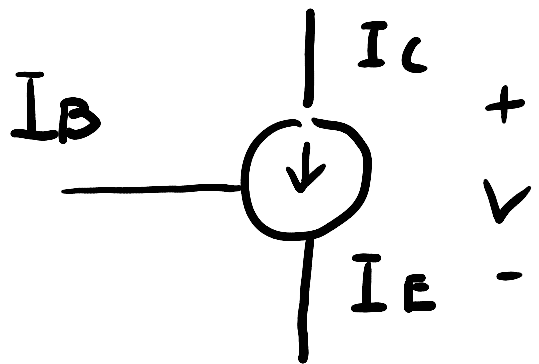


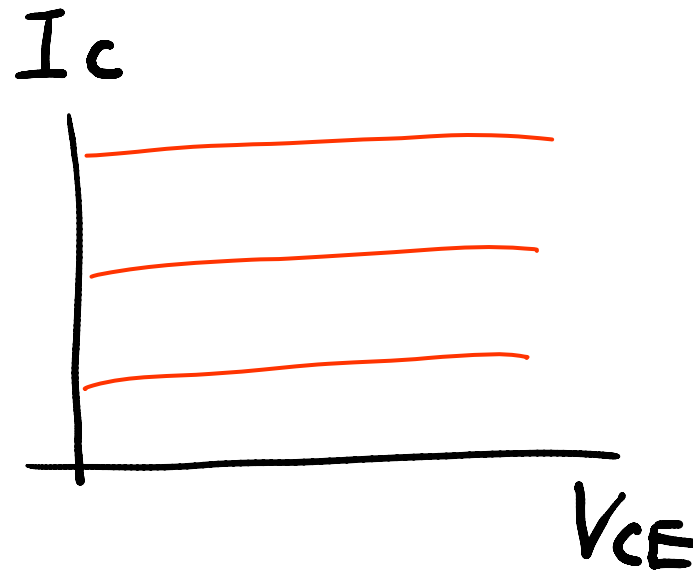
Lect. 2: Transistors

- What is a transistor?

I. Current-controlled current source

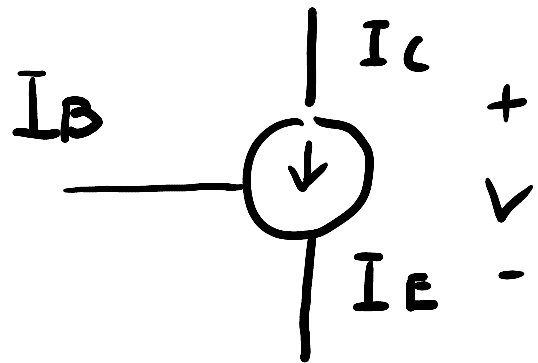


$$I_C = \beta I_B$$



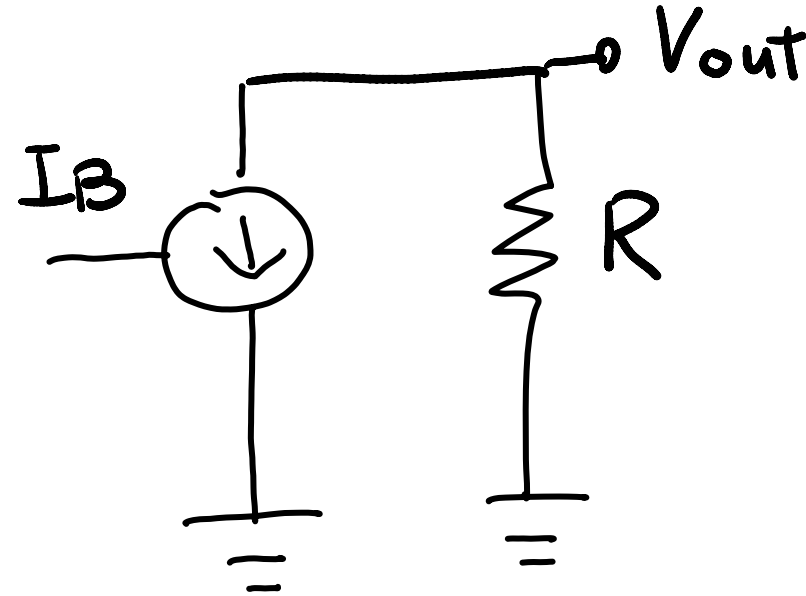
Lect. 2: Transistors

I. Current-controlled current source: What can you do with it?



$$I_C = \beta I_B$$

Amplifier!
- Current amplifier



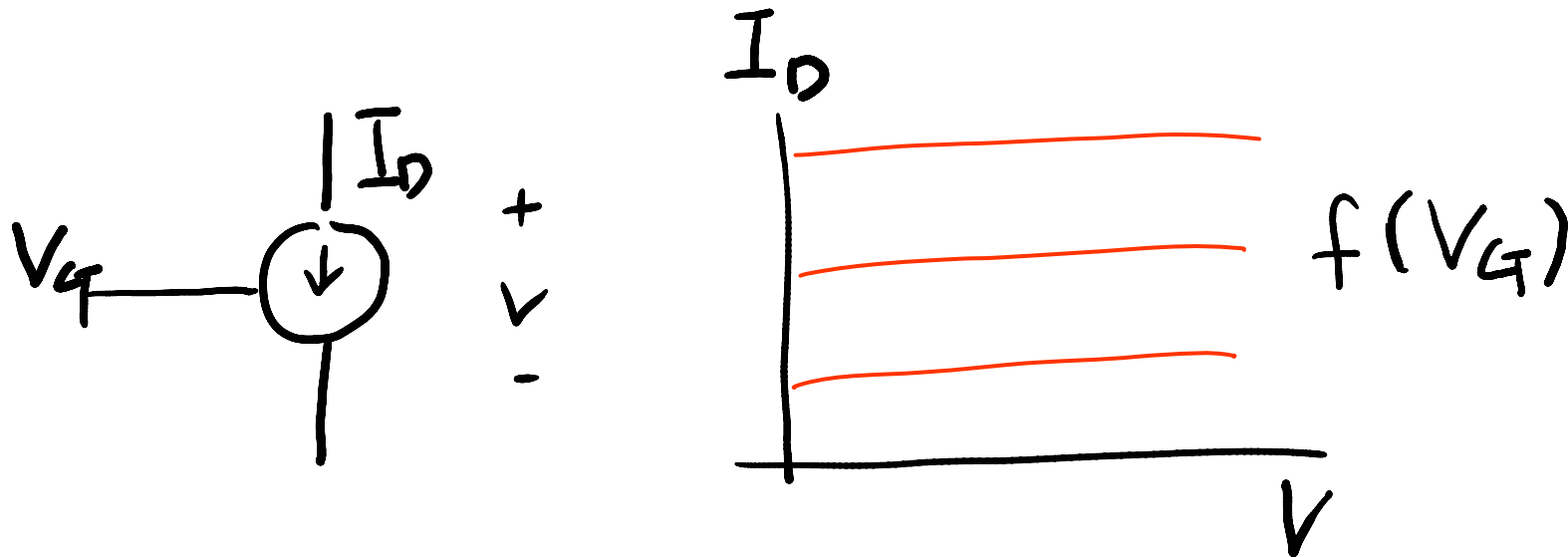
$$V_{out} = -\beta I_B R$$

Transimpedance amplifier

Lect. 2: Transistors

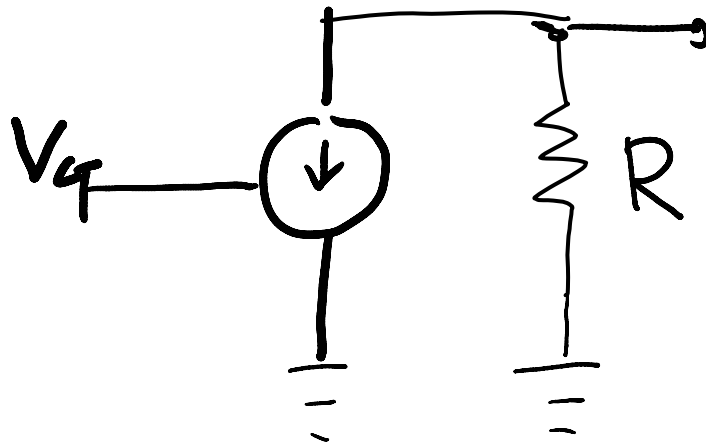
- What is a transistor?

2. Voltage-controlled current source



Lect. 2: Transistors

Voltage-controlled current source: What can you do with it?



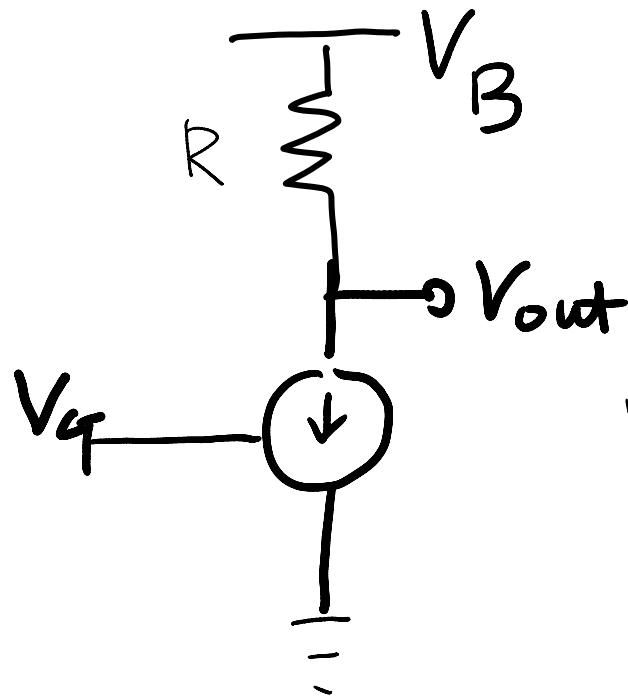
$$V_{out} = -I_D \cdot R$$
$$= -g V_G R$$

$$\frac{V_{out}}{V_G} = -g \cdot R$$

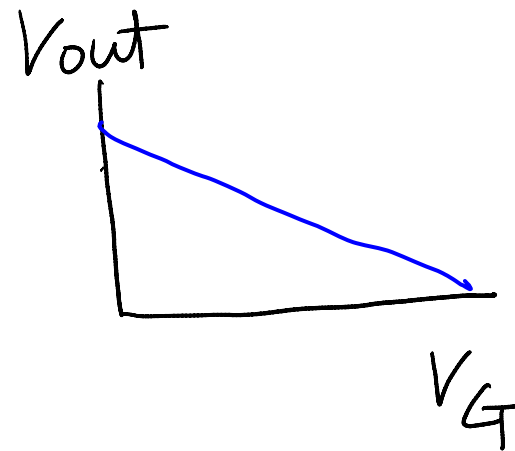
Voltage amplifier

Lect. 2: Transistors

I. Voltage-controlled current source: What can you do with it?



$$\begin{aligned} V_{out} &= V_B - I_D \cdot R \\ &= V_B - g V_G \cdot R \end{aligned}$$



Inverter

Lect. 2: Transistors

- What is a transistor?

Transistors are either current-controlled current source
or voltage-controlled current source.

→ can act as amplifiers (analog applications)
and inverters (digital applications)

→ Transistors are the basic building block for electronics !!!

Lect. 2: Transistors

-How to realize transistors?

Three terminals: One controlling current flow between the other two

Vacuum Tubes:

Cathod, Anode (plate) , Grid(s)

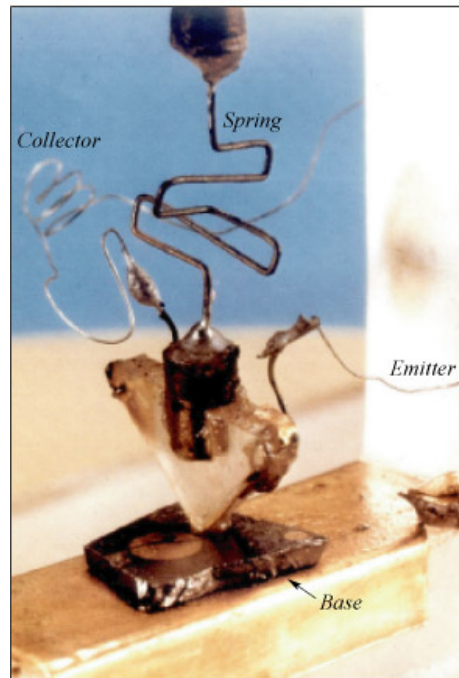


Lect. 2: Transistors

-How to realize transistors? Semiconductors

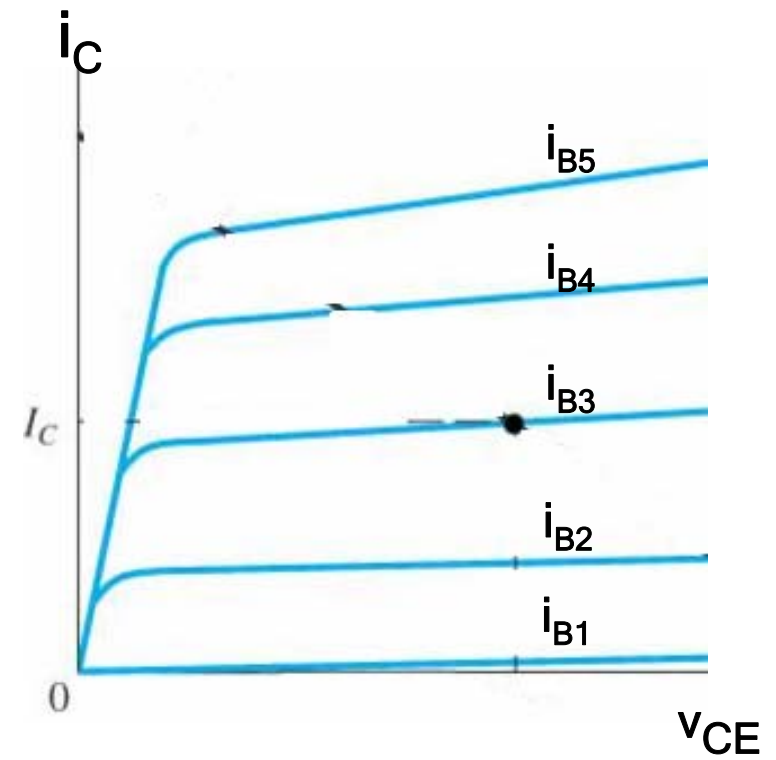
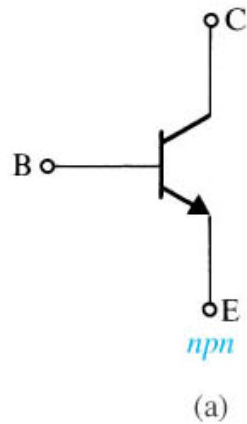
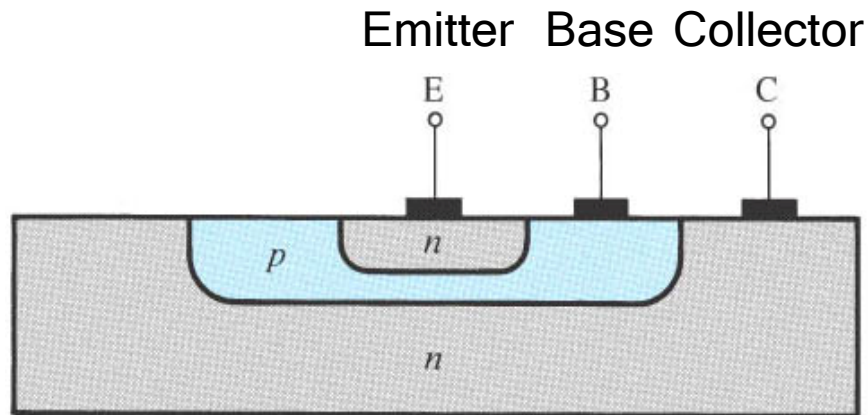
Three terminals: One controlling current flow between the other two

The first point contact transistor
William Shockley, John Bardeen, and Walter Brattain
Bell Laboratories, Murray Hill, New Jersey (1947)



Lect. 2: Transistors

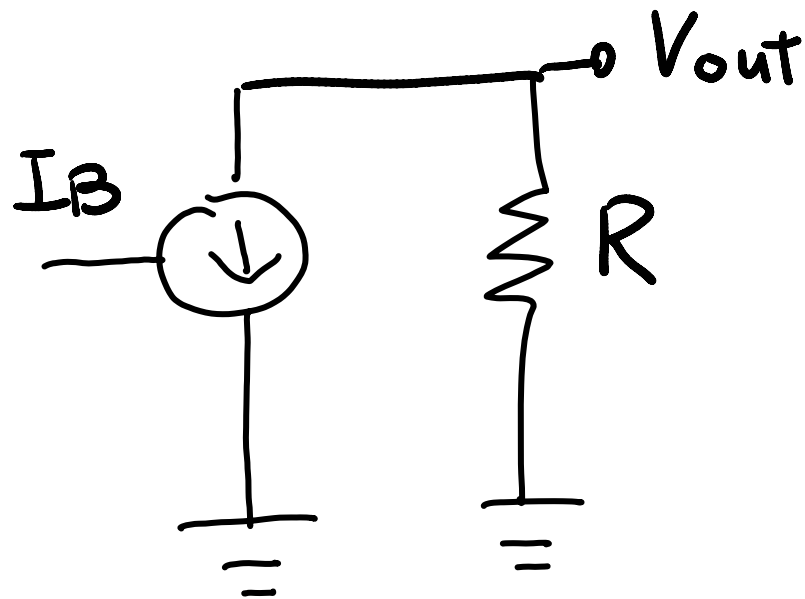
Bipolar Junction Transistor



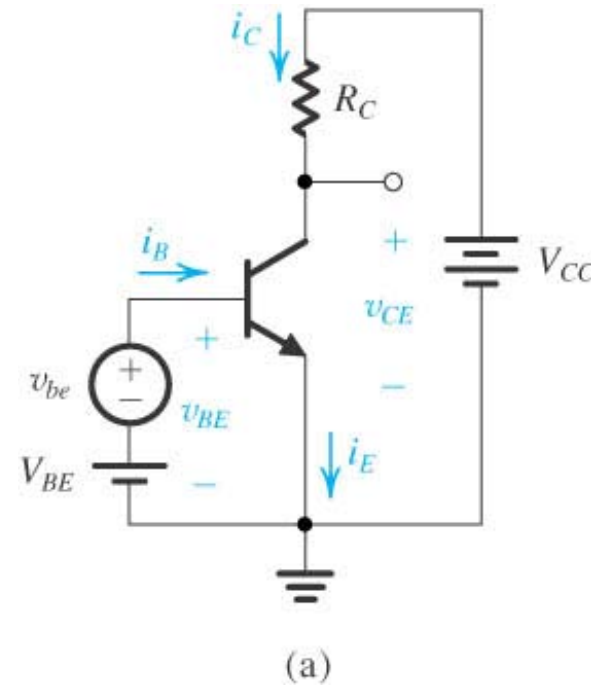
Current-controlled current source

Lect. 2: Transistors

Transimpedance amplifier



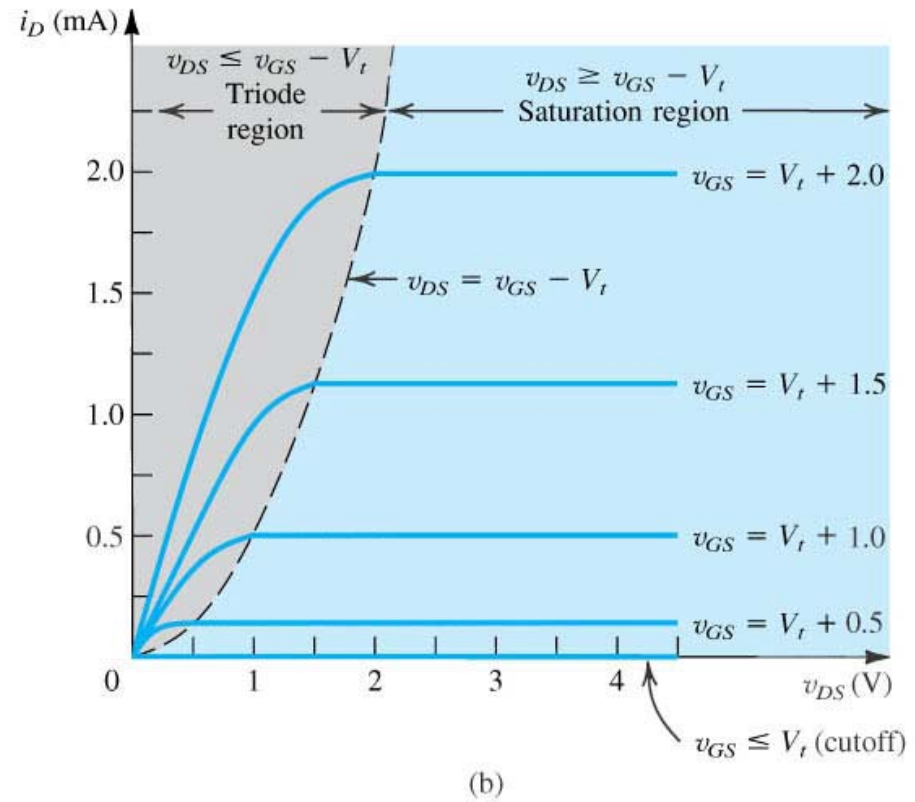
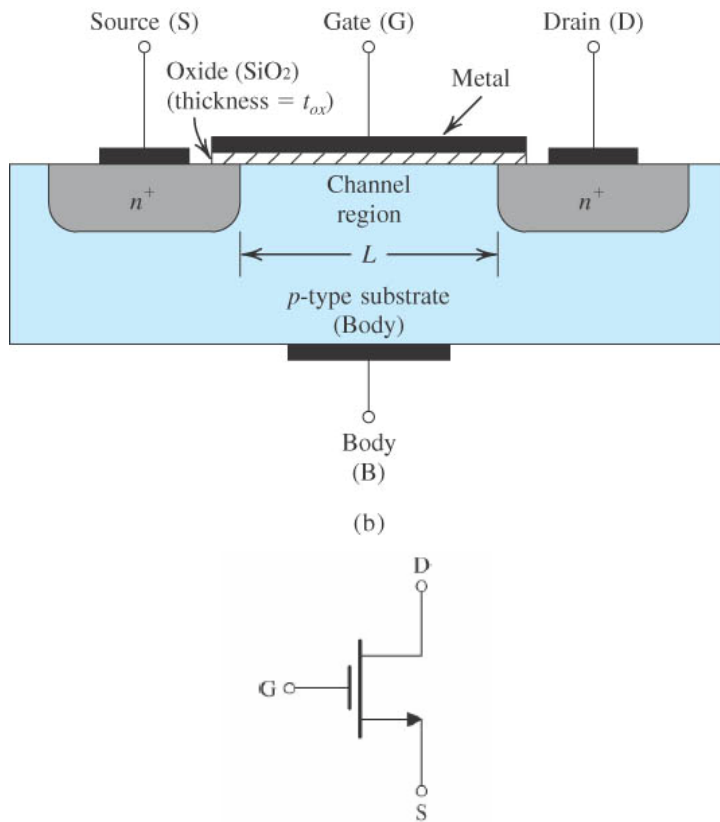
$$V_{out} = -\beta I_B R$$



$$v_{ce}/i_b = -\beta R_C$$

Lect. 2: Transistors

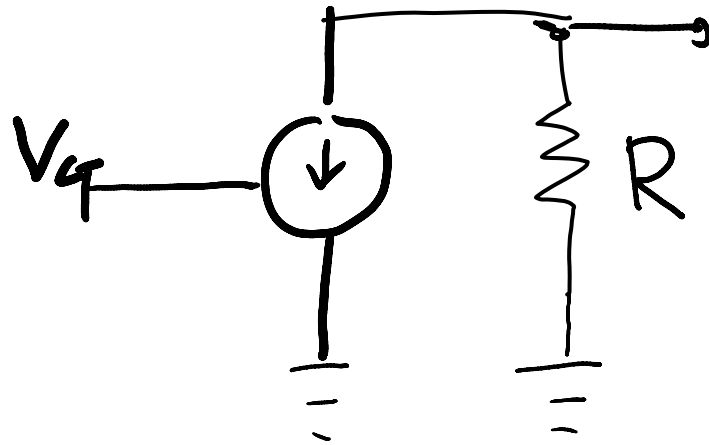
MOSFET transistors



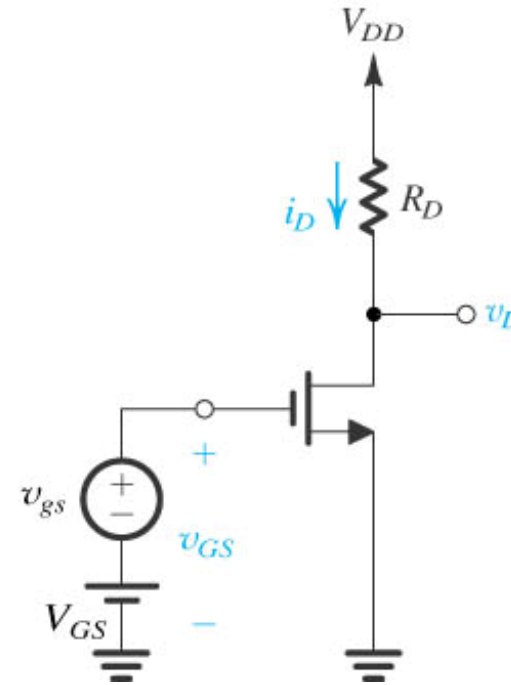
Voltage-controlled current source

Lect. 2: Transistors

Voltage amplifier



$$\frac{V_{out}}{V_G} = -g \cdot R$$



$$v_{ds}/v_{gs} = -g_m R_D$$