Lecture13:
Physics of MOS transistors (5)

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GIST Lecture on April 13, 2015 (Internal use only)

Channel-length modulation

- Don't be confused!
  - Long (or short) channel device is an electronic device. (System)
  - The channel-length modulation occurs at both cases. (Phenomena)
  - Only for the short channel device, its effect is significant.

Mid-term examination

- Time and location
  - April 20 (Mon), 13:00 ~ 14:40
  - Room 229, College building A
- Coverage
  - Ch. 2, Ch. 3, Ch. 6
  - Additionally, Ch. 17 (Up to Lecture14)
- Problems (*tentative*)
  - Total twenty (20) problems
  - Five (5) minutes for each problem
  - 100 minutes long
- Policy
  - No cellphone, no calculator

Office hour before mid-term

- A special session (***April 17***)
  - The group study room (Room 304) in the library is reserved.
  - The reservation is valid from 14:00 ~ 17:00.

(college.gist.ac.kr)

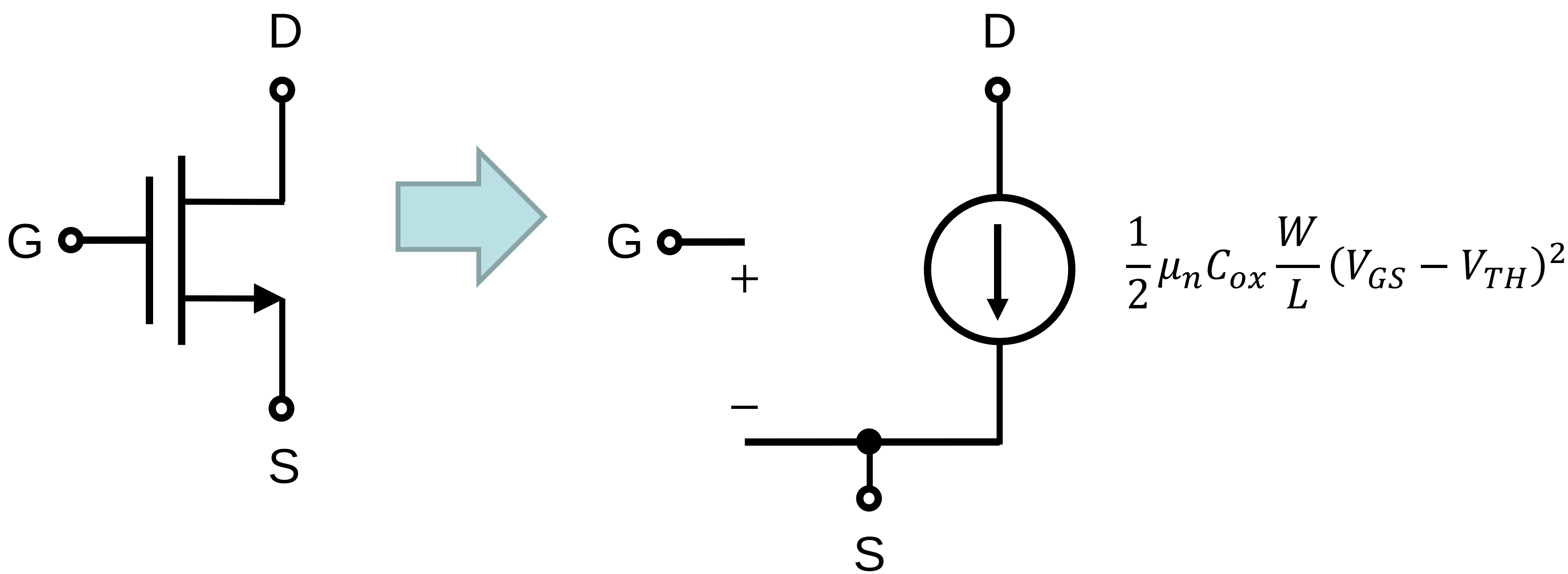
Large-signal model (1/2)

- Saturation region

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{TH})^2$$

  – Drain current is determined by gate voltage. (*voltage-controlled current source*)

  – *Channel-length modulation?*

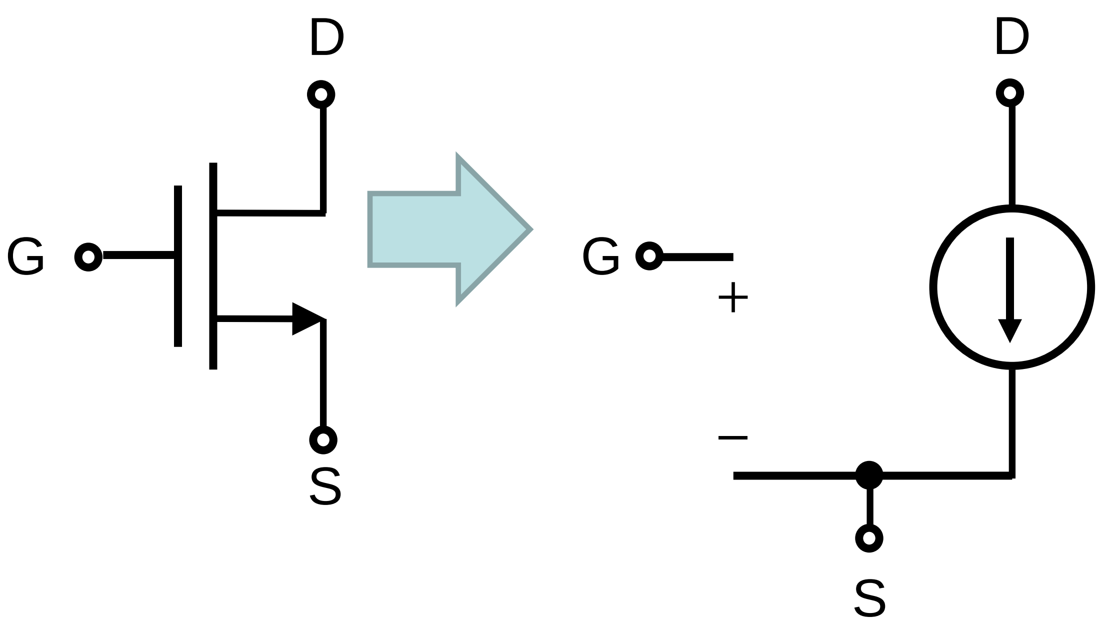


Large-signal model (2/2)

- Triode region

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}[2(V_{GS} - V_{TH})V_{DS} - V_{DS}^2]$$

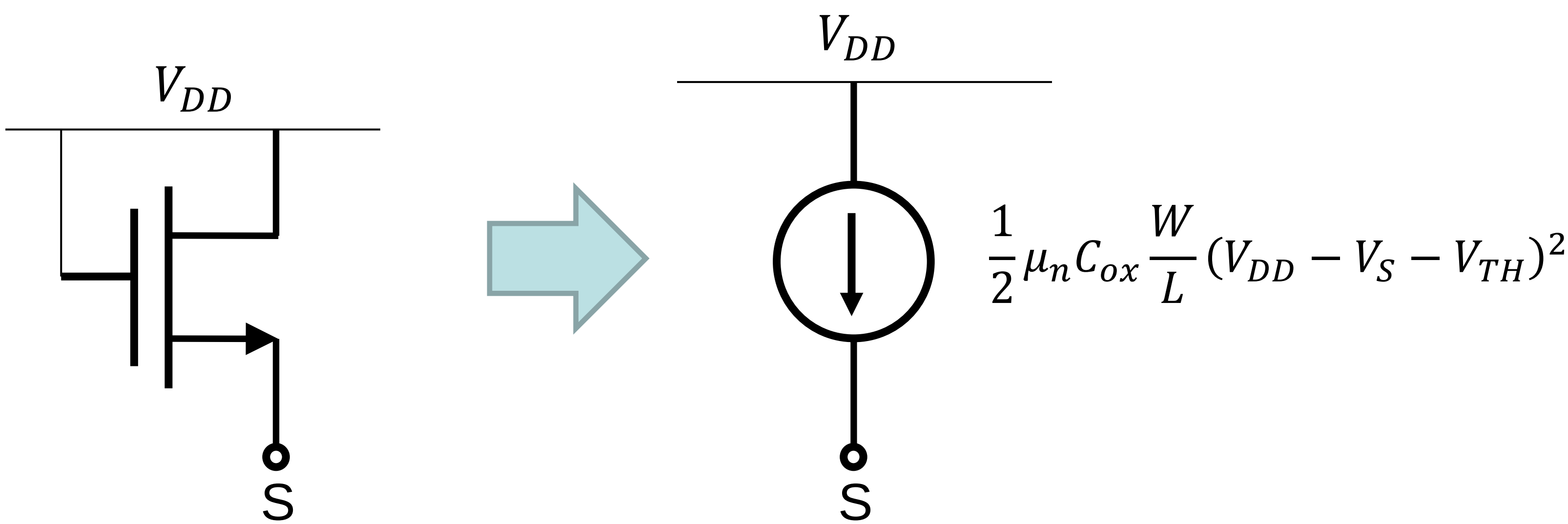
  – Still, it can be described by a *voltage-controlled current source*.



$$\frac{1}{2}\mu_n C_{ox}\frac{W}{L}[2(V_{GS} - V_{TH})V_{DS} - V_{DS}^2]$$

Example 6.13

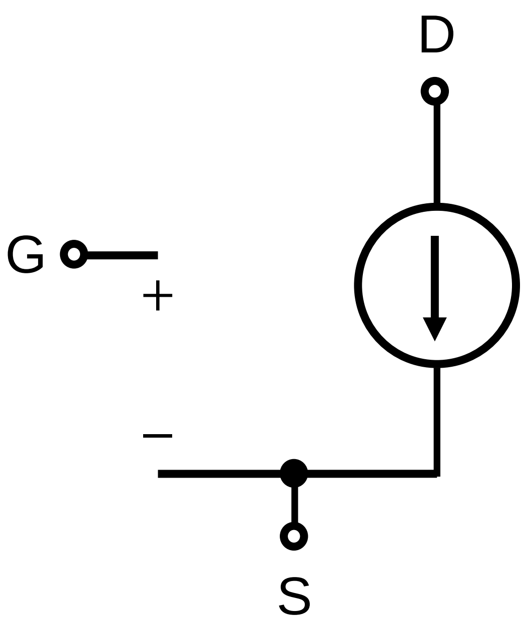
- Always in the saturation region!
  - Any necessary condition?

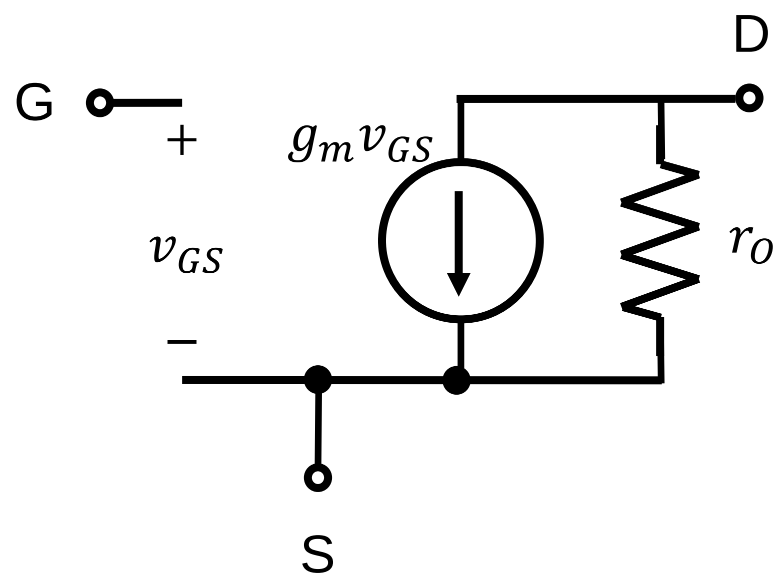


Gate and drain are tied.
They are connected to V_{DD}.

Small-signal model

- The large-signal model is complete (within its accuracy limitation).
  - But, for small-signal analysis, it is convenient to have the small-signal model.



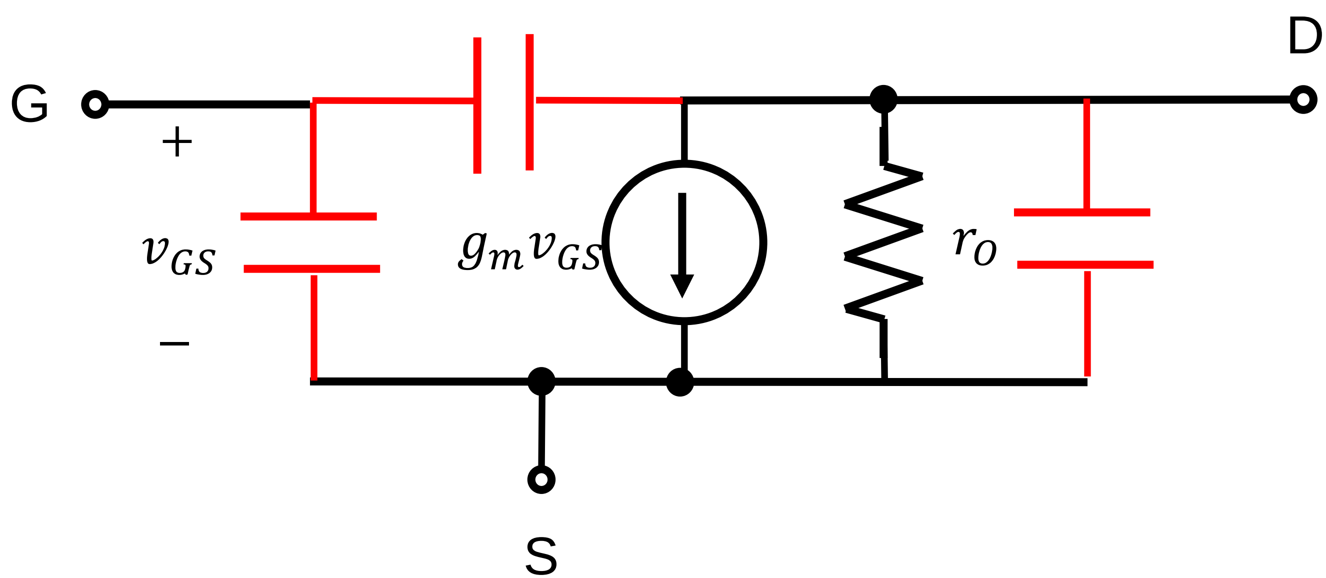


$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{TH})^2(1 + \lambda V_{DS})$$

What is g_m and r_O?

Time-dependent one?

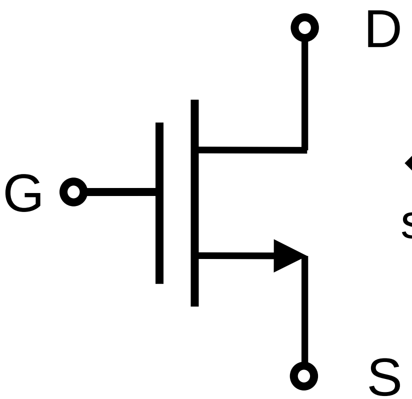
- Everything was in the dc steady-state…
  - How about the frequency-dependent case?
  - Capacitive components can be seen.
  - *Their physical origin?*



High-frequency, equivalent-circuit model for the case in which the source is connected to the substrate

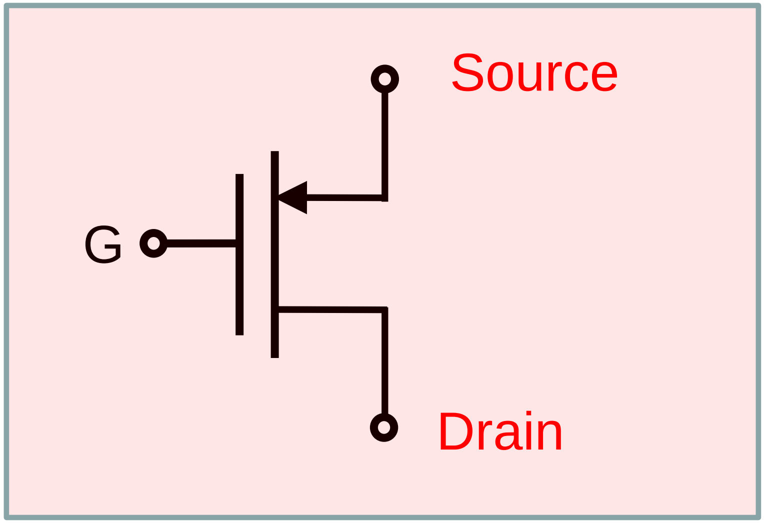
CMOS

- 9’s complementary of 123?
  - 876
- Complementary MOS
  - Here we have an NMOSFET.
  - A device where the transport is dominated by holes



← NMOSFET symbol

PMOSFET → symbol



- Why is it important?

Reading your textbook

- We covered the remaining part of Ch. 6.

- On Wednesday, we will cover Sec. 17. 1.