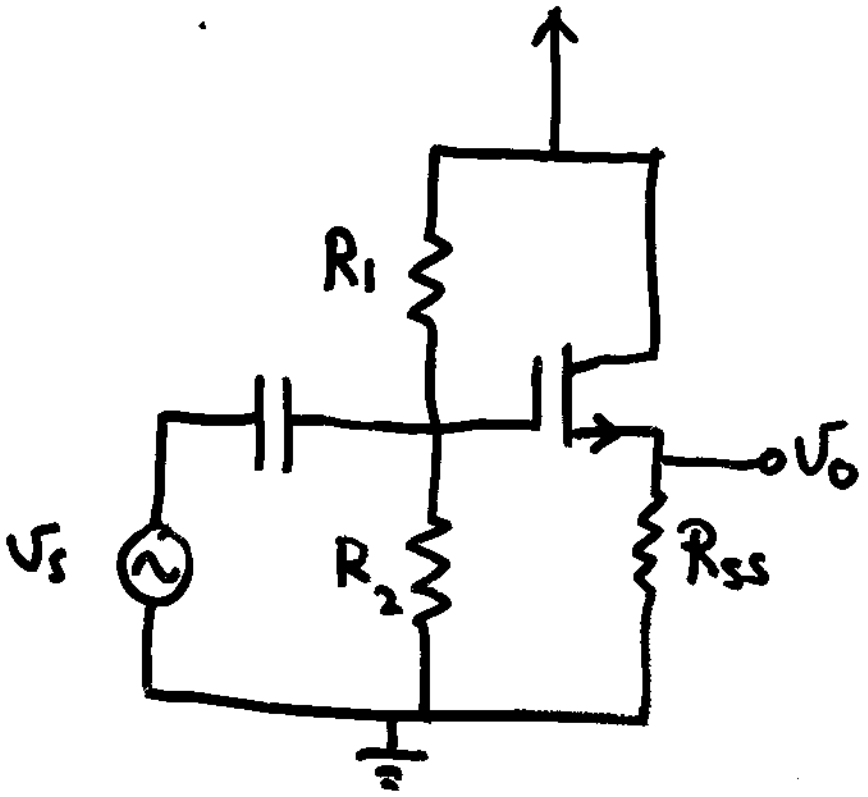
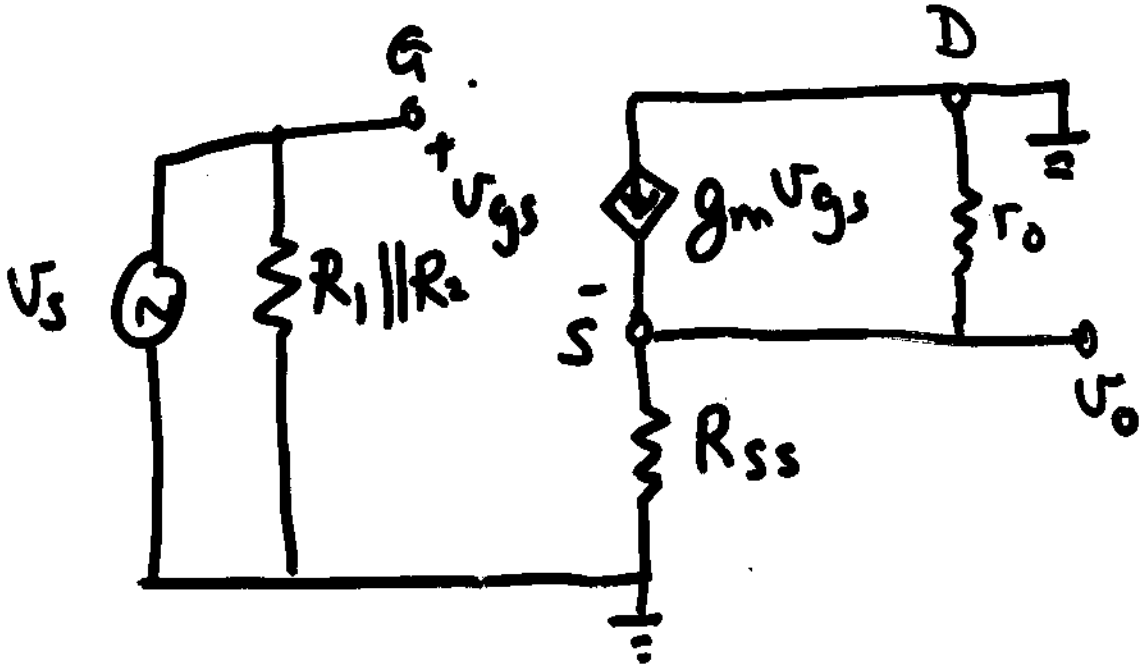
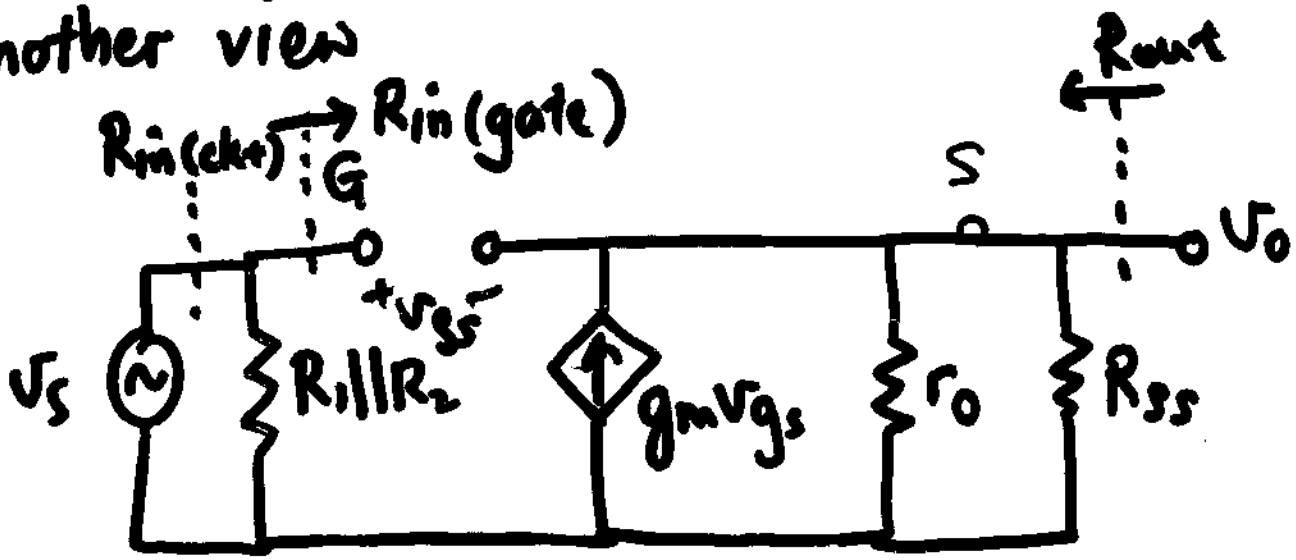
Common-Drain Amplifier
(Source follower)



a.c. equivalent circuit



Another view



$$V_o = g_m V_{gs} (r_o \| R_{ss})$$

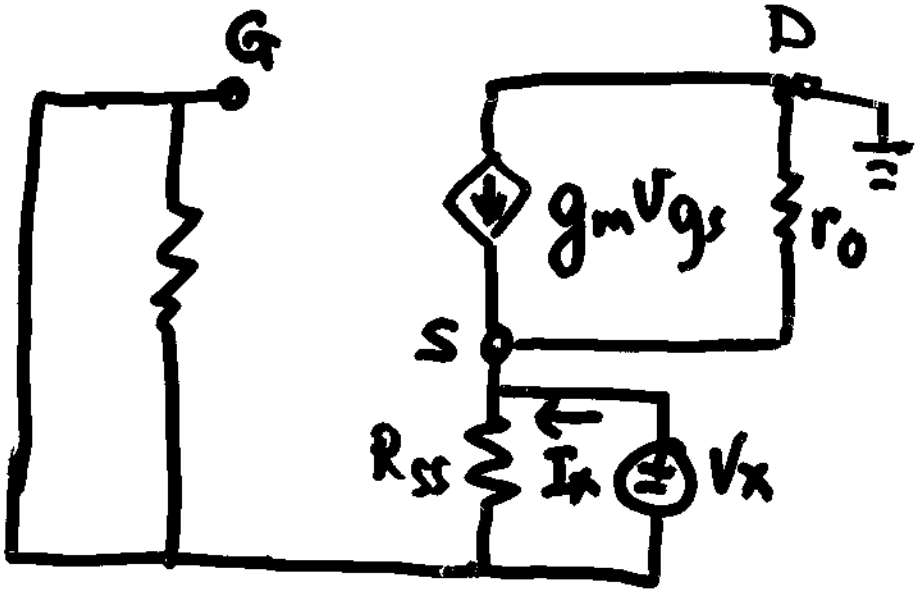
$$V_s = V_{gs} + V_o$$

$$A_{V_s} = \frac{V_o}{V_s} = \frac{g_m (r_o \| R_{ss})}{1 + g_m (r_o \| R_{ss})}$$

$$R_{in(gate)} = \infty$$

$$R_{in(ckt)} = R_1 \| R_2$$

Output impedance



$$I_x = \frac{V_x}{R_{SS}} + \frac{V_x}{r_o} + g_m V_x \qquad (V_x = -V_{gs})$$

$$R_{out} = \frac{V_x}{I_x} = R_{SS} \parallel r_o \parallel \frac{1}{g_m}$$

CC - CD Analogy

CC $$A_{VS} = \frac{(\beta+1)(R_E \| r_o)}{r_\pi + (\beta+1)(R_E \| r_o)}$$

$$R_{in(ckt)} = R_1 \| R_2 \| (r_\pi + (\beta+1)(R_E \| r_o))$$

$$R_{out} = R_E \| r_o \| \frac{r_\pi}{\beta+1}$$

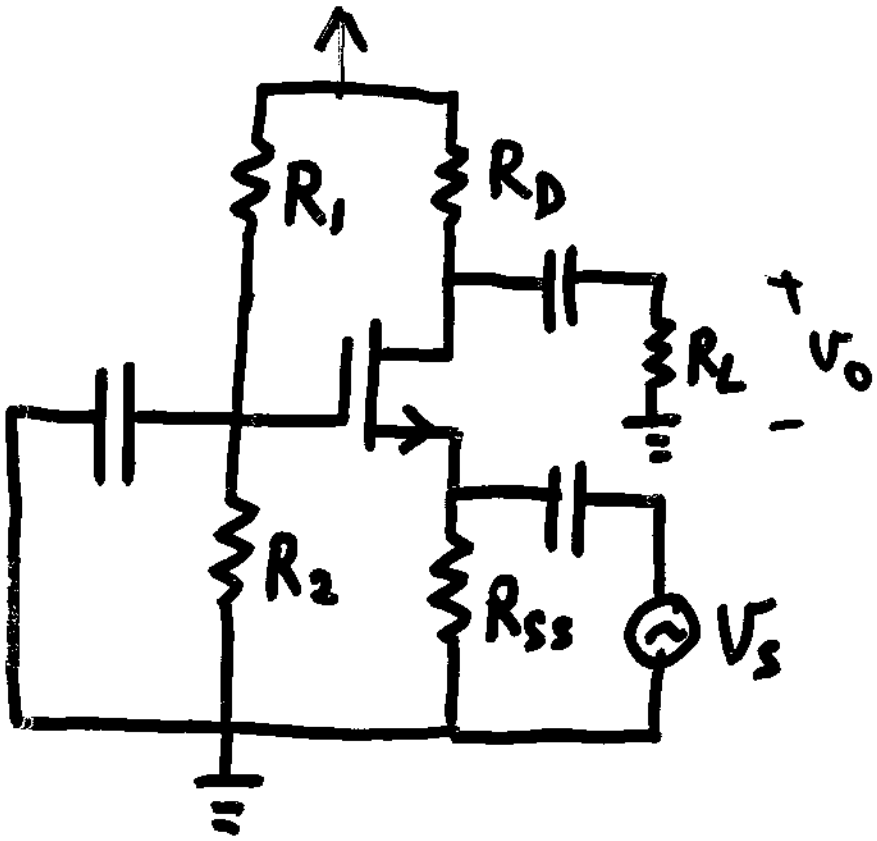
$\beta \to \infty$, $r_\pi \to \infty$, $\frac{\beta}{r_\pi} \to g_m$, $R_E \to R_{SS}$

CD $$A_{VS} = \frac{g_m (R_{SS} \| r_o)}{1 + g_m (R_{SS} \| r_o)}$$

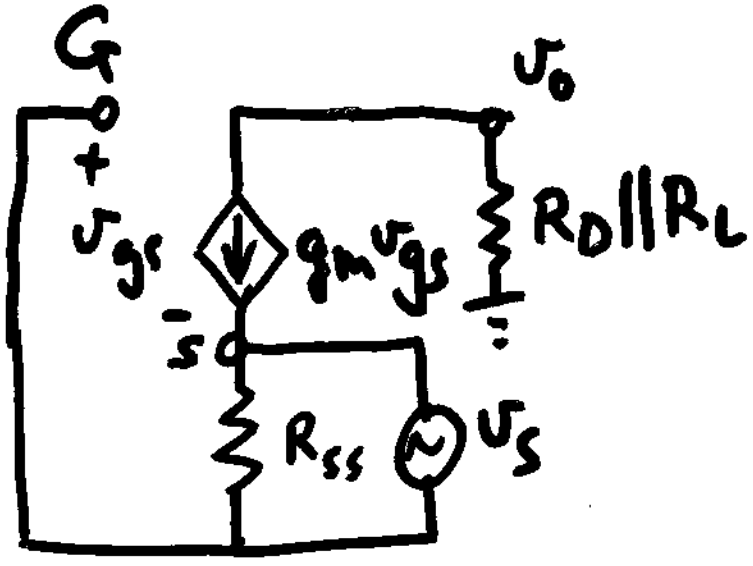
$$R_{in(ckt)} = R_1 \| R_2$$

$$R_{out} = R_{SS} \| r_o \| \frac{1}{g_m}$$

Common-Gate Amplifier



a.c. eq. (ignoring r_o)



$$v_o = g_m v_s (R_D \| R_L)$$

$$A_{v_s} = \frac{v_o}{v_s} = g_m (R_D \| R_L)$$

$$R_{in(ckt)} = \frac{1}{g_m} \| R_{ss}$$

$$R_{out} = R_D$$

$$A_{i_s} = \frac{v_o / R_L}{v_s / R_{in(ckt)}}$$

$$= g_m \frac{R_D}{R_D + R_L} \frac{R_{ss}}{1 + g_m R_{ss}}$$

$$\simeq \frac{R_D}{R_D + R_L}$$

Summary/Comparison

	R_{in}	R_{out}	A_v	A_i
CE	moderate	large	large	large
CB	small	large	large	< 1
CC	large	small	< 1	large
CS	immense	large	large	large
CG	small	large	large	< 1
CD	immense	small	< 1	large