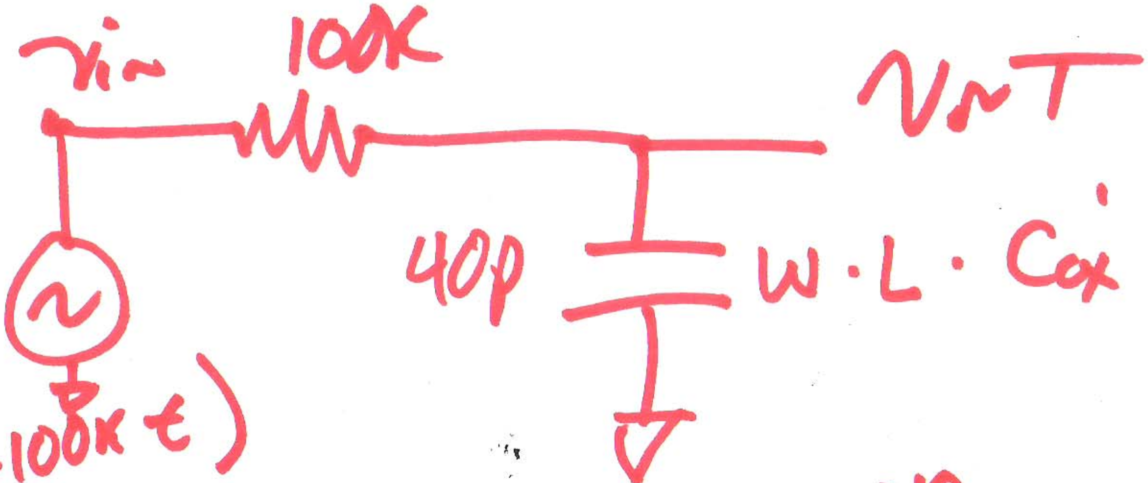
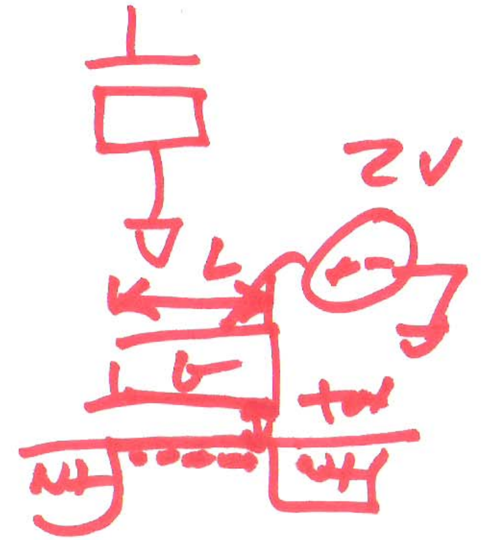
# EE 320 Electronics

3/31/14




$2V + 1mV \cdot \sin(2\pi \cdot 100k\, t)$




p-sub

$$\frac{\varepsilon_{ox}}{t_{ox}} \cdot W \cdot L \qquad 3.9 \cdot 8.85 \times 10^{-12} \frac{F}{m}$$

$C'_{ox}$ #2

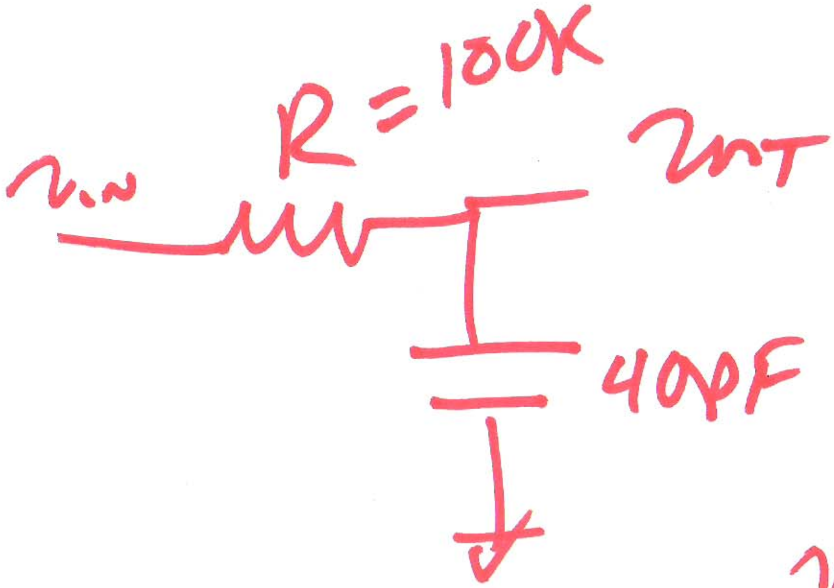
$$100\,\text{Å} = 100 \cdot 10^{-10} = 10^{2} \cdot 10^{-10} = 10^{-8}$$

$$0.01\mu = 10n = 10^{-8}$$

$$C = W \cdot L \cdot C'_{ox}$$

$$= \cancel{100\mu} \cdot \cancel{100\mu} \cdot \frac{3.9 \cdot 8.85 \times 10^{-12} F}{\cancel{\mu}} \cdot \frac{1}{\cancel{0.01\mu}}$$

$\approx 40pF$




$$v_{out} = v_{in} \cdot \frac{\frac{1}{j\omega 40p}}{\frac{1}{j\omega 40p} + 100k}$$

$$v_{out} = v_{in} \cdot \frac{1}{1 + j \cdot 2\pi \cdot 100k \cdot 40pF \cdot 100k}$$

$$\cancel{10^{10}} \cdot 40 \cdot 10^{-12}$$

$$\cdot 4$$

$$6.28 \cdot .4 \simeq 2.5$$

$$-\angle \tan^{-1} \frac{2.5}{1} = \sim 40^\circ$$

$$T = 10\mu$$

$$|v_{out}| = 1mV \cdot \frac{1}{\sqrt{1^2 + (2.5)^2}}$$

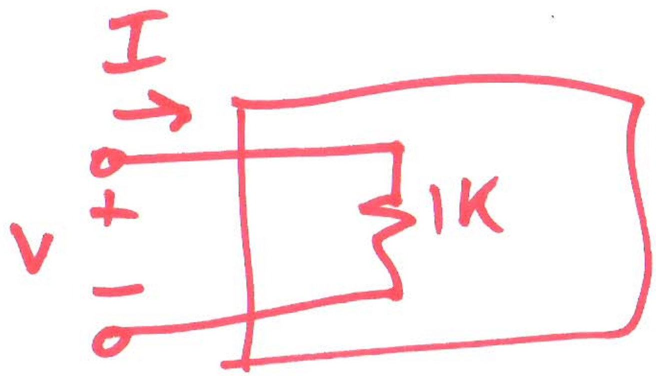
$$\theta = \frac{t_d}{T} \cdot 360$$

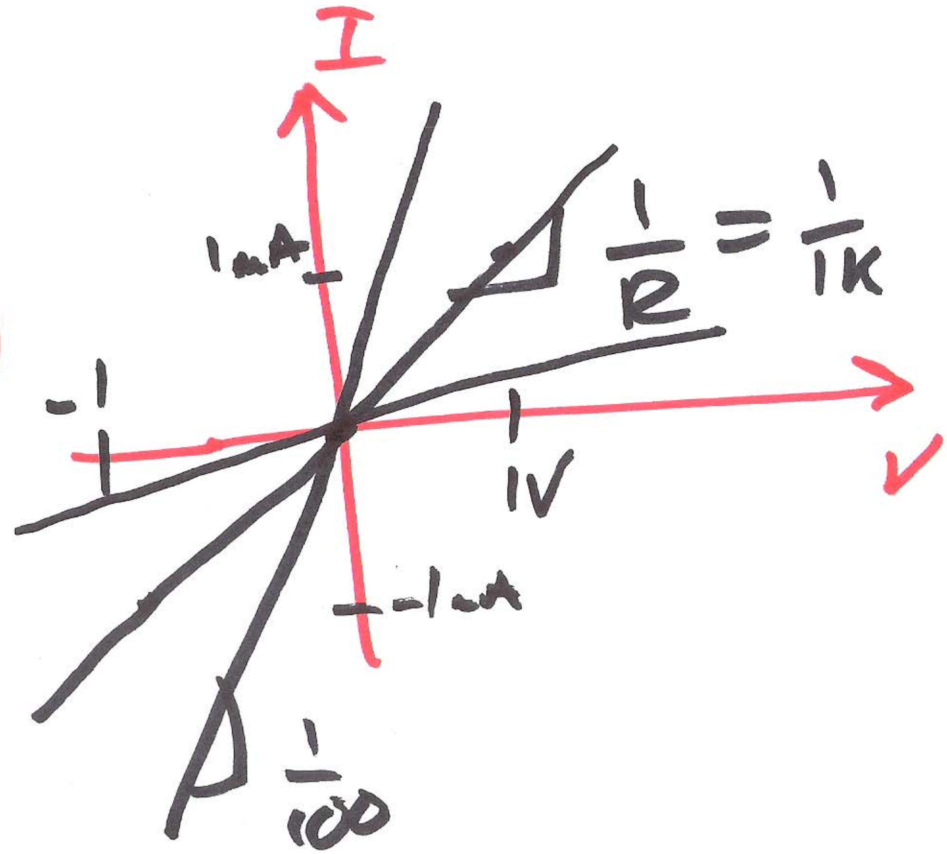
$$t_d \simeq \underline{1.64s}\ ?$$

$$|v_{out}| \simeq .4mV \quad \frac{1}{2.7}$$



2)



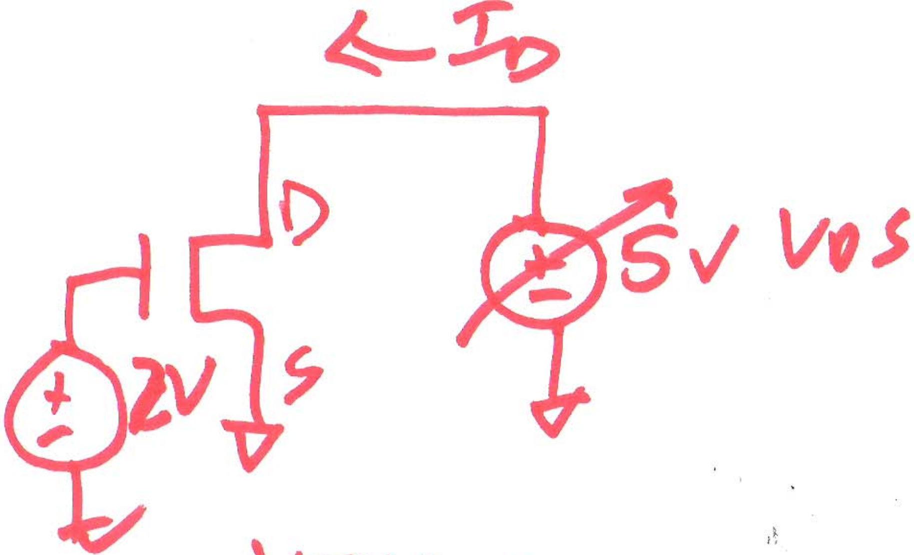



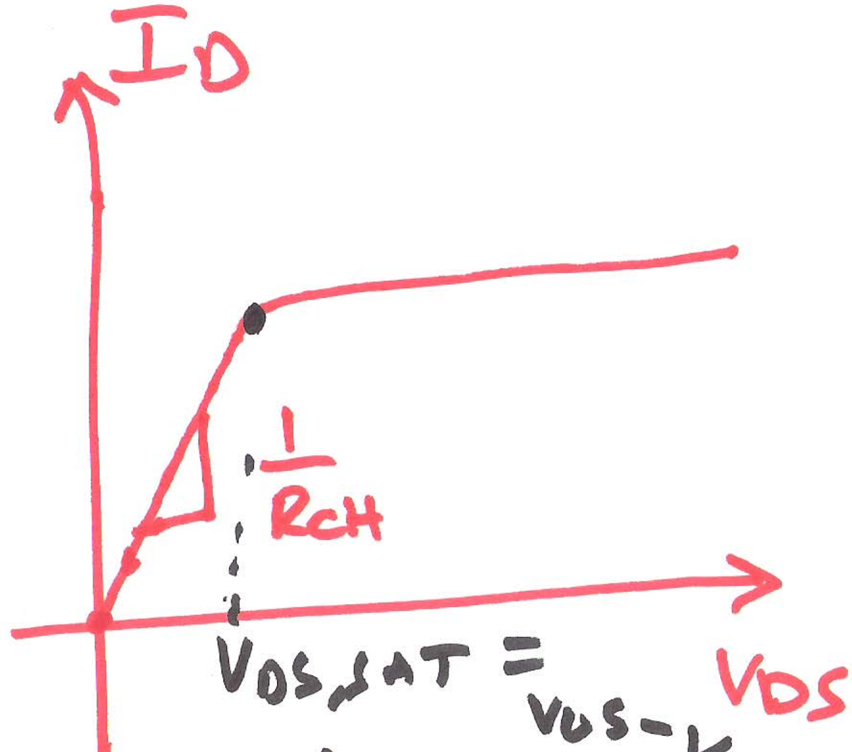

$$V = I \cdot 1K$$

$$\boxed{I = \frac{V}{1K}}$$

$R = 100$

$R = 10K$



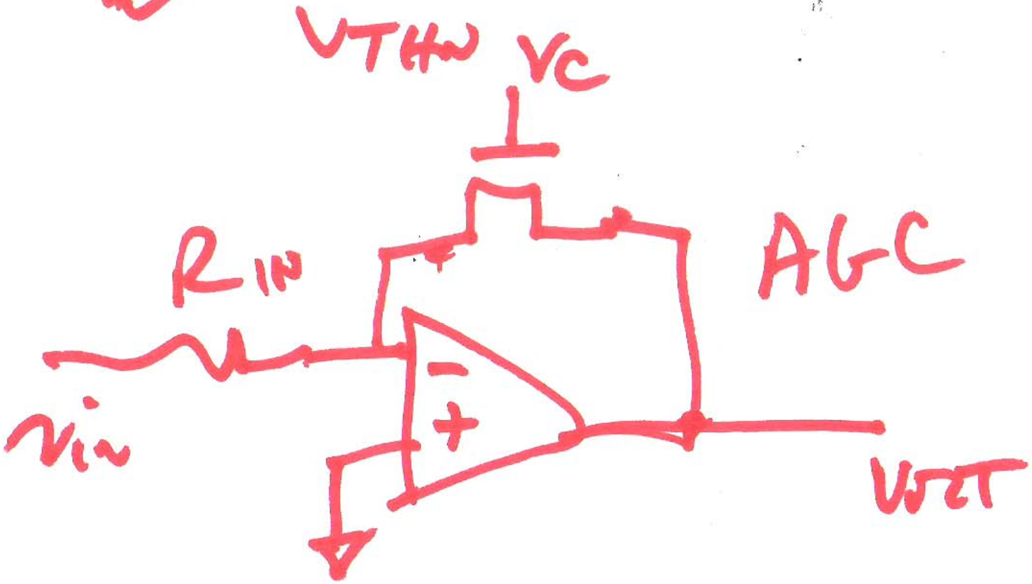




$V_{DS,SAT} = V_{GS} - V_{THN}$

for triode

$V_{GS} > V_{THN}$

$V_{DS} \leq V_{GS} - V_{THN}$




$$\frac{v_{out}}{v_{in}} = -\frac{R_{CH}}{R_{in}}$$

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

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

triode

for SAT

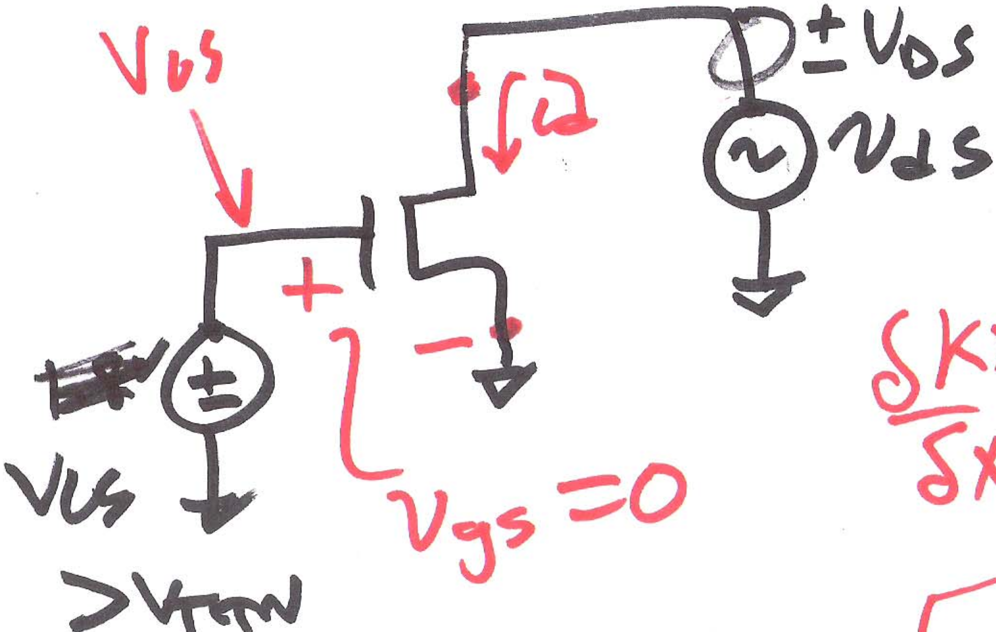
$$V_{DS} = V_{GS} - V_{THN}$$

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

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

Saturation!

DC = 0 = $V_{DS}$




$V_{DS} \geq V_{GS} - V_{THN}$ for SAT

$$\frac{\delta K x^2}{\delta x} = 2Kx \cdot \cancel{\frac{\delta x}{\delta x}}^{\,1} \geq \text{pos. \#}$$

NO!

in triode

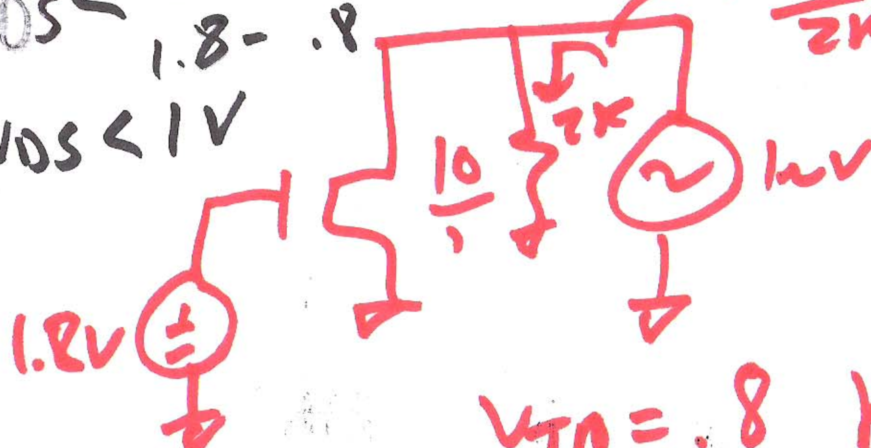
$$\frac{1}{R_{ch}} = \frac{\delta i_D}{\delta v_{DS}}\Bigg|_{\substack{I_D = \text{CONST} \\ V_{DS} = \text{CONST}}} = \frac{\delta}{\delta v_{DS}}\left[KP \cdot \frac{W}{L}\left((V_{GS} - V_{THN})v_{DS} - \frac{v_{DS}^2}{2}\right)\right]$$

$$= KP\frac{W}{L}\left[(V_{GS} - V_{THN}) - v_{DS}\right]$$

$$\frac{1}{R_{CH}} = KP\frac{W}{L}\left[(V_{GS} - V_{THN}) - v_{ds}\right]$$

$$\boxed{R_{CH} \approx \frac{1}{KP\cdot\frac{W}{L}(V_{GS} - V_{THN})}}$$

for triode
$V_{DS} < V_{GS} - V_{THN}$
1.8 - .8
$V_{DS} < 1V$



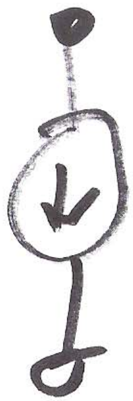

$\frac{1mV}{2K} = \frac{1}{2}\mu A$

$V_{TO} = .8 \quad KP = 50\mu$

$$R_{CH} = \frac{1}{50\mu\cdot\frac{10}{1}(1)} = \frac{1}{500\mu} = \underline{\underline{2K}}$$

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

$$V_{GS} = \sqrt{\frac{2\,\cancel{I_D}^{\,1{,}000\mu}}{\underset{50\mu}{KP}\cdot\underset{100}{W/L}}} + \cancel{V_{THN}}^{\,.8}$$



1mA

$$= \sqrt{\frac{2000}{50\cdot 100}} + .8$$

$$\sqrt{.4} + .8$$

$$.63 + .8$$

$$\underline{\underline{1.43V}}$$

for SAT $(V_{GS} > V_{THN})$

$V_{DS} \geq V_{GS} - V_{THN}$

$V_D - V_S \geq V_G - V_S - V_{THN}$

$V_D \geq V_G - V_{THN}$

$3.43 - .8$

$V_D \geq \underline{2.63V}$