Scaling Implications

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Figure 14.38 The MOSFET channel length has been reduced by a factor of 2 every about 5 years. This phenomenon, known as Moore’s law, is continuing.
Figure 14.39 The velocity of electrons in the channel of an NMOS transistor reach a constant velocity $v_{sat} \approx 10^7$ cm/s when the electric field $E$ reaches a critical value $E_{cr}$. A similar situation occurs for $p$-channel devices.
Figure 14.40 Velocity saturation causes the $i_D - V_{DS}$ characteristic to saturate at $V_{DSSat}$. This early saturation results in a current $I_{DSat}$ that is lower than the value for a long-channel device.
Figure 14.41 The $i_D - v_{DS}$ characteristics of a short-channel MOSFET. Note the three different regions of operation: triode; saturation; and velocity saturation.
Figure 14.42 The $i_D - v_{GS}$ characteristic of a short-channel NMOS transistor operating at $v_{DS} > V_{DSat}$. Observe the quadratic and the linear portions of the characteristic. Also note that in the absence of velocity saturation, the quadratic curve would continue as shown with the broken line.
Figure 14.43: The $i_D - v_{GS}$ characteristic of a short channel MOSFET. To show the details of subthreshold conduction a logarithmic scale is needed for $i_D$. 