

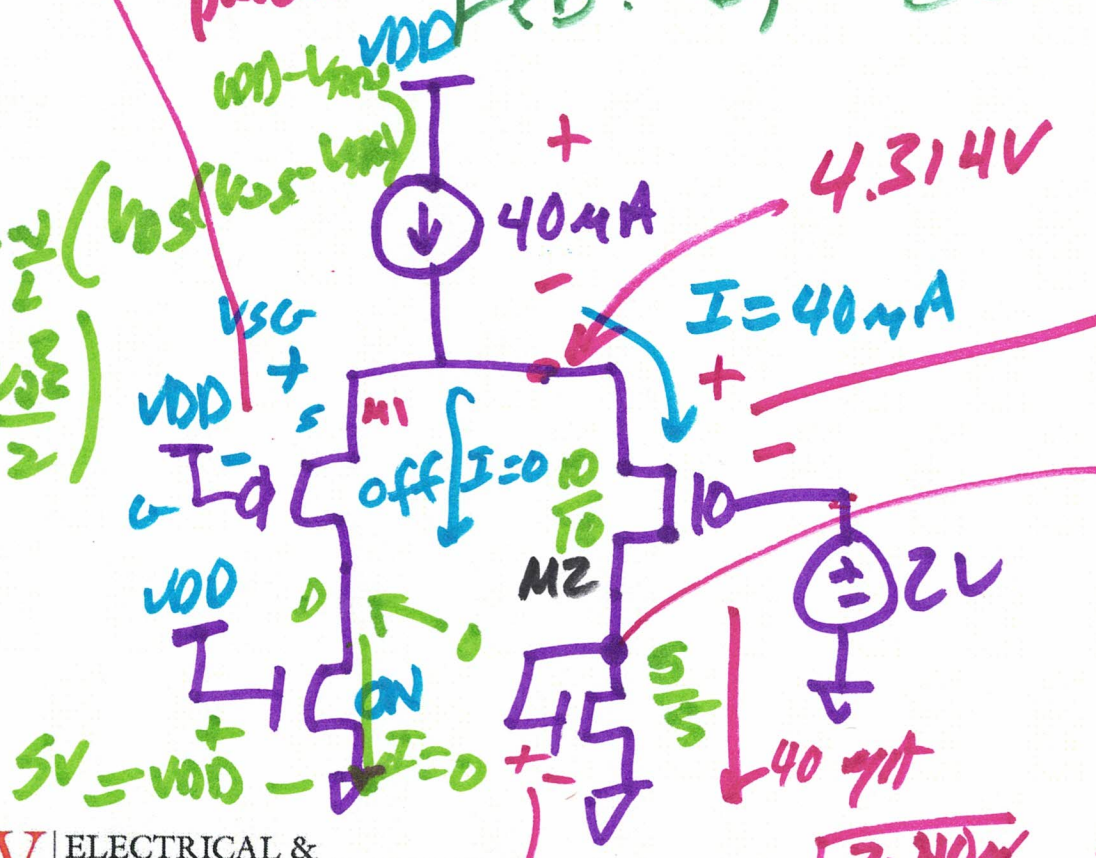
EE 420 / ECG 620
 Analog IC DESIGN
 Lecture 5
 Feb. 6, 2019

$V_{SG}(M1) = 4.314 - 5V$
 $= -0.686V$

$V_D \leq V_G + V_{THP}$
 $1.61 \leq 2 + 0.9$
 M2 IN SAT? yes
 $V_{SD} \geq V_{SG} - V_{HP}$

NOT V_{THP}
 pmos off
 $V_{DD} = 5V$

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



$V_{SG} = 2.314$
 $= 4.314 - 2$

$V_{SG} = \sqrt{\frac{2 \cdot 40\mu A}{40\mu A \cdot \frac{10}{10}} + 0.9}$

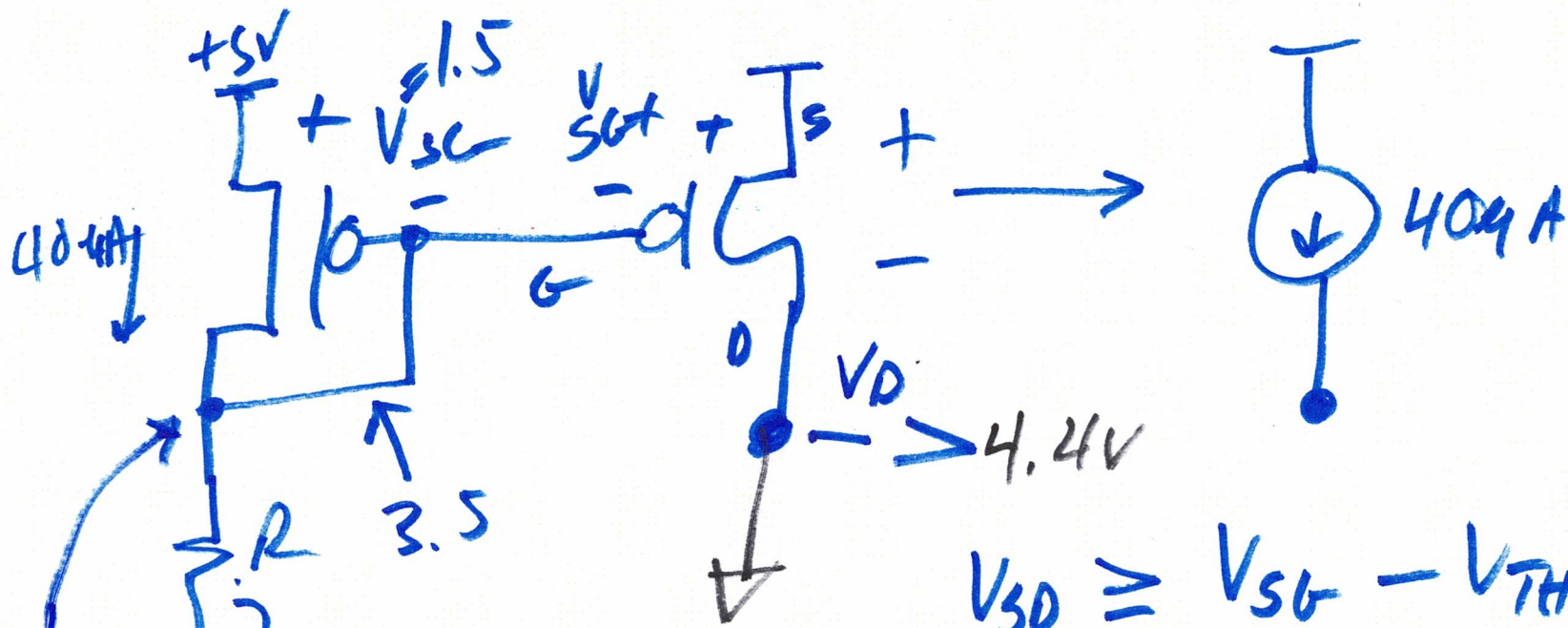
$V_{SG} = 2.314V$

$1.61V$

$V_{GS} \approx 1.61$
 ≈ 0.8

$+ 0.8 = \sqrt{\frac{2}{3}} + 0.8$

1)



$$40\mu A \cdot R = 3.5V$$

$$R = \frac{3.5}{40\mu A}$$

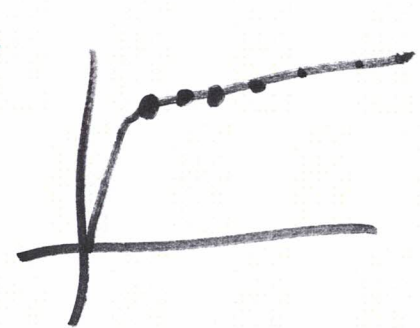
$$V_{DD} - V_{SG} = R \cdot I$$

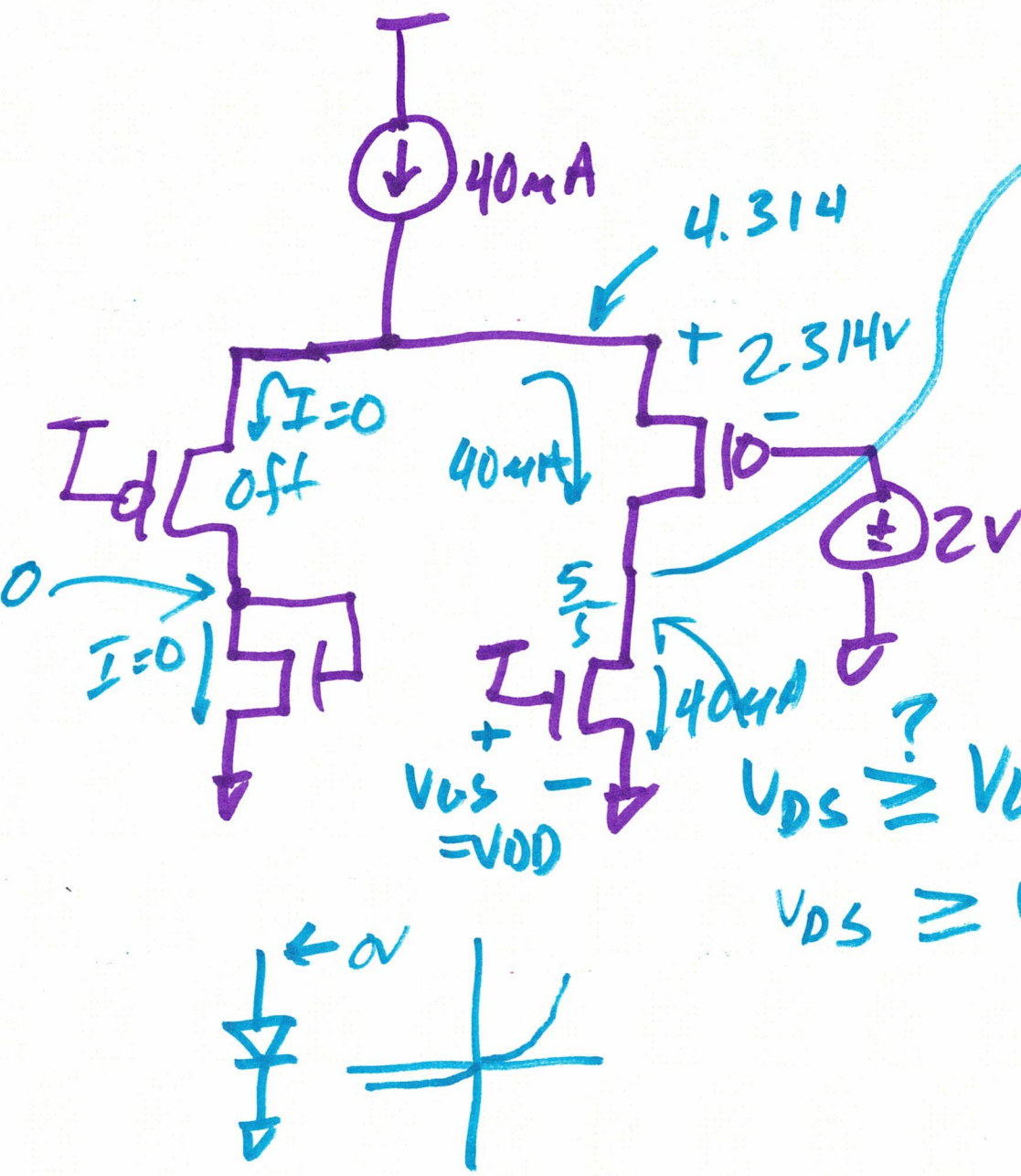
$$V_{SD} \geq V_{SG} - V_{THP}$$

$$V_{DD} - V_D \geq 1.5 - .9 = 0.6V$$

$$V_{DD} - V_D \geq 0.6$$

$$\frac{V_{DD} - V_{SG}}{R} = \frac{K_P P}{2} \cdot \frac{L_P}{L_P} (V_{SG} - V_{THP})^2$$





$$I_D = \frac{K_{PN}}{2} \frac{W}{L} \left(V_{DS} (V_{DD} - V_{GS}) - \frac{V_{DS}^2}{2} \right)$$

.0032 4.2

$$40\mu A \approx 120\mu A \cdot \frac{5}{5} \left(V_{DS} (V_{DD} - 0.8) \right)$$

$$V_{DS} = \frac{1}{3} \cdot \frac{1}{4.2} = \frac{1}{12.6}$$

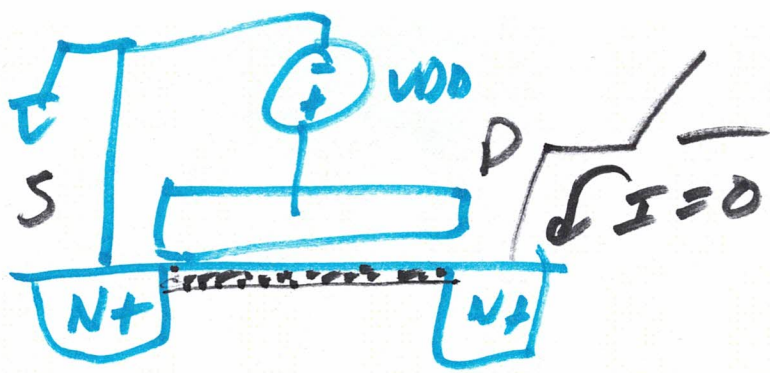
$$V_{DS} = 0.08V$$

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

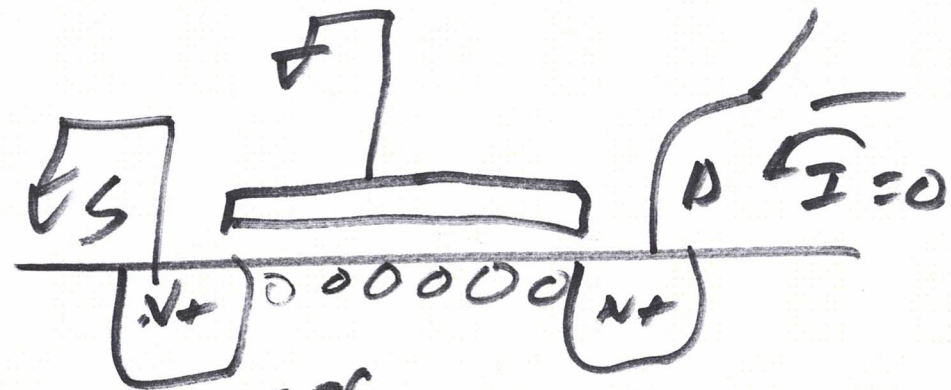
$$V_{DS} \geq V_{DD} - 0.8 = 4.2?$$

NO!

3)



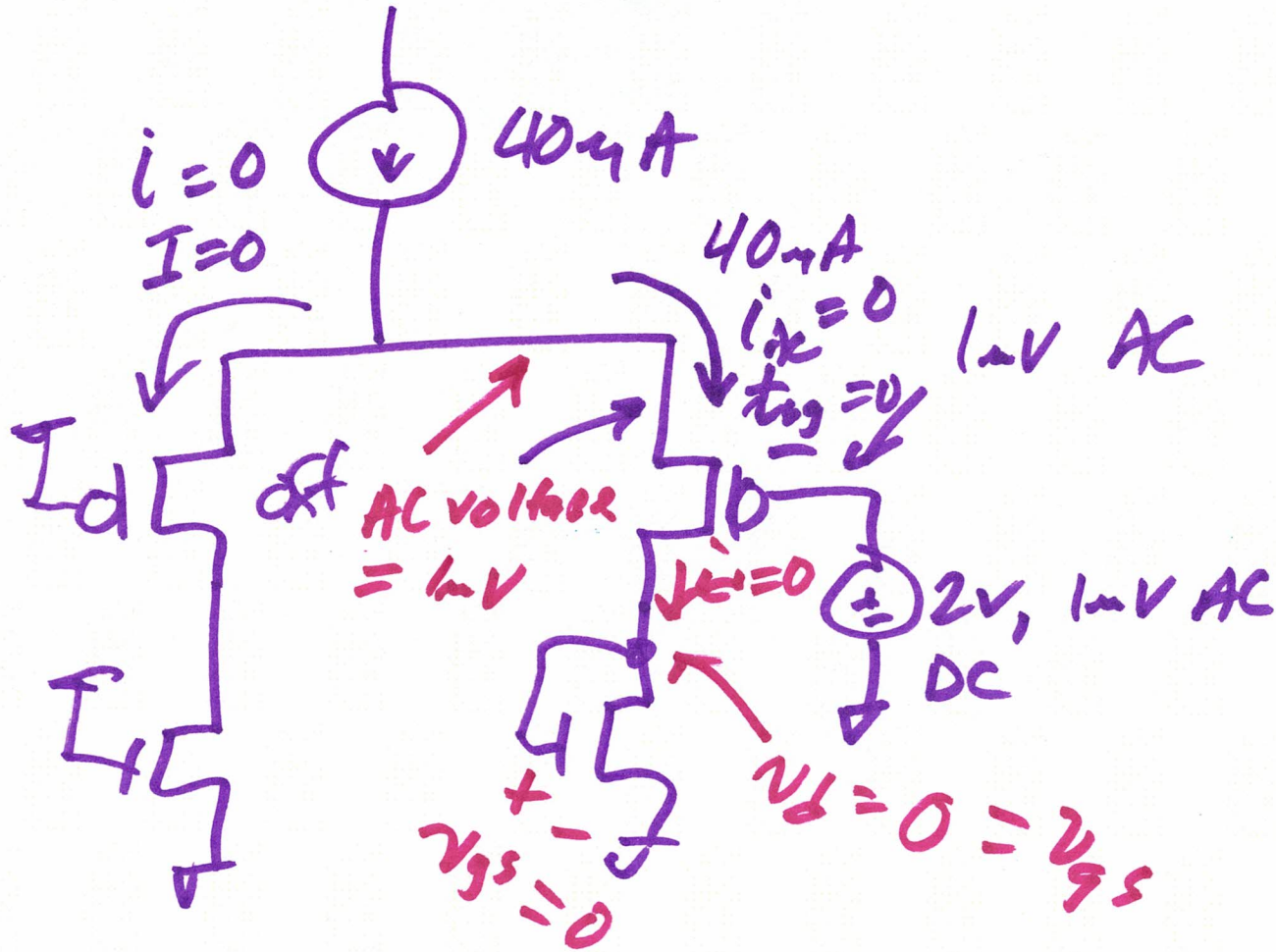
triode
P-sub



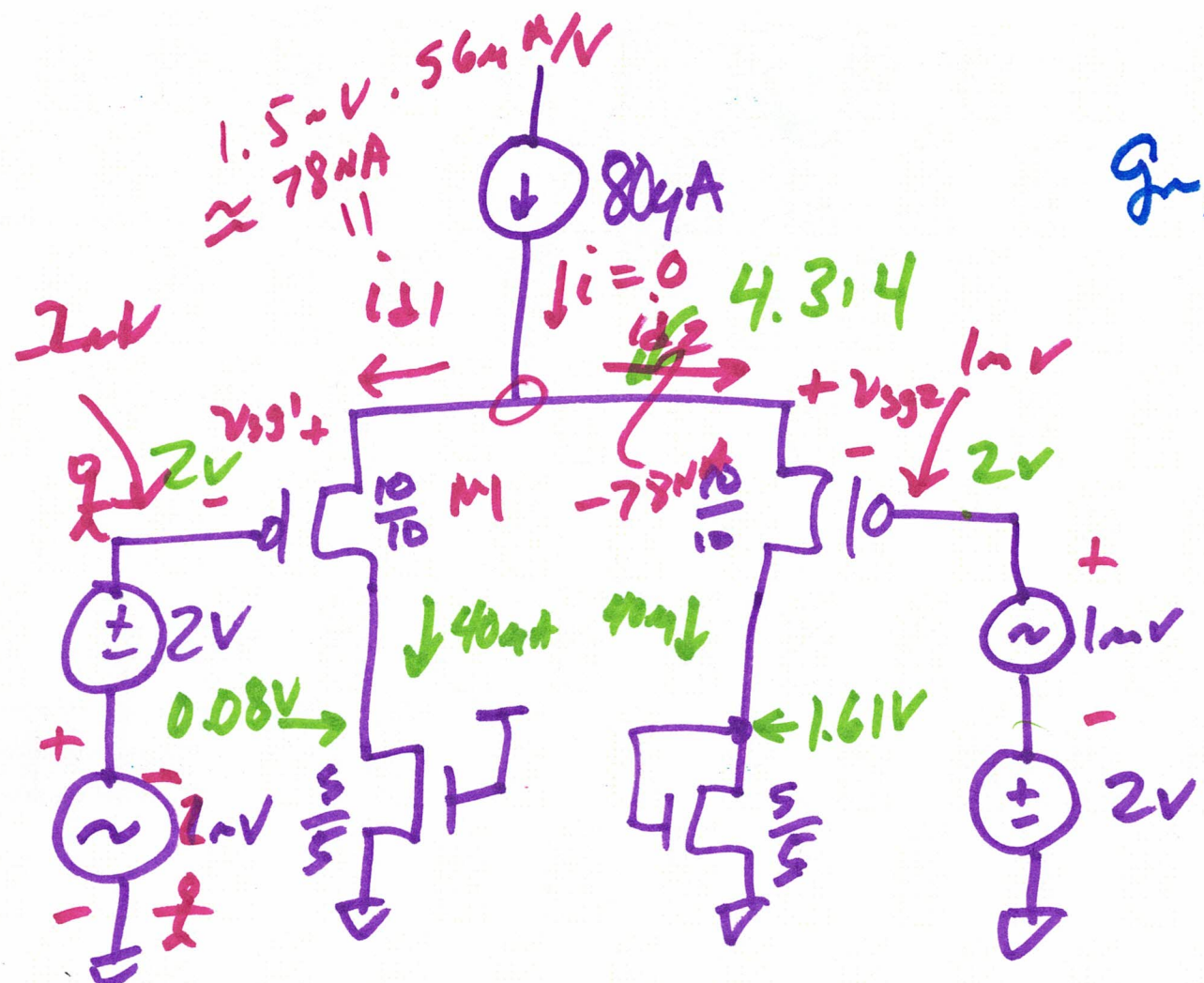
off

P-sub

AC



5)



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

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

$$= \sqrt{2 \cdot 40 \mu\text{A} \cdot 40 \mu\text{A} \cdot \frac{10}{10}}$$

$$= 40 \mu\text{A} \cdot \sqrt{2} = 56 \mu\text{A/V}$$

$$g_m = \frac{56 \mu\text{A}}{\text{V}}$$

$$g_{m2gs} = i_d$$

$$+(-2 \text{ mV}) + V_{gs1} - V_{gs2} - 1 \text{ mV} = 0$$

$$V_{gs1} = 1.5 \text{ mV} \quad i_{d1} + i_{d2} = 0, \quad i_{d1} = -i_{d2} \quad \left(-\frac{i_{d2}}{g_{mN}} \right)$$

$$-3 \text{ mV} + \frac{i_{d1}}{g_{mN}} + \frac{i_{d1}}{g_{mN}} = 0$$

$$-3 \text{ mV} + V_{gs1} + V_{gs1} = 0$$

b) $V_{gs2} = -1.5 \text{ mV}$