
DIC L8: MOSFET (2)

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2.2. Long-channel (1)

- Current through the channel depends on
 - How much “electron” charge is in the channel?
 - Number of mobile carriers
 - How fast is the charge moving?

- Charge

$$Q_{channel} = C_g(V_{gc} - V_t) \quad \text{Eq. (2.1)}$$

- Note) $Q_{channel}$ for electrons. (It should be negative, but in Eq. (2.1), it is understood.)
- Note) V_{gc} appears instead of V_{gb} .

2.2. Long-channel (2)

- Capacitance

$$C_g = C_{OX}WL$$

Eq. (2.2)

- The “oxide capacitance,” C_{OX} , is given as

$$C_{OX} = \frac{\epsilon_{OX}}{t_{OX}}$$

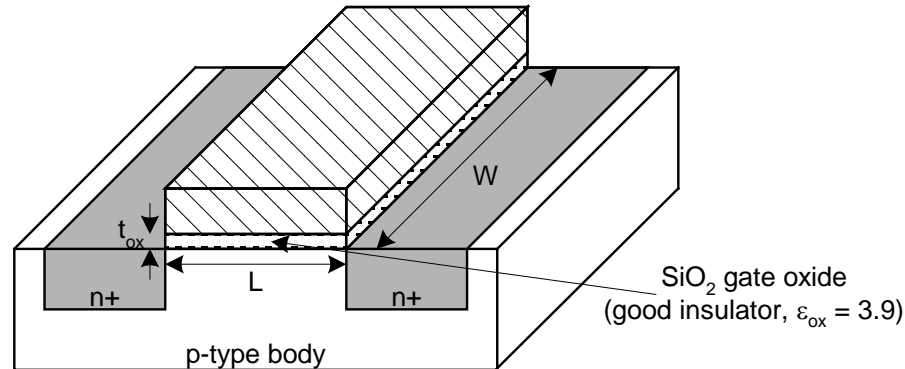


Fig. 2.6

2.2. Long-channel (3)

- IV characteristics

- After some manipulation, we have

Subthreshold $I_d = 0$

Linear $I_d = \beta \left(V_{gs} - V_t - \frac{V_{ds}}{2} \right) V_{ds}$ Eq. (2.10)

Saturation $I_d = \frac{\beta}{2} (V_{gs} - V_t)^2$

- Here,

$$\beta = \mu_n C_{ox} \frac{W}{L}$$

2.3. Capacitance (1)

- Any two conductors separated by an insulator have capacitance.
- Gate to channel capacitor is very important.
 - It creates channel charge which is necessary for operation.
- Source and drain have capacitance to body across the reverse-biased diodes.
 - It is called the diffusion capacitance because it is associated with source/drain diffusion regions.

2.3. Capacitance (2)

- Gate capacitance

$$C_g = C_{ox}WL$$

Eq. (2.2)
(You have seen it before!)

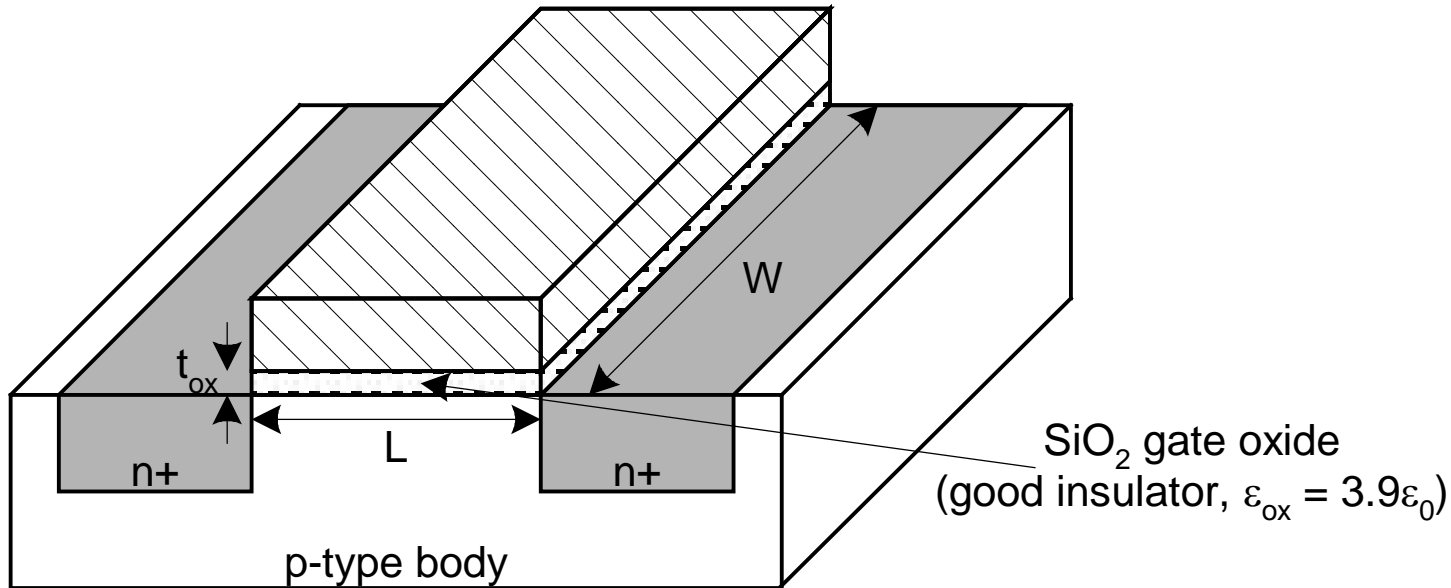


Fig. 2.6

2.3. Capacitance (3)

- Diffusion capacitance, C_{sb} and C_{db}
 - Due to the PN junction between a diffusion region and the substrate.

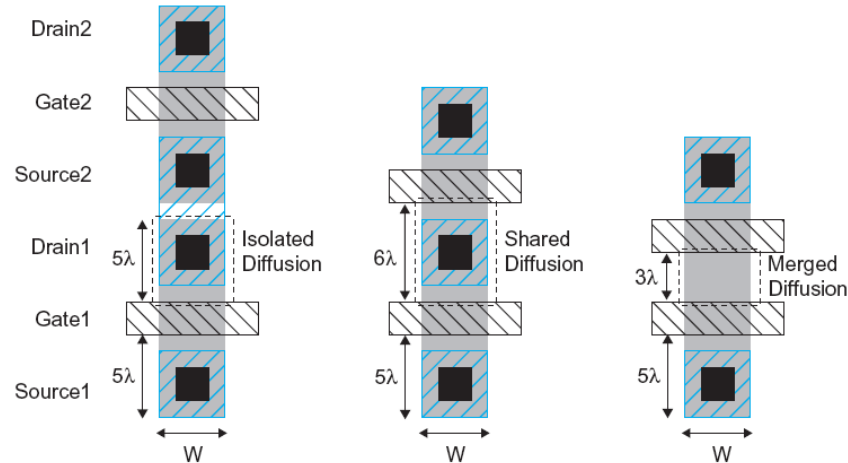


Fig. 2.8

Homework#3

- Solve the exercise problems of the textbook.
 - Exercises 2.1, Exercise 2.2, Exercise 2.3, Exercise 2.4, and Exercise 2.5 (Five problems)
- Consider a NMOS with $V_g=1.8$ V. Its V_t is 0.4 V. The channel length is 180 nm.
 - Draw that “potential” as a function of the position.
 - Consider the drain voltage up to 1.4 V.
- Due: October 15, 2019 (Before the lecture starts)
 - Upload your Homework to our GitHub repository.