Electronics : ENEE 236 ⟹ L15, Part 1 & Part 2 MOSFET

Midpoint Bias : For maximum Symmetrical Swing

- Place Qpoint in the midde point of the transfer charactristic to allow for Maximum swing between I_{DSS} & Zero

$\boxed{1}$ let $I_D = 0.5 I_{DSS}$

$$0.5\, \cancel{I_{DSS}} = \cancel{I_{DSS}} \left(1 - \frac{V_{GS}}{V_P}\right)^2$$

$$0.5 = \left(1 - \frac{V_{GS}}{V_P}\right)^2$$

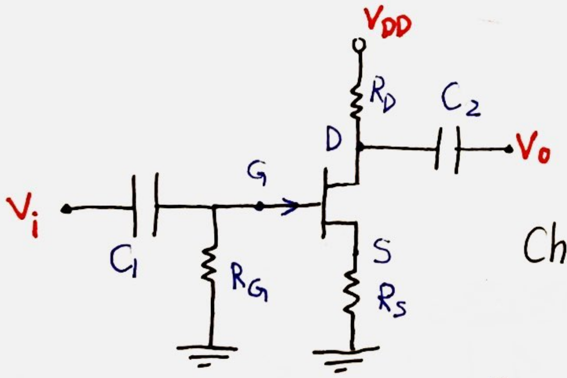
$$\sqrt{0.5} = 1 - \frac{V_{GS}}{V_P} \Rightarrow \frac{V_{GS}}{V_P} = 1 - \sqrt{0.5}$$

$$V_{GS} = V_P\left(1 - \sqrt{0.5}\right)$$

$$V_{GS} = V_P\,(0.2928)$$

$$\therefore V_{GS} \cong \frac{V_P}{3.41}$$

$\boxed{2}$ let $V_D = 0.5\, V_{DD}$



$V_P = V_{GS}(\text{off}) = -3V$

$I_{DSS} = 12\text{ mA}$

Choose R_D & R_S for mid point Bias

$V_D = \frac{1}{2} V_{DD},\ 6mA = I_D$ بنا

$= 6V$

$I_D = 0.5\, I_{DSS} = 6\text{ mA}$

$V_D = 0.5\, V_{DD} = 6V$

$$\leftarrow V_{GS} = \frac{V_{GS}(\text{off})}{3.4} = \frac{-3}{3.4} = -0.882V$$

$= V_G - V_S$

$V_{GS} = 0 - V_S$

$V_S = -(-0.882)$

$$R_S = \frac{V_S}{I_D} = \frac{0.882}{6mA} = 147\Omega$$

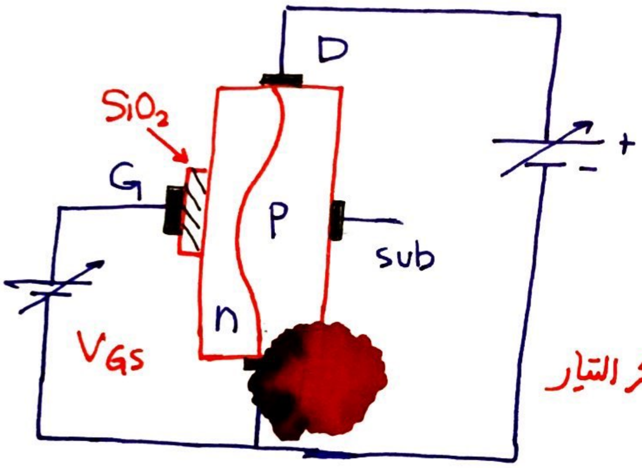
$$V_{DD} - I_D R_D - V_D = 0 \Rightarrow R_D = \frac{V_{DD} - V_D}{I_D} = 1K\Omega$$

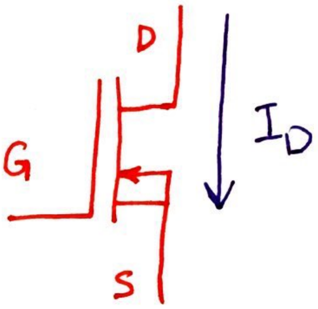
Electronics : ENEE236 → L15 : Part 2

Metal Oxide Semiconductor

1. DMOSFET : Depletion type Mosfet

2. EMOSFET : Enhancement type Mosfet





كل ما نزيد الالكترونات ظ من جهة G " RB " بسكر التيار لما يوصل لـ Vp

الاختلاف الرئيسي بينه وبين JFET انو ما في Pn Junction ←

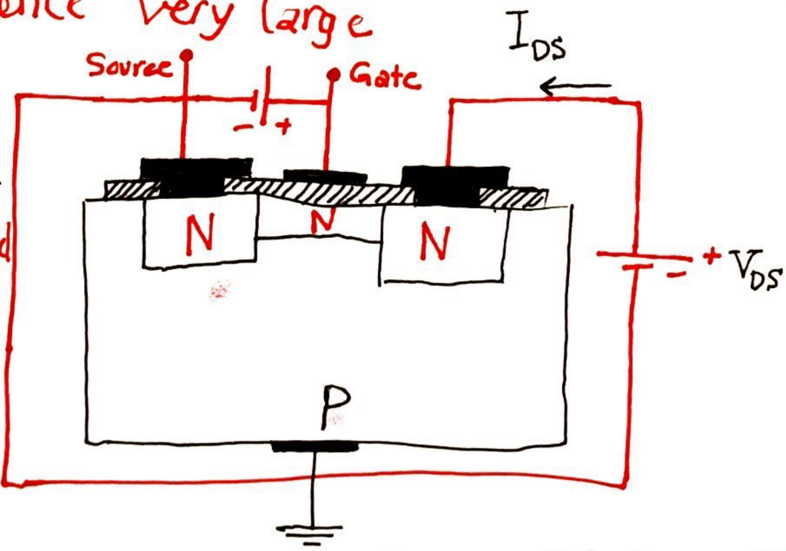
Instead, the gate of the MosFET in isolaled form the channel by a Silicon dioxide (SiO_2) Large.

Due to this the Input resistance of MOSFET is greater than JFET

Input Z "Impedence" very large

Depletion type Mos.

Construction of n-Channel DMOFET



اذا حطينا Voltage > 0 من جهة Gate فـ بجذب P بالتالي بزيد الـ Conduction electrones يعني بزيد التيار I_{DSS}

Metal Oxide Semiconductor Field Effect Transistor MosFET

Depletion Mode

$0 \geqslant V_{GS} > V_P$ سالب

$I_D < I_{DSS}$

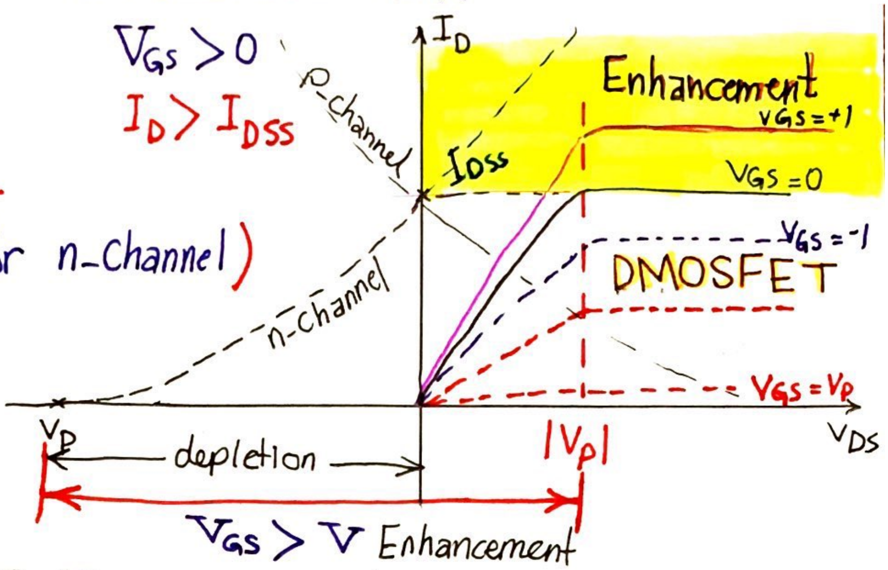
Enhancement Mode

$V_{GS} > 0$

$I_D > I_{DSS}$

$V_{GS} > V_P$ (negative for n-channel)

can be +ve or -ve



$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

$V_P \rightarrow$ سالب

$I_D < I_{DSS} \Leftarrow$ اذا سالبة // $I_D > I_{DSS} \Leftarrow 0 < V_{GS}$ اذا موجبة

* For the n-channel

$V_{GS} > V_P$ "negative"

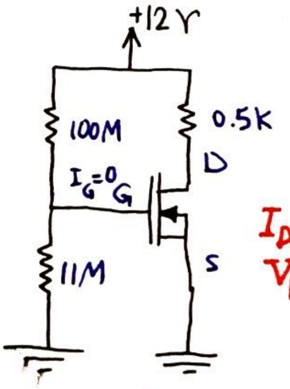
$V_{DS} > V_{GS} - V_P$

* For the p-channel

$V_{GS} < V_P$ "positive"

$V_{DS} < V_{GS} - V_P$

Example



$I_{DSS} = 4mA$

$V_P = -5V$

$$I_{DS} = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2 \quad \ldots \boxed{1}$$

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

$$V_G = \frac{11M}{111M} \times 12 = 1.19V \ldots \boxed{2}$$

$$I_{DS} = I_{DSS}\left(1 - \frac{V_G}{V_P}\right)^2$$

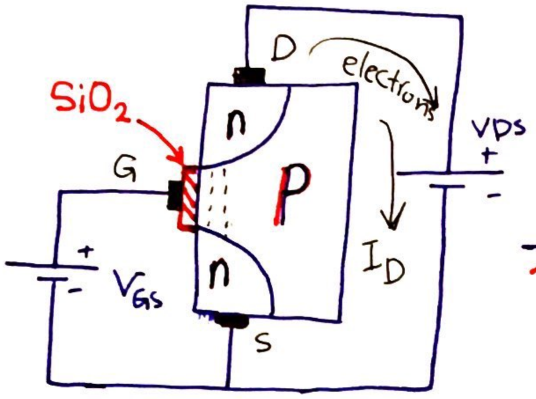
$$I_{DS} = 4mA\left(1 - \frac{1.19}{-5}\right)^2 = 6.13\,mA > I_{DSS}$$!! This is possible AND DMOSFET

. Will operate In Enhancement Mode.

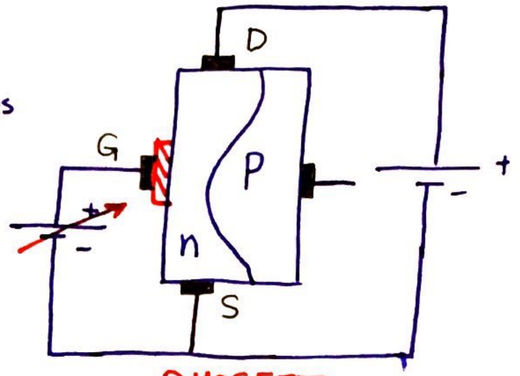
$$V_{DS} = V_{DD} - 0.5K\, I_{DS} = 8.93V$$

$$V_{DS} \overset{?}{>} V_{GS} - V_P = 6.19$$

$$8.93 \overset{?}{>} 1.19 - -5 = 6.19 \checkmark$$

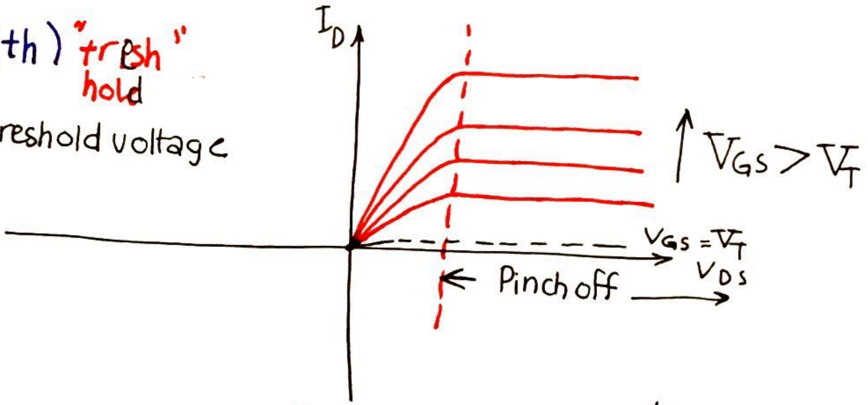


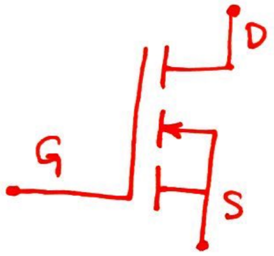
EmosFET
n-channel



DMOSFET

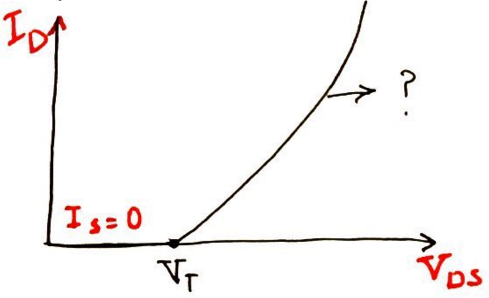
$V_{GS} \geqslant V_{GS}(th)$ "tresh hold"
V_T treshold voltage





$$I_D = \underline{\underline{k_n}} \left(V_{GS} - V_T \right)^2$$

datasheet or calculated



Test point @ $V_{GS} = 5V$
$I_D = 4mA$
$V_T = 3V$

$$\Rightarrow K_n = \frac{I_D}{(V_{GS} - V_T)^2} = \frac{4mA}{(5-3)^2} = 1mA/V^2$$

In the Pinch off Region _ EMOSFET

$$i_{DS}(t) = k_n \left(V_{GS}(t) - V_T \right)^2$$

$$|V_{DS}| > |V_{GS} - V_T|$$

$V_{GS} > V_T$ → موجبة n-Channel
$V_{GS} < V_T$ → سالبة P-Channel