CHAPTER 7

Basic FET Amplifiers

- For linear amplifier function, FET is normally biased in the saturation region

AC PARAMETERS

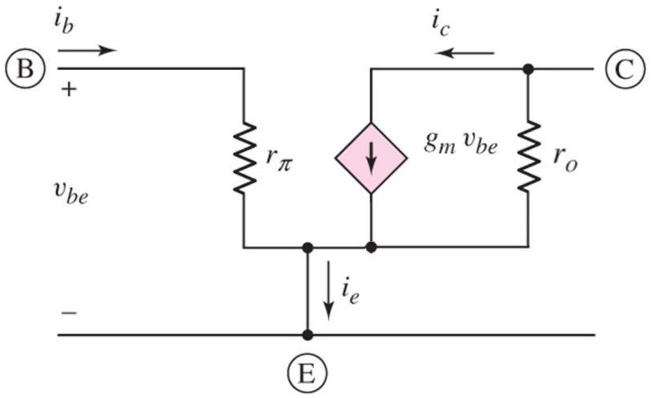
$$g_m = 2\sqrt{K_n I_{DQ}}$$

$$r_0 = \frac{V_A}{I_{DQ}}$$

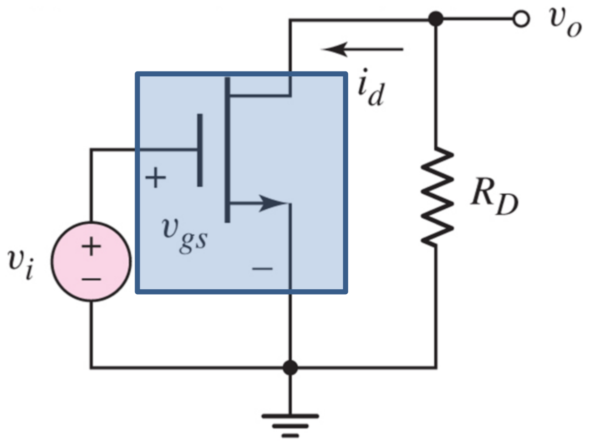
where

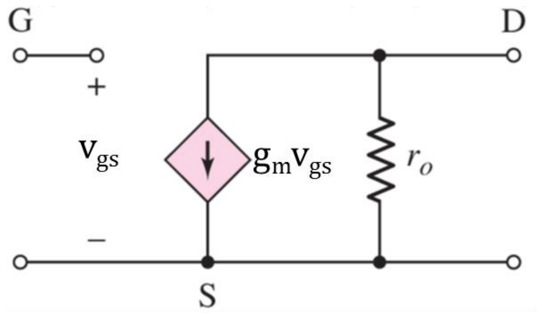
$$V_A = \frac{1}{\lambda}$$

Need to do DC Analysis first to find I_D



BJT AC Equivalent





NMOS Transistor Small-Signal Parameters

- Derivation of g_m

$$I_D = K_n (V_{GS} - V_{TN})^2$$

$$I_D = K_n (V_{GS}^2 - 2V_{GS}V_{TN} - V_{TN}^2)$$

$$I_D = K_n V_{GS}^2 - 2 K_n V_{GS}V_{TN} - K_n V_{TN}^2)$$

$$g_m = \frac{\partial I_D}{\partial V_{GS}} = 2K_n V_{GS} - 2 K_n V_{TN} = 2 K_n (V_{GS} - V_{TN})$$

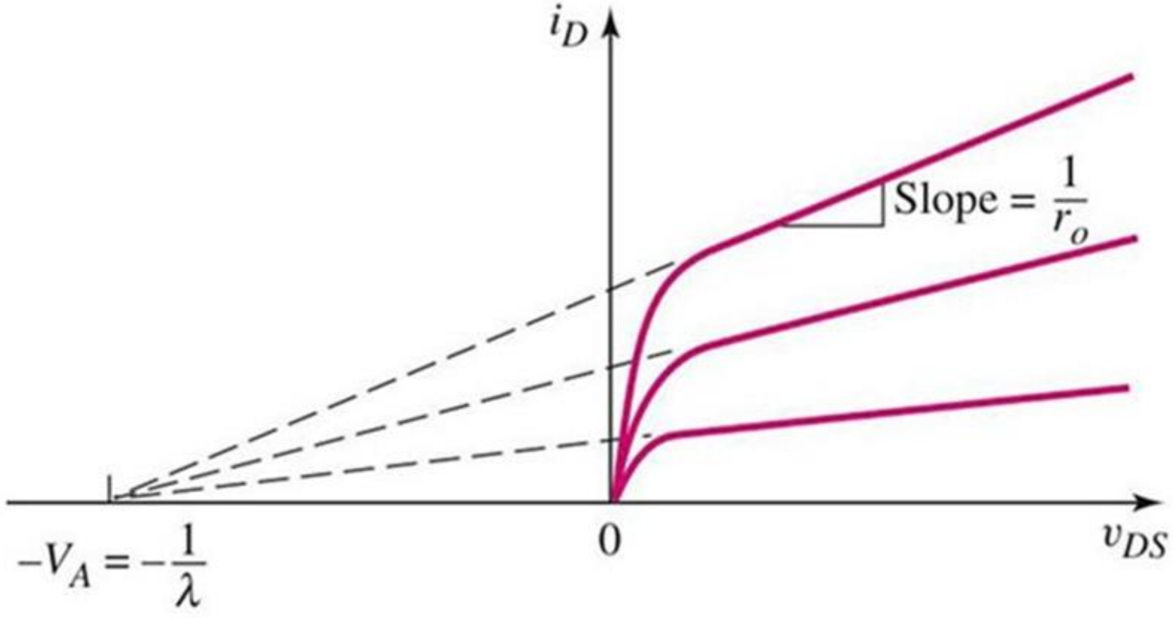
Differentiation of I_D with respect to V_{GS}

$$g_m = 2 K_n \sqrt{\frac{I_D}{K_n}}$$

$$g_m = 2 \sqrt{\frac{K_n^2 I_D}{K_n}}$$

$$g_m = 2\sqrt{K_n I_D}$$

Channel Length Modulation:
Early Voltage



NMOS Transistor Small-Signal Parameters

- Derivation of r_o

$$I_D = K_n (V_{GS} - V_{TN})^2 (1 + V_{DS} \lambda)$$

Differentiation of I_D with respect to V_{DS}

$$r_o = \frac{\partial I_D}{\partial V_{DS}}^{-1} = [\lambda K_n (V_{GS} - V_{TN})^2]^{-1}$$

$$r_o = \frac{1}{[\lambda K_n (V_{GS} - V_{TN})^2]} = \frac{V_A}{I_D}$$

⇒

$$r_o = \frac{V_A}{I_D}$$