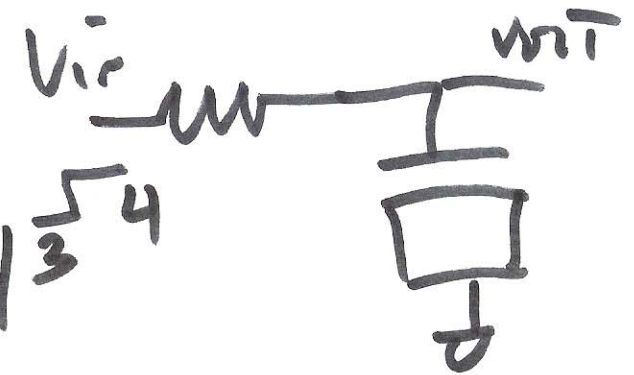


EE 320

4/7/14  $\sqrt[3]{4}$



Lecture 18

$I_D = g_m V_{GS}$

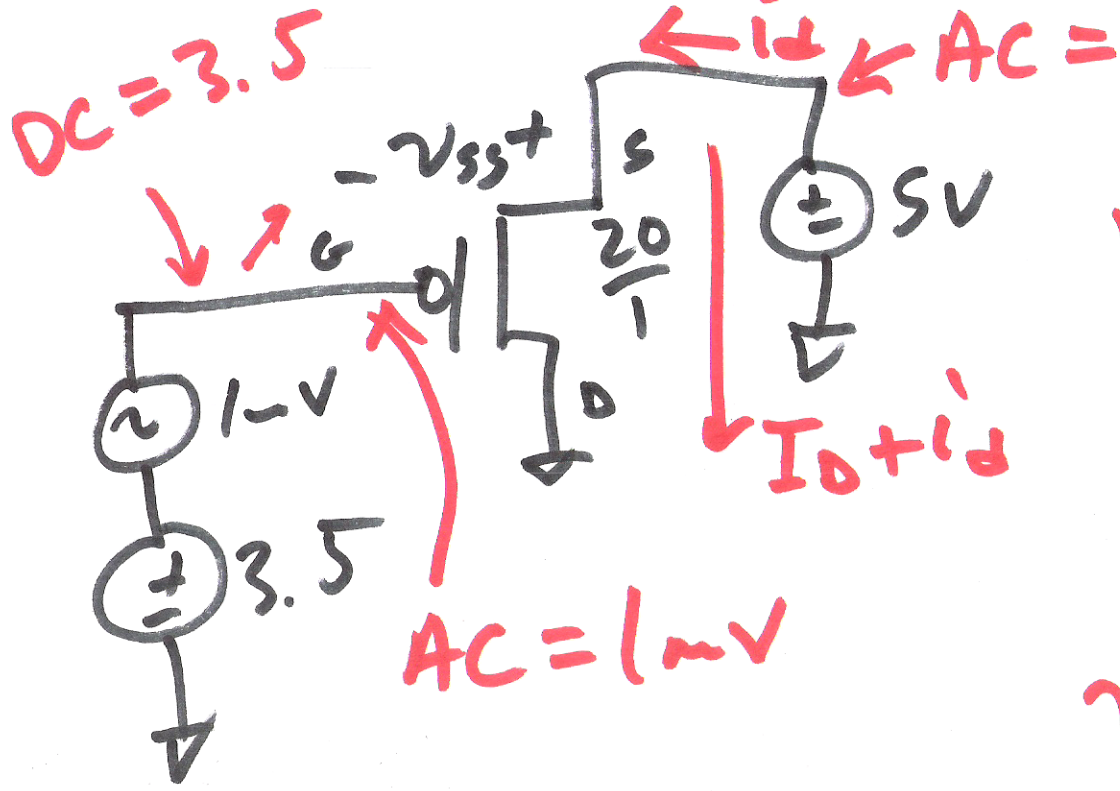
Review for Midterm 2!

- Study your old exam & quizzes
- Study your H.W. esp the latest H.W.

Derive  $g_m$  &  $R_{eff}$

- 1) Show how to bias transistor schematic
- 2) APPLY AC test voltages
- 3) use EQNS. to det  $g_m$  &  $R_{eff}$

1)



$$V_{SG} = V_S - V_G$$

$$= 5 - 3.5$$

$$V_{SG} = 1.5V$$

$$v_{sg} = 0 - 1mV = -1mV$$

$$i_d = g_m v_{sg}$$

$$= 480 \mu A \cdot (-1mV)$$

$$g_m = \frac{K_P \cdot W}{L} (V_{GS} - V_{THN})$$

$$= 40 \mu \frac{20}{1} (1.5 - .9)$$

$$i_d = -480 \mu A$$

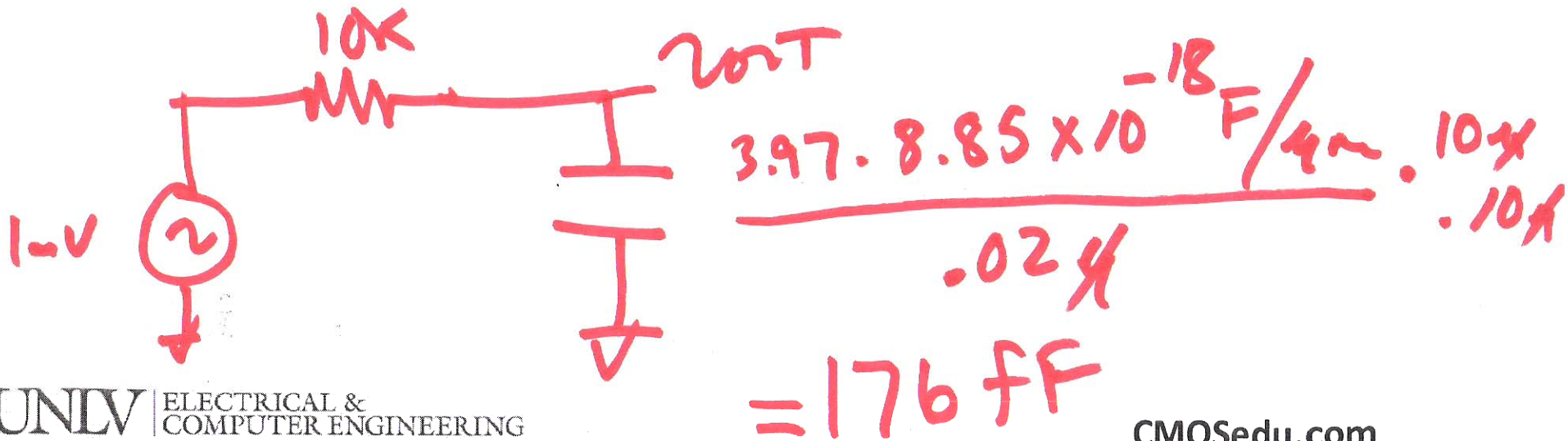
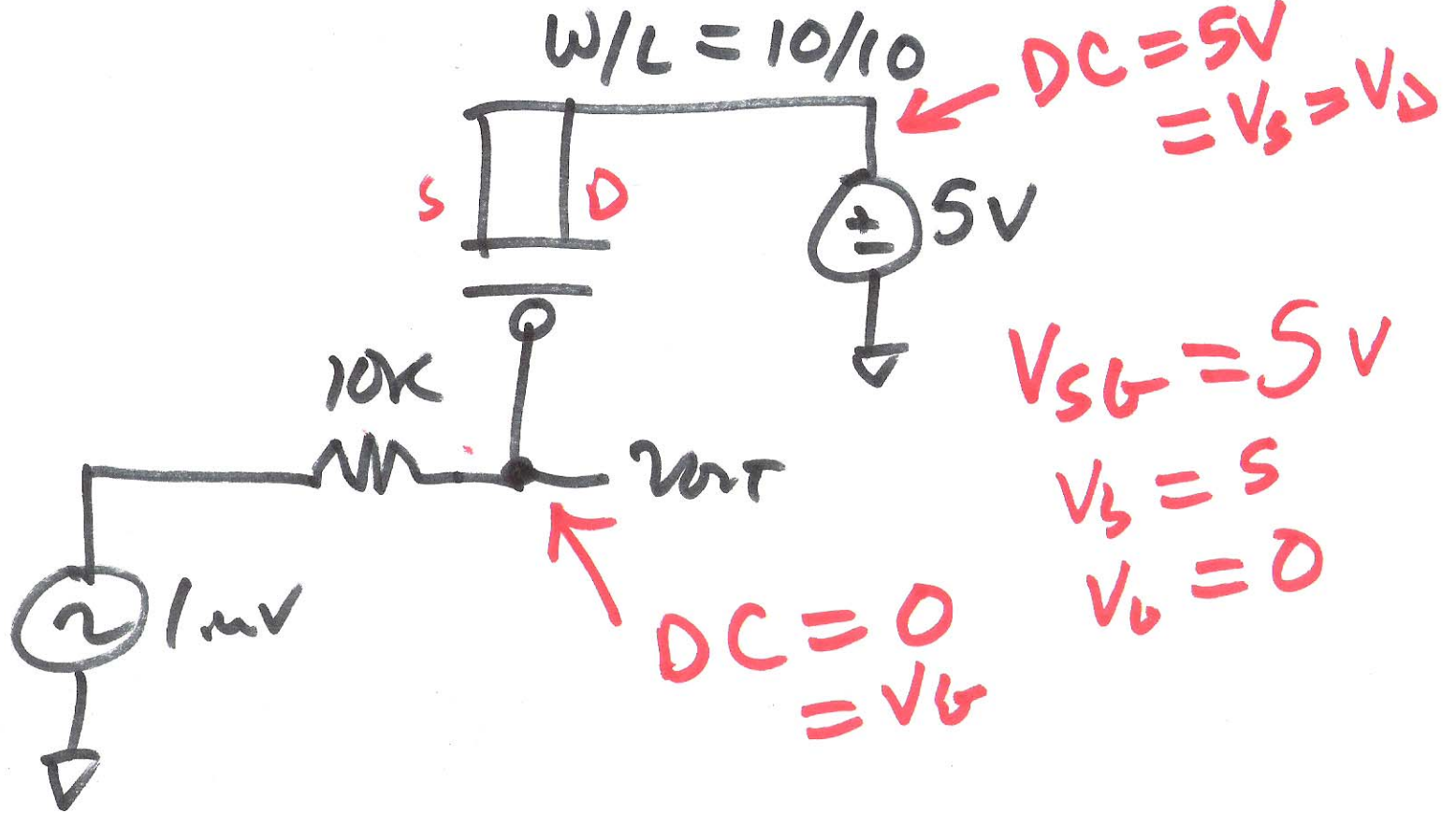
$$3.5 \text{ V}_{GS} + v_g \quad g_m = 480 \mu A/V$$



$$I_D = \frac{WKP}{L^2} (V_{SG} - V_{THN})^2$$

2)

1)



3)

$$V_{RT} = \frac{1}{2} \text{ mV} = 1 \text{ mV} \cdot \frac{1}{j2\pi f \cdot 176 \text{ f}}$$

$$176 \times 10^{-15} \cdot 10^3 \cdot 10^{-12} \cdot \frac{1}{j2\pi f \cdot 176 \text{ f} + 10 \text{ K}}$$

$$1760 \times 10^{-12}$$

$$1.76 \text{ n}$$

$$\frac{1}{2} = \frac{1}{\sqrt{1^2 + (2\pi f \cdot 1.76 \text{ n})^2}}$$

$$\sqrt{1^2 + ( )^2} = 2$$

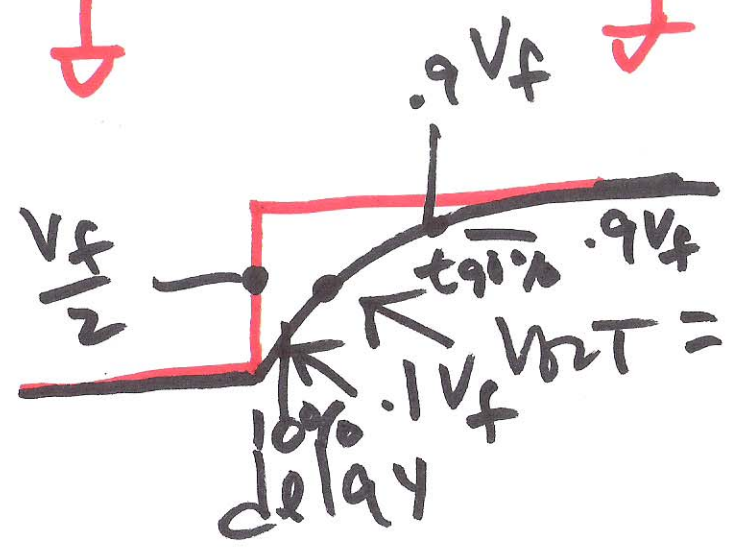
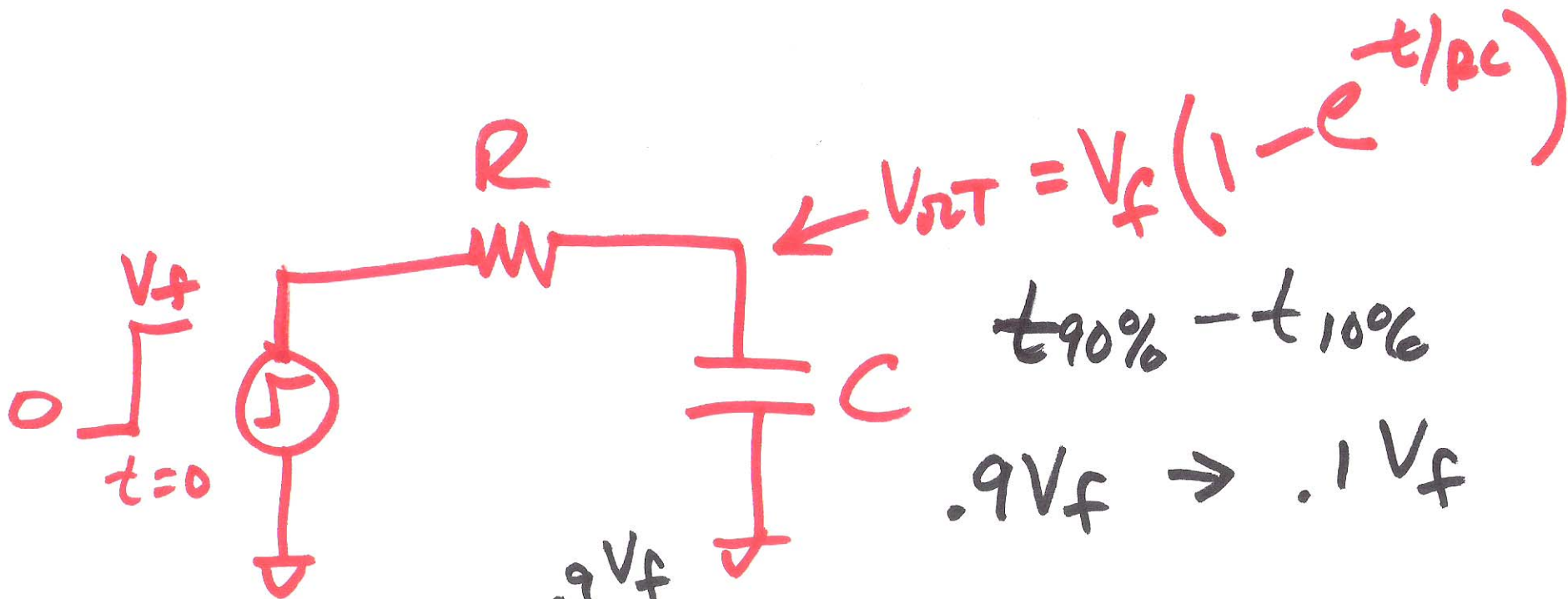
$$1^2 + (2\pi f \cdot 1.76 \text{ n})^2 = 4$$

$$2\pi f \cdot 1.76 \text{ n} = \sqrt{3}$$

$$f = \frac{\sqrt{3}}{2\pi \cdot 1.76 \text{ n}} = 157 \text{ MHz}$$

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d)



$$\frac{V_f}{2} = V_f(1 - e^{-t_d/RC})$$

$$-\frac{1}{2} = -e^{-t_d/RC}$$

$$t_d = \ln \frac{1}{2} \cdot RC = \underline{\underline{0.7RC}}$$

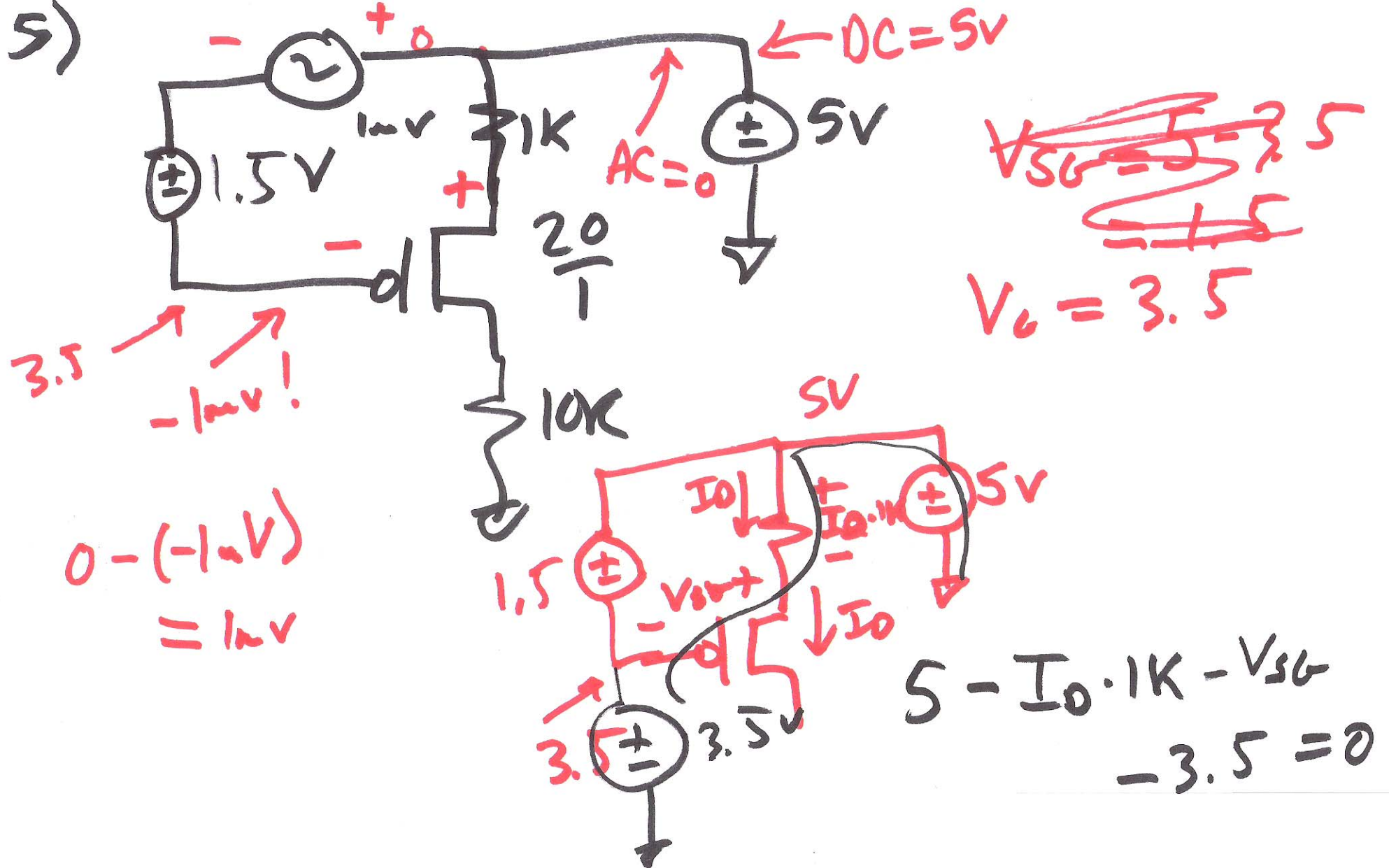
$$.9V_f = V_f (1 - e^{-t_{90\%}/RC})$$

$$.1V_f = V_f (1 - e^{-t_{10\%}/RC})$$

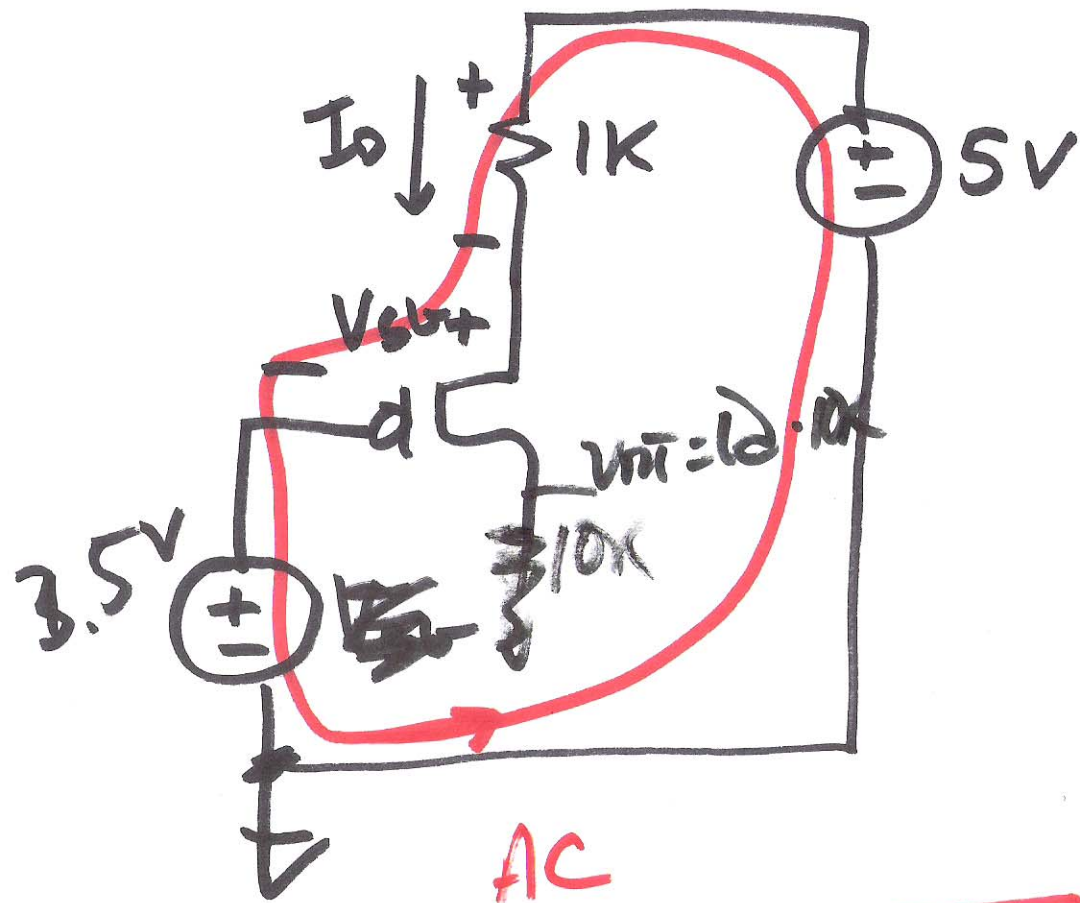
$$t_r = t_{90\%} - t_{10\%} = 2.2RC$$

H.w. verify!

5)



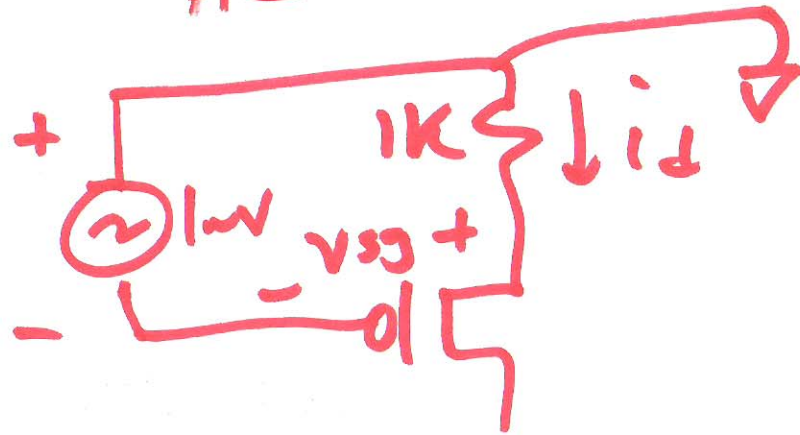
1)



$$5 - I_D \cdot 1k - V_{GS} - 3.5V = 0$$

$$1.5 = I_D \cdot 1k + V_{GS}$$

$$I_D = \frac{K_P}{2} \cdot \frac{W}{L} (V_{GS} - V_{TH})^2$$

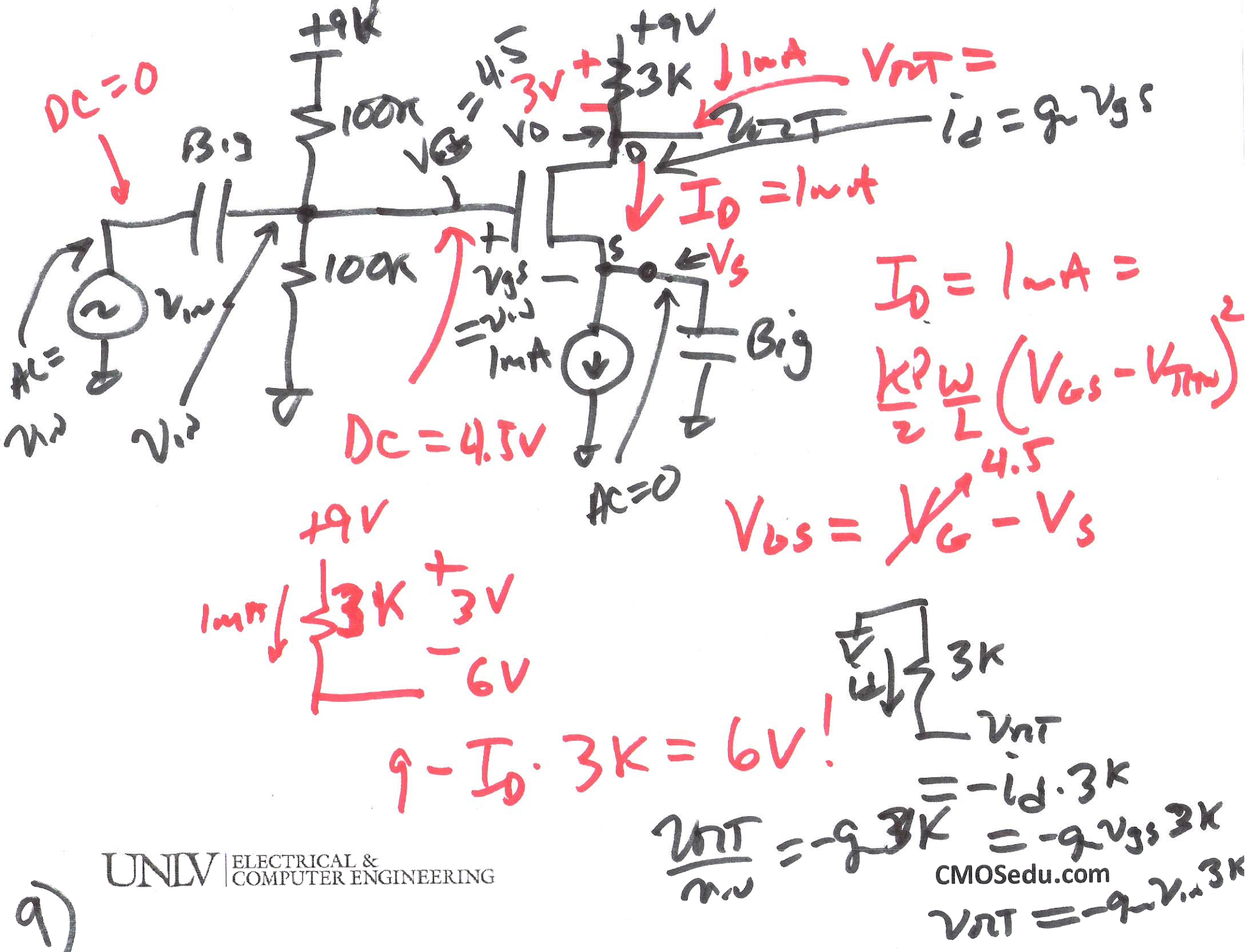


$$1.5 = i_D \cdot 1k + V_{GS}$$

$$V_{GS} = \frac{i_D}{g_m}$$

$$g_m = K_P \cdot \frac{W}{L} (V_{GS} - V_{TH})$$





9)