Introduction to Electronic Circuit

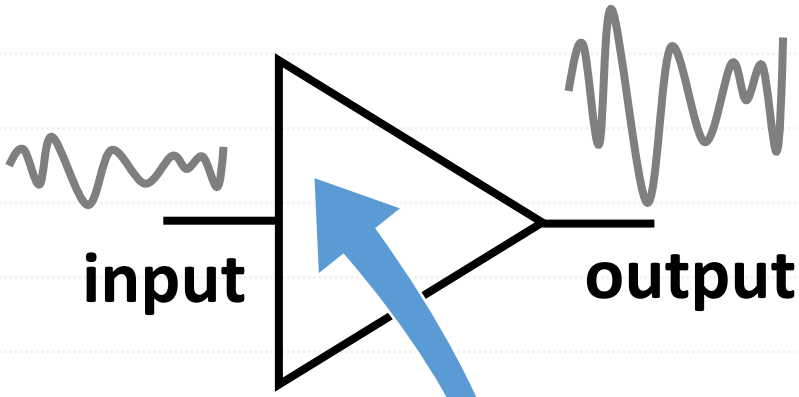
Hanwool Jeong

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Goal of Electronic Circuit

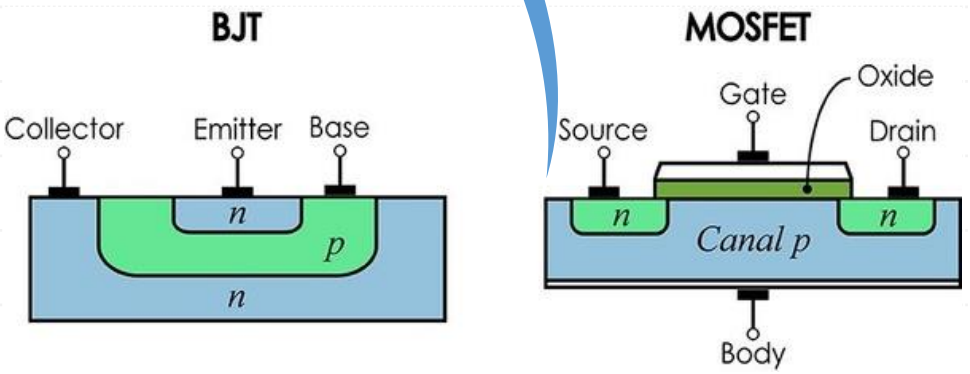
- Understanding structure & operation of **transistor** based **amplifier**

Amplifier

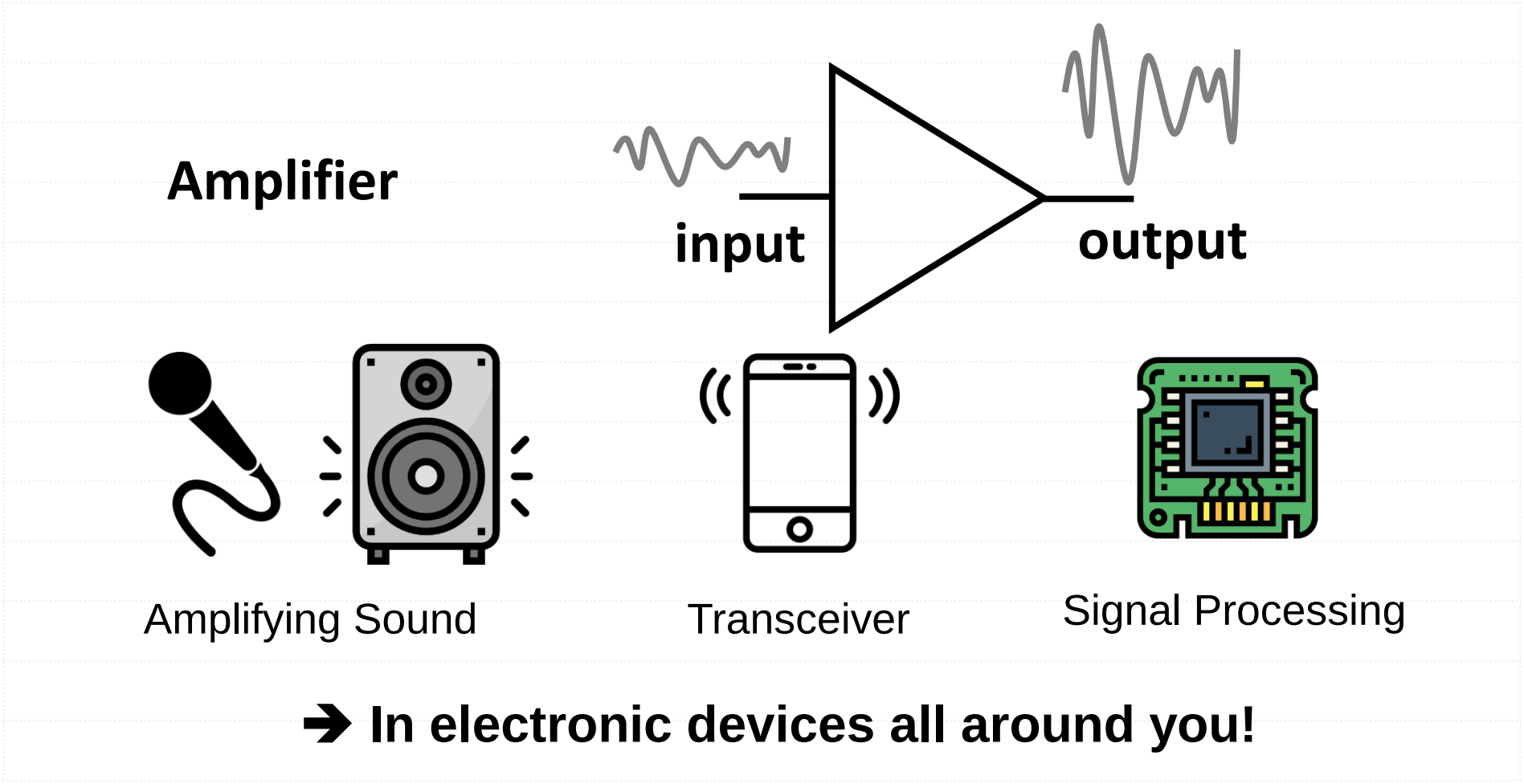


Transistor

= Semiconductor Device

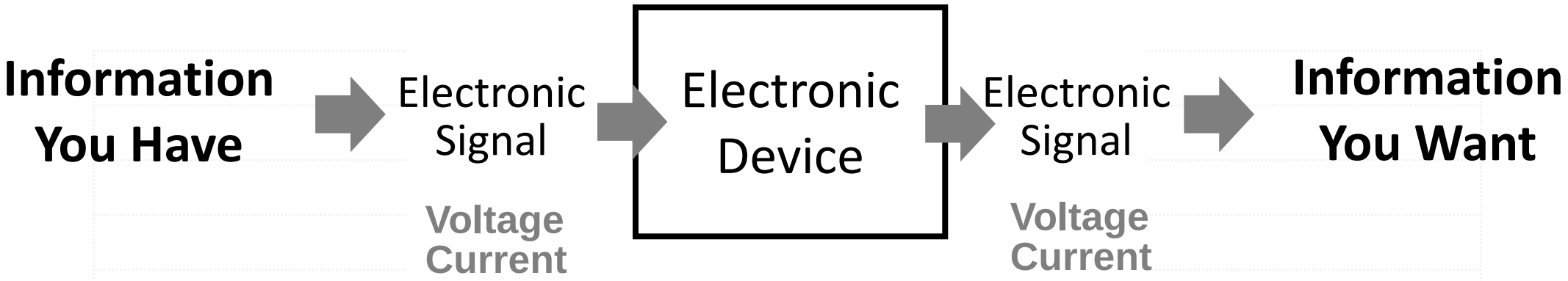


Amplifier?

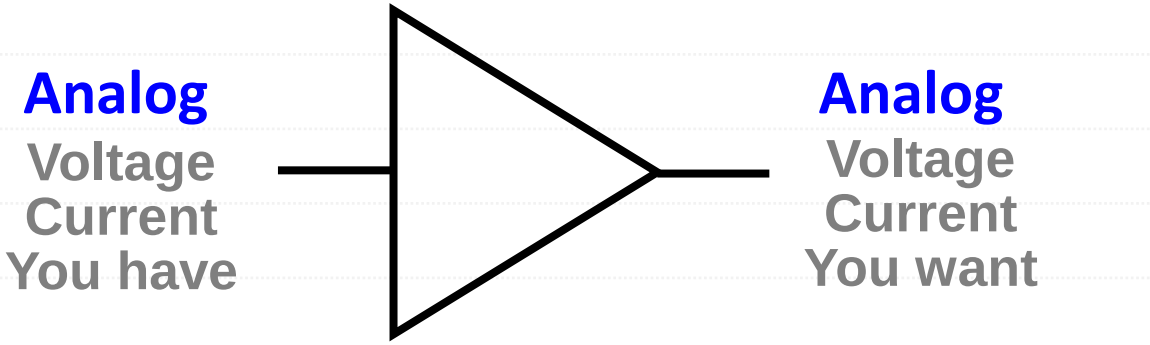


➔ **In electronic devices all around you!**

Generalizing Amplifier

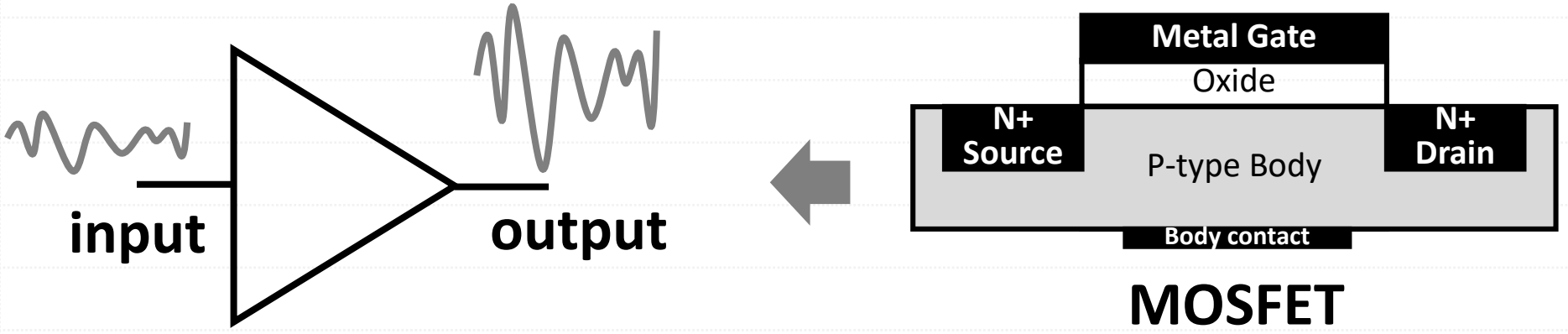


All we have to do is processing Voltage/Current!



How Can You Amplify a Voltage Signal?

With Semiconductor Device!

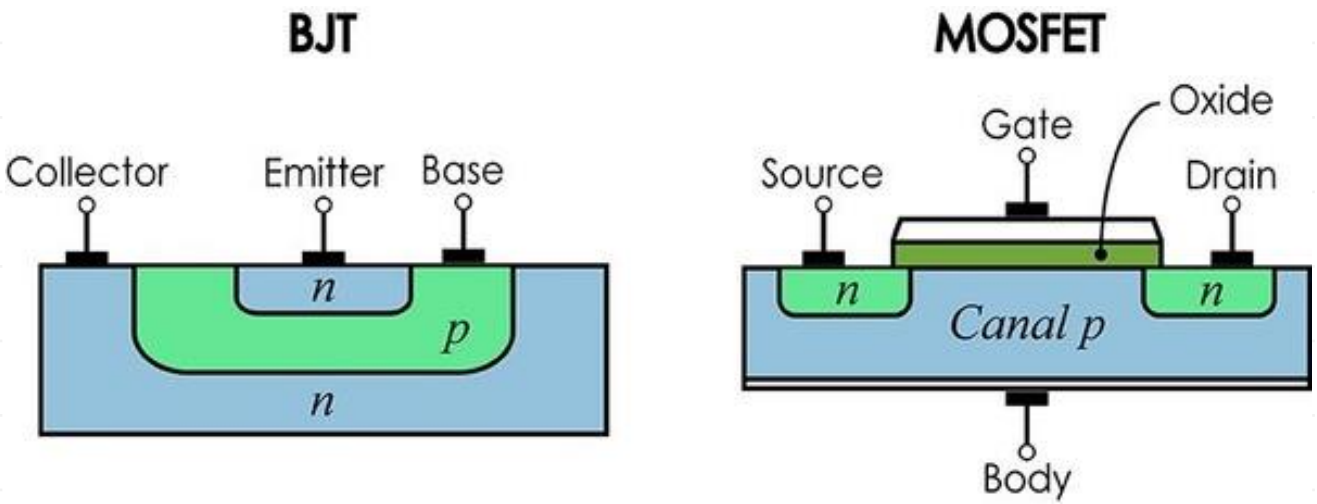


We should understand MOSFET first

To know why MOSFET can be used to implement amplifier

Why Only MOSFET?

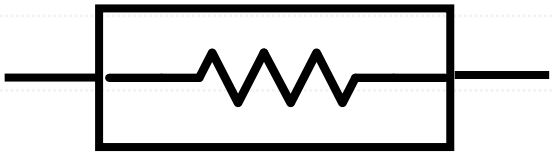
- Don’t forget we learn the **circuit**, not device.



What is Semiconductor?

- How do you know about “semiconductor”?
- First you should understand what “**resistance**” is.

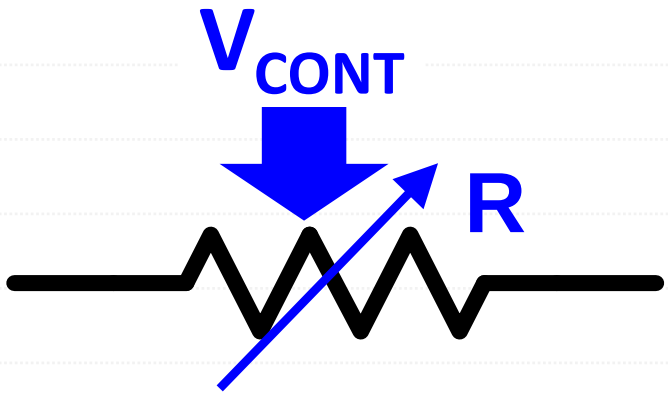
R = Voltage/Current = V/I



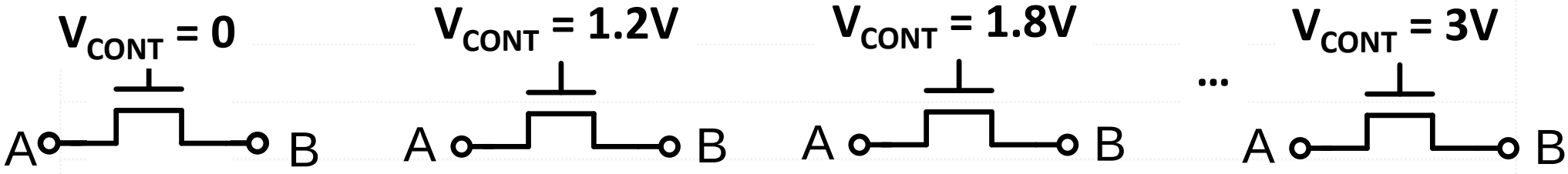
- Conductor = R is small **vs.** Insulator = R is large
- Semiconductors are materials which have the resistance b/w conductors and insulators
- More importantly, the resistance of semiconductors are usually adjusted by applied voltage/heat/light …

Semiconductor Device

- Imagine a semiconductor device ← Voltage **controls R**



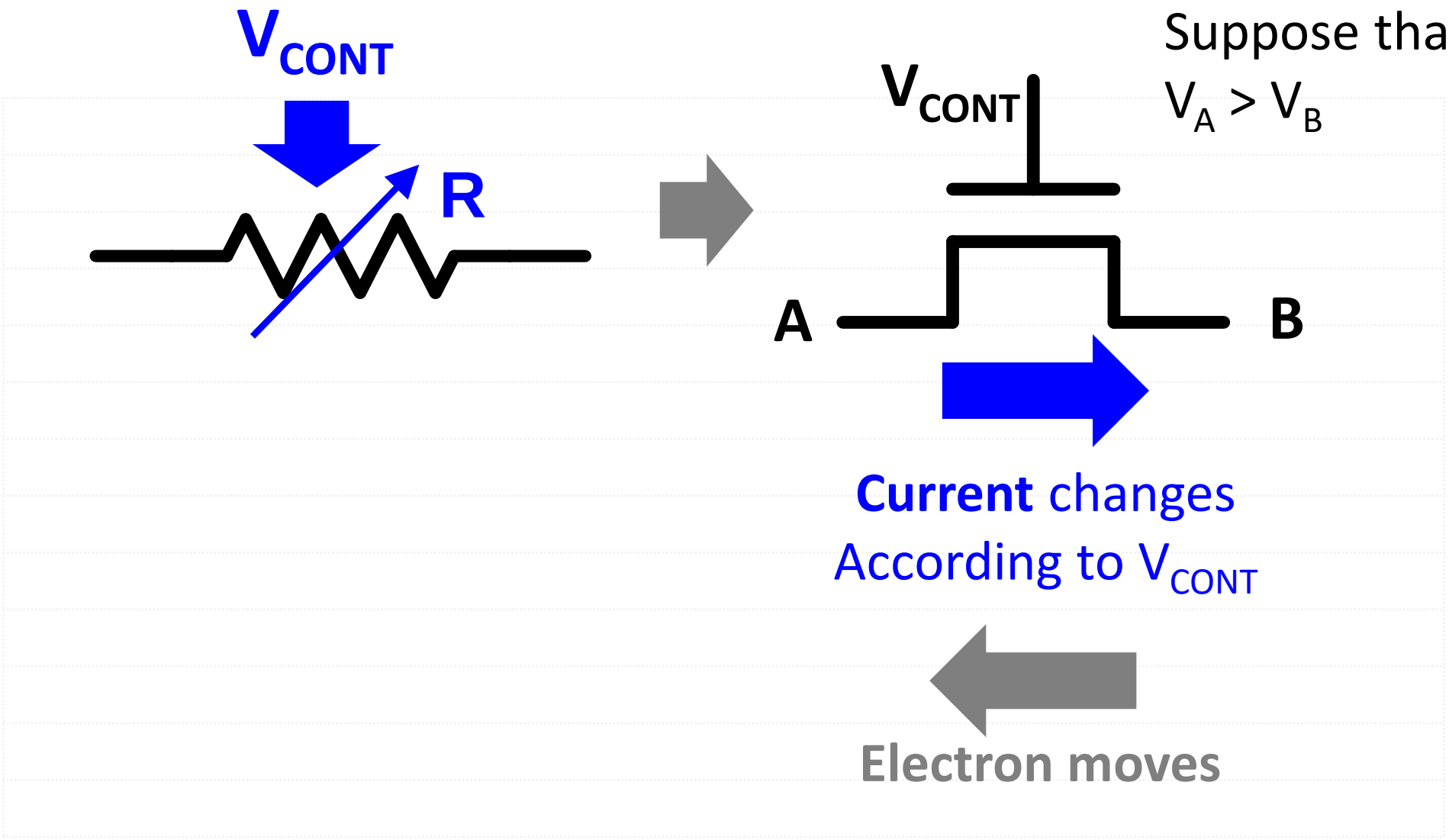
Suppose that R ↓ with V_{CON} ↑



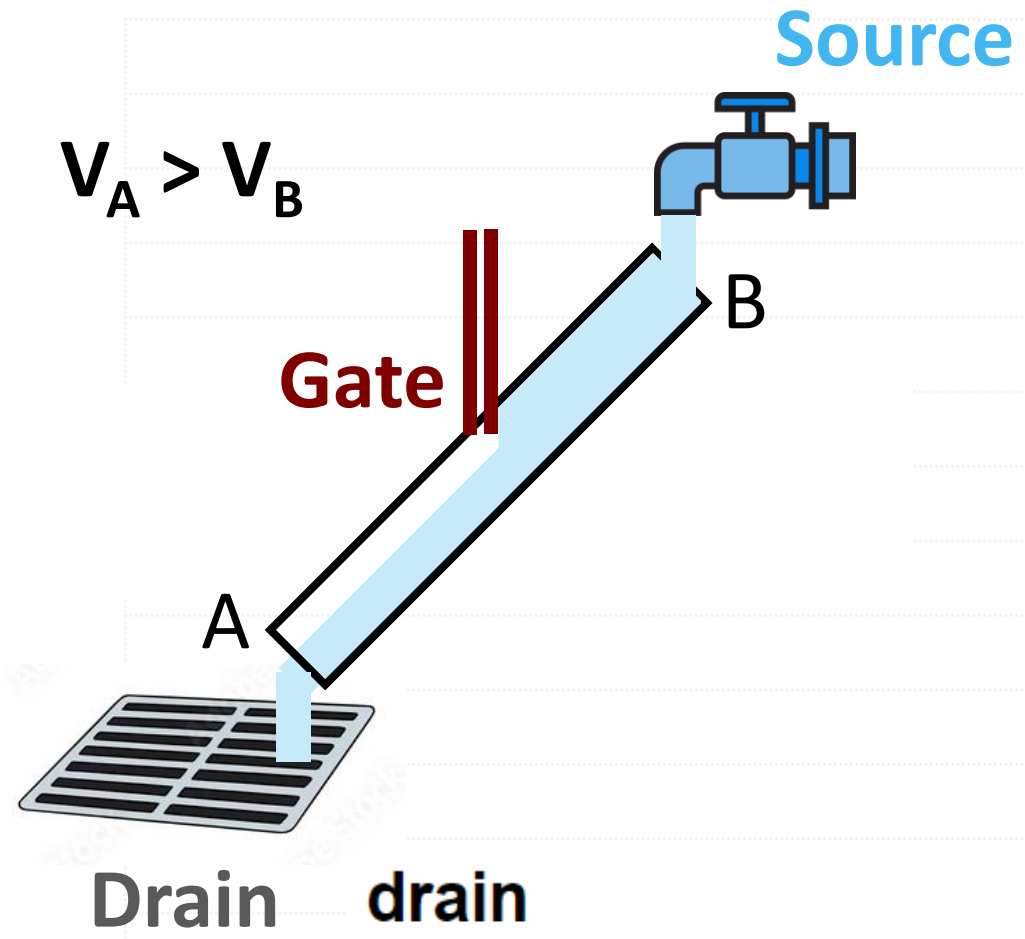
R is very large

R is very small

Can We Say with “Current” instead of R?

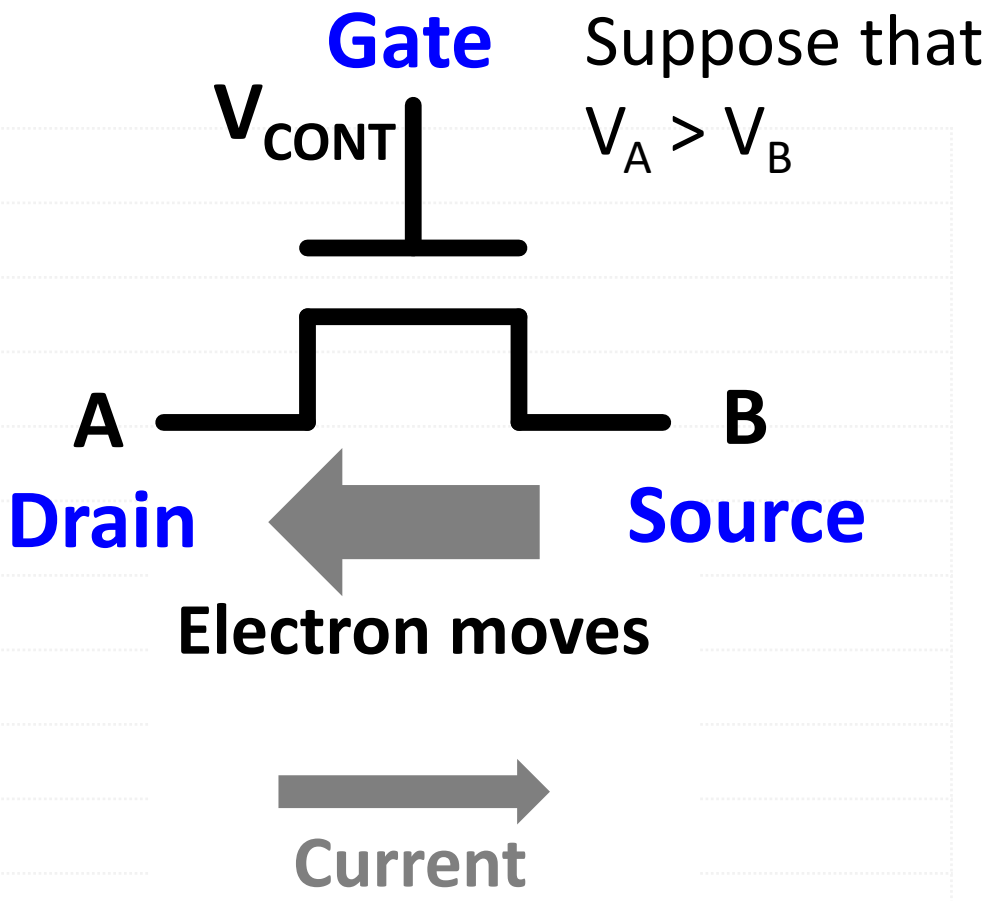


Can We Name Node As ..



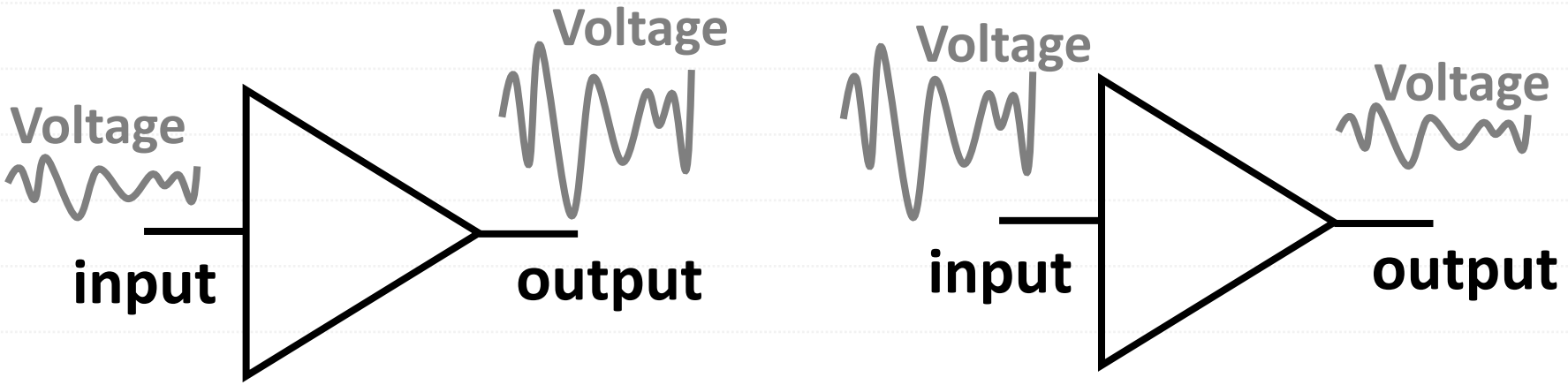
drain

1. 물을 빼내다 2. (액체를) 따라 내다 3. 배수관



Let's Start With Voltage Amplifier

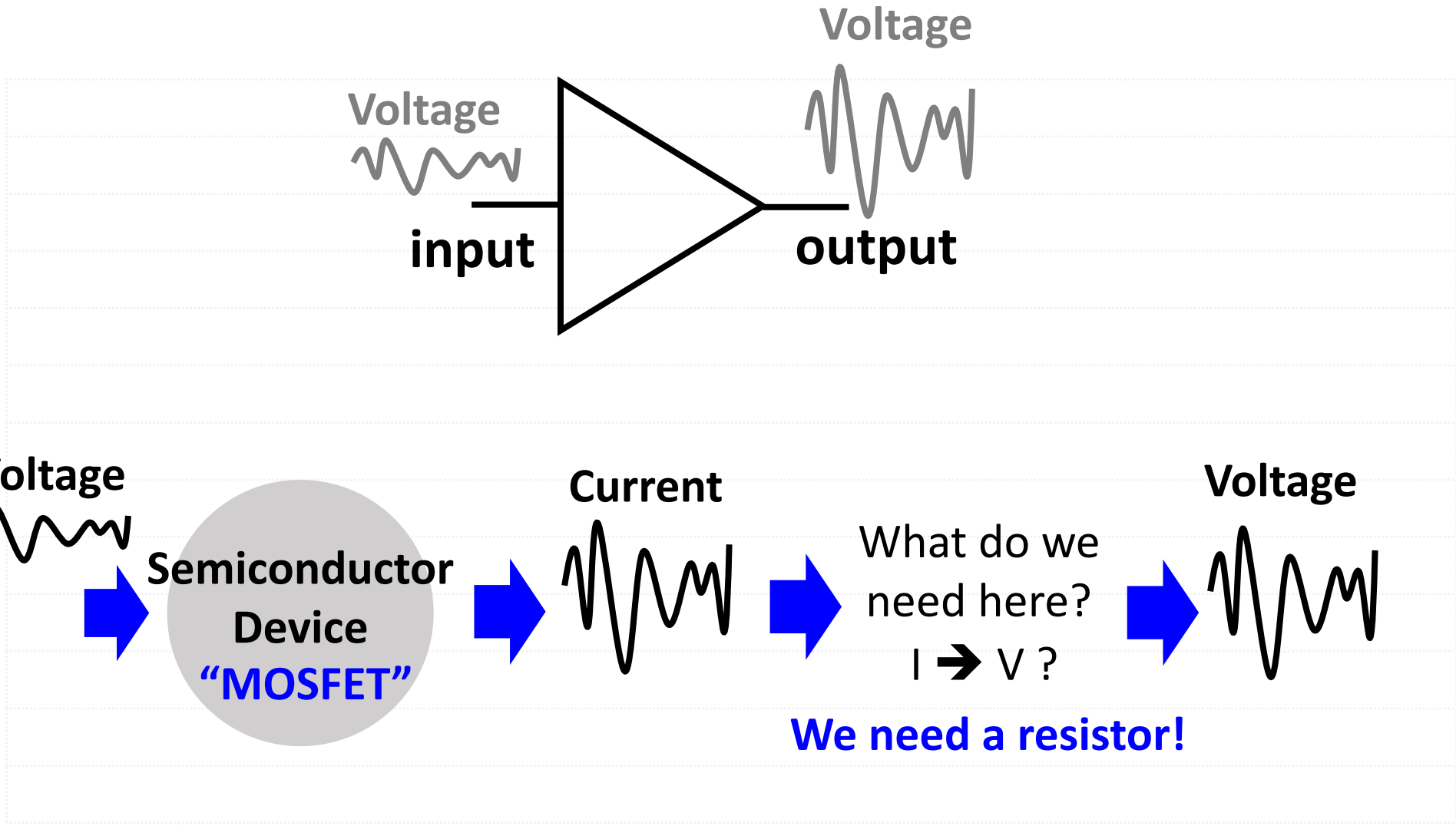
- Voltage Amplifier means V_{out} / V_{in} = A (constant)



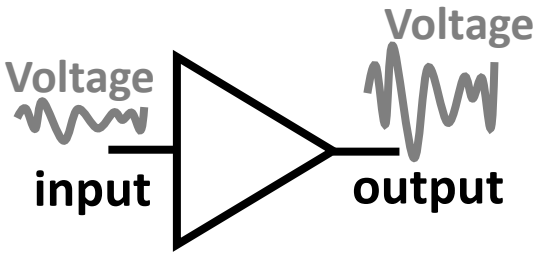
Now we have semiconductor device.

How can you make voltage amplifier?

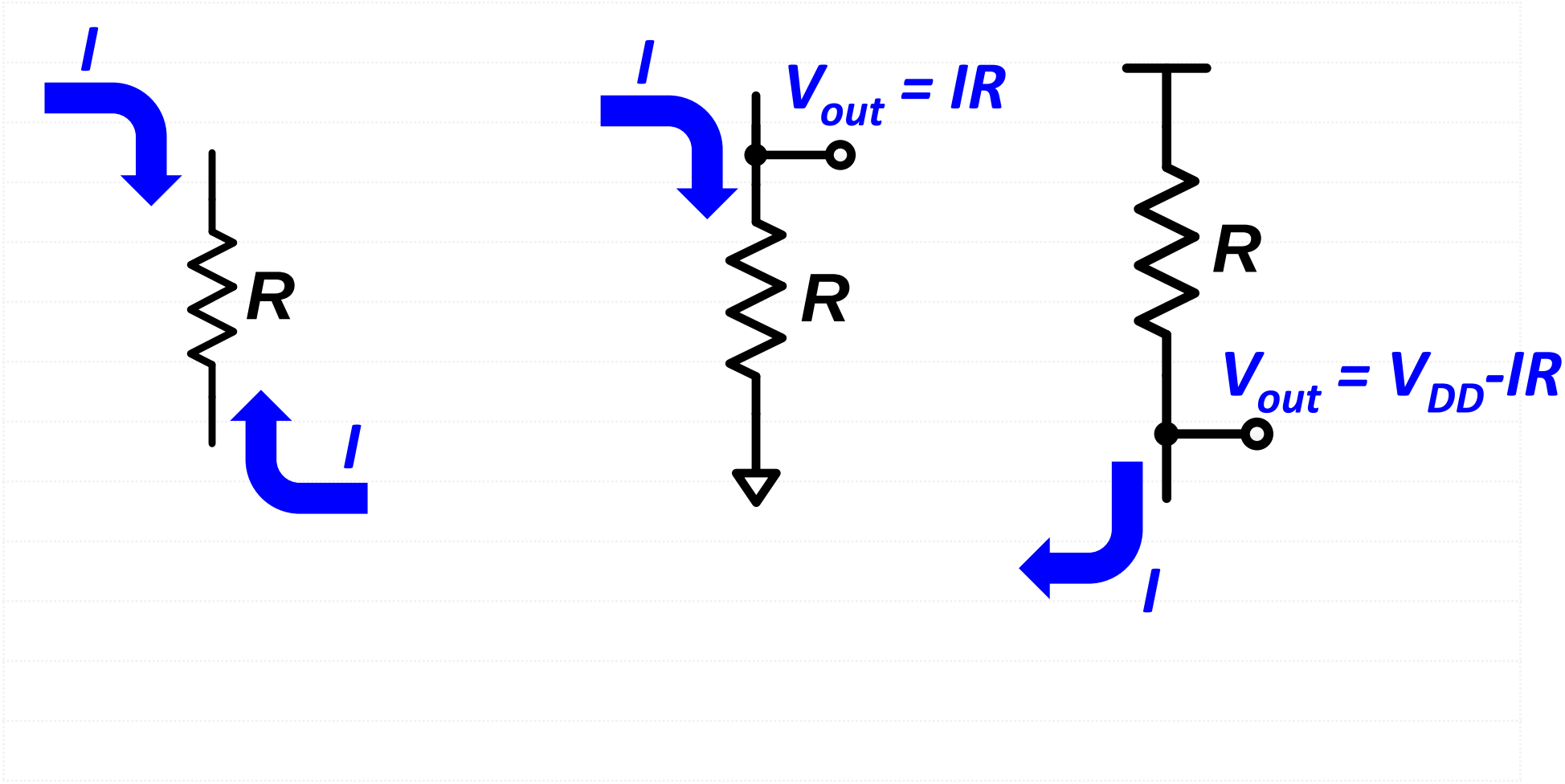
Voltage Amp vs. Semiconductor Device



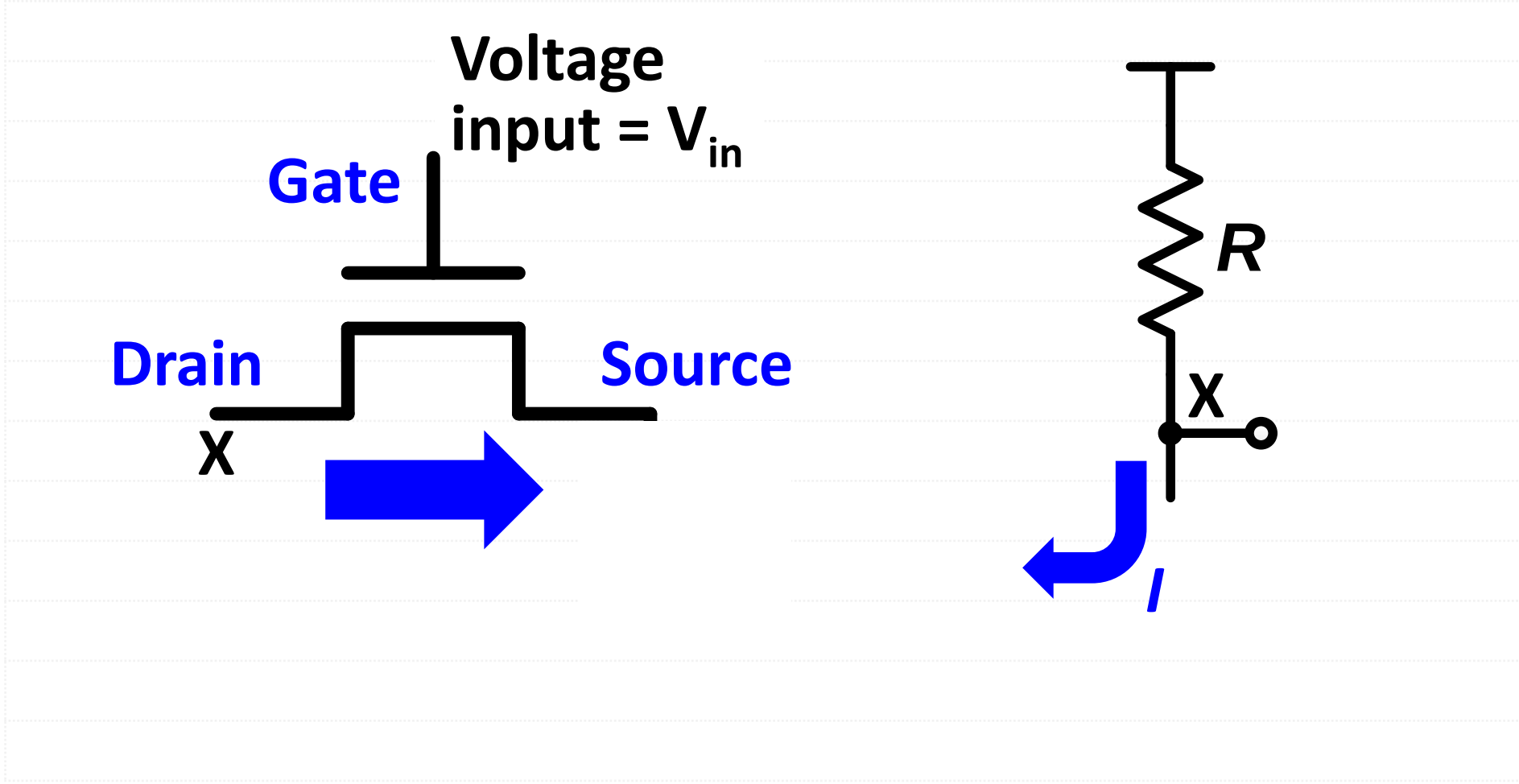
Revisit V = IR



- Suppose that I is generated by semiconductor

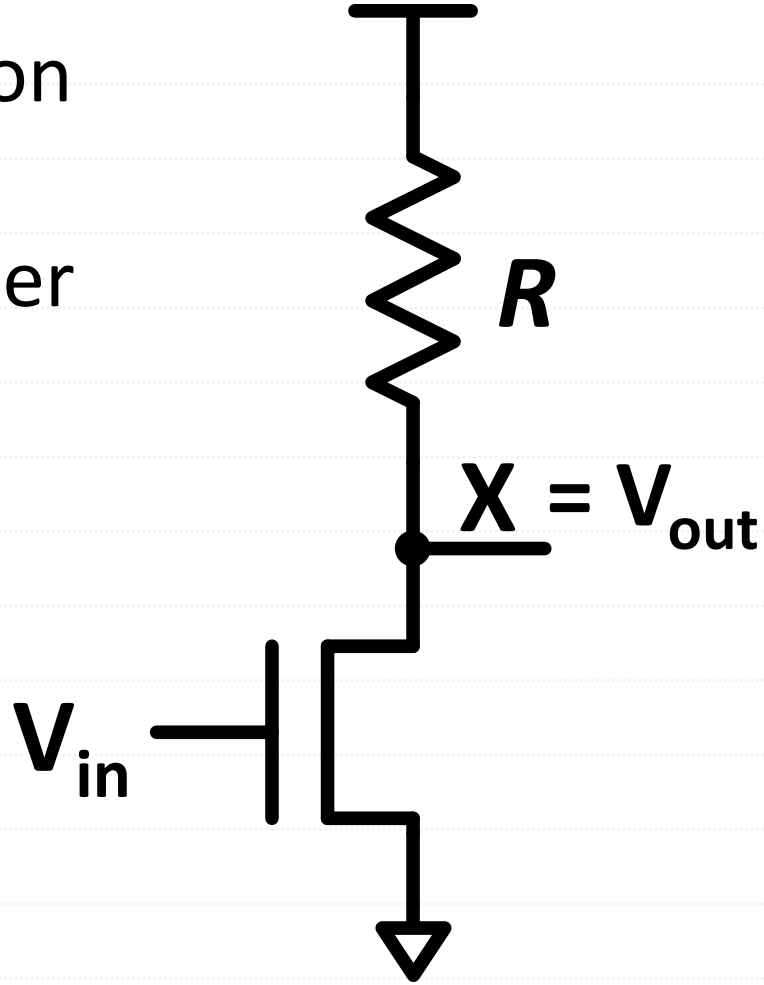


Now Voltage Amplifier!

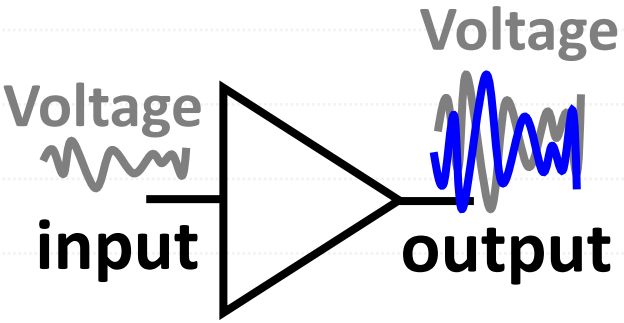


Voltage Amplifier is Formed!

Common Source Amplifier

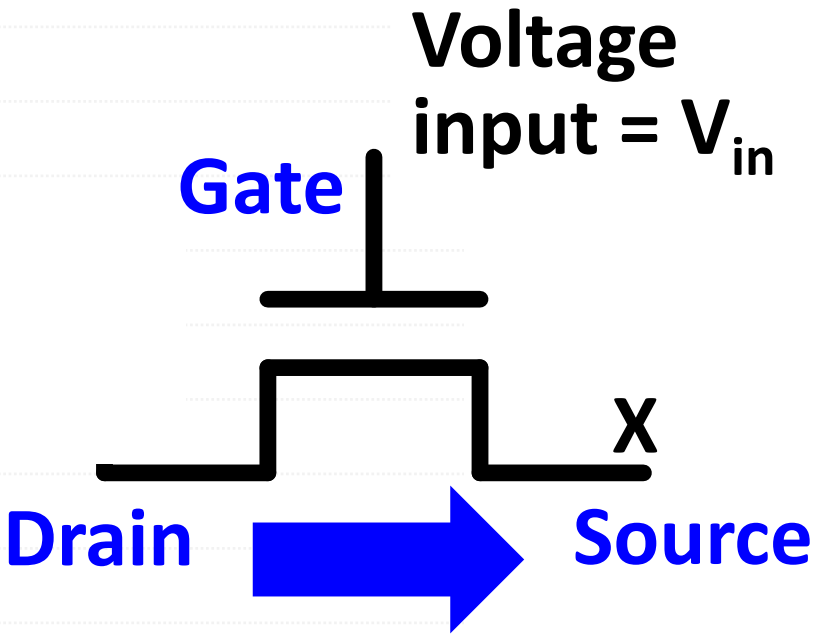


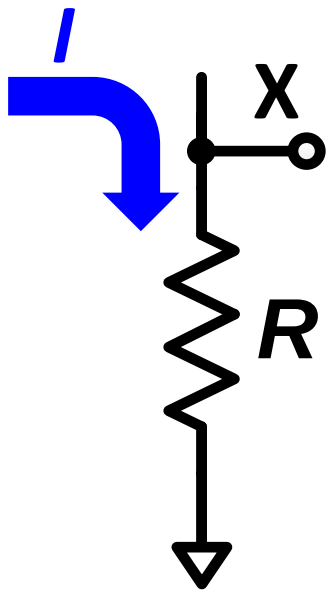
Is it real Voltage Amp?



Negative Gain

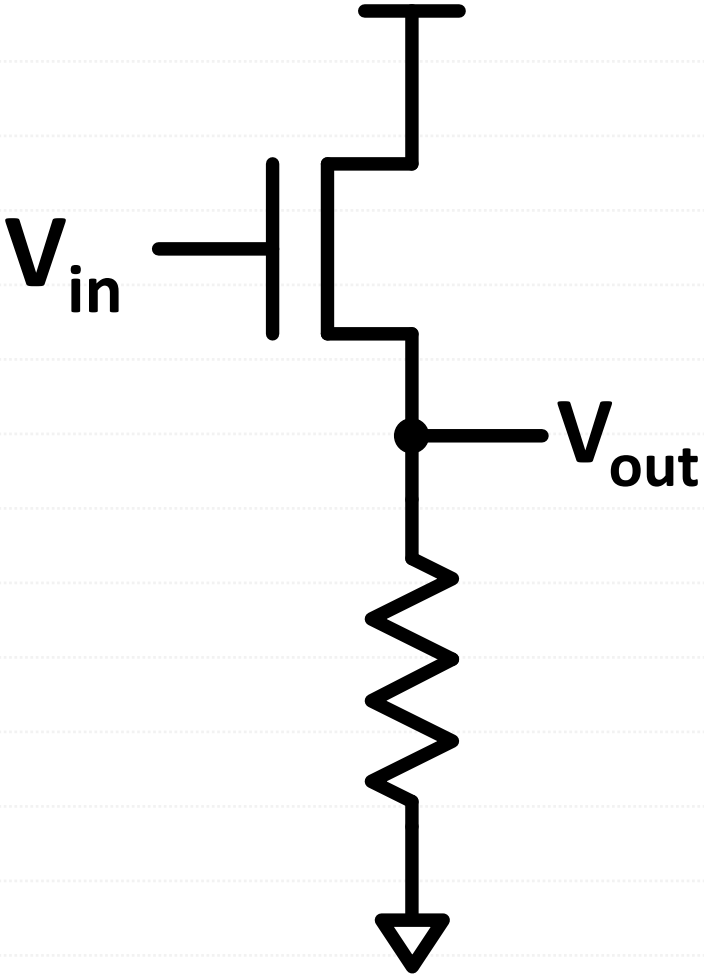
Can’t We Use R w/ Grounded?





Another Kind of Voltage Amplifier is Formed

Source Follower



There are Further Questions to be Answered

- How is much the actual gain by amplifier? $A_v = V_{out}/V_{in}$?
  - ➔Can't we estimate the actual output value for given input?
  - ➔Quantitative vs. Qualitative
- Difference b/w common source and common gain amplifier?
- Why do we use $A_v \leq 1$?
- Is there any other various amplifier structure?
- Voltage range? Speed?

We should start with understanding MOSFET deeply!

Ultimate Goal of Circuit Design Study

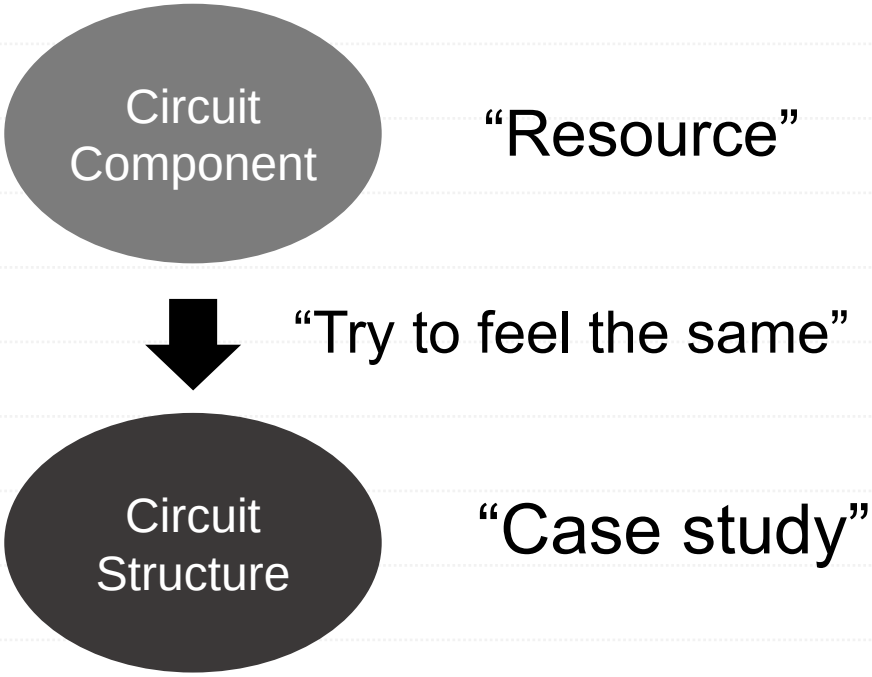


You should keep questioning

How can they think of it?

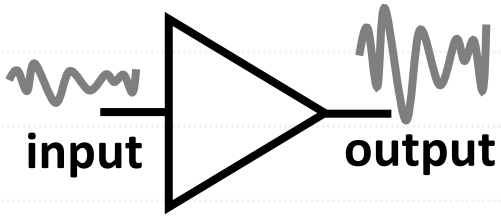
How can I utilize it to achieve a goal?

NOT just saying, I know how it works

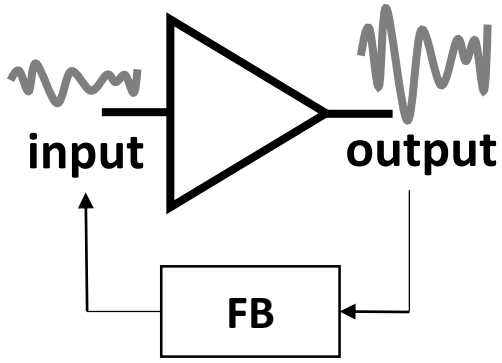


Electronic Circuit (1) vs. (2)

- In (1),
  - Device physics and transistors
  - Various single-ended amplifier topologies
  - Bias circuits



- In (2), we will see:
  - Operational amplifier
  - Cascode stages and current mirror
  - Differential amplifiers
  - Frequency response (and Filter)
  - Feedback



Checkpoints

- Goal of electronic circuit
- Quick view for semiconductor & amplifier
- What we will see in this course