Lecture13:
MOSFET, small-signal model

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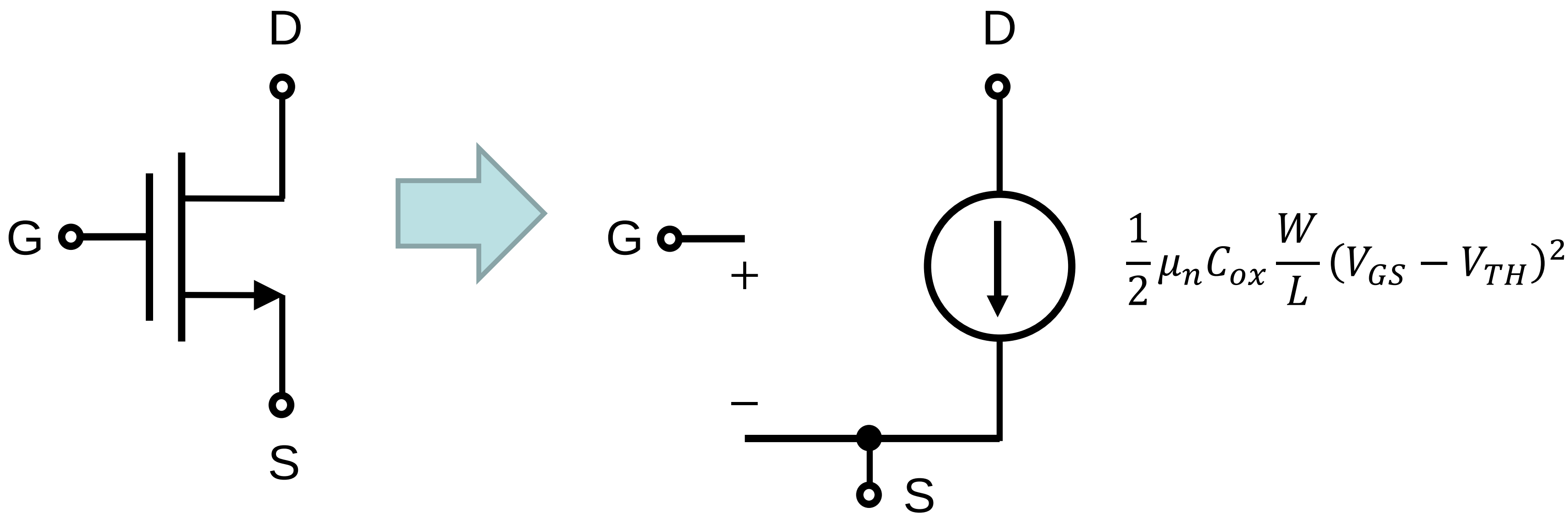
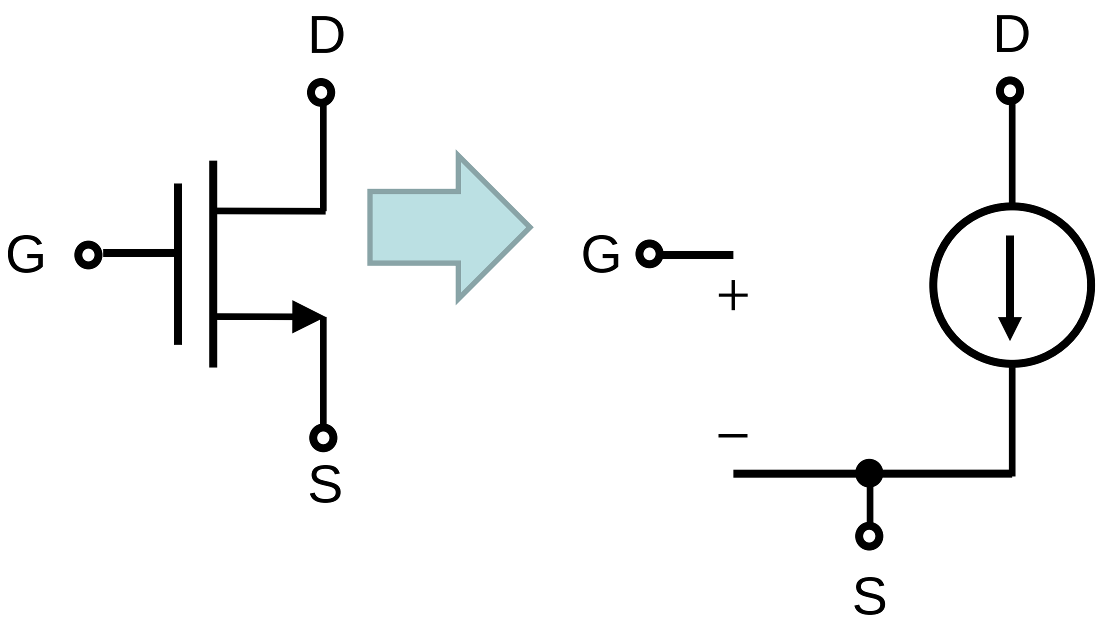
Large-signal model (1/2)

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



Large-signal model (2/2)

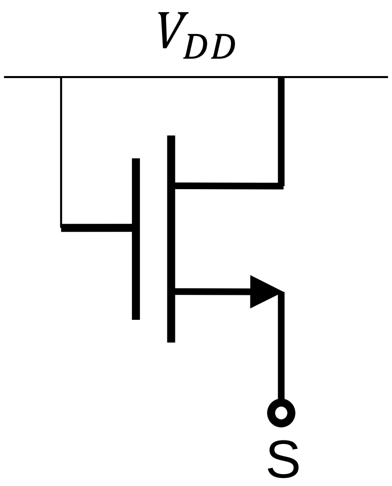
- Triode region
  - Still, it can be described by a *voltage-controlled current source*.

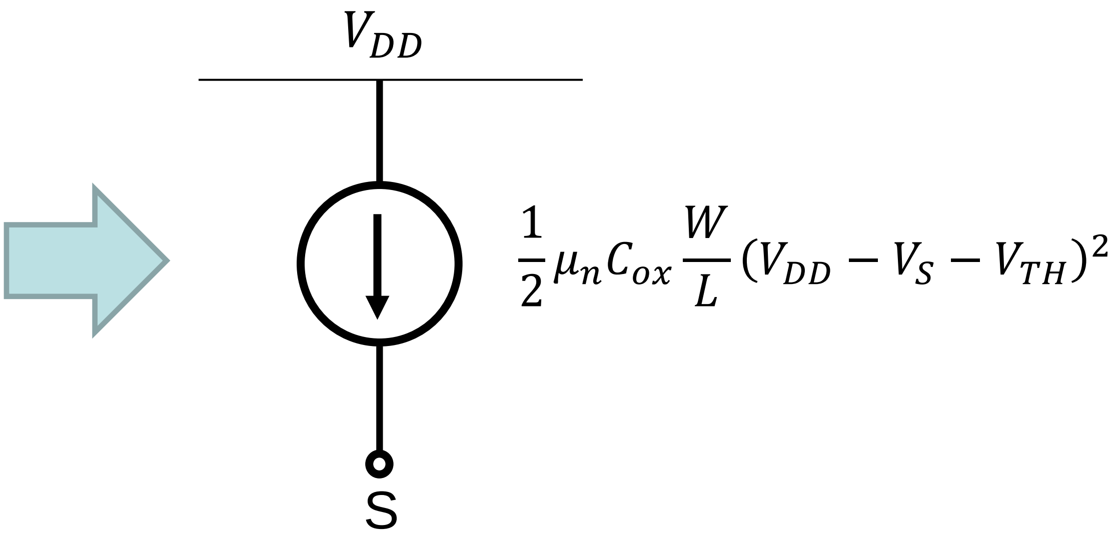


$$\frac{1}{2}\mu_n C_{ox}\frac{W}{L}[2(V_{GS}-V_{TH})V_{DS}-V_{DS}^2]$$

Example 6.13 (Razavi)

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

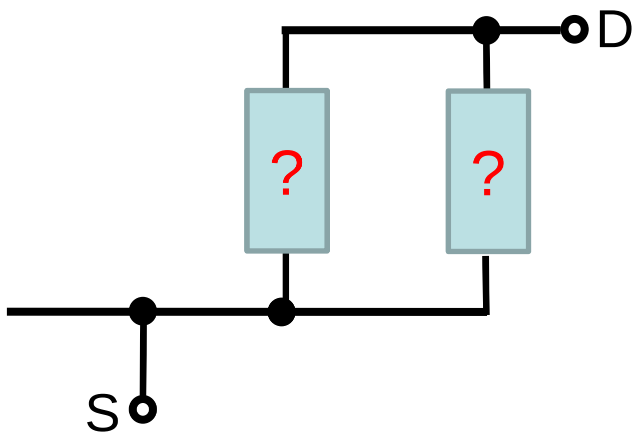




Gate and drain are tied.
They are connected to V_{DD}.

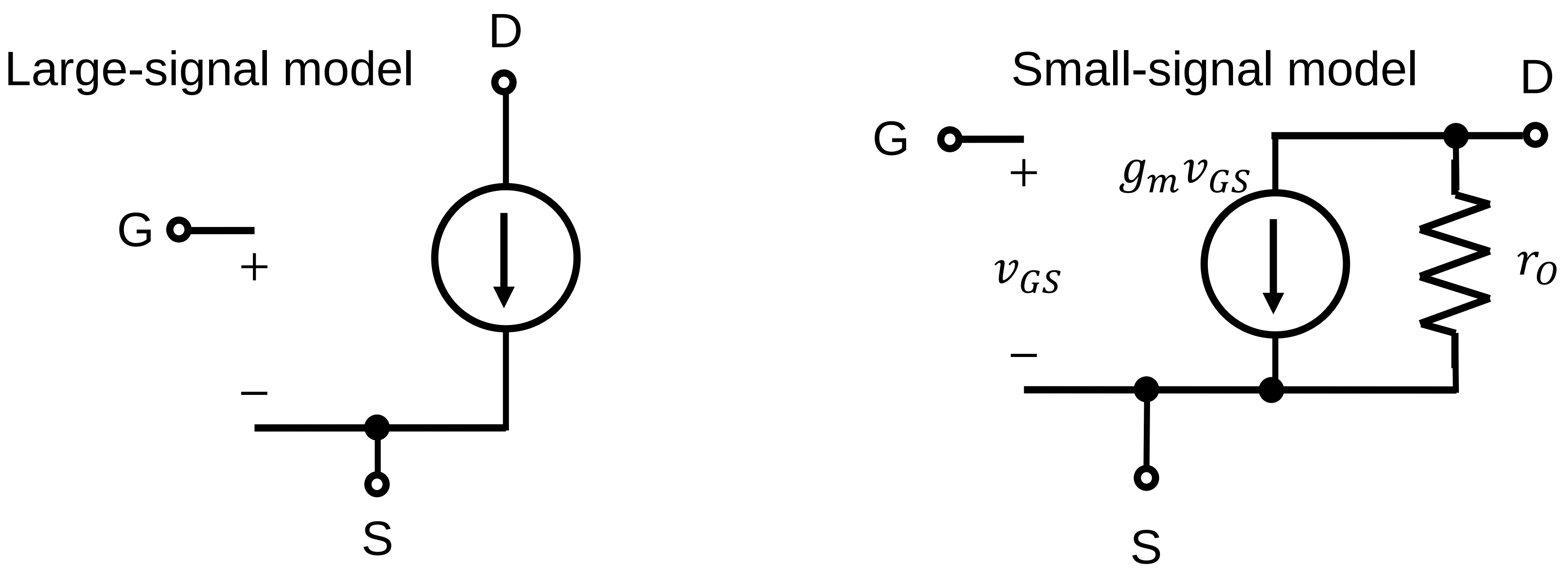
Small-signal current

- Using the transconductance (g_m) and the output resistance (r_O),
  - The small-signal drain current is given as $i_D = g_m v_G + \frac{v_D}{r_O}$.
  - When we build a small-signal model, two contributions must be separately considered.



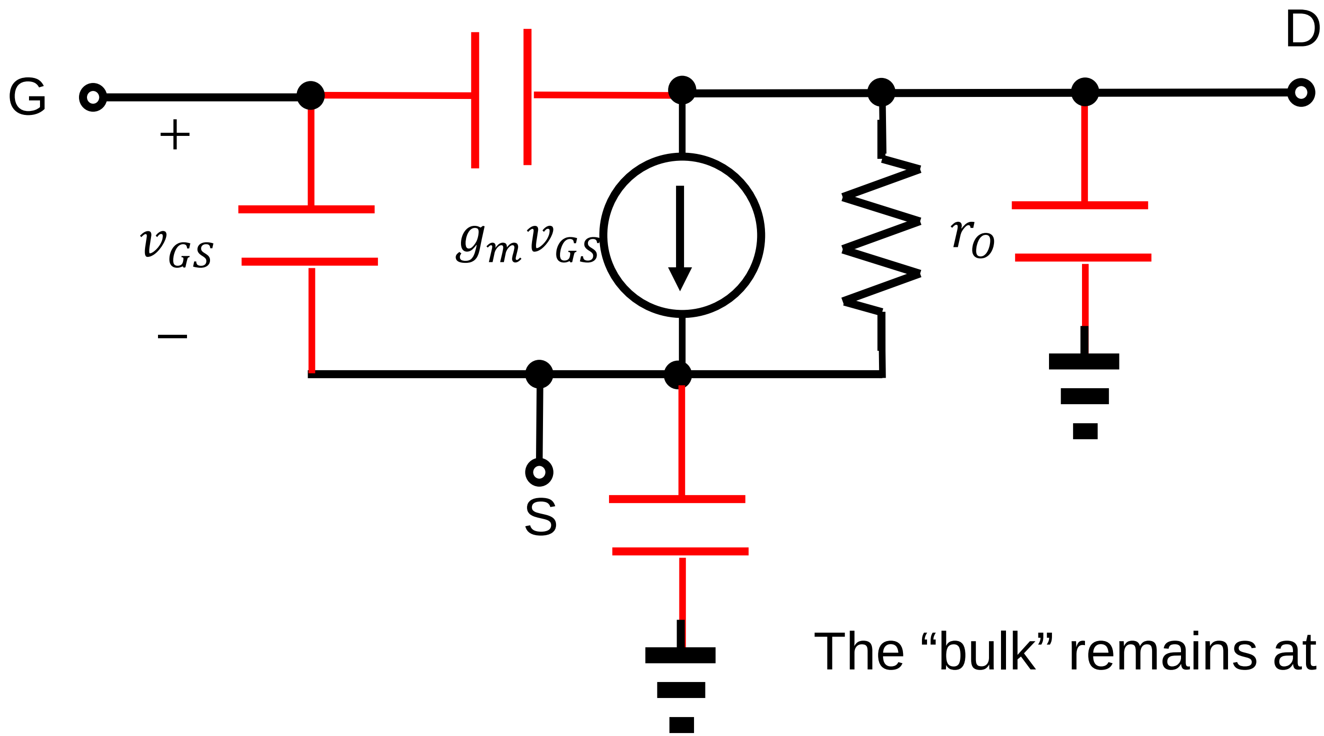
Small-signal model

- For small-signal analysis, a small-signal model for the MOSFET is introduced.



Time-dependent one?

- In general, capacitive components can be seen.



The “bulk” remains at ac ground.

At low frequencies

- Capacitor current is $I = C\frac{dV}{dt}$.
  - When a sinusoidal dependence, for example $\sin \omega t$, is assumed, the capacitor current is proportional to ω.
  - At low frequencies, ω can be regarded as a small number.
  - In other words, the electric conduction between two nodes becomes rather weak.
  - Therefore, we often neglect the capacitive components in the small-signal model.
  - Of course, at higher frequencies, they become very important.