

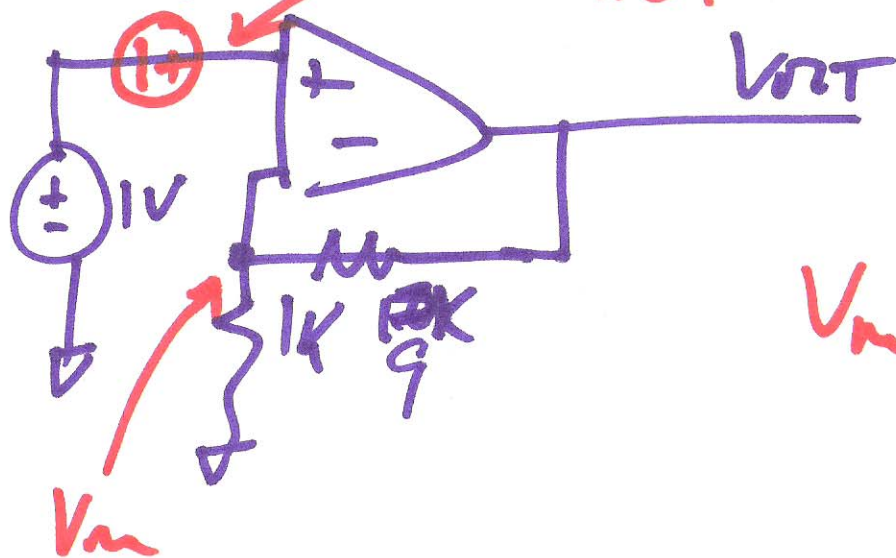
# EE 320

## Engineer Electronics I

May the fourth (be with you)

Lecture 27 2015

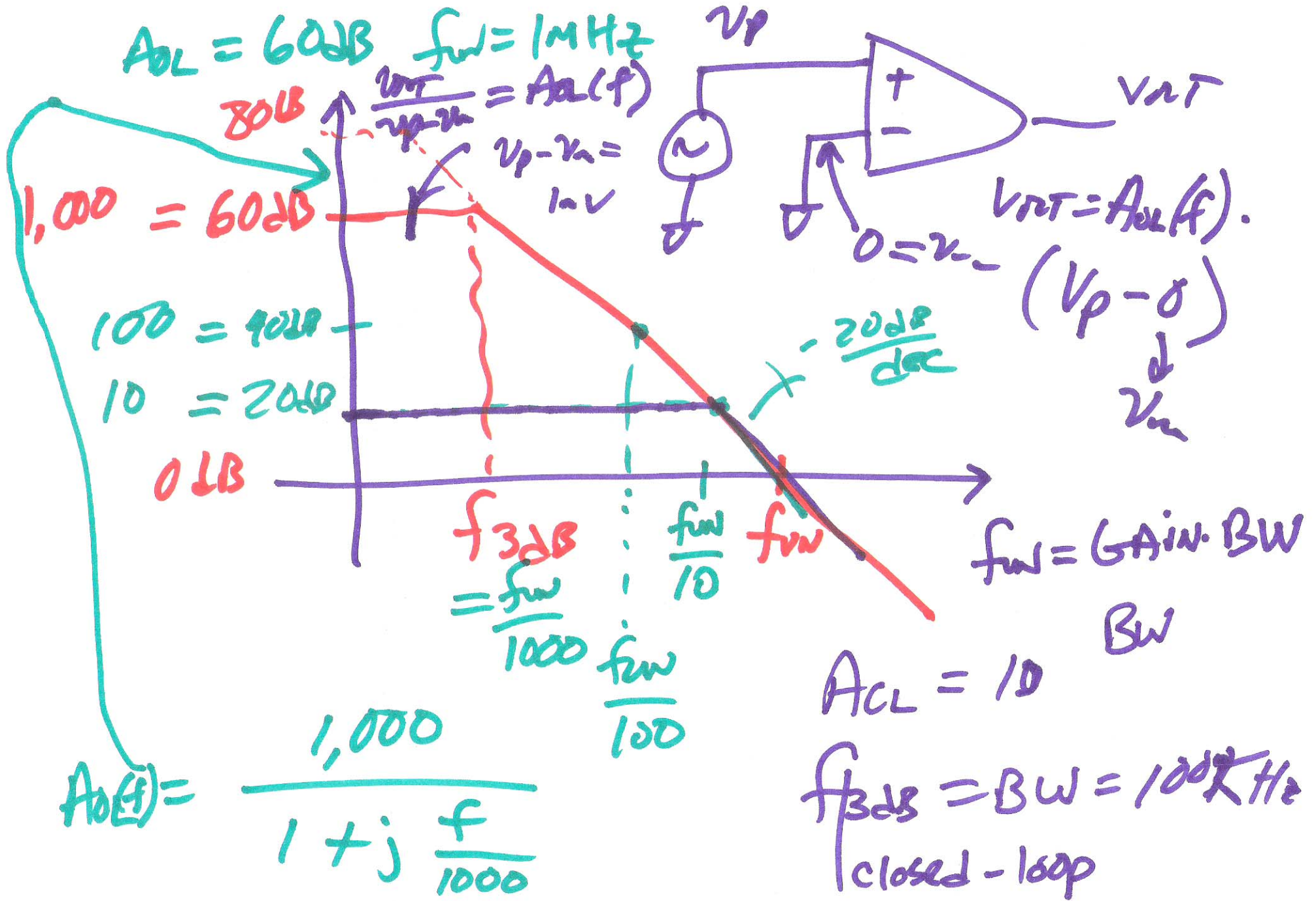
$V_{OS} = \pm 10 \text{ mV}$   $A_{OL} = 100$   $V_{OS} = 10 \text{ mV}$   
 $1.01 \text{ or } .99 = V_P = 1 \pm .01 \text{ V}$



$$V_{OUT} = 100(1 \pm .01 - V_m)$$

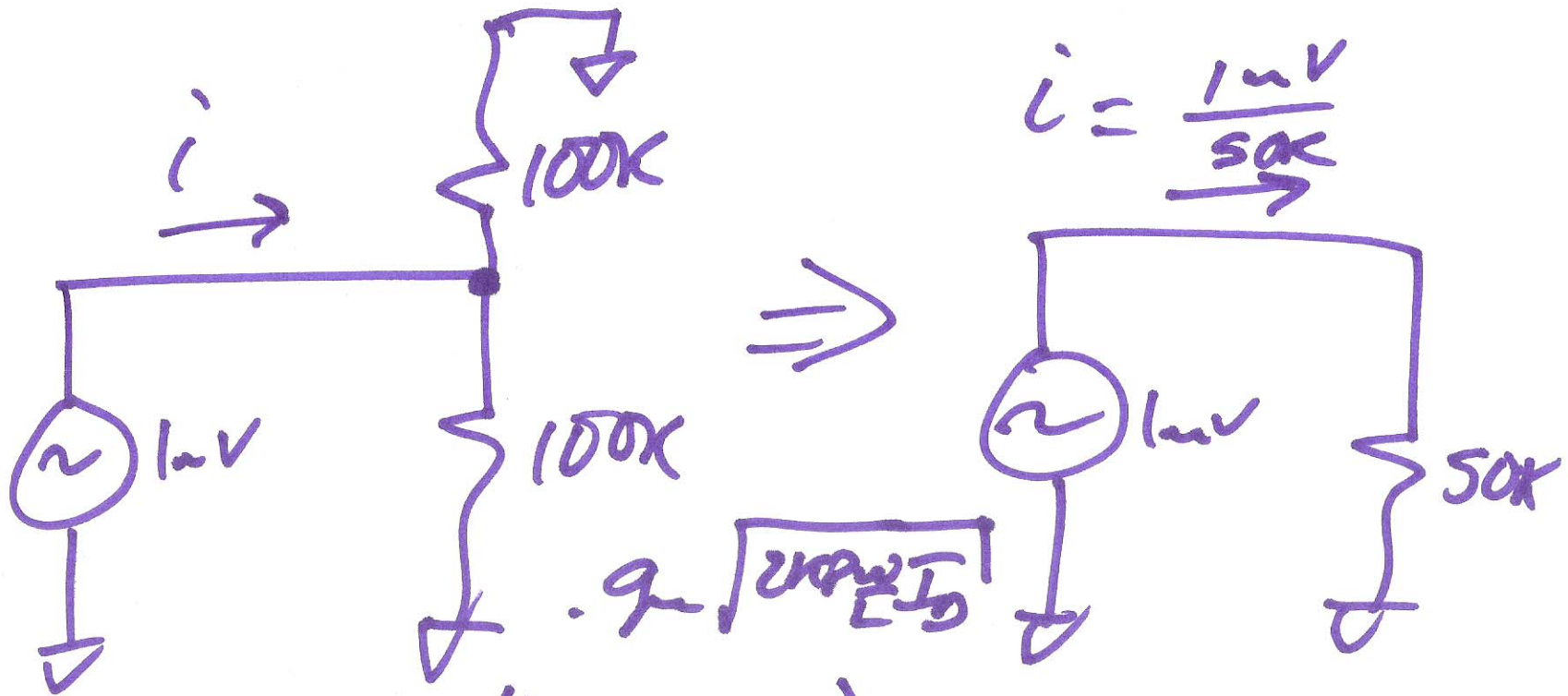
$$V_m = V_{OUT} \cdot \frac{1K}{1K + 9K}$$

1)



$$A_{OL}(f) = \frac{1,000}{1 + j \frac{f}{1000}}$$

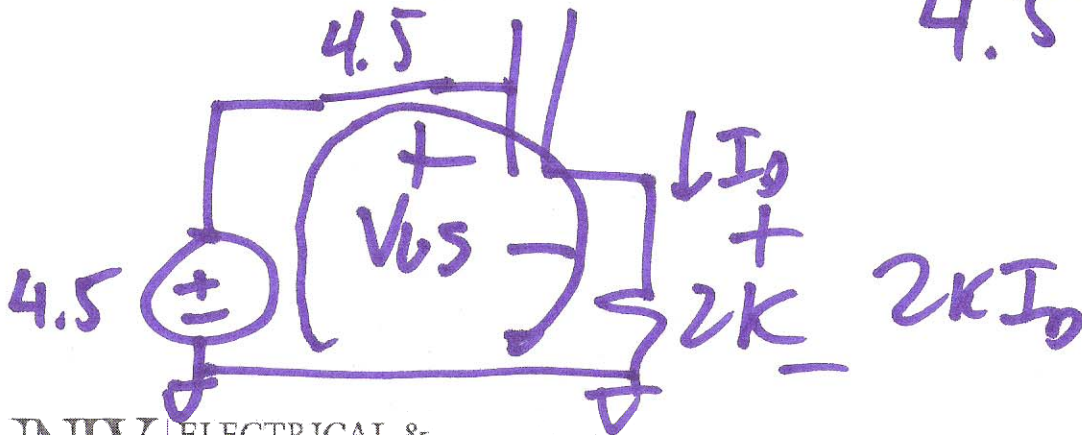
2)



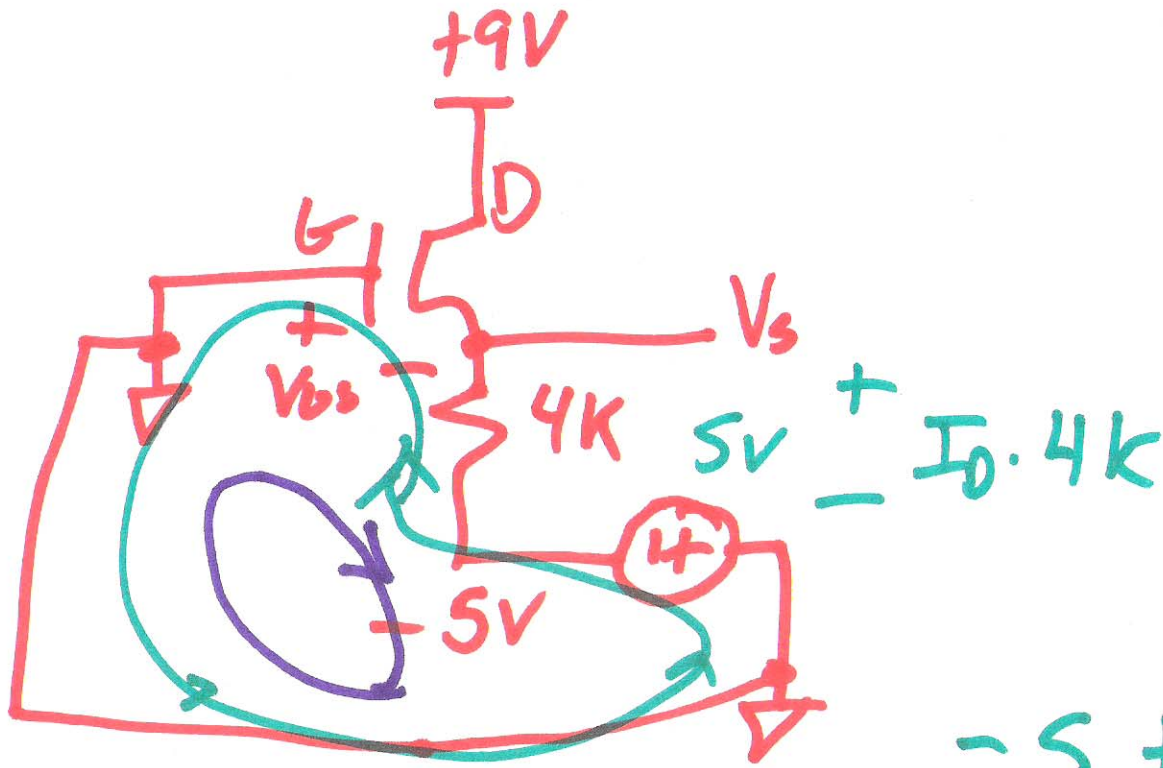
$$g = \frac{K_P \cdot W}{2L} (V_{GS} - V_{TH})$$

$$4.5 - V_{GS} - 2K I_D = 0$$

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



3)



$$+ \quad -$$

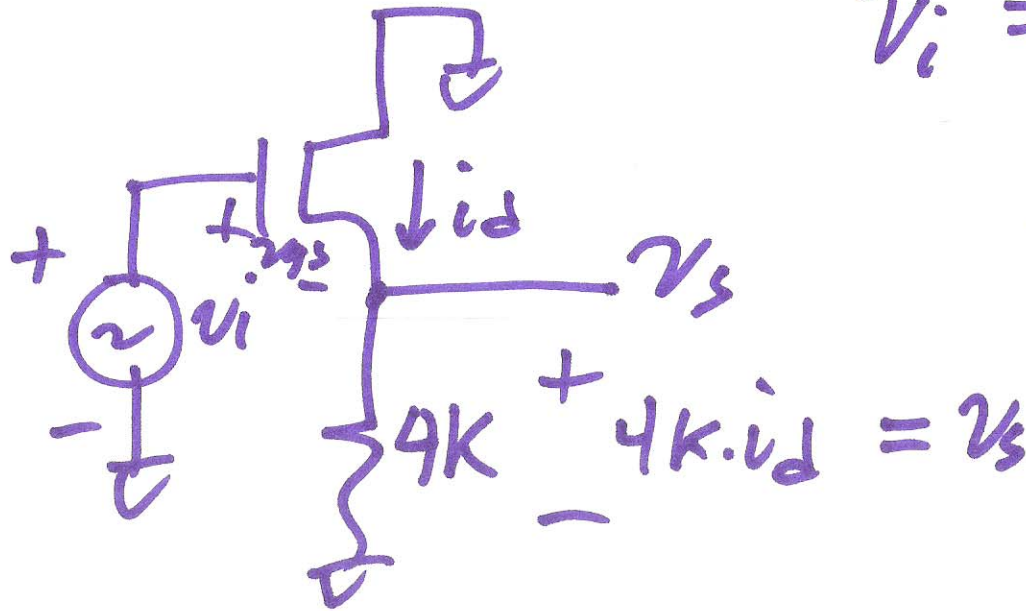
$$I_D \cdot 4k$$

$$-5 + I_D \cdot 4k + V_{GS} = 0$$

$$-V_{GS} - I_D \cdot 4k + 5 = 0$$

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

4)

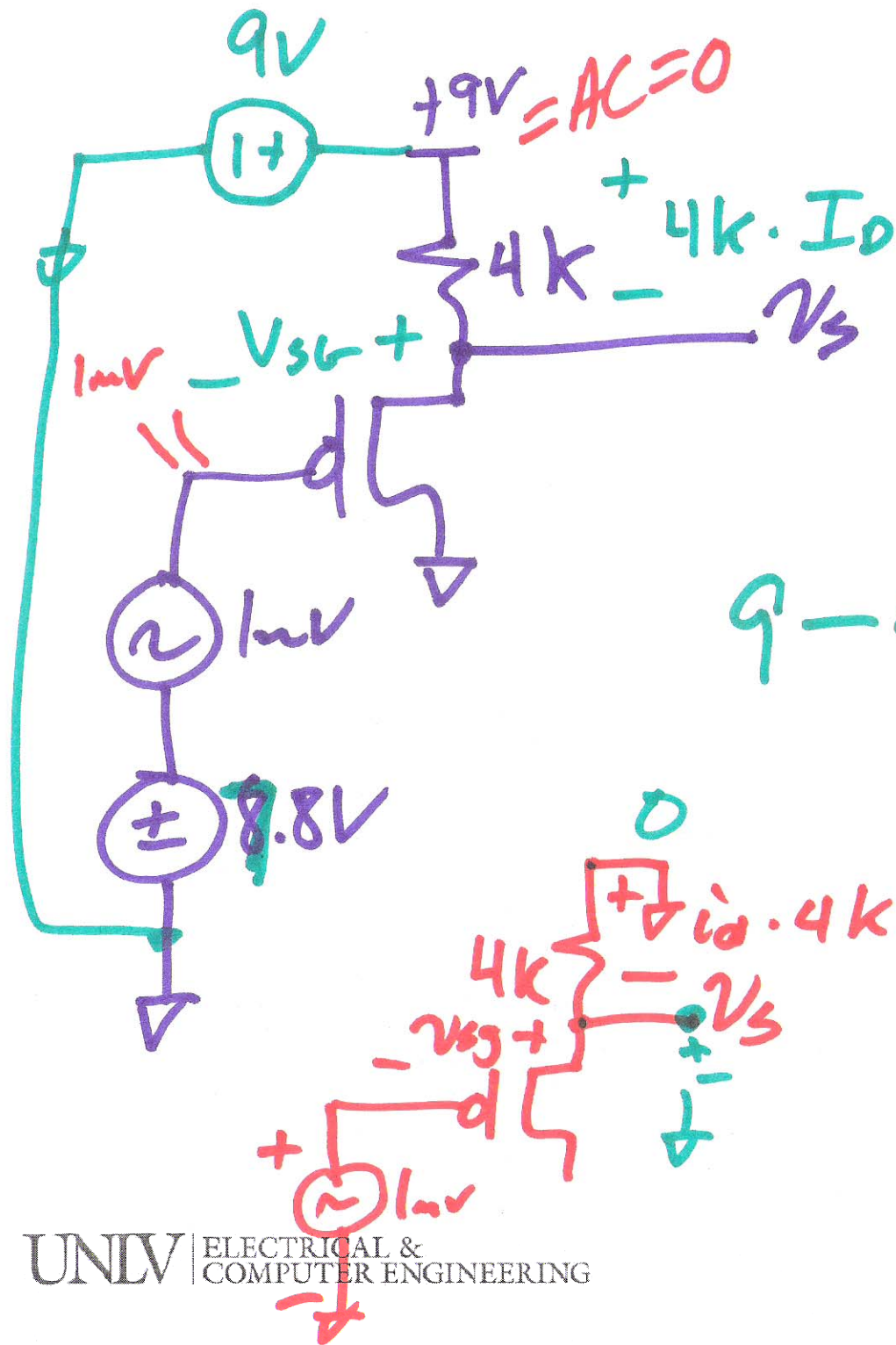


$$v_i - v_{gs} - v_s = 0$$

$$v_i = v_{gs} + i_d \cdot 4K$$

$$i_d = g_m v_{gs}$$

5)



$$V_S = 9 - 4k \cdot I_D$$

DC

$$9 - 4k \cdot I_D - V_{SG} - 8.8 = 0$$

$$I_D = \frac{K_P \cdot W}{2} (V_{SG} - V_{THP})^2$$

$$1mV + V_{SG} + i_d \cdot 4k = 0$$

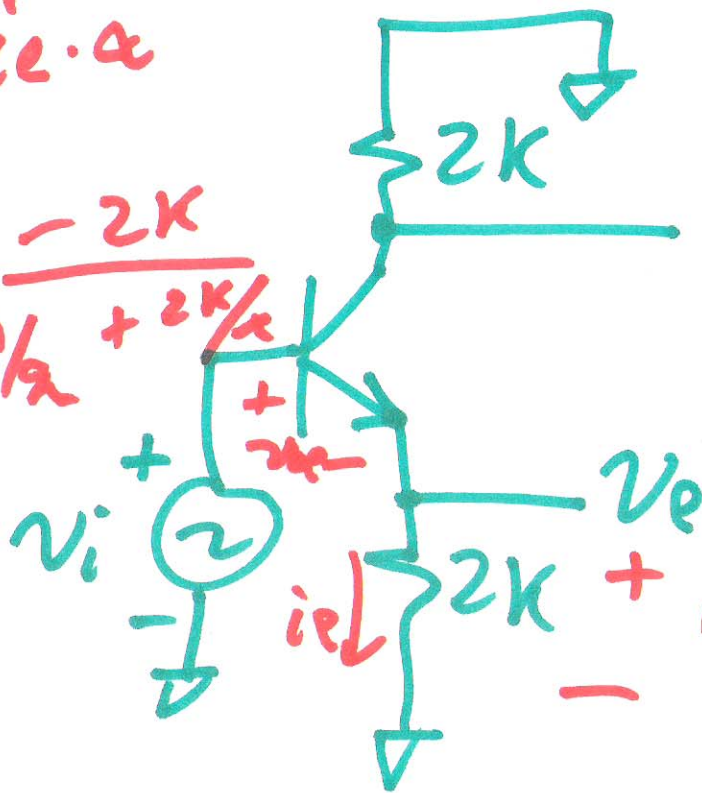
$$V_S = -i_d \cdot 4k$$

6)

# NPN BJT

$$i_c = i_e \cdot \alpha$$

$$\frac{v_c}{v_i} = \frac{-2k}{\frac{1}{g_m} + \frac{2k}{\alpha}}$$



$$v_c = -i_c \cdot 2k \quad i_e = \frac{i_c}{\alpha}$$

$$v_i - v_{be} - 2k \cdot i_e = 0$$

$$i_c = g_m v_{be}$$

$$= \frac{I_c}{N_V T} \cdot v_{be}$$

$$= \frac{I_e \alpha}{N_V T} \cdot v_{be}$$

$$v_e = 2k \cdot i_e$$

$$v_i = v_{be} + 2k i_e$$

$$i_c = r_e \cdot v_{be} \cdot \alpha$$

$$\frac{i_c}{g_m} + \frac{i_e 2k}{\alpha} = \frac{i_e \cdot \alpha}{g_m} + 2k i_e$$

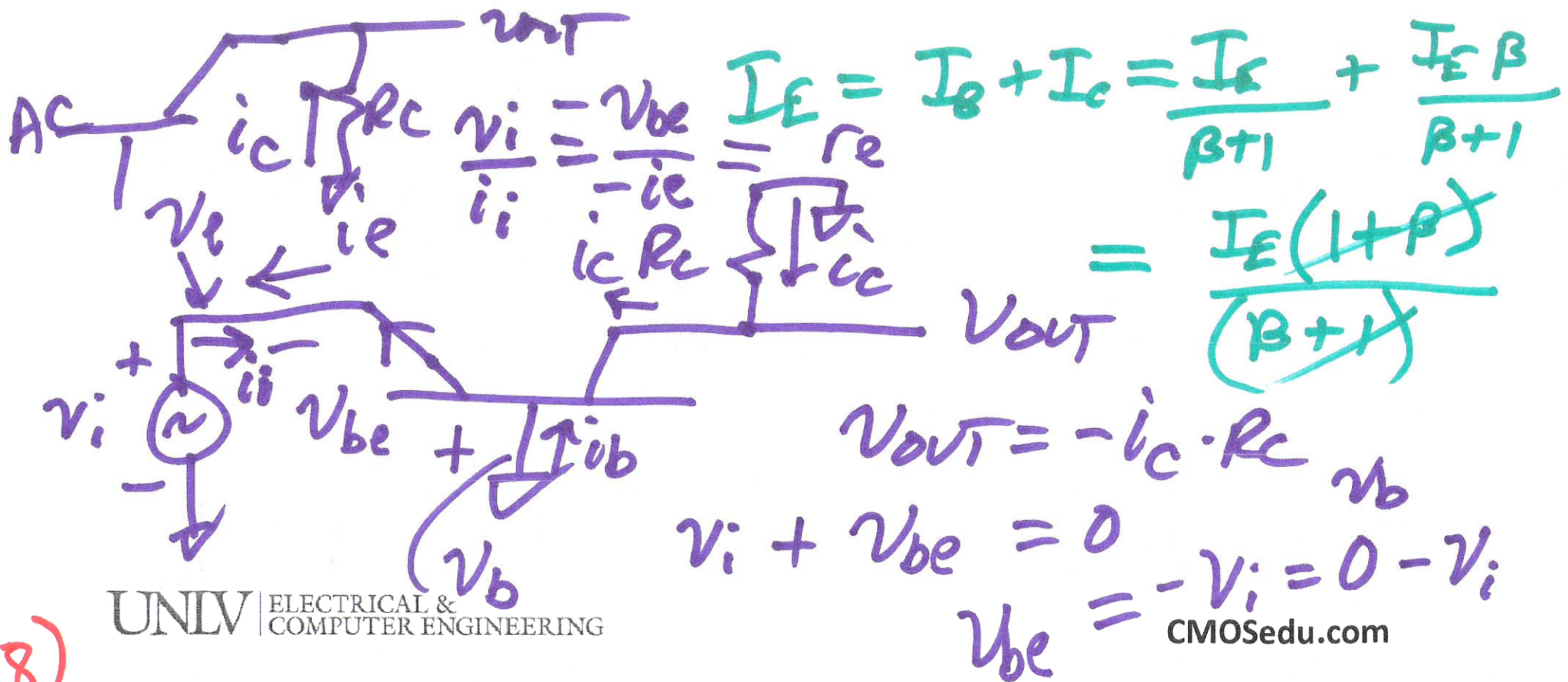
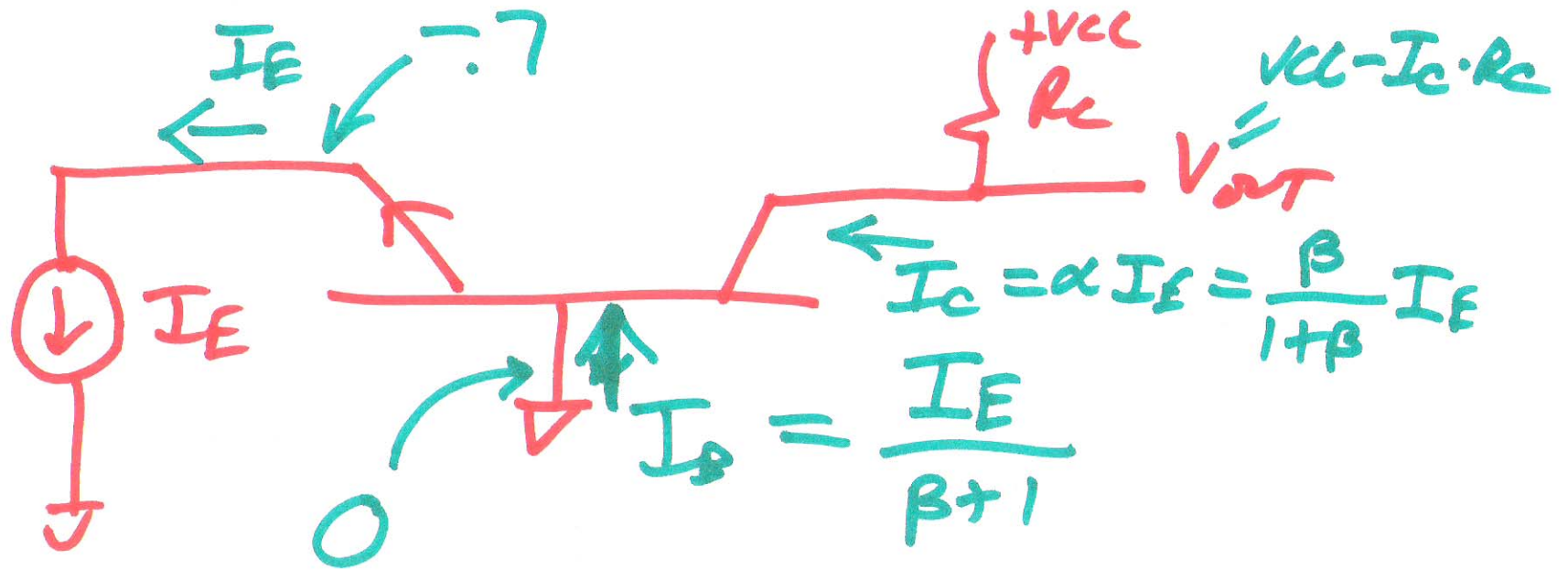
$$\frac{\alpha}{g_m} = r_e$$

$$\frac{v_c}{v_i} = \frac{2k}{\frac{\alpha}{g_m} + 2k}$$

$$r_e = \frac{I_E}{N_V T}$$

7)

DC



8)



$$i_c = g_m v_{be} = g_m (-v_i), \quad v_i = \frac{-i_c}{g_m}$$

$$v_{out} = -i_c \cdot R_c$$

$$\frac{v_{out}}{v_i} = \frac{-i_c \cdot R_c}{\frac{-i_c}{g_m}} = \underline{\underline{R_c \cdot g_m}}$$

a)