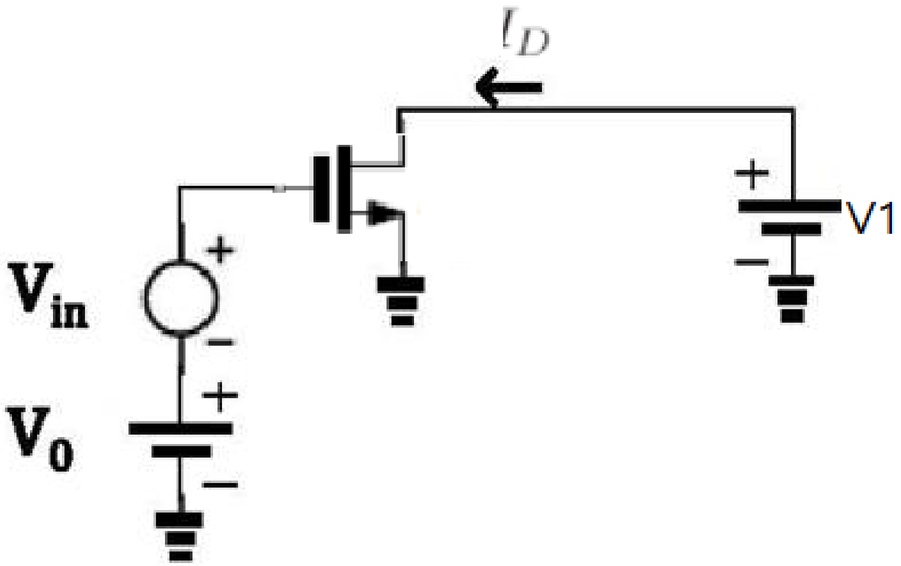
Lesson 28: Small-Signal Model

2012142164 Shin dong woo



$$\lambda = 0$$

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

$$= \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_O - V_{TH} + V_m sinwt)^2$$

Assume $V_m \ll V_0 - V_{TH}$ & $(1+\varepsilon)^2 \approx 1 + 2\varepsilon$

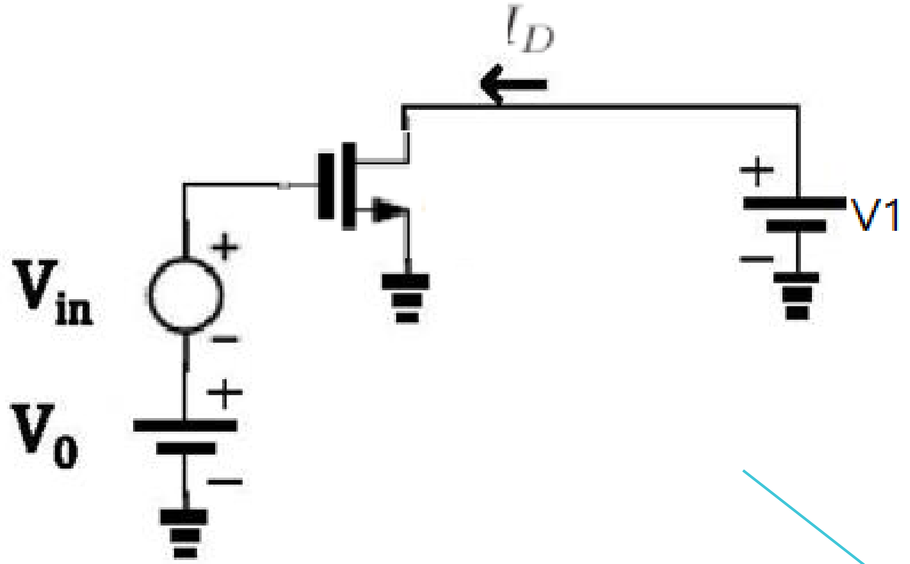
$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_0 - V_{TH})^2 \left(1 + 2\frac{V_m sinwt}{V_O - V_{TH}}\right)$$

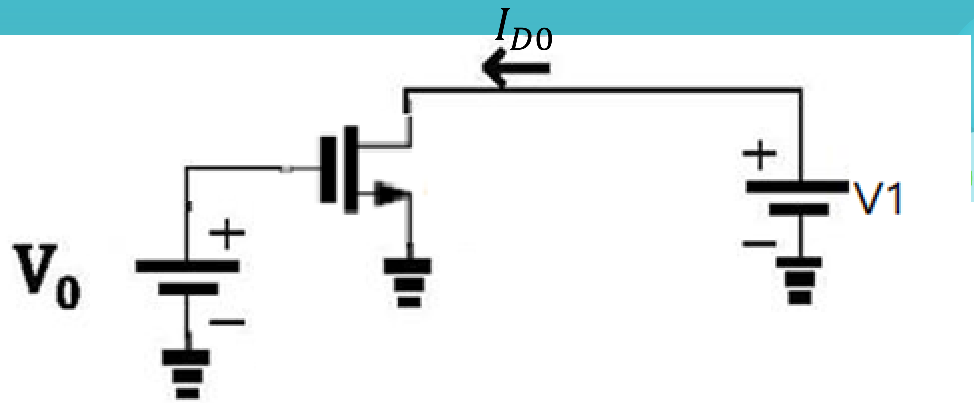
$$I_{D0} = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_0 - V_{TH})^2$$

$$I_D = I_{D0} + 2\frac{I_{D0}}{V_O - V_{TH}}V_m sinwt$$

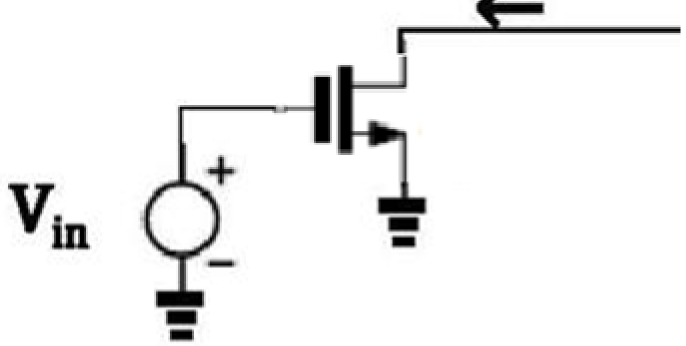
Bias current

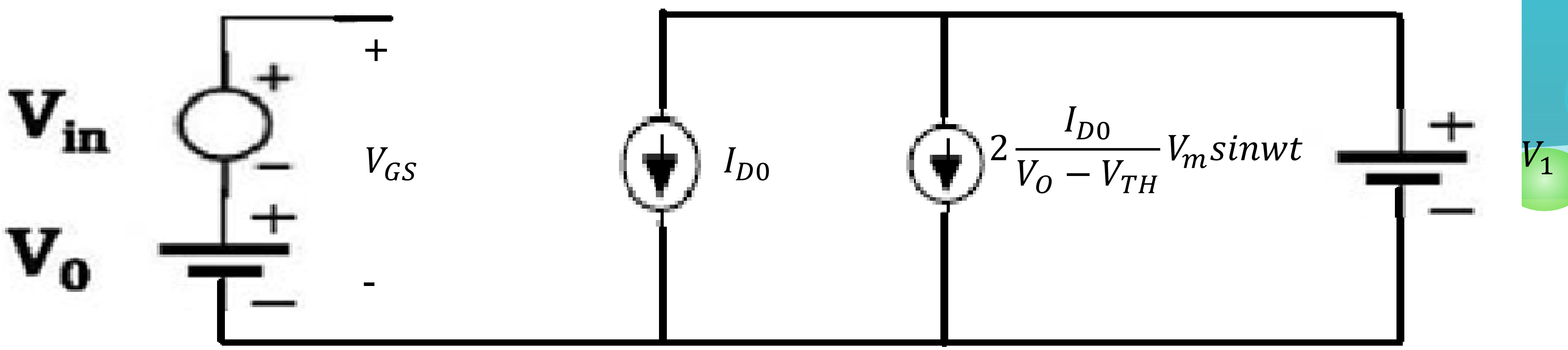
signal current





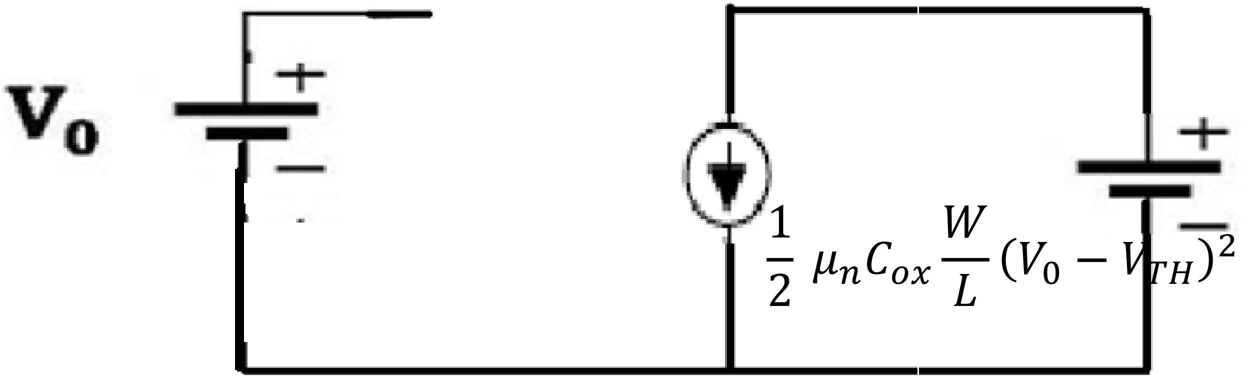
$$2\frac{I_{D0}}{V_O - V_{TH}}V_m sinwt$$

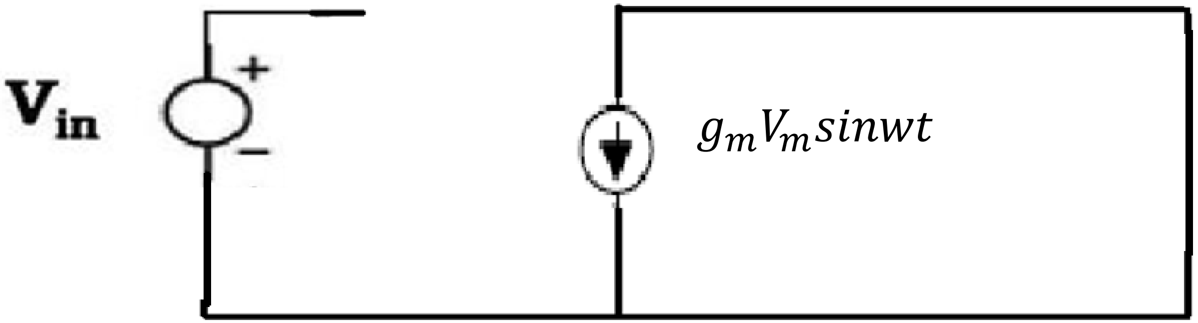




trans conductance

$$g_m = 2\frac{I_{D0}}{V_O - V_{TH}}$$





Large signal
(bias model)=>const.

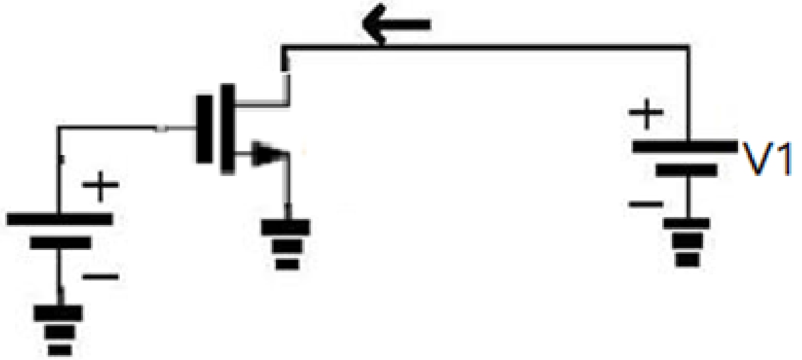
Small signal model
=>changed by time

General procedure for constructing a small signal model

1. Apply proper bias voltages to the device

$$I_D = I_{D0} + g_m \Delta V$$

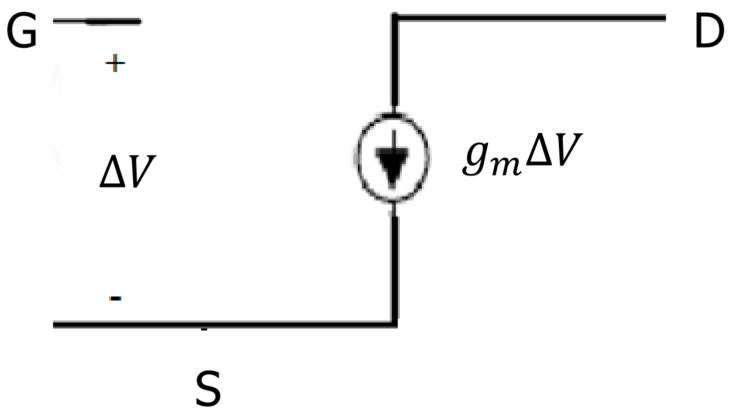
$V_0 + \Delta V = \mathbf{V_0}$

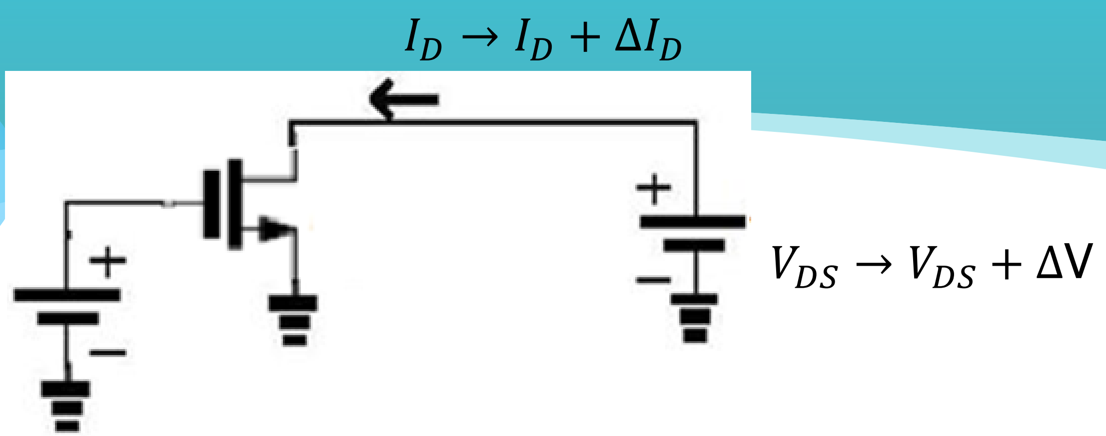


2. Increment the voltage difference between two terminals.

3. Measure all current increments.

4. Model this change by a proper electrical device.





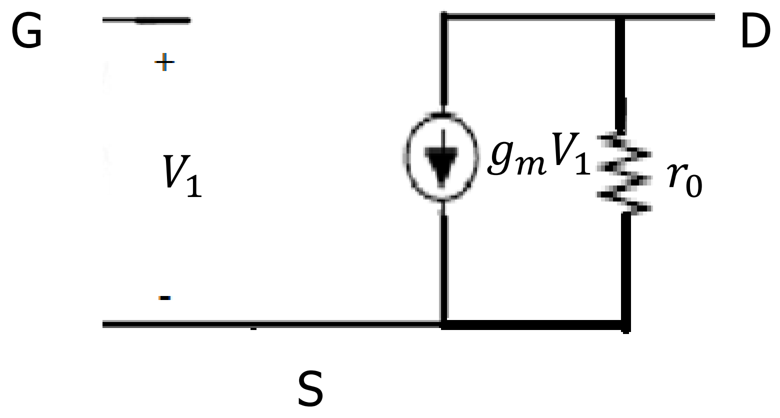
$$I_D + \Delta I_D = \frac{1}{2}\,\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{TH})^2(1 + \lambda V_{DS} + \lambda \Delta V)$$

$$=> \Delta I_D = \frac{1}{2}\,\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{TH})^2(\lambda \Delta V)$$

$$=> \frac{\Delta V}{\Delta I_D} = \left(\frac{1}{2}\,\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{TH})^2\lambda\right)^{-1}$$

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

$$\frac{\Delta V}{\Delta I_D} \approx \frac{1}{\lambda I_D} = r_0$$



THANK YOU FOR LISTENING