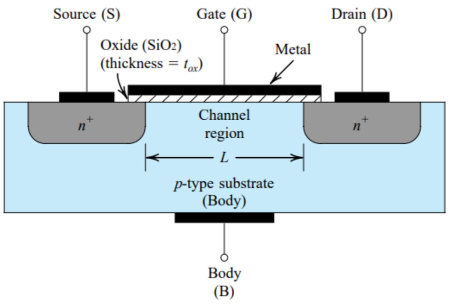
Maybe there is something here not again



The size of the "process" indicates the minimum possible channel length.

Magnitude of the electron charge in the channel [Q]:

$$|Q| = C_{OX}(WL)v_{OV}$$

C_{OX} is the oxide capacitance, [F/m^2]

$$C_{OX} = \frac{\epsilon_{OX}}{t_{OX}}$$

ϵ_{OX} is the permittivity of the SiO_2.
t_{OX} is the oxide thickness.

For C_{OX} per micron squared, use $C = C_{OX}WL$ [fF]

$$i_D = \left[(\mu_n C_{OX})\left(\frac{W}{L}\right)(v_{GS} - V_t)\right] v_{DS}$$

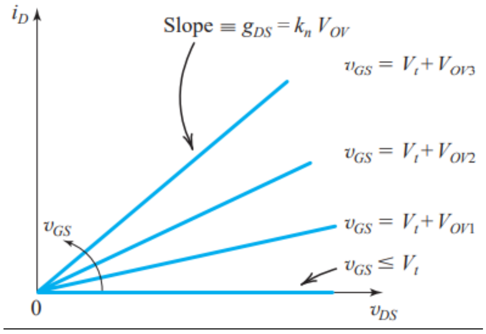
$$i_D = [g_{DS}]\, v_{DS}$$

$$k_n^{'} = \mu_n C_{OX}$$

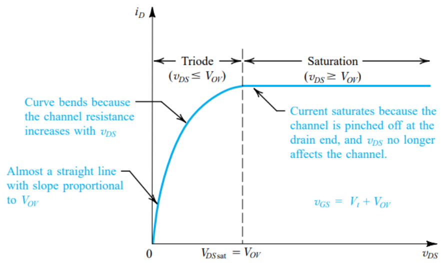
$$k_n = k_n^{'}(W/L)$$

When V_{DS} is small, the MOSFET behaves as a linear resistance r_{DS} whose value is controlled by the gate voltage v_{GS}.

$$r_{DS} = \frac{1}{g_{DS}}$$



Triode vs Saturation



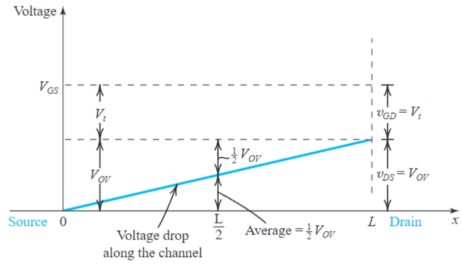
Triode ($v_{DS} \leq V_{OV}$)

$$i_D = k_n^{'}\left(\frac{W}{L}\right)\left(V_{OV} - \frac{1}{2}v_{DS}\right)v_{DS}$$

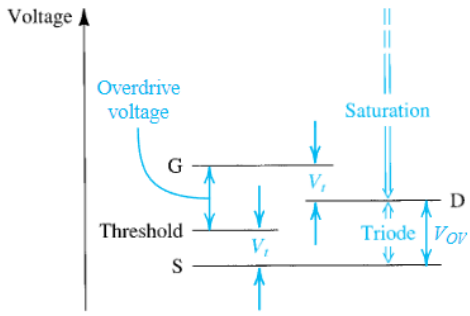
$$i_D = k_n^{'}\left(\frac{W}{L}\right)\left[(v_{GS} - V_t)v_{DS} - \frac{1}{2}v_{DS}^2\right]$$

Saturation ($v_{DS} \geq V_{OV}$)

$$i_D = \frac{1}{2}k_n^{'}\left(\frac{W}{L}\right)V_{OV}^2$$



Constant V_{OV} can be replaced by variable v_{OV}. PMOS transistors operate similarly but the polarity is reversed, so v_{GS} must be negative and larger than a negative v_{tp}, as is v_{DS} negative.



If you care about **channel-length modulation**, then use the expression:

$$i_D = \frac{1}{2}k_n^{'}\left(\frac{W}{L}\right)(v_{GS} - V_{th})^2(1 + \lambda v_{DS})$$

$v_{DS} = -\frac{1}{\lambda}$ | $V_A = \frac{1}{\lambda}$ | $V_A = V_A^{'}L$

V_A has units of volts.

$V_A^{'}$ has units of volts per micron.