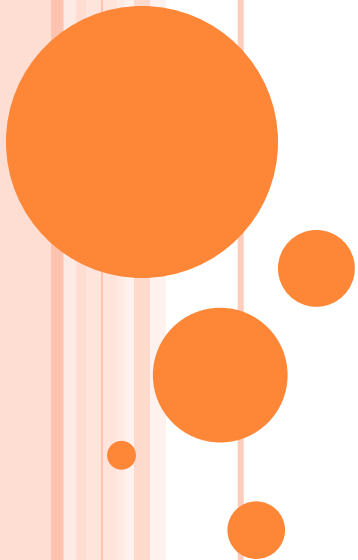


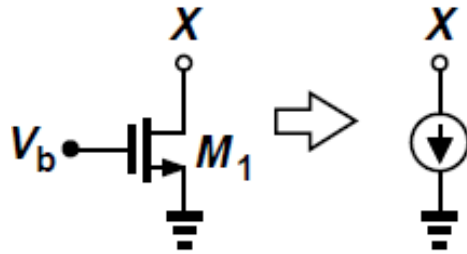
Common-Source Stage 2

Lecture 37, 38

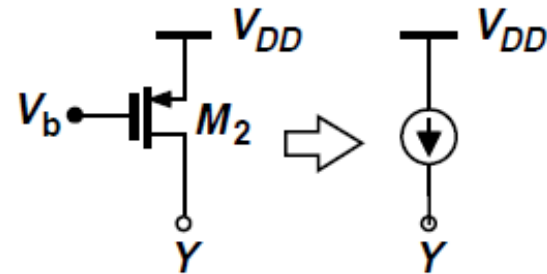
2014142120 Shin ChaJin



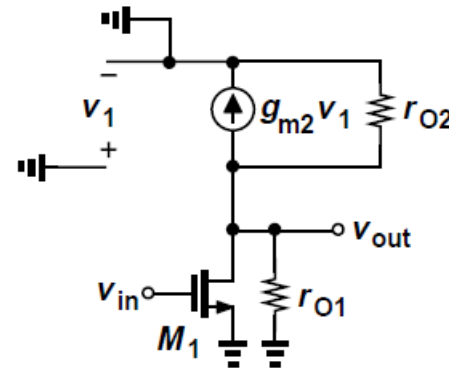
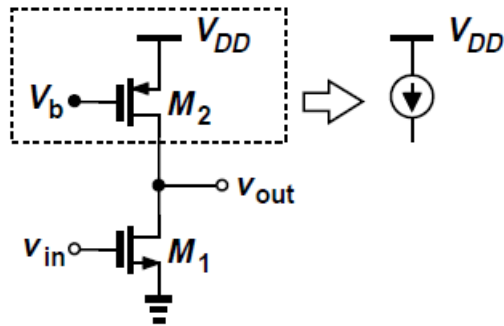
Current Source Load



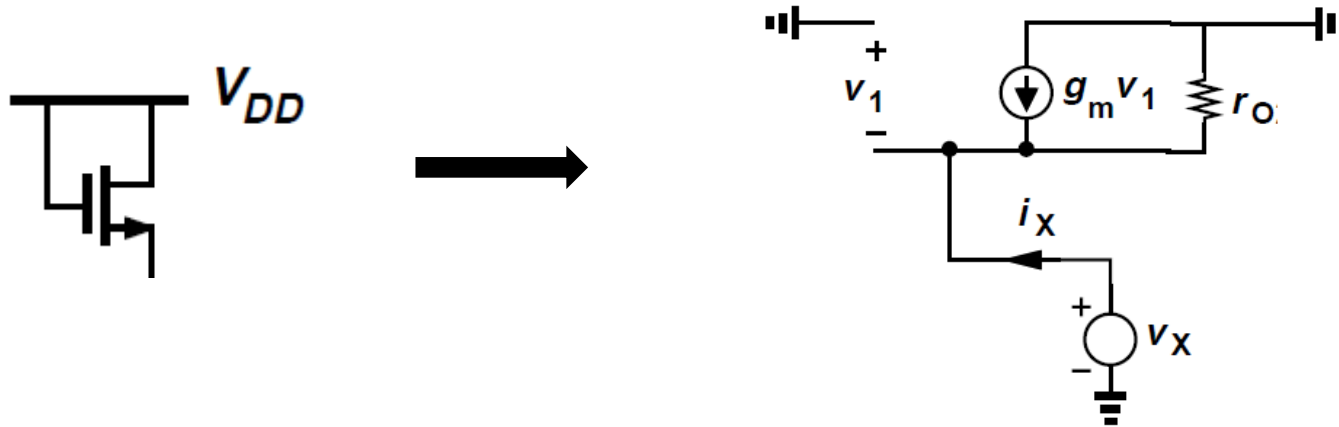
NMOS as a current source



PMOS as a current source



Diode Connected Load



$$V_1 = -V_X$$

$$V_X + g_m r_0 V_X = i_X r_0$$

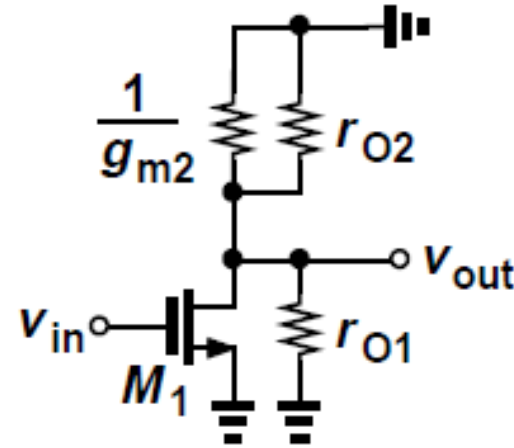
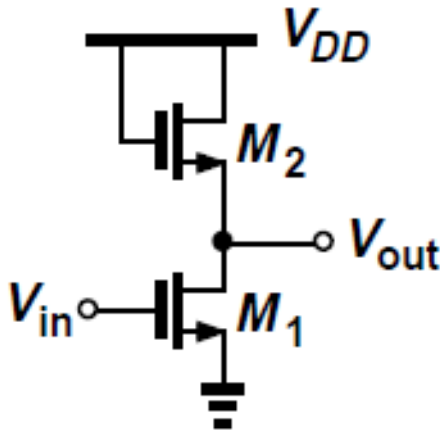
$$i_{r_0} = i_X + g_m V_1$$

$$\frac{V_X}{i_X} = \frac{r_0}{1 + g_m r_0} = \frac{1}{\frac{1}{r_0} + g_m} = \frac{1}{g_m} \parallel r_0$$

$$V_X = (i_X + g_m V_1) r_0$$



Diode Connected Load



$$A_v = -g_{m1} \times \frac{1}{g_{m2}} \quad g_m = \sqrt{2\mu_n C_{ox} \frac{W}{L} I_D}$$

$$A_v = -\frac{\sqrt{2\mu_n C_{ox} \left(\frac{W}{L}\right)_1 I_D}}{\sqrt{2\mu_n C_{ox} \left(\frac{W}{L}\right)_2 I_D}} = -\sqrt{\frac{\left(\frac{W}{L}\right)_1}{\left(\frac{W}{L}\right)_2}} \quad (\lambda=0)$$

$$A_v = -g_{m1} \times \left(\frac{1}{g_{m2}} \parallel r_{O1} \parallel r_{O2}\right) \quad (\lambda \neq 0)$$

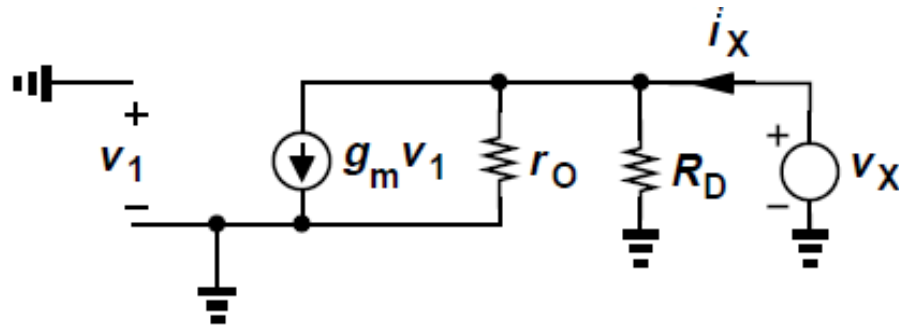


I/O Impedance of CS Stage

- Input Impedance

$$R_{in} = \frac{V_x}{i_x} = \infty$$

- Output Impedance



$$V_1 = 0$$

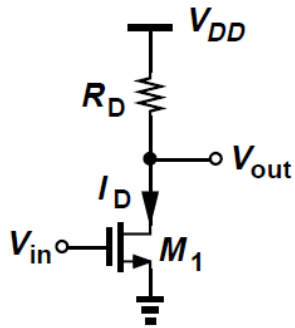
$$g_m V_1 = 0$$

$$\frac{V_X}{i_X} = R_D || r_o$$

$$r_o || R_D$$



Gain Variation



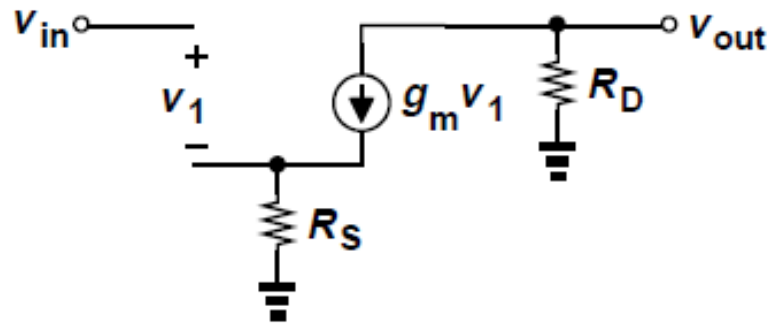
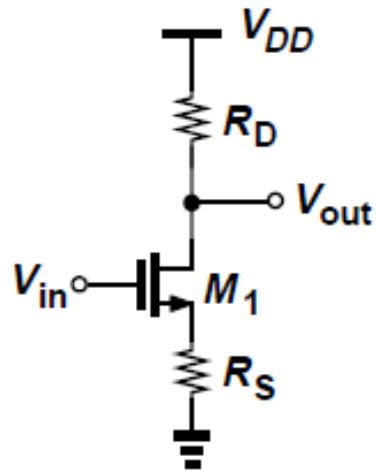
$$A_V = -g_m(R_D || r_O)$$
$$g_m = \sqrt{2\mu_n C_{ox} W/L I_D}$$

- 1. Temperature – μ_n
- 2. Supply voltage – I_D
- 3. Process
- 4. Signal level

$$I_D = \mu_n C_{ox} \frac{W}{L} \left\{ (V_{GS} - V_{TH})V_{DS} - \frac{1}{2}V_{DS}^2 \right\}$$



CS Stage with Degeneration



$$V_{in} = v_1 + g_m v_1 R_s$$

$$v_1 = \frac{v_{in}}{1 + g_m R_s}$$

$$v_{out} = -g_m v_1 R_D$$

$$\frac{v_{out}}{v_{in}} = -\frac{g_m R_D}{1 + g_m R_s} = -\frac{R_D}{\frac{1}{g_m} + R_s}$$

$$A_V = -\frac{\text{Resistance tied between Drain and ac GND}}{\frac{1}{g_m} + \text{Resistance tied between Source and ac GND}}$$

Thank you for listening !

