MOS FIELD-EFFECT TRANSISTORS (IGFET)

- n, p - MOSFET { DEPLETION-MODE / ENHANCEMENT-MODE

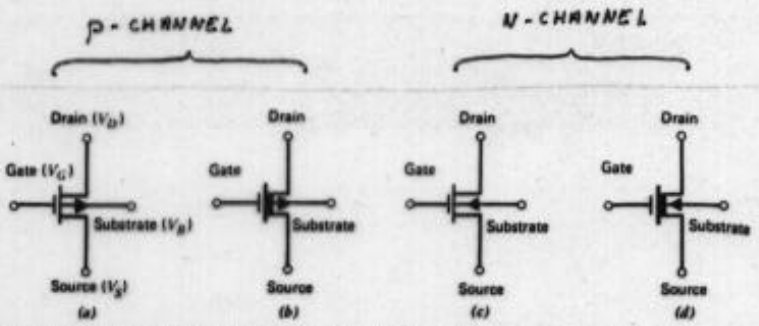


Figure 9.2 Electrical symbols for MOSFETs: (*a*) *p*–channel enhancement, (*b*) *p*–channel depletion, (*c*) *n*–channel enhancement, (*d*) *n*–channel depletion devices.

→ p-n JUNCTION between substrate and channel

n-MOSFET : ENHANCEMENT MODE

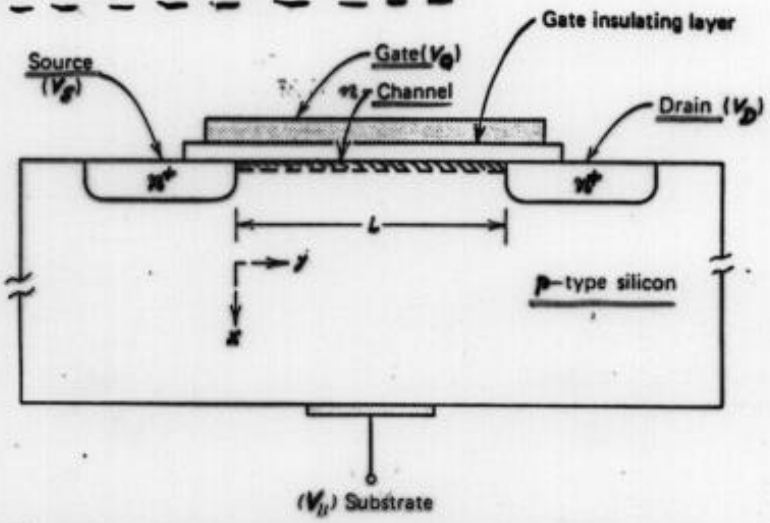
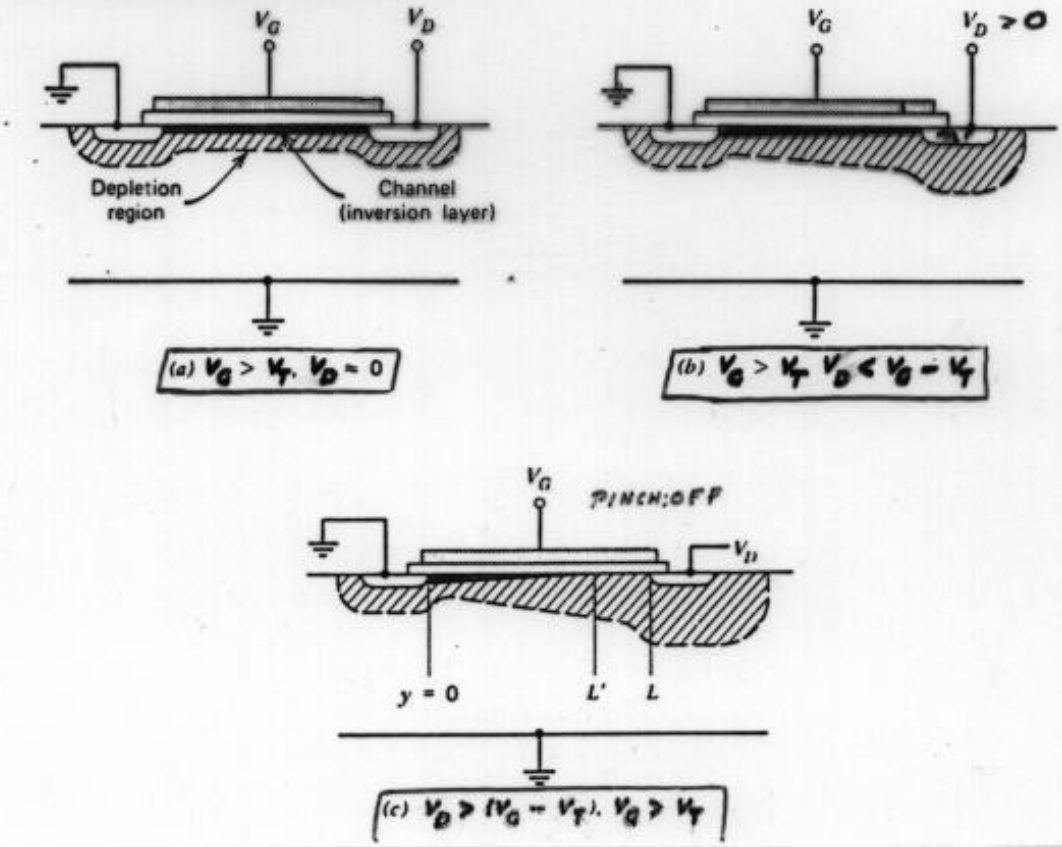
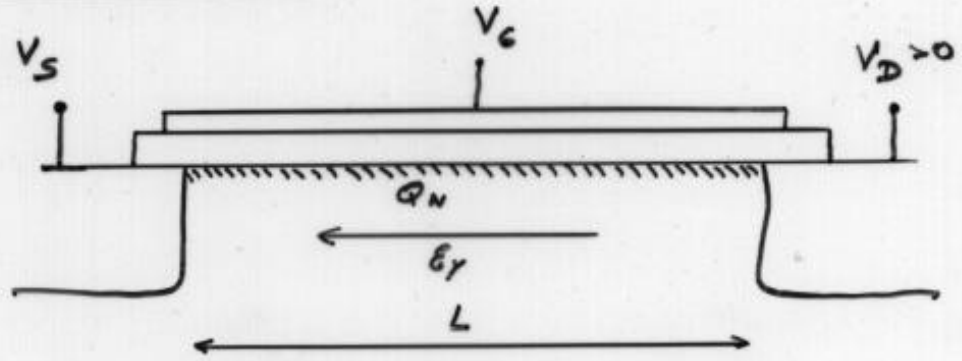


Figure 9.1 Basic elements of an *n*–channel, MOSFET. The source to drain spacing is designated *L* and the device width (in the *z* direction) is *W*.

CHARGE CONTROL OPERATION



LUMPED ANALYSIS



$$I_D = -\frac{Q_N}{T_{tr}}$$

Q_N : CHANNEL CHARGE = $Q_m \, WL$ (CHARGE DENSITY, CHANNEL WIDTH)

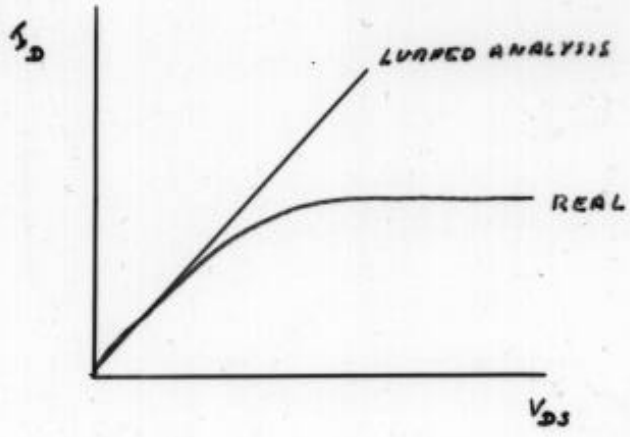
$$= -C_{ox}(V_G - V_T)\,WL$$

$$T_{tr} = \frac{L}{v_d}$$

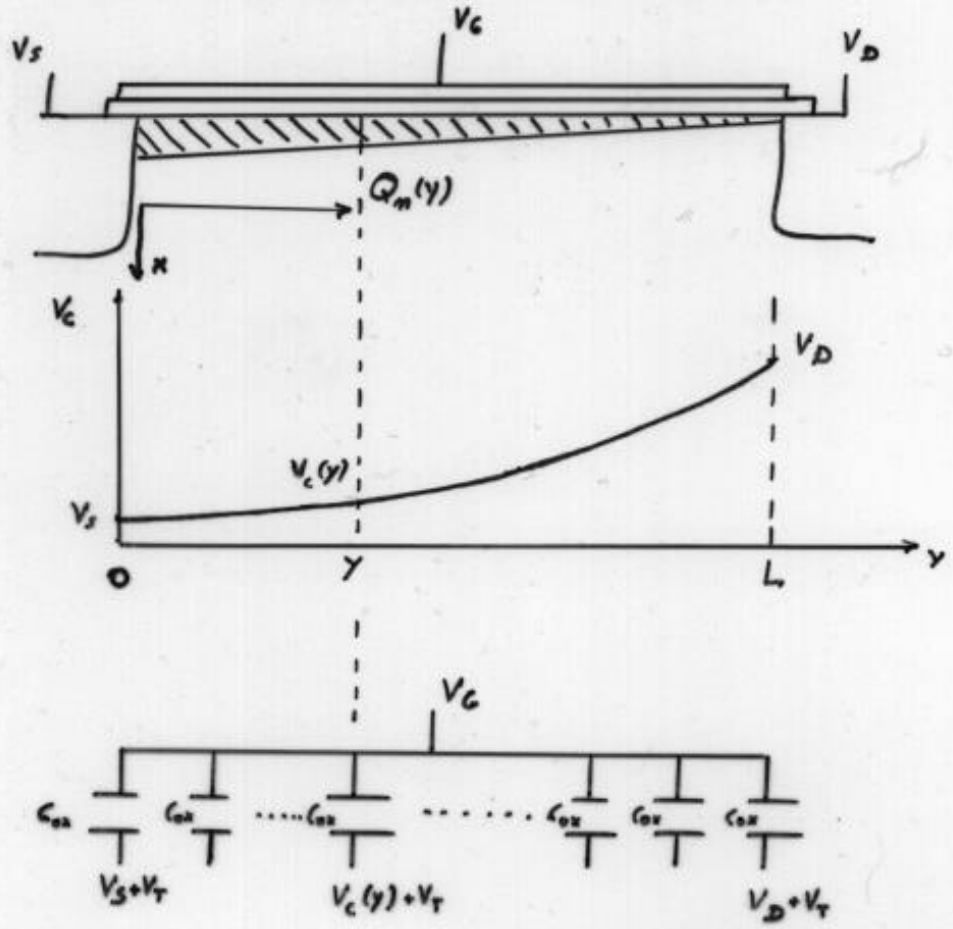
$$\begin{cases} v_d = -\mu_n \mathcal{E}_y \\ |\mathcal{E}_y| = \dfrac{V_D - V_S}{L} \end{cases}$$

$$\Rightarrow I_D = \mu_n C_{ox} \frac{W}{L}(V_G - V_T)V_{DS}$$

$$I_D \propto (V_G - V_T)\,V_{DS}$$



- GRADUAL CHANNEL APPROXIMATION ($V_{GT} \gg V_D$)



WHAT IS $Q_m(y)$? $\Rightarrow$ $\boxed{Q_m(y) = -C_{ox}[V_G - V_T - V_c(y)]}$

CONDITIONS: $V_{GT} \gg V_D$

OR $\begin{cases} \left|\frac{\partial}{\partial y}\phi\right| \ll \left|\frac{\partial \phi}{\partial x}\right| \\ |\mathcal{E}_y| \ll |\mathcal{E}_x| \end{cases}$ ϕ: ELECTROSTATIC POTENTIAL