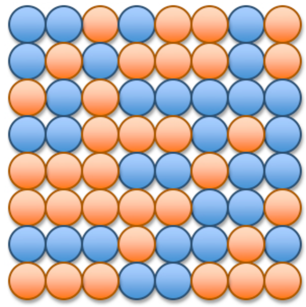
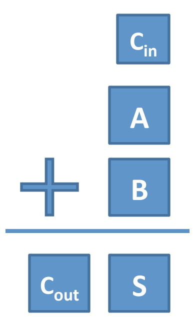


UNIT 8B

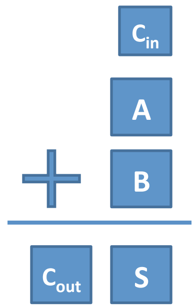
Computer Organization: Levels of Abstraction

A Full Adder



A	B	C_{in}	C_{out}	S
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

A Full Adder

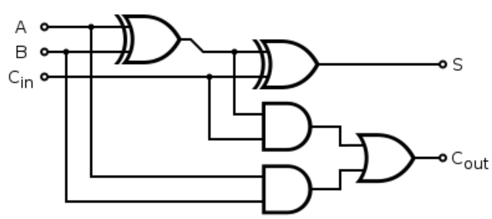


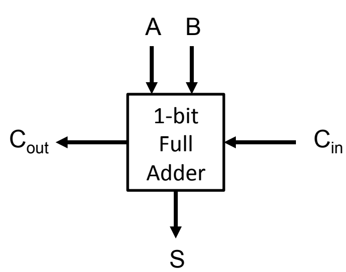
A	B	C_{in}	C_{out}	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

$S = A \oplus B \oplus C_{in}$

$C_{out} = ((A \oplus B) \wedge C_{in}) \vee (A \wedge B)$

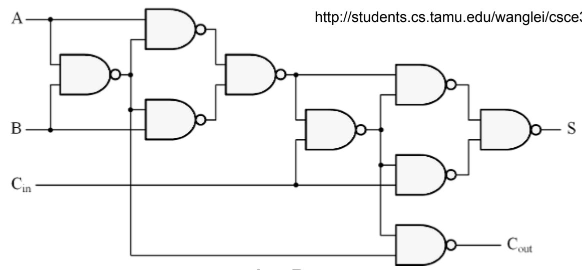
Full Adder (FA)

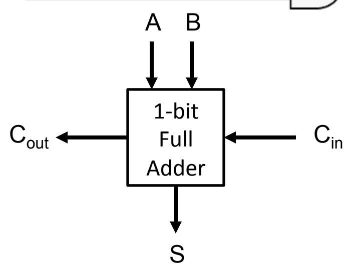




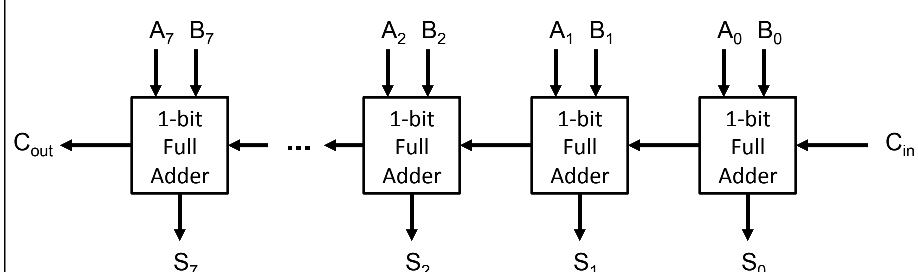
Another Full Adder (FA)

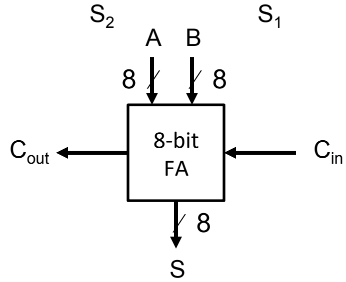
http://students.cs.tamu.edu/wanglei/csce350/handout/lab6.html





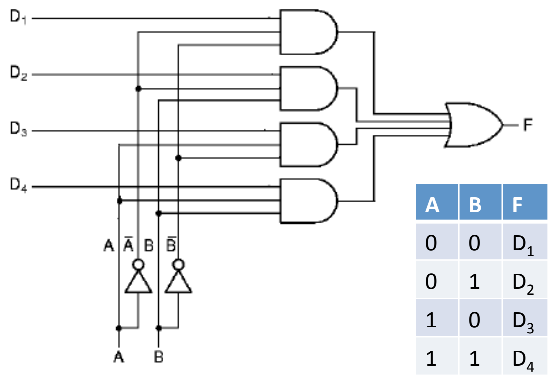
8-bit Full Adder

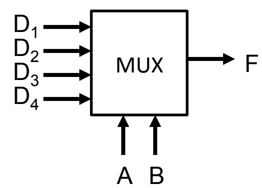




Multiplexer (MUX)

- A multiplexer chooses between a set of inputs.

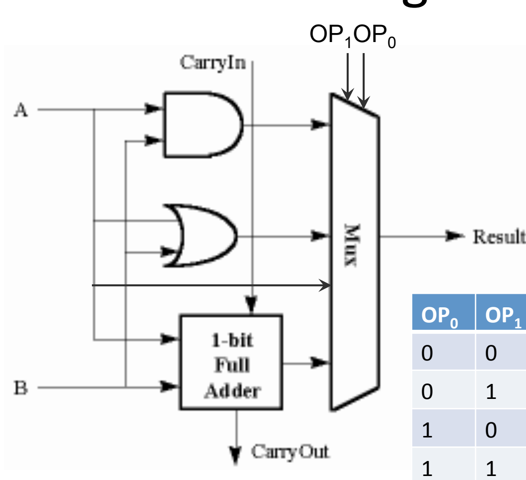


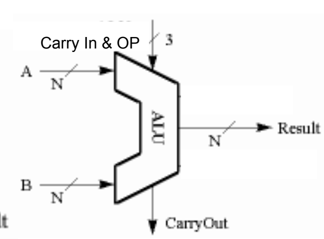


A	B	F
0	0	D_1
0	1	D_2
1	0	D_3
1	1	D_4

http://www.cise.ufl.edu/~mssz/CompOrg/CDAintro.html

Arithmetic Logic Unit (ALU)



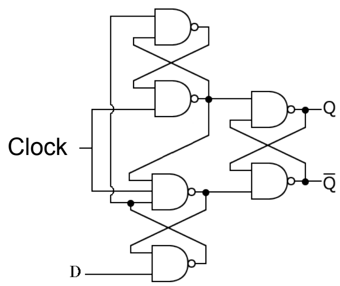


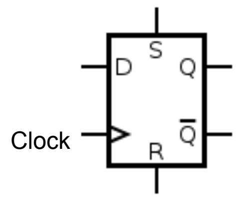
OP_0	OP_1	F
0	0	A ∧ B
0	1	A ∨ B
1	0	A
1	1	A + B

http://cs-alb-pc3.massey.ac.nz/notes/59304/l4.html

Flip Flop

- A flip flop is a sequential circuit that is able to maintain (save) a state.
  - Example: D (Data) Flip-Flop – sets output Q to input D when clock turns on. (Images from Wikipedia)

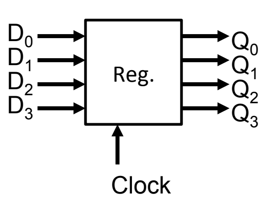


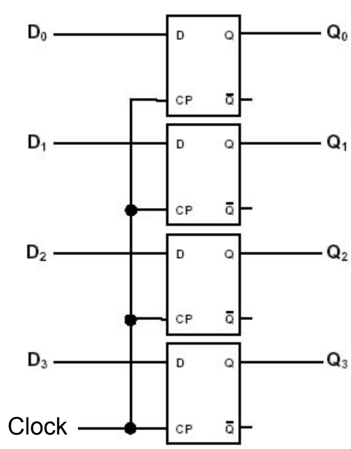


S=Set Q to 1,
R=Reset Q to 0

Registers

- A register is just a set of edge-triggered flip-flops. Registers are triggered by a clock signal.



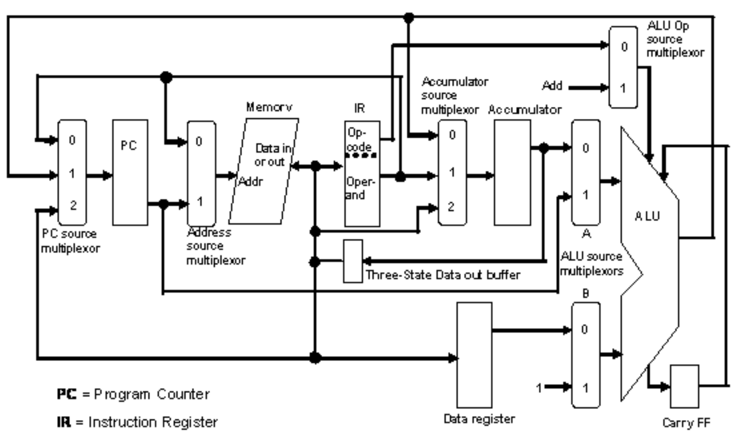


http://cpuville.com/register.htm

Central Processing Unit (CPU)

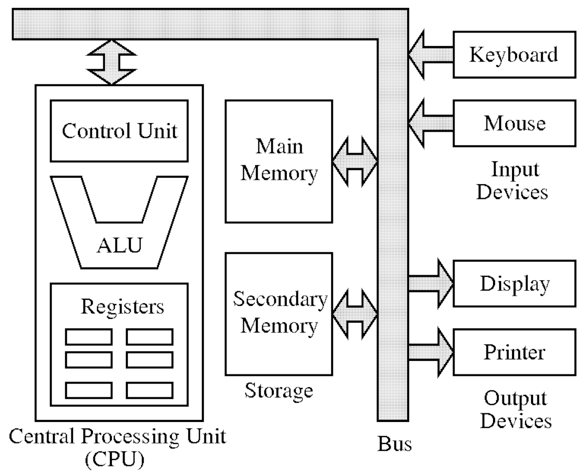
- A CPU contains:
  - Arithmetic Logic Unit to perform computation
  - Registers to hold information
    - Instruction register (current instruction being executed)
    - Program counter (to hold location of next instruction in memory)
    - Accumulator (to hold computation result from ALU)
    - Data register(s) (to hold other important data for future use)
  - Control unit to regulate flow of information and operations that are performed at each instruction step

A sample CPU



http://cpuville.com/main.htm

Computer



http://cse.iitkgp.ac.in/pds/notes/intro.html

Abstraction

- We can use layers of abstraction to hide details of the computer design.
- We can work in any layer, not needing to know how the lower layers work or how the current layer fits into the larger system.

  -> transistors
  -> gates
  -> circuits (adders, multiplexors, flip-flops)
  -> central processing units (ALU, registers, control)
  -> computer

von Neumann Architecture

- Most computers follow the **fetch-decode-execute** cycle introduced by John von Neumann.
  – Fetch next instruction from memory.
  – Decode instruction and get any data it needs (possibly from memory).
  – Execute instruction with data and store results (possibly into memory).
  – Repeat.

Programming a Machine

- All instructions for a program are stored in computer memory in binary, just like data.
- A program is needed that translates human readable instructions (e.g. in Python) into binary instructions ("machine language").
  – An interpreter is a program that translates one instruction at a time into machine language to be executed by the computer.
  – A compiler is a program that translates an entire program into machine language which is then executed by the computer.