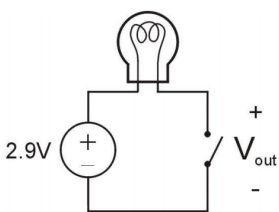# Transistors

NOTE02 - A brief introduction to transistors

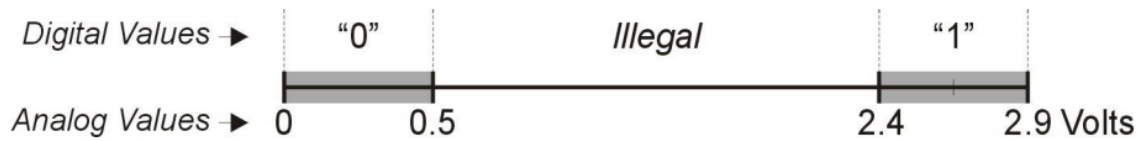| A transistor is a **switch**.	

Switch open:
- No current through circuit
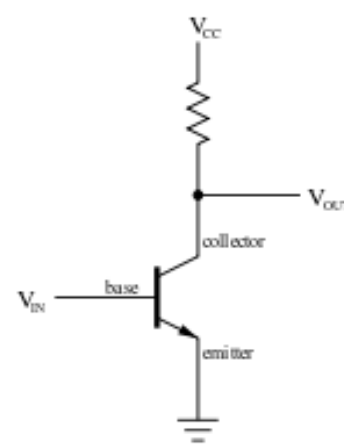- Light is **off**
- V_{out} is **+2.9V**

2.9V

V_{out}

Switch closed:
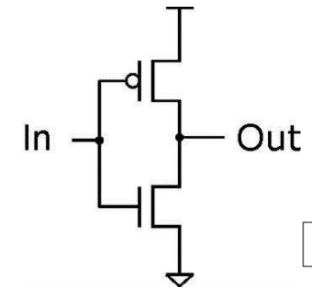- Short circuit across switch
- Current flows
- Light is **on**
- V_{out} is **0V**

Analog voltage mapped into digital bits.

Digital Values → "0" *Illegal* "1"

Analog Values → 0 0.5 2.4 2.9 Volts

An **inverter**, Vout = NOT(Vin)

V_{CC}

V_{OUT}

collector

base

V_{IN}

emitter

In — Out

In	Out
0 V	2.9 V
2.9 V	0 V

In	Out
0	1
1	0

Truth table

AND, OR, NOT is complete. Can construct any truth table/boolean equation with these 3.

AND = transistors in series. OR = transistors in parallel.

Transistor technology typically works with **negative logic**: NAND, NOR, NOT.

(a)   (b)   (c)

NAND

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

NOR

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0
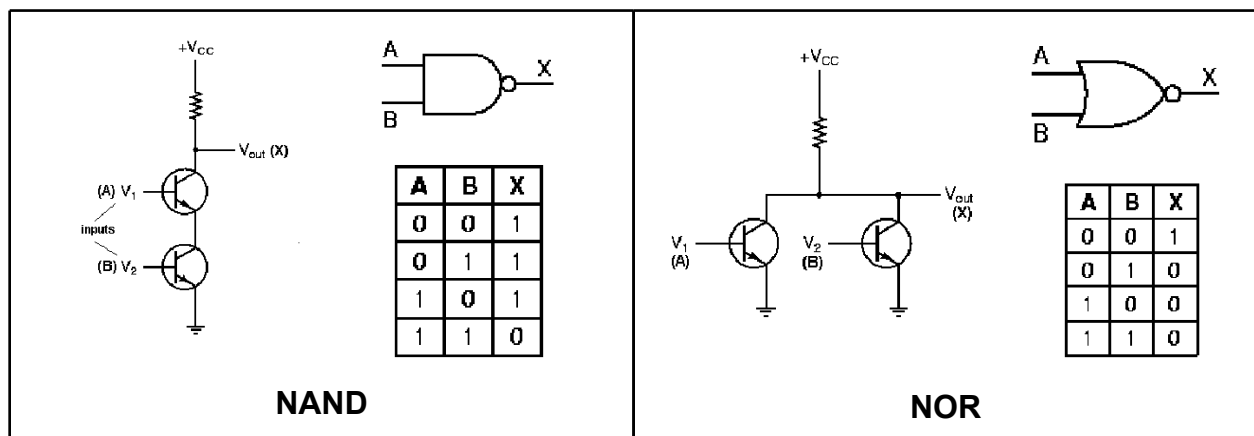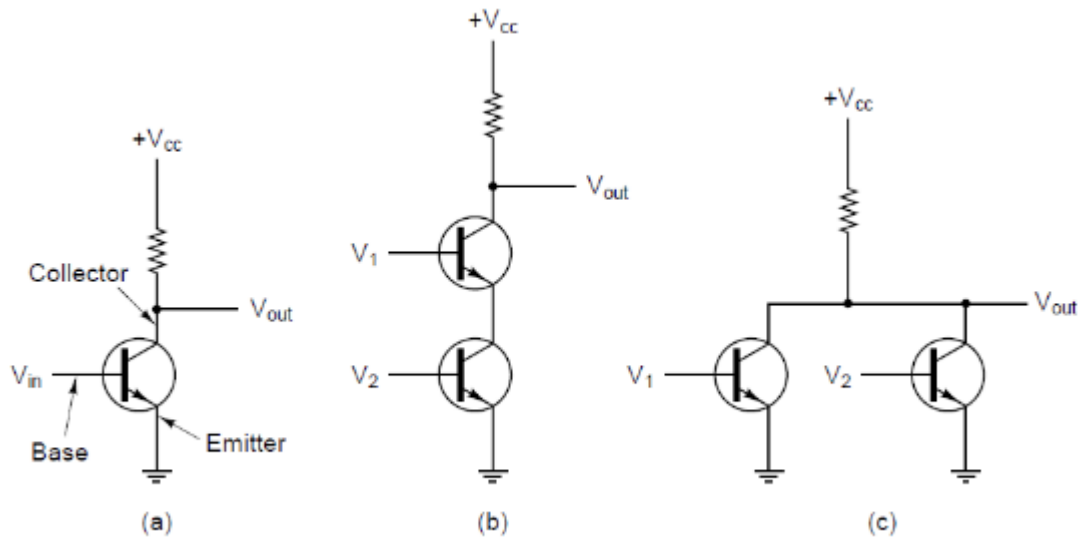
No matter… AND = NOT(NAND); OR = NOT(NOR)

Multi-input gates? Connecting gates? Combinational. Sequential?

Links:

- Introduction to Computer Engineering - a lecture Powerpoint; I like the first 15 slides showing how to build logic gates with transistors
- www.youtube.com/watch?v=CkX8SkTgB0g - Part 1, show the basics of why a "transistor is a resistor whose value changes"

Wikipedia facts (en.wikipedia.org/wiki/Transistor):

- A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power.
- The term transistor was coined by John R. Pierce as a portmanteau of the term "transfer resistor"
- From November 17, 1947 to December 23, 1947, John Bardeen and Walter Brattain at AT&T's Bell Labs in the United States, performed experiments and observed that when two gold point contacts were applied to a crystal of germanium, a signal was produced with the output power greater than the input.
- Shockley, Bardeen, and Brattain were jointly awarded the 1956 Nobel Prize in Physics "for their researches on semiconductors and their discovery of the transistor effect."[11]