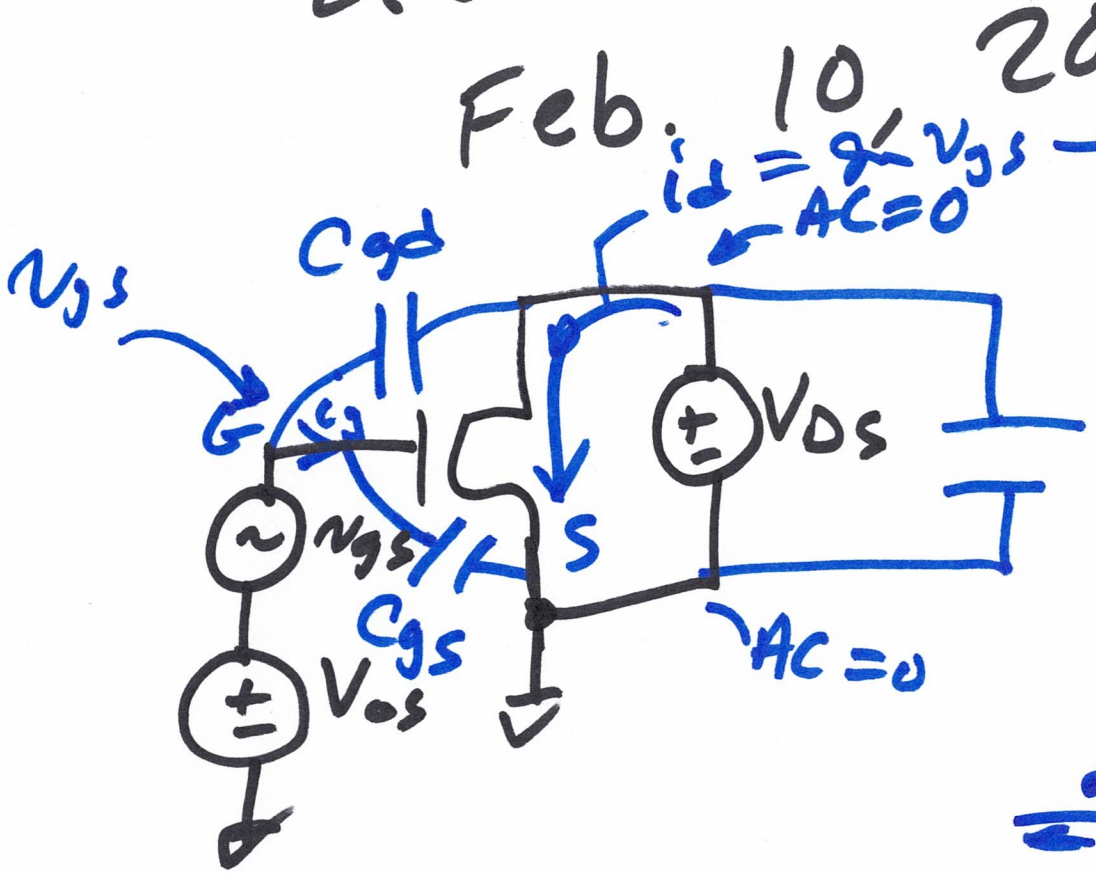
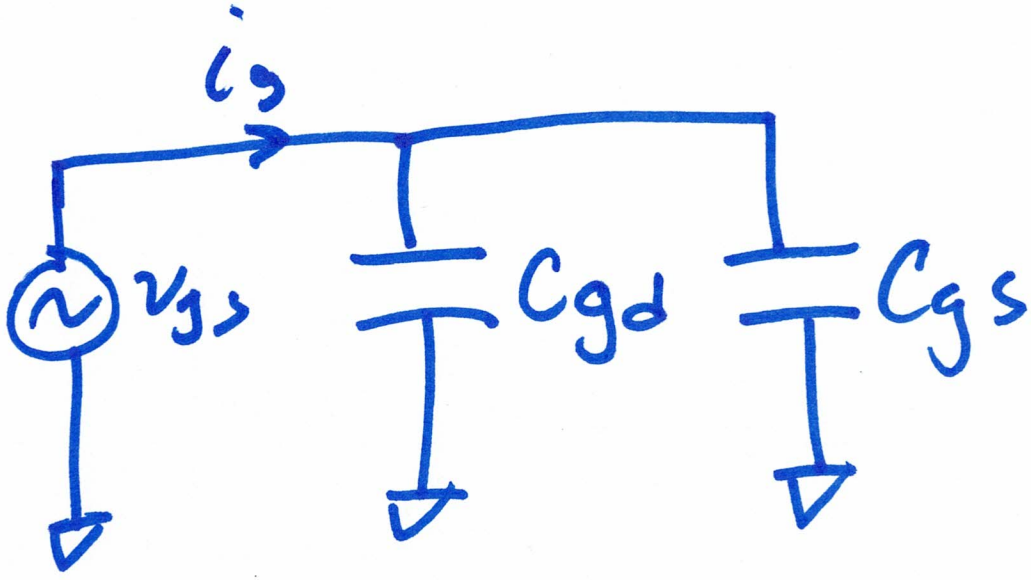
EE 420/ECG 620
Analog IC Design
Lecture 6
Feb. 10 2020



displacement current

Takhee



$$i_g = \frac{v_{gs}}{\frac{1}{jw(C_{gd}+C_{gs})}} = v_{gs} \cdot jw(C_{gd}+C_{gs})$$

$$v_{gs} = \frac{i_d}{g_m}$$

$$\left|\frac{i_d}{i_g}\right| = \frac{g_m}{w \cdot (C_{gd}+C_{gs})}$$

$$1 = \left|\frac{i_d}{i_g}\right| = \frac{g_m}{2\pi f_T (C_{gd} + C_{gs})}$$

$$C = \frac{\epsilon \cdot A}{t}$$

ϵ_{ox} / tot.

$$\left|\frac{i_d}{i_g}\right| = 1 \;,\; f = f_T$$

f_T : transition freq.

$\mu_N \cdot C_{ox}'$

$$g_m = KP \cdot \frac{W}{L}\underbrace{(V_{GS} - V_{THN})}_{\text{overdrive}}, \quad V_{OVN} = V_{DS,SAT}$$

$\beta = KP \cdot \frac{W}{L}$

amp ↓ attenuation

$$f_T = \frac{g_m}{2\pi \cdot (C_{gd} + C_{gs})}$$

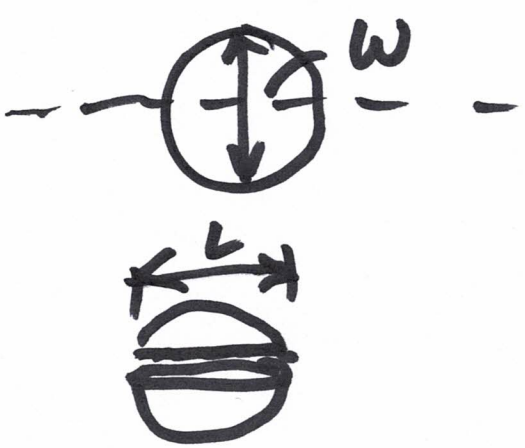
$\beta = \mu_N C_{ox} \cdot \frac{W}{L}$

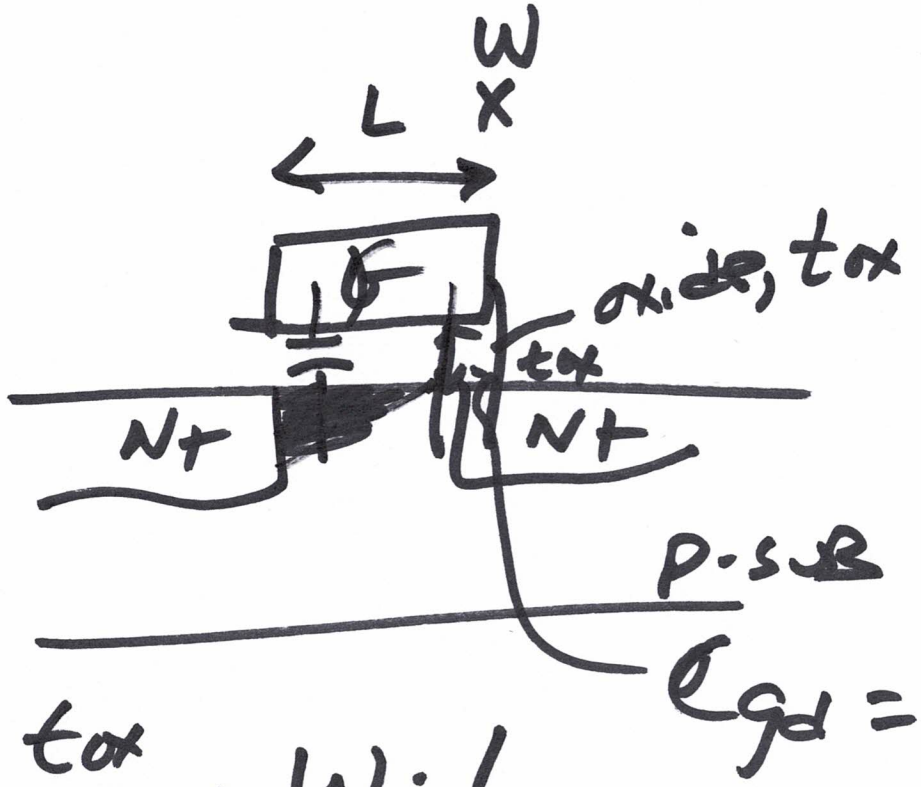
$$f_T \approx \frac{\mu_N \cdot C_{ox}' \cdot (V_{GS} - V_{THN}) \cdot \frac{W}{L}}{2\pi \cdot \frac{2}{3} W \cdot L \cdot C_{ox}'}$$

$\frac{2}{3} C_{ox}$

$C_{gs} >> C_{gd}$

3)

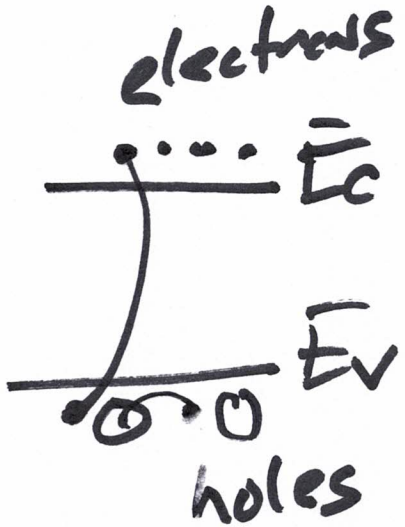




$$C_{ox} = \underbrace{\frac{t_{ox}}{t_{ox}}}_{C_{ox}'} \cdot W \cdot L$$

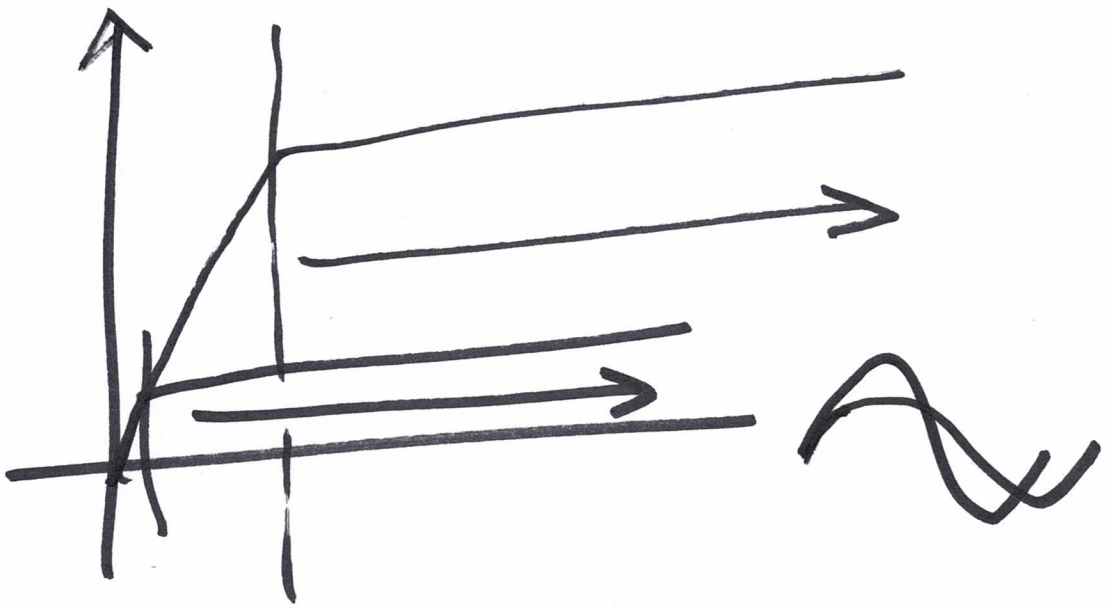
$$C_{gd} =$$

$$f_T \simeq \frac{\mu_N \cdot (V_{GS} - V_{THN}) \cdot}{2\pi \cdot \frac{2}{3} \cdot L^2}$$

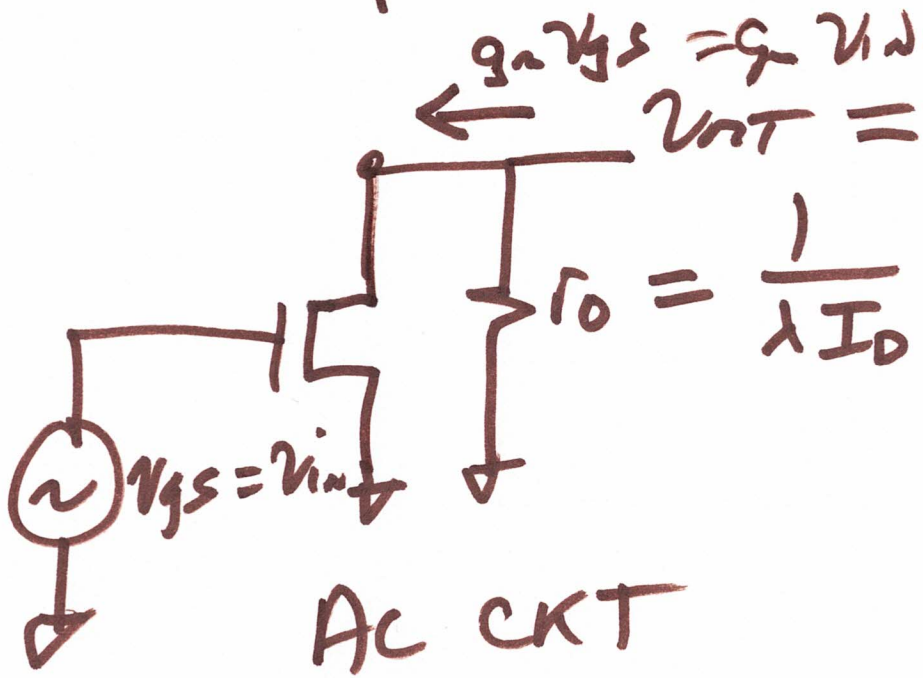


$$V_{GS} - V_{THN} = V_{DS,SAT} = V_{OV,N}$$

W → selected based current drive needed



Open-CKT Gain



$$\text{Open CKT} = \left|\frac{v_{out}}{v_{in}}\right| = g_m \cdot \frac{1}{\lambda I_D} = \frac{\sqrt{2K_P \cdot \frac{W}{L} \cdot I_D}}{\lambda I_D}$$

gain

$$g_m r_o = \frac{\sqrt{2K_P \cdot \frac{W}{L}}}{\lambda \sqrt{I_D}}$$

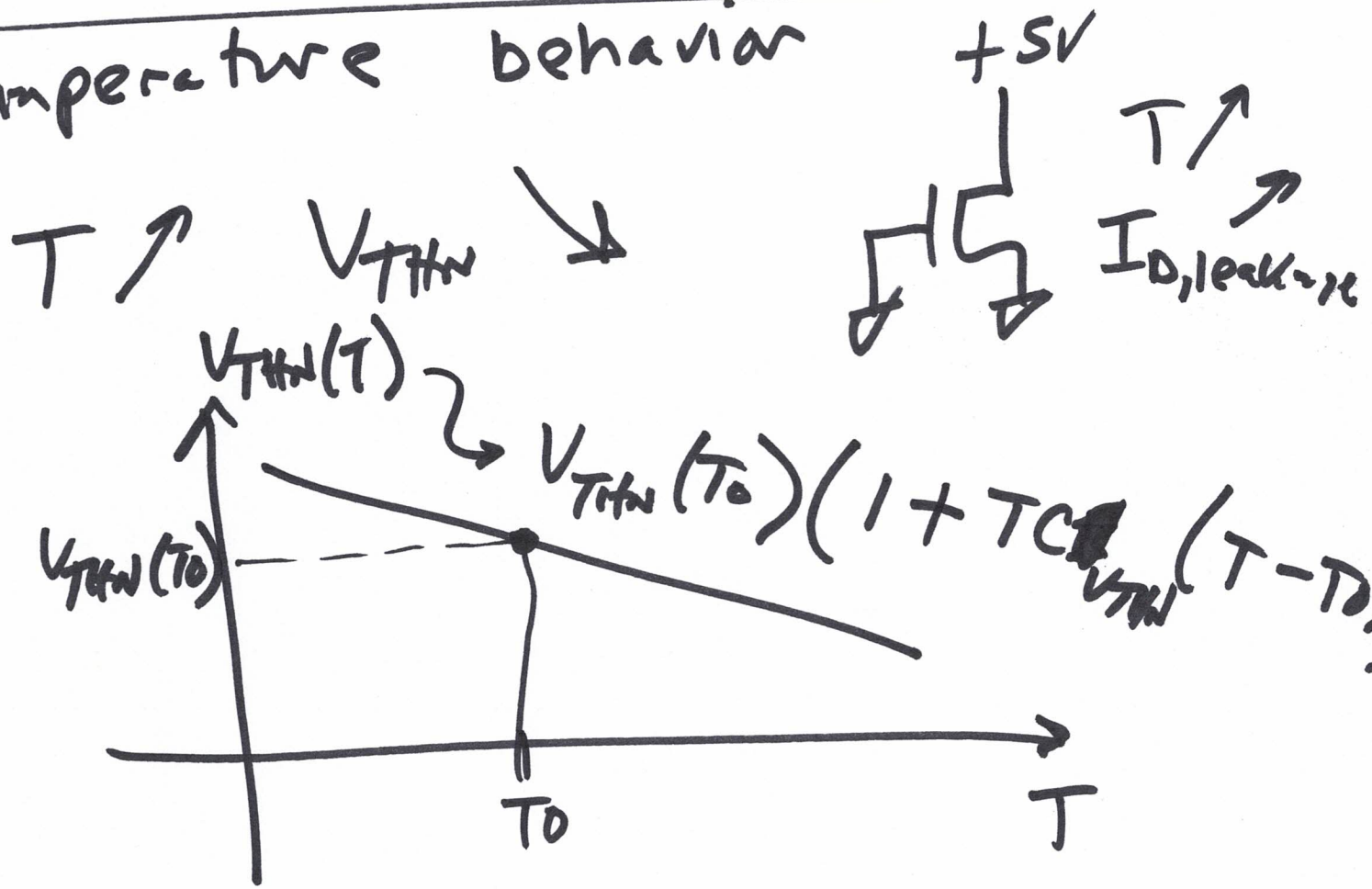
low I_D

$g_m r_o \uparrow$

Figure of MERIT

GAIN · FT (product)

Temperature behavior



4

$\mu \downarrow \quad T \uparrow \qquad\qquad V_{THN} \downarrow \quad T \uparrow$

$$I_D = \frac{\mu_N \cdot C_{ox}}{2} \cdot \frac{W}{L}\left(V_{GS} - V_{THN}\right)^2$$