Tuesday, March 19, 2013
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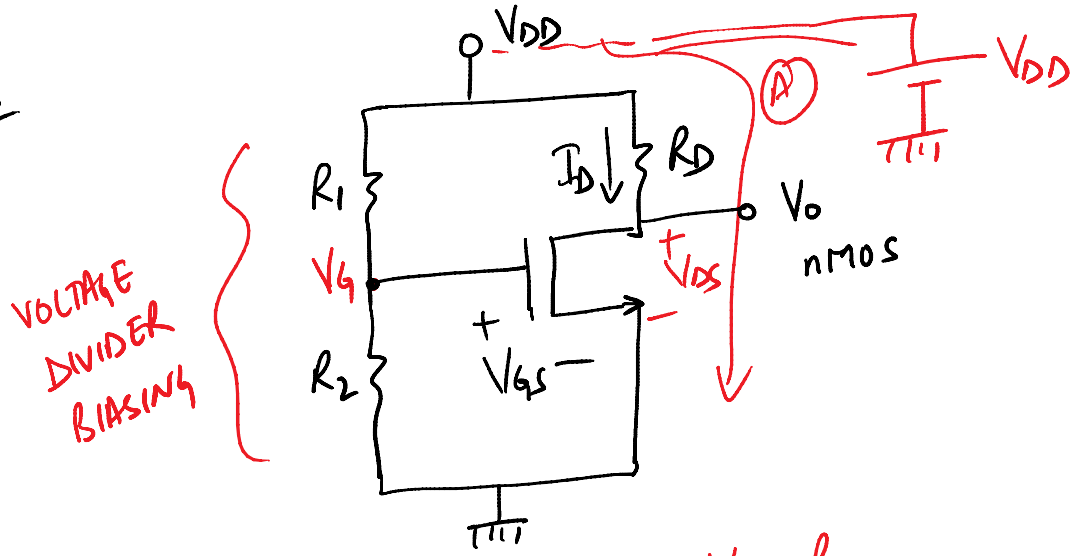
LECTURE -38

Q



$$V_G = V_{GS} = \frac{V_{DD} R_2}{R_1 + R_2}$$

IF $V_{GS} > V_{TN}$ AND WE ARE IN SAT. REG.

$V_{DS} > V_{DS(SAT)} = V_{GS} - V_{TN}$

$$I_D = K_n (V_{GS} - V_{TN})^2$$

KVL LOOP (A)

$V_{DS} = V_{DD} - I_D R_D$ [LL EQUATION]

$P_T \rightarrow$ POWER DISSIPATED IN THE TRANSISTOR

$P_T = V_{DS} I_D$

$R_1 = 30k\Omega$ $R_2 = 20k\Omega$ $R_D = 20k\Omega$ $V_{DD} = 5V$

$V_{TN} = 1V$ $K_n = 0.1\ mA/V^2$

$$V_G = V_{GS} = \left(\frac{20K}{20K + 30K}\right) 5 = 2V$$

ASSUMING TR. IS IN SAT.

Q-POINT (V_{DS}, I_D)

$$I_D = K_n (V_{GS} - V_{TN})^2 = (0.1m)(2-1)^2 = 0.1mA$$

$$V_{DS} = 5 - (0.1m)(20K) = 3V$$

$$P_T = V_{DS} I_D = (0.1)(3) = 0.3m\ W$$

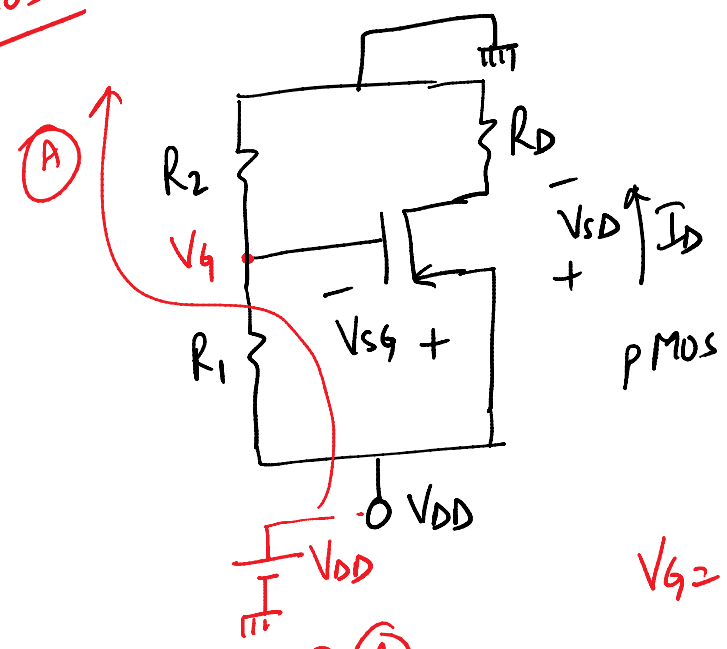
$$V_{DS(SAT)} = V_{GS} - V_{TN} = 2 - 1 = 1V$$

$V_{DS} > V_{DS(SAT)}$ $\therefore$ TR. IS IN SAT.

* FOR TURN-ON $V_{GS} > V_{TN}$
* FOR SAT. $V_{DS} > V_{DS(SAT)}$

Tuesday, March 19, 2013
4:15 PM

PMOS



$$V_G = \frac{V_{DD} R_2}{R_1 + R_2}$$

KVL LOOP (A)

$$-V_{DD} + V_{SG} + V_G = 0$$

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

ENHANCEMENT MODE

pMOS $V_{TP} < 0$

V_{SG} → POSITIVE

V_{GS} → NEGATIVE

TO TURN ON

$$V_{GS} < V_{TP}$$

IF IN SAT.

$$I_D = K_P (V_{SG} + V_{TP})^2$$

$$V_{SD} = V_{DD} - I_D R_D \quad \text{[LL EQUATION]}$$

SAT. $V_{SD} > V_{SD(SAT)} = V_{SG} + V_{TP}$

Ex

$R_1 = R_2 = 50k\Omega \quad V_{DD} = 5V \quad R_D = 7.5k\Omega$

$V_{TP} = -0.8V \quad K_P = 0.2mA/V^2$

$$V_G = \left(\frac{R_2}{R_1+R_2}\right)V_{DD} = \left(\frac{50k}{50k+50k}\right)5 = 2.5V$$

$$V_{SG} = V_{DD} - V_G = 5 - 2.5 = 2.5V$$

ASSUME TR. IS IN SAT.

$$I_D = K_P (V_{SG}+V_{TP})^2 = (0.2m)(2.5-0.8)^2$$

$$= 0.578mA$$

$$V_{SD} = V_{DD} - I_D R_D = 5 - (0.578m)(7.5K)$$

$$= \underline{0.665V}$$

$$V_{SD(SAT)} = V_{SG} + V_{TP} = 2.5 - 0.8 = \underline{1.7V}$$

$V_{SD} < V_{SD(SAT)} \longrightarrow$ ∴ TR. IS NOT IN SAT.!

$$I_D = K_p \left[2 (V_{SG} + V_{TP}) V_{SD} - V_{SD}^2 \right] \quad \text{TRIODE}$$

$$V_{SD} = V_{DD} - I_D R_D$$

$$\therefore I_D = K_p \left[2 (V_{SG} + V_{TP}) (V_{DD} - I_D R_D) - (V_{DD} - I_D R_D)^2 \right]$$

$$I_D = (0.2m) \left[2 (2.5 - 0.8) (5 - I_D (7.5K)) - (5 - I_D (7.5K))^2 \right]$$

QUADRACTIC EQ.

SOLVE FOR I_D

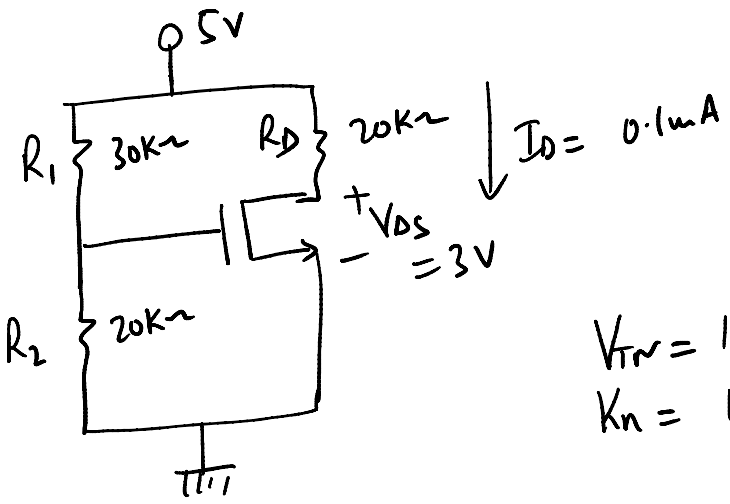
TWO VALUES OF I_D WHICH WILL GIVE TWO VALUES OF V_{SD}

CHOOSE THE VALUE OF I_D THAT LEADS TO A VALUE OF V_{SD}, WHICH WILL MAKE THE TRANSISTOR IN TRIODE REGION

$I_D = 0.515\ mA$

$V_{SD} = 1.14V$

Q3



$V_{TN} = 1V$

$K_n = 0.1mA/V^2$

$V_{DS} = V_{DD} - I_D R_D \rightarrow$ LL EQUATION

$= 5 - I_D(20K)$

$I_D = \frac{5}{20k} - \frac{V_{DS}}{20k}$

FIND THE TRANSITION POINT?

AT TRANSITION POINT

$V_{DS} = V_{DS(SAT)} = V_{GS} - V_{TN} = V_{DD} - I_D R_D$

$I_D = K_n (V_{GS} - V_{TN})^2$

$V_{GS} - V_{TN} = V_{DD} - (K_n) R_D (V_{GS} - V_{TN})^2$

$K_n R_D (V_{GS} - V_{TN})^2 + (V_{GS} - V_{TN}) - 5 = 0$

X X

QUADRATIC EQUATION

SOLVE FOR $V_{GS} - V_{TN}$

$V_{GS} - V_{TN} = 1.35 = V_{DS}$

1V

$\therefore \quad V_{GS} = 2.35\ V$

$I_D = (0.1m)(2.35-1)^2 = 0.182mA$

FOR $V_{GS} < 2.35V$ TR IS IN SAT.

$V_{GS} > 2.35V$ TR IS IN TRIODE REGION

AS $V_{GS} \uparrow \quad I_D \uparrow \quad V_{DS} \downarrow$