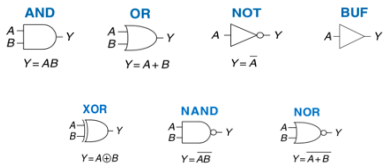
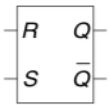
Quiz 1 Review Sheet

Circuits

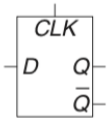
1. Logic Gates - Simple digital circuits that takes 1 or 2 binary input and produce a binary output. (Usually construct out of transistors)
   a) AND Gate - True if both A and B are True.
   b) OR Gate - True if either A or B is True (or both).
   c) NOT Gate - The output is the inverse of its input.
   d) XOR Gate - True if A and B is not the same.
   e) NAND = NOT + AND; NOR = NOT + OR



   f) SR Latch
      i. Set = 0 + Reset = 0 → Q and $\bar{Q}$ remains the last output (memory)
      ii. Set = 1 + Reset = 0 → Q = 1 and $\bar{Q}$ = 0
      iii. Set = 0 + Reset = 1 → Q = 0 and $\bar{Q}$ = 1
      iv. Set = 1 + Reset = 1 → Invalid



   g) D Flip-flop
      i. CLK = 0 → Q and $\bar{Q}$ remains the last output
      ii. CLK = 1 → Q = D

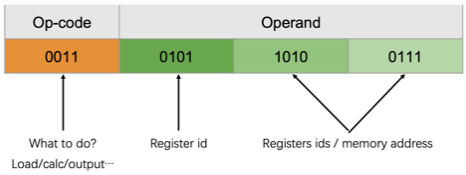


Memory and Storage

2. Memory Hierarchy (fast, expensive, small → slow, cheap, large)
   a) Registers (寄存器) – inside CPU, size small but very fast
   b) Primary Memory (主存/内存) – access directly by CPU
      i. Cache (缓存) – Some on CPU, some located between CPU and main memory, very fast, can be divided into L1, L2, L3
         1. L2 Cache – mostly implemented by SRAM (a kind of RAM, faster than DRAM, holds data as long as power is applied, cannot hold data when power is off)
      ii. Main Memory (内存)
         1. RAM – mostly implemented by DRAM (a kind of RAM, slower than SRAM, cheaper than SRAM, must be refreshed periodically, lose data when power off)
         2. ROM – read only memory, no overwritten, or modified, used as bootable devices (e.g., BIOS)
   c) Secondary Memory (外存) – cannot access directly by CPU
      i. Flash drive and SSD (固态硬盘) - Stores information by sending electronic signals to the storage medium and electrons are trapped within the isolator.
      ii. Magnetic disk (HDD) (磁盘/硬盘) - Magnetic coating on platter to store the data, data is read/written by moving the magnetic head.
      iii. Cloud Storage
3. Other
   a) Two principles of locality
      i. Nearby = Fast (nearby also loaded in cache)
      ii. Recent = Fast (loaded in cache)
      iii. A[i][j+1] is closer to A[i][j] than A[i+1][j]

Computer Architecture

4. The Principle of CPU
   a) Control Unit – Controls what to do (load/calc…)
   b) ALU – Do the (logical/mathematical) calculations.
   c) Registers
      i. Normal Registers – Temporally store data
      ii. Program Counter – Holds the address of the next instruction
      iii. Instruction Register – Holds the instruction now being executing
5. Program
   a) Two Kinds of Computer
      i. Fixed-program Computers – Cannot program, unless change the connection of circuits
      ii. Stored-program Computers – We can program it by using programming language
   b) Programming Language
      i. High Level Language – e.g. C/C++/Python
         1. Compiled Language (C/C++) – Execution happens after translation
         2. Interpreted Language (Python) – Execution happens together with translation (which slows down the execution speed)
      ii. Low Level Language
         1. Assembly Language – Still need a "translator"
         2. Machine Language – Can be understand by computers
            a) Example: Vole (A simple computer)



               i. Zero Step: Control Unit load instructions according to the address in program counter
               ii. First Step: Control Unit ask to load data from memory to registers
               iii. Second Step: Control Unit ask ALU to do calculations, and store the result in another register
               iv. Third Step: Control Unit ask to output data from registers to memory.

Other Key Points

6. The KISS Principle
   a) Keep it simple but stupid
   b) Keep it simple but not simpler
7. De Morgan's Law
   a) $\neg(P \vee Q) = \neg P \wedge \neg Q$
   b) $\neg(P \wedge Q) = \neg P \vee \neg Q$
8. The Moore's law
   a) Numbers on transistors on cost-effective integrated circuit double every 18 months.