EE 420/ECG 620

Lecture 7

Feb. 13, 2019

Analog IC Design

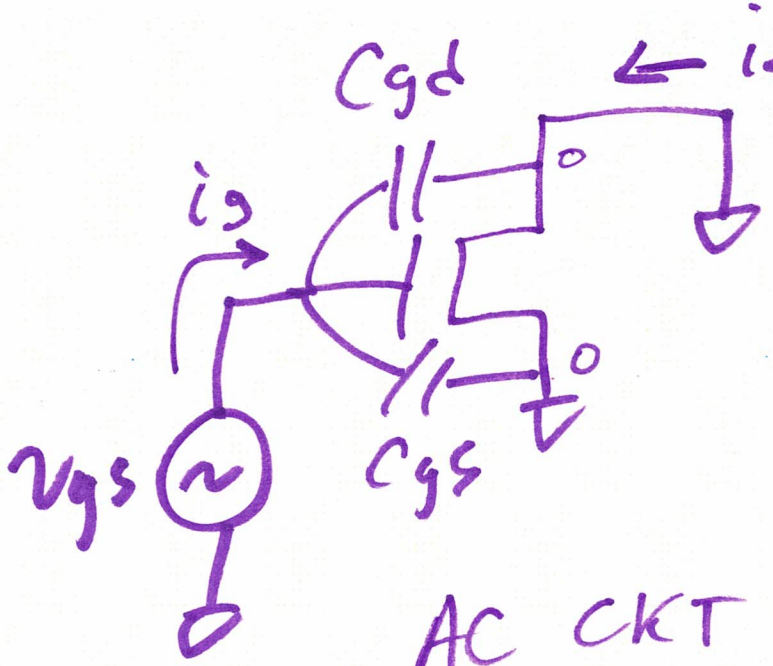
$$r_o = \frac{1}{\lambda I_D}$$

$$g_m \cdot r_o = \frac{\cancel{KP}\frac{W}{L}(V_{OS} - \cancel{V_{THN}}) \cdot 1}{\lambda \cancel{\frac{KP}{2}}\frac{W}{L}(V_{OS} - V_{THN})^2}$$

$$I_D = \frac{KP}{2}\cdot\frac{W}{L}(V_{OS} - V_{THN})^2 \quad = \quad \frac{2}{\lambda \cdot (V_{OS} - V_{THN})}$$

$$g_m r_o \propto \frac{1}{\lambda \cdot (V_{OS} - V_{THN})}$$

$V_{OS} \uparrow \quad g_m r_o \downarrow$



$$i_g = \frac{v_{gs}}{j\omega(C_{gs}+C_{gd})}$$

AC CKT $\left|\frac{i_d}{i_g}\right| = 1$ @ f_T

$$1 = \left|\frac{i_d}{i_g}\right| = \left|\frac{g_m}{j\omega_T(C_{gs}+C_{gd})}\right|$$

$$f_T = \frac{KP\frac{W}{L}(V_{GS}-V_{THN})}{2\pi(C_{gs}+C_{gd})} \qquad f_T = \frac{g_m}{2\pi(C_{gs}+C_{gd})}$$

$$f_T \propto (V_{GS}-V_{THN}) = V_{OVN} = V_{DS,SAT}$$

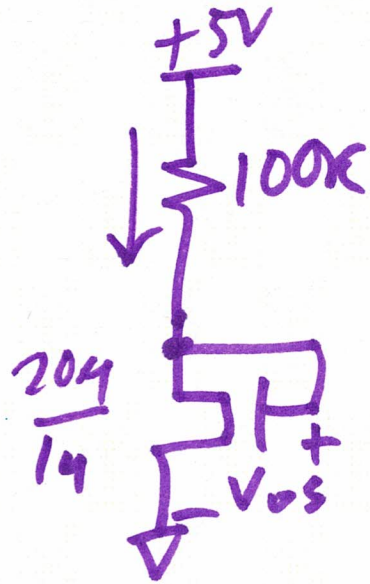
2) $V_{GS} \uparrow \; f_T \uparrow$

CURRENT MIRRORS

201132

1132

1µ process



$$\frac{5-V_{GS}}{100K} = \frac{120\mu}{2}\cdot\frac{20}{1}\cdot(V_{GS}-V_{TH})^2$$

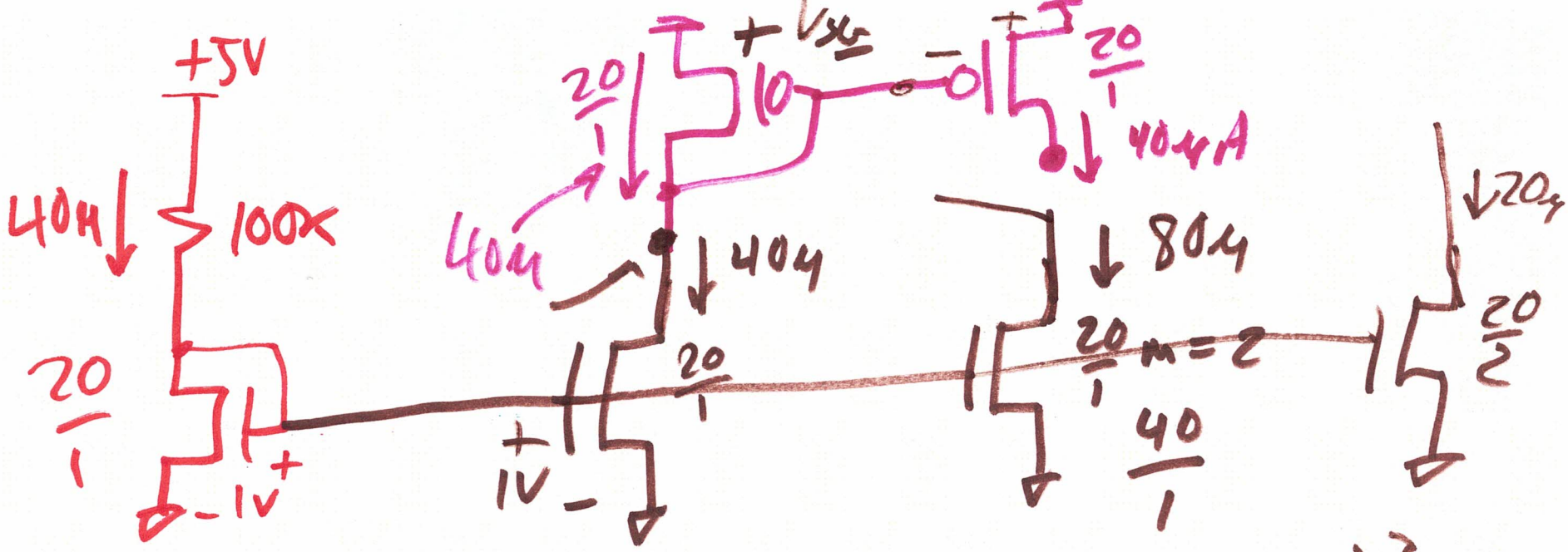
$$\frac{\frac{L}{R}}{5-V_{GS}} = 120(V_{GS}-.8)^2$$

L	R	V_{GS}
→ 4	4.8	1
4.05	2.7	.95
3.9	16.8	1.1
		9.7
4.03	3.9	
4.02	3.88	.98) .985
4.01	4.32	.99

$V_{GS} \cong 1V$

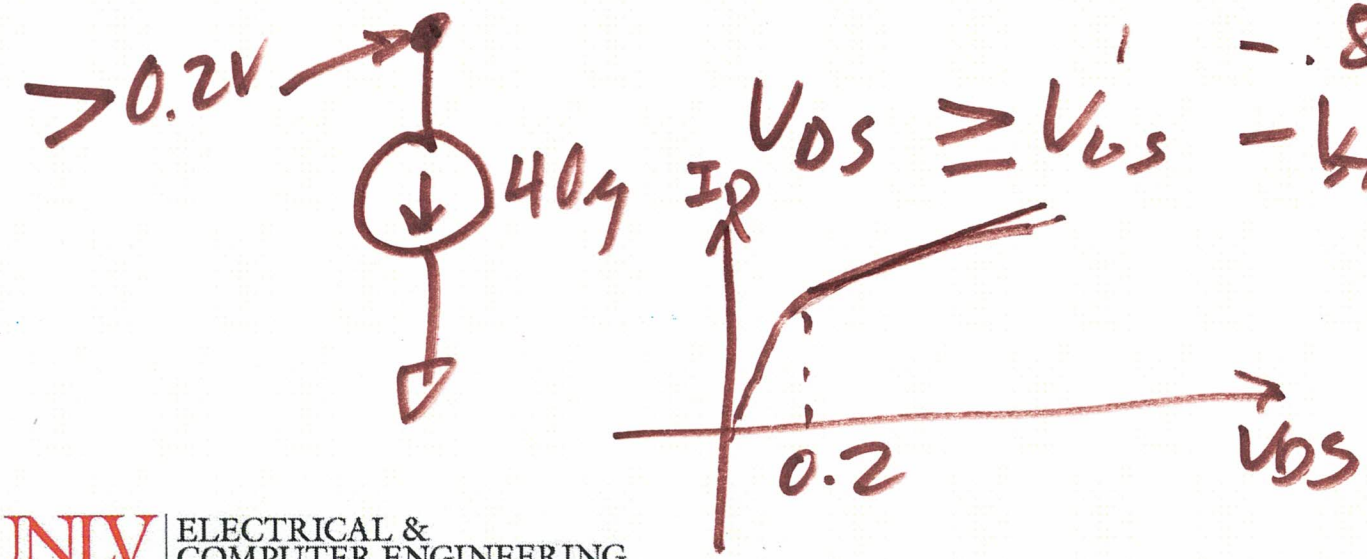
$$\frac{5-1}{100K} = 40\mu A$$

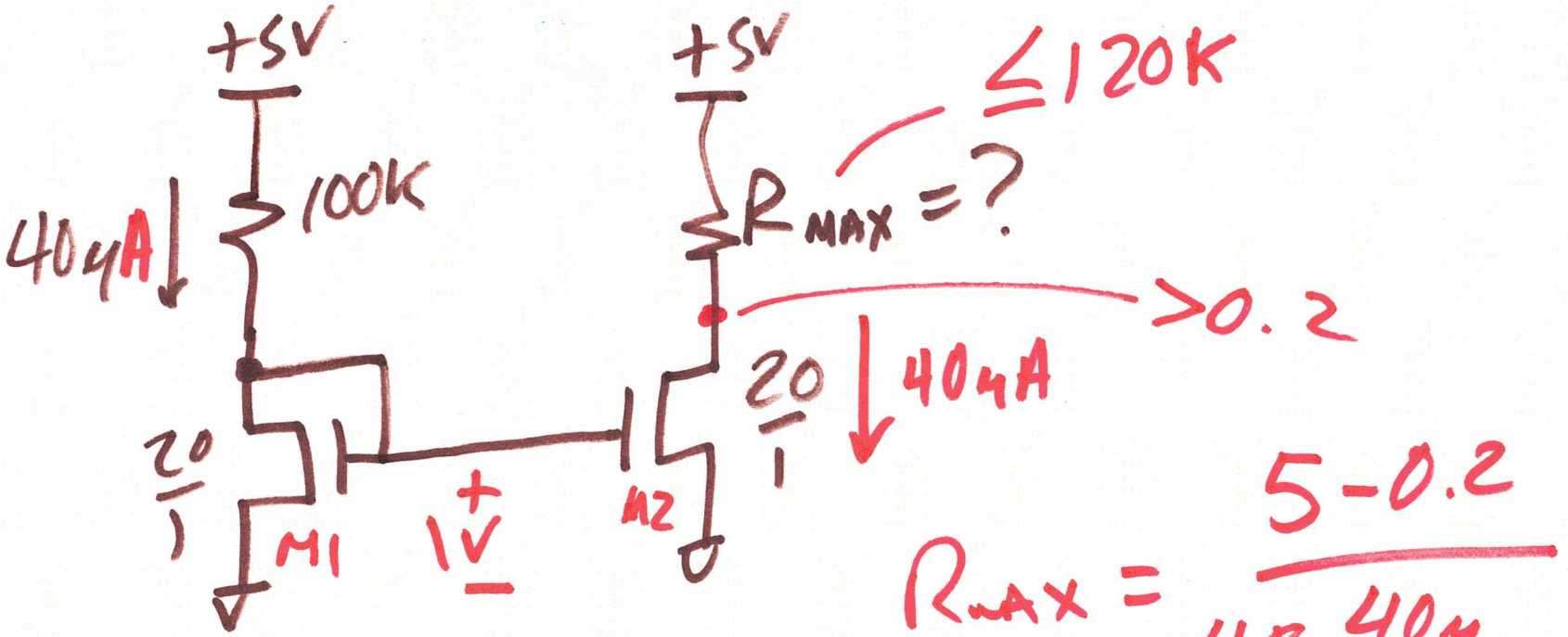
$$\frac{4\cdot 10}{10^6} = 40\mu A$$



$$80\mu = \frac{KP}{2} \cdot \frac{2W}{L}\left(V_{GS} - V_{TH}\right)^2$$

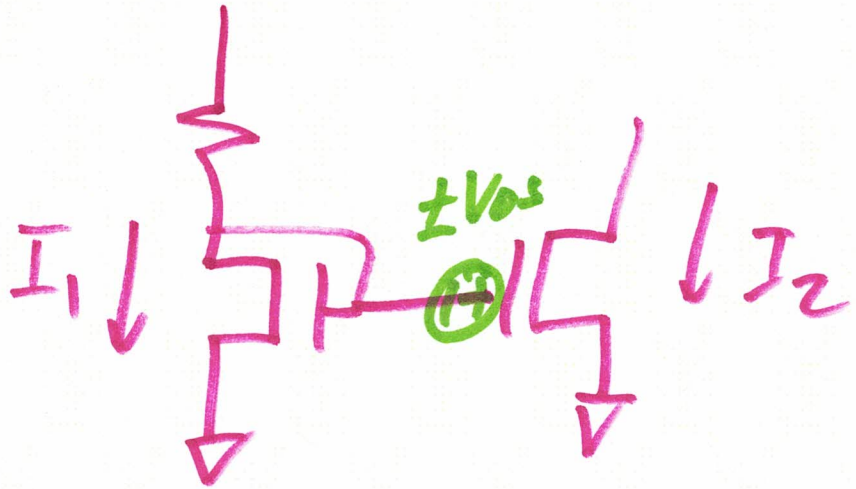
$$V_{DS} \geq V_{GS} - V_{TH} = 0.2$$





$$R_{MAX} = \frac{5 - 0.2}{40\mu} = \frac{4.8}{40\mu} = 120K$$

$$I_D = \frac{KP}{2}\frac{W}{L}(V_{GS} - V_{THN})^2$$



$$I_1 \neq I_2$$