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 states in an ideal m-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) $V_{GS} > V_{TN}$.

In silicon diodes, $e = 1.9 \text{ e}_0$, where $e_0 = 8.854 \times 10^{-14} \text{ Fcm}$. 
Figure 4.7 (a) MOSFET in the linear region. (b) MOSFET with channel just pinched off at the drain. (c) Channel pinch-off for $v_{ds} > v_{gs} - V_{TN}$. 

4.5 Saturation of the $I_f$ Characteristic
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,

\[ K_n = \mu_n C_{ox} \frac{W}{L} \quad i_G = 0 \quad i_B = 0 \]  

(4.25)

Cutoff region:
\[ i_{DS} = 0 \quad \text{for} \quad v_{GS} \ll V_{TH} \]  

(4.26)

Linear region:
\[ i_{DS} = K_n \left( v_{GS} - V_{TH} - \frac{v_{DS}}{2} \right) v_{DS} \quad \text{for} \quad v_{GS} - V_{TH} \gg v_{DS} \gg 0 \]  

(4.27)

Saturation region:
\[ i_{DS} = \frac{K_n}{2} (v_{GS} - V_{TH})^2 (1 + \eta v_{DS}) \quad \text{for} \quad v_{DS} \approx (v_{GS} - V_{TH}) \gg 0 \]  

(4.28)

Figure 4.9 Output characteristics for an NMOS transistor with \( V_{TH} = 1 \) V and \( K_n = 25 \times 10^{-6} \) A/V².

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.