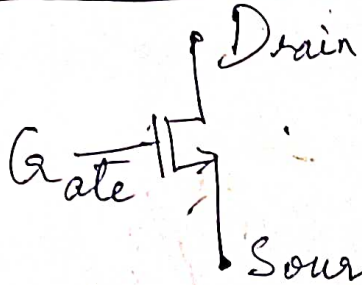
MOSFET DC CIRCUIT ANALYSIS

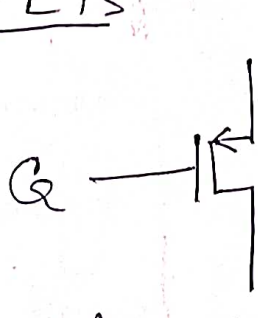
~~Common Source Circuit~~

METAL OXIDE SEMICONDUCTOR FIELD EFFECT TRANSISTOR

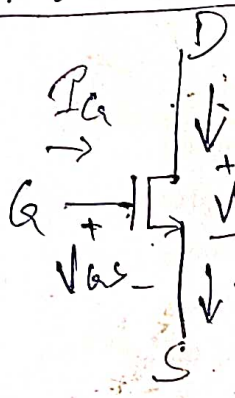
Enhancement Mode MOSFETs



n-channel enhancement mode MOSFET



p-channel enhancement mode MOSFET



$I_G = 0$ always since there is an insulator at the gate. Hence $I_D = I_S$.

If $V_{GS} > V_{TN}$ → threshold voltage of n-channel MOSFET

the MOSFET conducts and there will be a drain current.

Linear or Triode

$$I_D = K_n \left[2(V_{GS} - V_{TN}) V_{DS} - V_{DS}^2 \right]$$ if

$V_{GS} > V_{TN}$ and $V_{GS} - V_{TN} \leq V_{DS}$

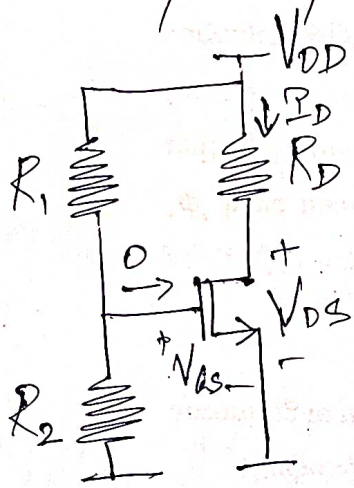
** Called as conduction parameter measured in A/V^2.

(and)

Saturation Region

$$I_D = K_n (V_{GS} - V_{TN})^2$$ if $V_{GS} \geq V_{TN}$ and $V_{DS} \geq V_{GS} - V_{TN}$

* Common Source Circuit: One of the basic configuration configurations is common-source circuit. The source terminal is at ground potto potential and is common to both input and output portions of the circuit. The circuit is shown adjacently.



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

Assuming that the device operates in saturation region. ($V_{DS} \geq V_{GS} - V_{TN}$)

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

Then $$V_{DS} = V_{DD} - I_D R_D$$

If $V_{DS} \geq V_{GS} - V_{TN}$ the above assumption is justified and analysis is correct. The power dissipated in the transistor is simply given by

$$P_T = V_{DS} I_D.$$

(V_{DS}, I_D) is also the operating point.

* Calculate the drain current and drain to source voltage of a common source circuit. Assume that $R_1 = 30k\Omega$, $R_2 = 20k\Omega$, $R_D = 20k\Omega$, $V_{DD} = 5V$, $V_{TN} = 1V$ and $K_n = 0.1 mA/V^2$.

$$V_G = V_{GS} = \frac{R_2}{R_1+R_2} V_{DD} = \frac{20}{20+30} \times 5 = 2\,V$$

Assuming that the transistor is biased in the saturation region, the drain current is

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

and

$$V_{DS} = V_{DD} - I_D R_D = 5 - 0.1 \times 20 = 3\,V$$

The power dissipated in transistor is

$$P_T = I_D V_{DS} = (0.1) \times 3 = 0.3\,mW$$

Note that $V_{DS} = 3V \geq 2 - 1 = 1V$: Hence the device is operating in saturation as originally assumed.

