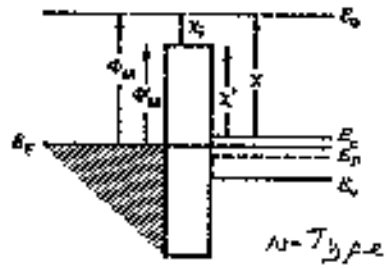


Figure 16.3 Equilibrium energy band diagram for an ideal MOS structure.

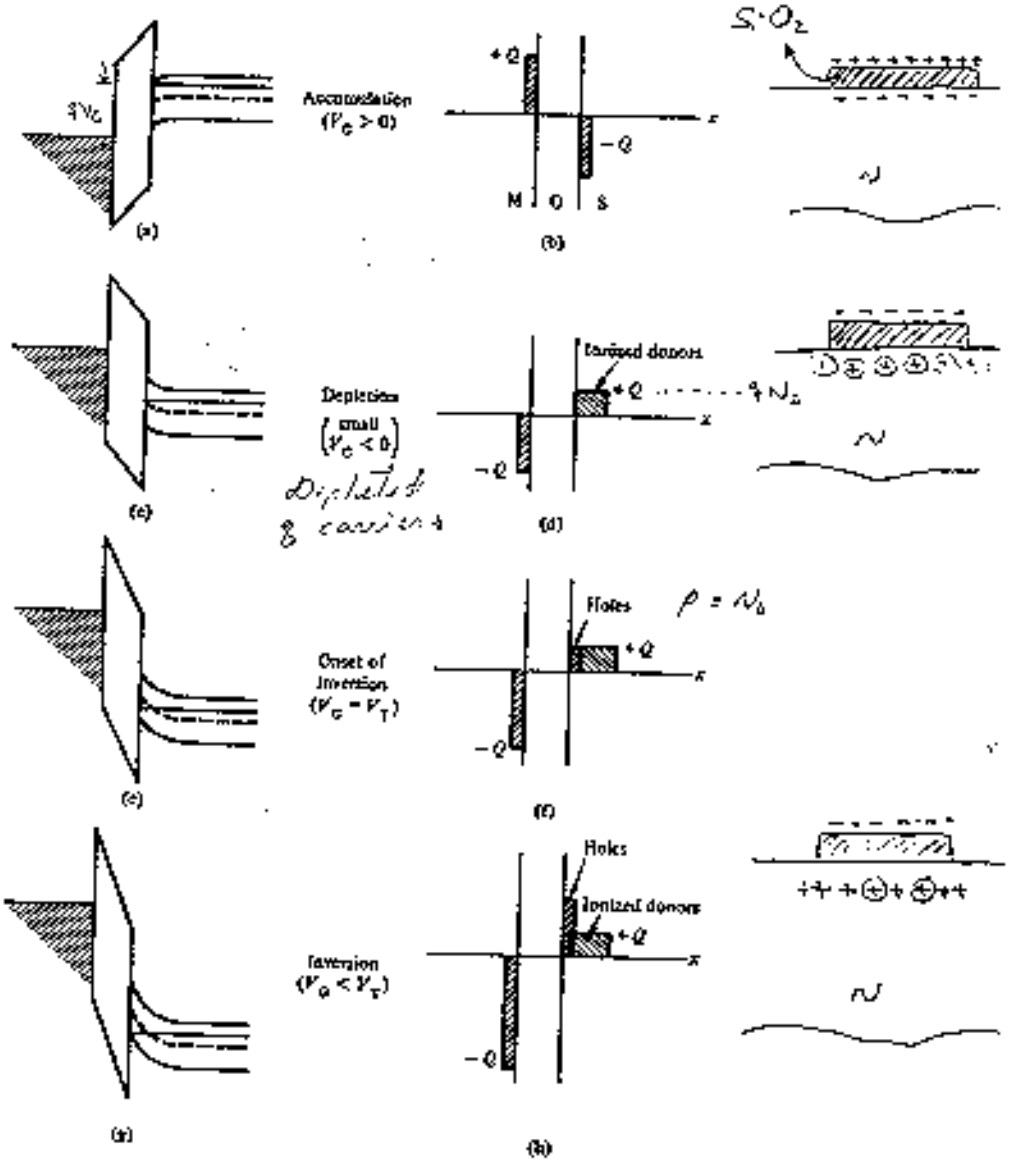


Figure 16.5 Energy band diagrams and corresponding block charge diagrams describing the static state in an ideal n-type MOS-capacitor.

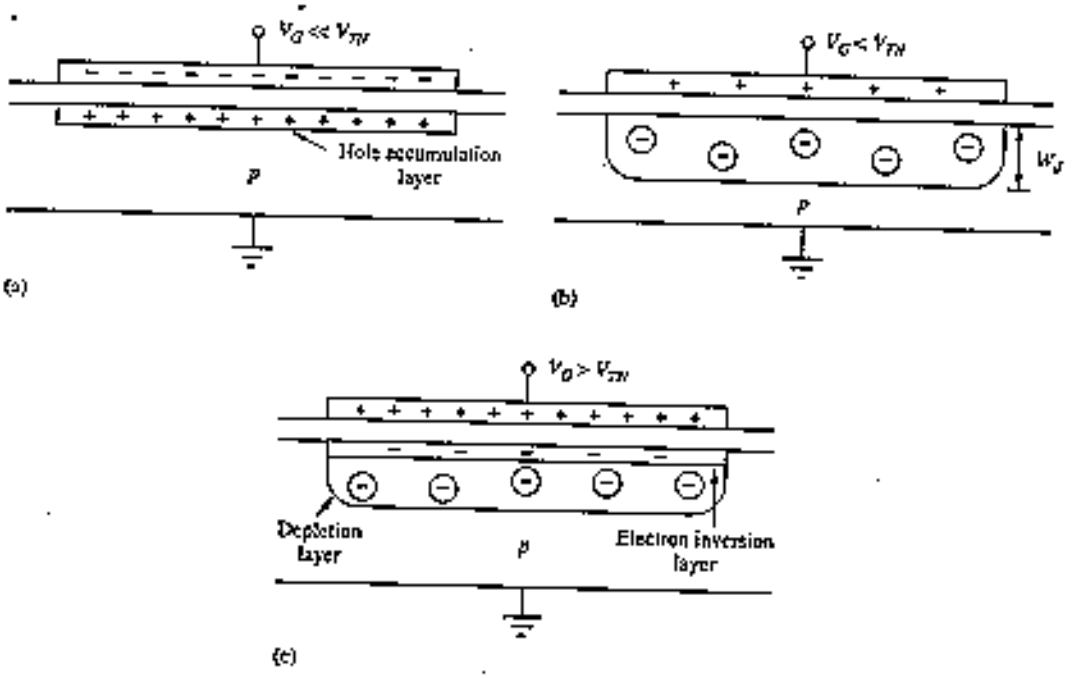


Figure 4.2 MOS capacitor operating in (a) accumulation, (b) depletion, (c) inversion.

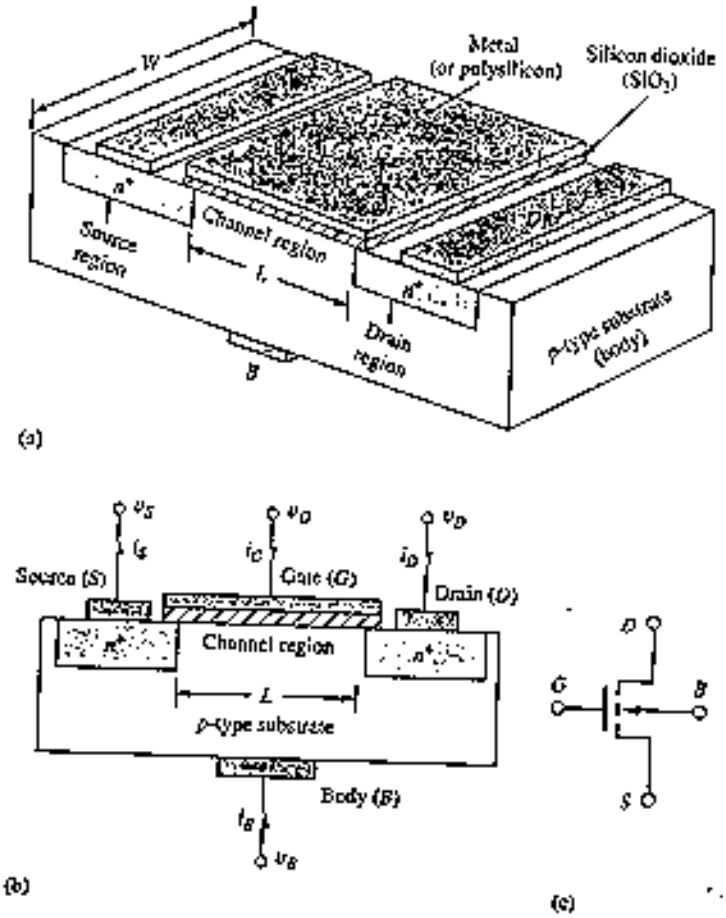
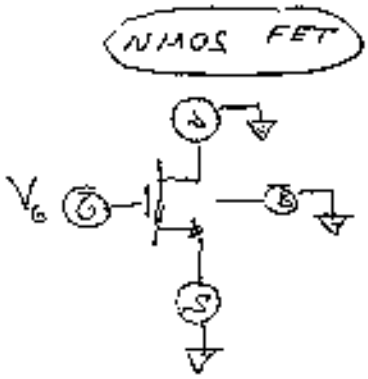


Figure 4.3 (a) NMOS transistor structure; (b) cross section; and (c) circuit symbol.



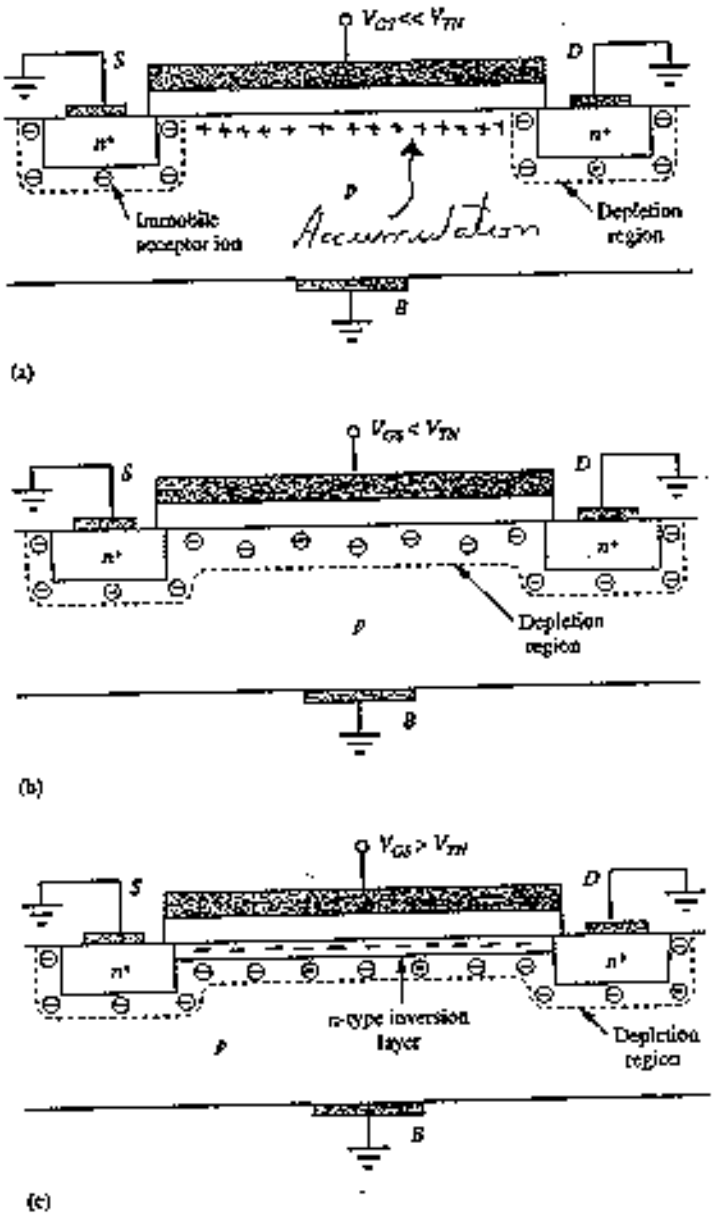


Figure 4.4 (a) $V_{GS} \ll V_{TN}$.
(b) $V_{GS} < V_{TN}$.
(c) $V_{GS} > V_{TN}$.

[1] For silicon dioxide, $\epsilon_{ox} = 3.9\epsilon_0$, where $\epsilon_0 = 8.854 \times 10^{-14}$ F/cm.

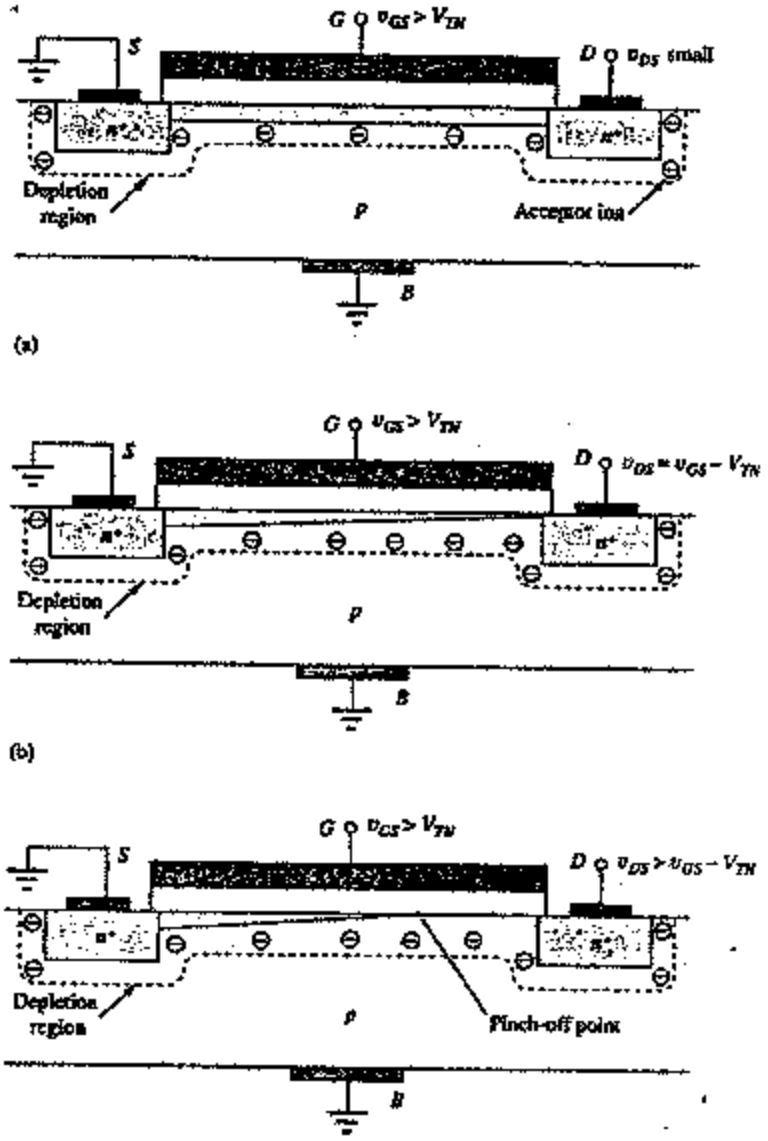


Figure 4.7 (a) MOSFET in the linear region. (b) MOSFET with channel just pinched off at the drain. (c) Channel pinch-off for $v_{DS} > v_{GS} - V_{TN}$.

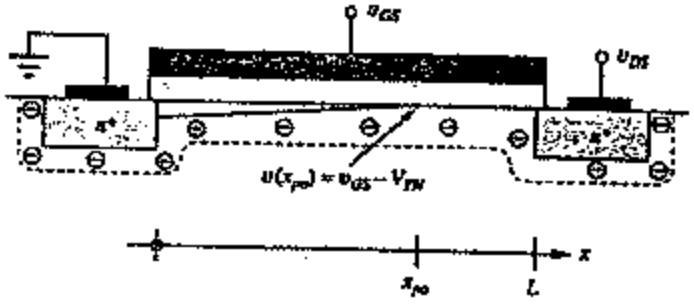


Figure 4.8 Inversion layer in the saturation region, also known as the pinch-off region.

NMOS Transistor Mathematical Model Summary

Equations (4.25) through (4.28) represent the complete model for the i-v behavior of the NMOS transistor. For all regions,

$$K_n = \mu_n C_{ox}'' \frac{W}{L} \qquad i_G = 0 \qquad i_B = 0 \tag{4.25}$$

Cutoff region :

$$i_{DS} = 0 \qquad \text{for } v_{GS} \leq V_{TN} \tag{4.26}$$

Linear region :

$$i_{DS} = K_n\left(v_{GS} - V_{TN} - \frac{v_{DS}}{2}\right)v_{DS} \qquad \text{for } v_{GS} - V_{TN} \geq v_{DS} \geq 0 \tag{4.27}$$

Saturation region :

$$i_{DS} = \frac{K_n}{2}(v_{GS} - V_{TN})^2(1 + \lambda v_{DS}) \qquad \text{for } v_{DS} \geq (v_{GS} - V_{TN}) \geq 0 \tag{4.28}$$

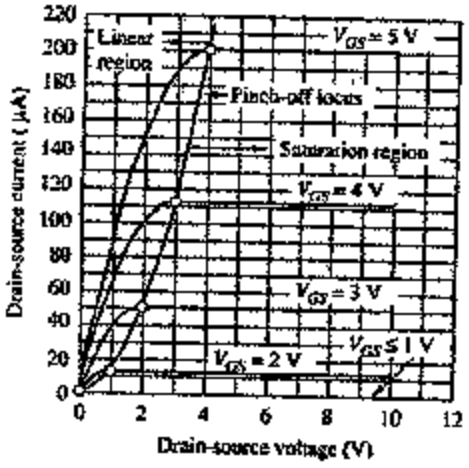


Figure 4.9 Output characteristics for an NMOS transistor with $V_{TN} = 1$ V and $K_n = 25 \times 10^{-6}$ A/V^2.

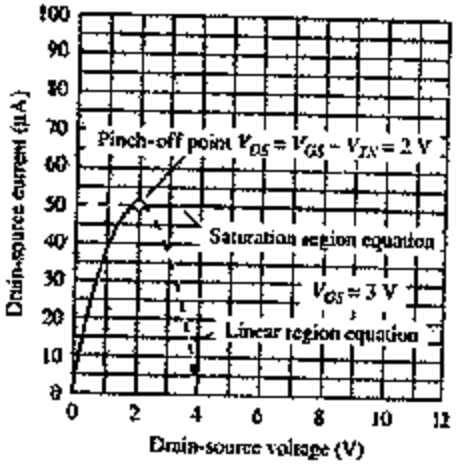


Figure 4.10 Output characteristic showing intersection of the linear region and saturation region equations at the pinch-off point.

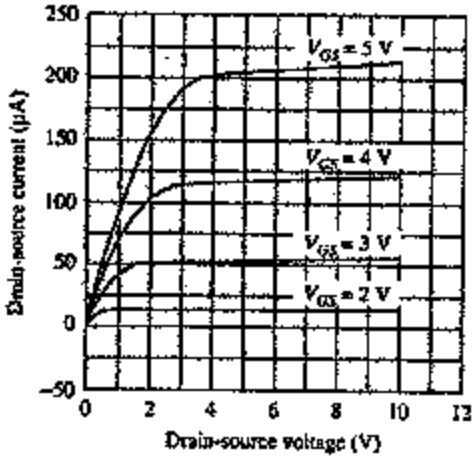


Figure 4.11 Output characteristics including the effects of channel-length modulation.