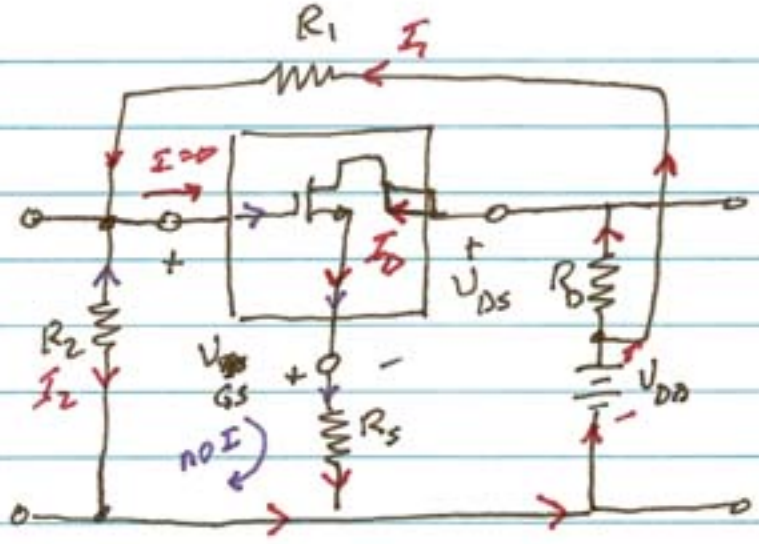
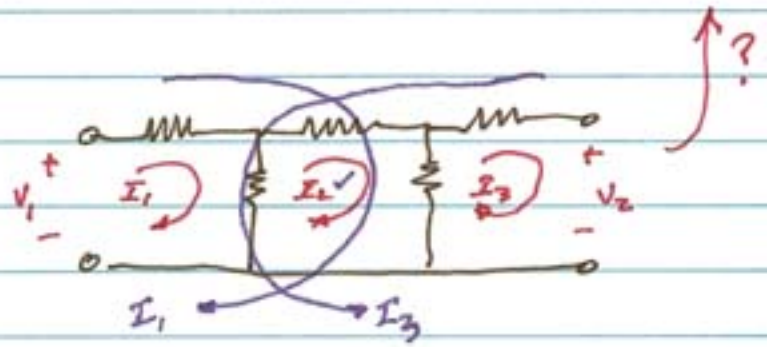


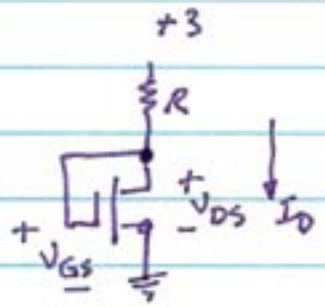




| | | | |
|---|---|---|---|
| 1) | $R_1 I_1 + R_2 I_2 = V_{DD}$ | C | $I_1$ |
| 2) | $R_D I_D + R_S I_D + V_{DS} = V_{DD}$ | C | $I_2$ |
| 3) | $-I_2 R_2 + V_{GS} + I_D R_S = 0$ | C | $I_D$ |
| 4) | $I_D = \frac{1}{2} k_n' (\frac{W}{L})(V_{GS} - V_t)^2$ | D | $V_{DS}$ |
| 5) | $I_1 = I_2$ | C | $V_{GS}$ |

C = circuit eqn

D = device eqn

Example 4.3




$V_{GS} = V_{DS}$ <

$I_G = 0$

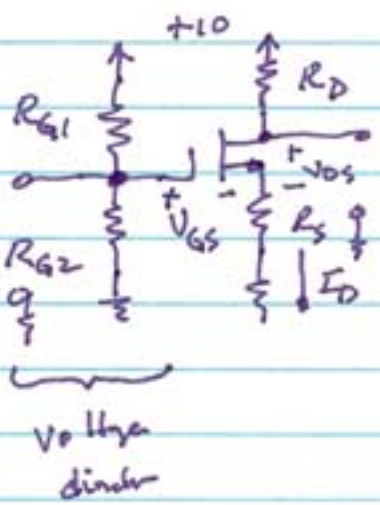
$3 = R I_D + V_{DS}$ <

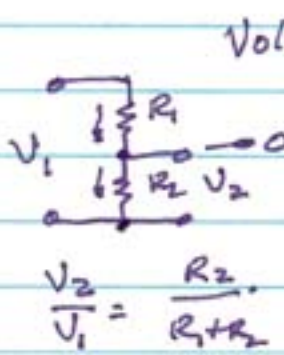
$I_D = \frac{1}{2} K_n' \left(\frac{W}{L}\right)(V_{GS} - V_t)^2$ <

Example 4.4

as with Ex 4.3 but $V_{GS} = 5$

Example 4.5



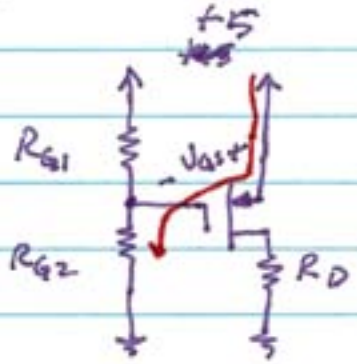

$$V_G = \left(\frac{R_{G1}}{R_{G1} + R_{G2}}\right) 10 = \text{known value}$$

$V_G = V_{GS} + R_S I_D$ <

$10 = R_D I_D + R_S I_D + V_{DS}$ <

$I_D = \frac{1}{2} K_n' L \frac{W}{L} (V_{GS} - V_t)^2$ <

Example 4.6




$$\left(\frac{R_{G2}}{R_{G1}+R_{G2}}\right)5 = V_G$$

$I_D = 0.5\text{mA}$

$I_D = \frac{1}{2}K_p'\left(\frac{W}{L}\right)(V_{GS}-V_t)^2$

$I_D \rightarrow V_{GS}$

$5 = V_{GS} + V_{RG2} = V_{GS} + V_G$

$V_{GS} \rightarrow V_{RG2}$

$5 = I_{RG1}R_{G1} + I_{RG2}R_{G2}$

$I_{RG1} = I_{RG2}$

$V_{RG1} + V_{RG2} = 10$

$$I_{RG} = I_{RG1} = I_{RG2} = \frac{5}{R_{G1}+R_{G2}}$$

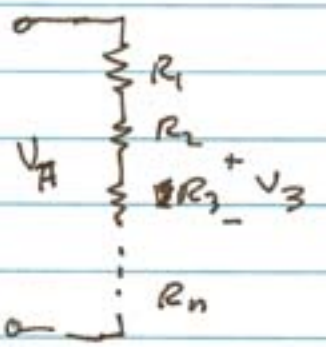
$R_{G1} = \checkmark$

$R_{G2} = -$

$V_D = 3$

$R_D I_D = 3$

$R_D = \frac{3}{I_D} = \checkmark$

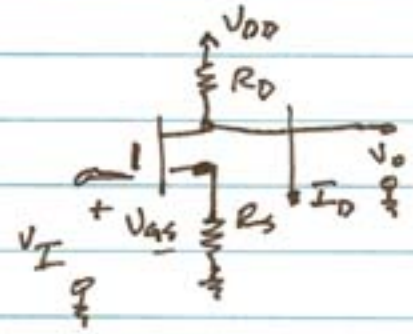



$$\frac{V_3}{V_A} = \frac{R_3}{R_1+R_2+\dots R_n}$$

$$\frac{V_4}{V_A} = \frac{R_4}{R_1+R_2+\dots+R_n}$$

$$\frac{V_3+V_4}{V_A} = \frac{R_3+R_4}{R_1+R_2+\dots+R_n}$$

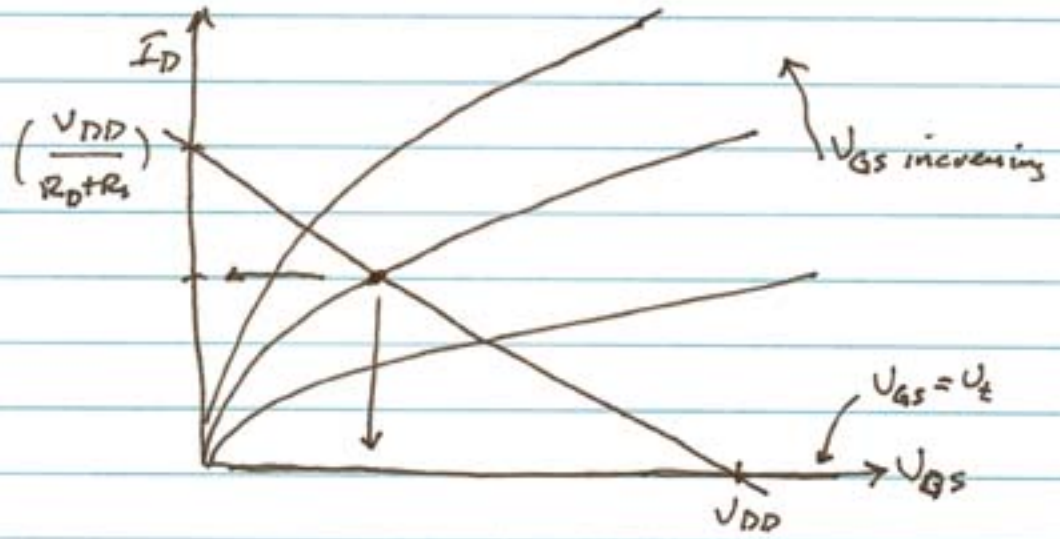
## Graphic Analysis of DC voltages + Currents




$$V_{DD} = R_D I_D + V_{DS} + R_S I_D$$
$$= (R_D+R_S) I_D + V_{DS}$$

2 eqn
2 unknowns

relation $V_D \leftrightarrow I_D$




Simultaneous solution: V-I characteristic

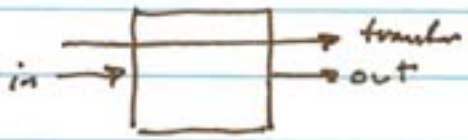
$V_{DD} = (R_D+R_S) I_D + V_{DS}$ circuit

need $V_{GS}$ to determine operating point

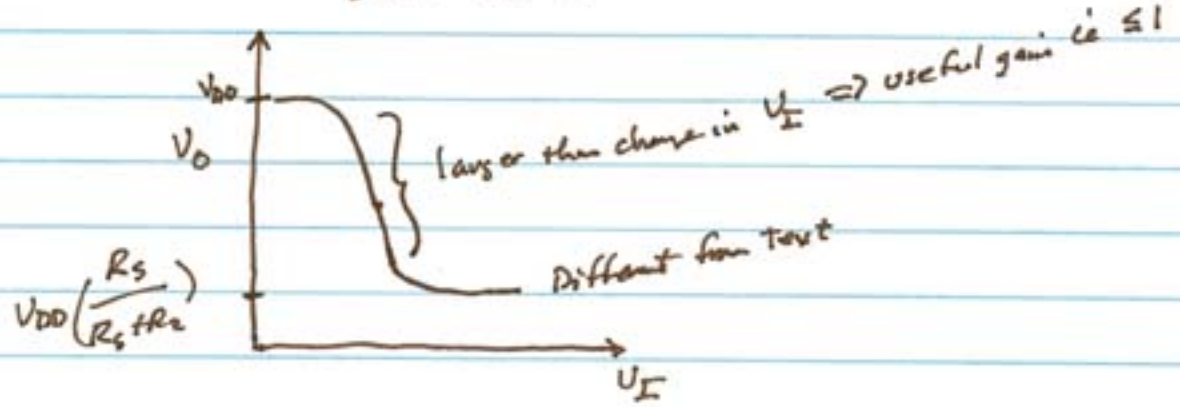
$$V_I = V_{GS} + I_D R_S$$

$$I_D = \frac{1}{2} K_n' \left(\frac{W}{L}\right)(V_{GS} - V_t)^2$$

Transfer Characteristic → Gain




$out = f(in)$ transfer




$$V_{DD} = R_D I_D + R_S I_D + V_{DS}$$

$V_{DD}$: fixed; $R_D I_D + R_S I_D$: increase; $V_{DS}$: decrease