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Cover Illustration: The chip shown is the ADXL-50 surface-micromachined accelerometer. For the first time, sensor and signal conditioning are combined on a single monolithic chip. In its earliest application, it was a key factor in the improved reliability and reduced cost of modern automotive airbag systems. Photo reprinted with permission of Analog Devices, Inc.

The i_D - v_{DS} Characteristics

Figure 5.11(a) shows an n -channel enhancement-type MOSFET with voltages v_{GS} and v_{DS} applied and with the normal directions of current flow indicated. This conceptual circuit can be used to measure the i_D - v_{DS} characteristics, which are a family of curves, each measured at a constant v_{GS} . From the study of physical operation in the previous section, we expect each of the i_D - v_{DS} curves to have the shape shown in Fig. 5.6. This indeed is the case, as is evident from Fig. 5.11(b) which shows a typical set of i_D - v_{DS} characteristics. A thorough understanding of the MOSFET terminal characteristics is essential for the reader who intends to design MOS circuits.

The characteristic curves in Fig. 5.11(b) indicate that there are three distinct regions of operation: the **cutoff region**, the **triode region**, and the **saturation region**. The saturation region is used if the FET is to operate as an amplifier. For operation as a switch, the cutoff and triode regions are utilized. The device is cut off when $v_{GS} < V_t$. To operate the MOSFET in the triode region we must first induce a channel,

$$v_{GS} \geq V_t \quad (\text{Induced channel}) \quad (5.8)$$

and then keep v_{DS} small enough so that the channel remains continuous. This is achieved by ensuring that the gate-to-drain voltage is

$$v_{GD} > V_t \quad (\text{Continuous channel}) \quad (5.9)$$

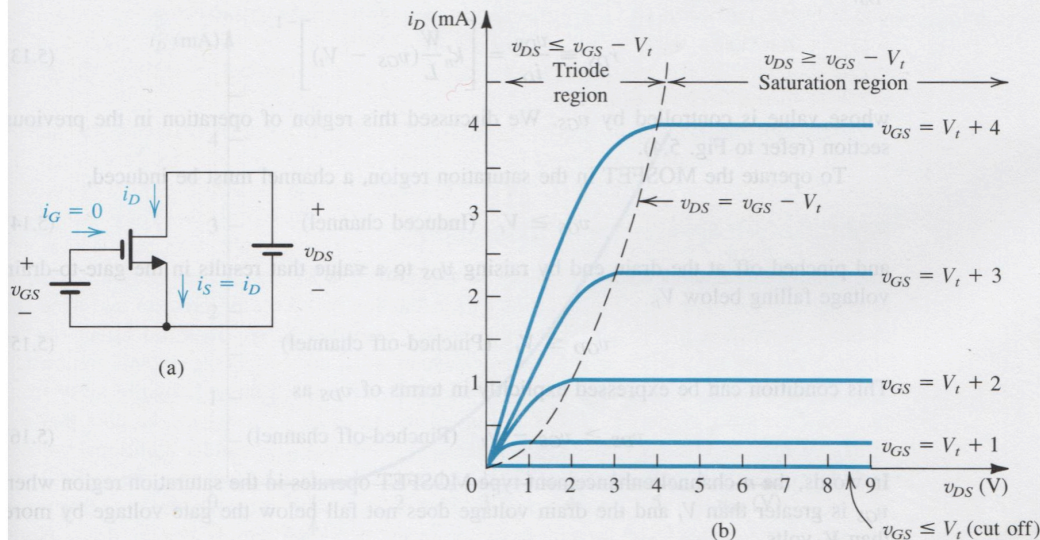


Fig. 5.11 (a) An n -channel enhancement-type MOSFET with v_{GS} and v_{DS} applied and with the normal directions of current flow indicated. (b) The i_D - v_{DS} characteristics for a device with $V_t = 1$ V and $k'_n(W/L) = 0.5$ mA/V².