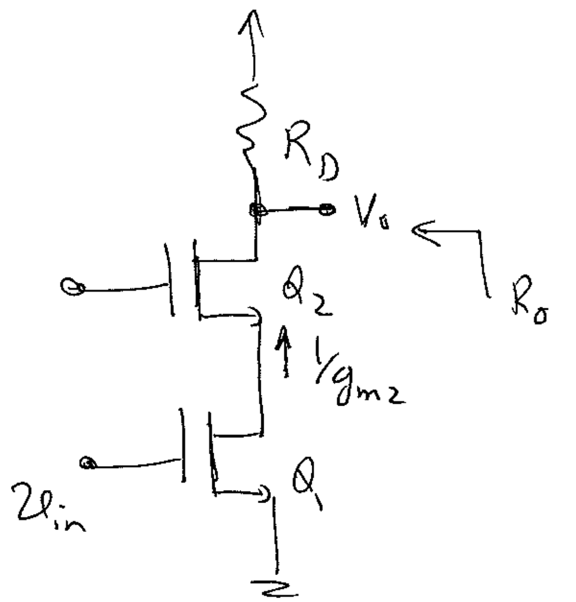
$$R_o \simeq g_{m2} r_{o2} r_{\pi 2}$$

Total Gain $= -g_{m1}(r_{o1} \| r_{\pi 2}) \cdot g_{m2} r_{o2}$

if ignoring r_o's

$$A_v = -g_{m1} \cdot \frac{1}{g_{m2}} \times g_{m2} \cdot R_L = -g_{m1} R_L$$

MOS Cascode



$$R_o = r_{o2}(1 + g_{m2} r_{o1}) \simeq g_{m2} r_{o1} r_{o2}$$

$$\text{Gain ignoring } r_o\text{s} = \left(-g_{m1} \cdot \frac{1}{g_{m2}}\right) \times \left(g_{m2} \cdot R_D\right)$$

$$= -g_{m1} R_D$$