Overview

- **Introduction**
- **Logic Gates**
- **Flip Flops**
- Registers
- Counters
- Multiplexer/ Demultiplexer
- Decoder/ Encoder

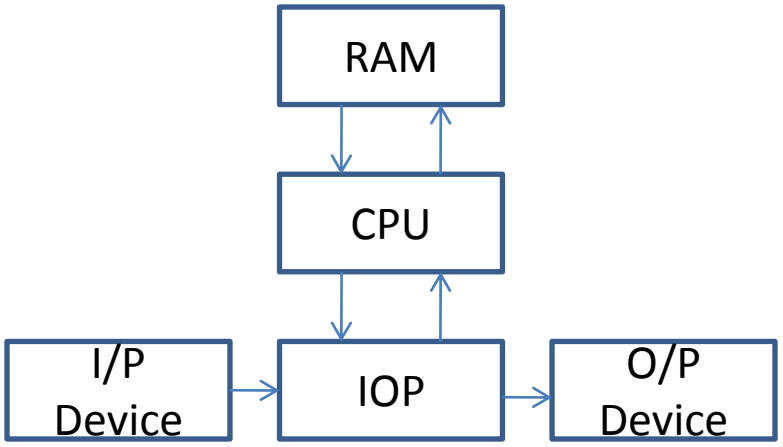
Introduction

Digital Computer

A computer that stores data in terms of digits (numbers) and proceeds in discrete steps from one state to the next

Binary digits

The states of a digital computer typically involve binary digits. A binary digit is called a ***bit***



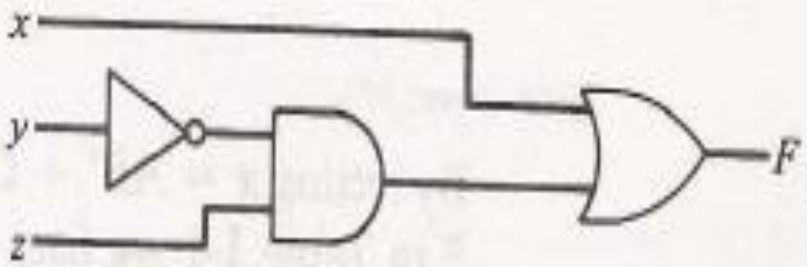
Block diagram of a digital computer

Boolean Algebra

Figure 1-3 Truth table and logic diagram for $F = x + y'z$.

x	y	z	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

(a) Truth table



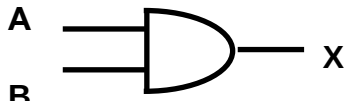
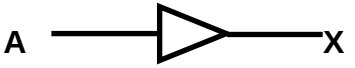
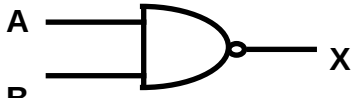
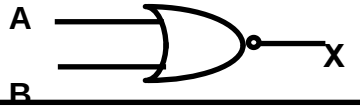
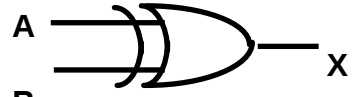
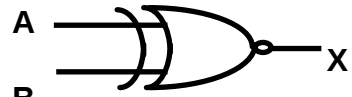
(b) Logic diagram

Boolean Identities

TABLE 1-1 Basic Identities of Boolean Algebra

(1) $x + 0 = x$	(2) $x \cdot 0 = 0$
(3) $x + 1 = 1$	(4) $x \cdot 1 = x$
(5) $x + x = x$	(6) $x \cdot x = x$
(7) $x + x' = 1$	(8) $x \cdot x' = 0$
(9) $x + y = y + x$	(10) $xy = yx$
(11) $x + (y + z) = (x + y) + z$	(12) $x(yz) = (xy)z$
(13) $x(y + z) = xy + xz$	(14) $x + yx = (x + y)(x + z)$
(15) $(x + y)' = x'y'$	(16) $(xy)' = x' + y'$
(17) $(x')' = x$	

Logic Gates

Name	Symbol	Function	Truth Table
AND		X = A • B or X = AB	A B | X 0 0 | 0 0 1 | 0 1 0 | 0 1 1 | 1
OR		X = A + B	A B | X 0 0 | 0 0 1 | 1 1 0 | 1 1 1 | 1
NOT		X = A’	A | X 0 | 1 1 | 0
Buffer		X = A	A | X 0 | 0 1 | 1
NAND		X = (AB)’	A B | X 0 0 | 1 0 1 | 1 1 0 | 1 1 1 | 0
NOR		X = (A + B)’	A B | X 0 0 | 1 0 1 | 0 1 0 | 0 1 1 | 0
XOR Exclusive OR		X = A ⊕ B or X = A’B + AB’	A B | X 0 0 | 0 0 1 | 1 1 0 | 1 1 1 | 0
XNOR Exclusive NOR or Equivalence		X = (A ⊕ B)’ or X = A’B’+ AB	A B | X 0 0 | 1 0 1 | 0 1 0 | 0 1 1 | 1

- Is NAND Gate a complement of AND gate?

a)True

b)False

Types of circuits

1) Combinational Circuits
2) Sequential Circuits

Flip Flops

Characteristics

- **2 stable states**
- **Memory capability**
- **Operation is specified by a Characteristic Table**

The Storage elements employed in clocked sequential circuits, capable of storing one bit of information, are called **Flip Flops**

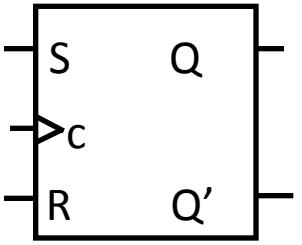
The most common types of flip flops are

- SR (Set Reset)
- D (Data)
- JK
- T (Toggle)

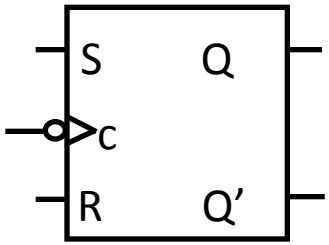
Clocked Flip Flops

In a large digital system with many flip flops, operations of individual flip flops are required to be synchronized to a clock pulse. Otherwise, the operations of the system may be unpredictable.

Clock pulse allows the flip flop to change state only when there is a clock pulse appearing at the C terminal (as shown in fig).



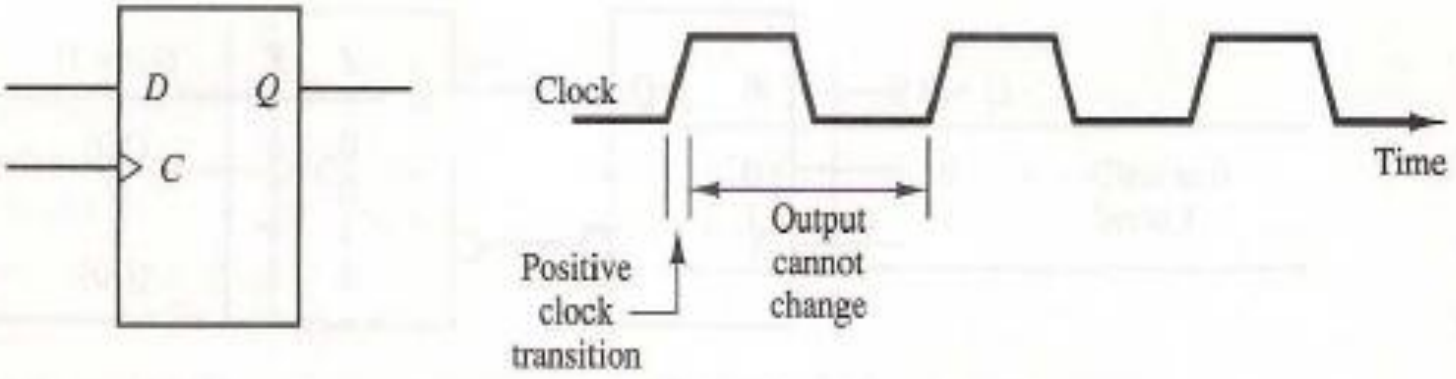
operates when clock is high



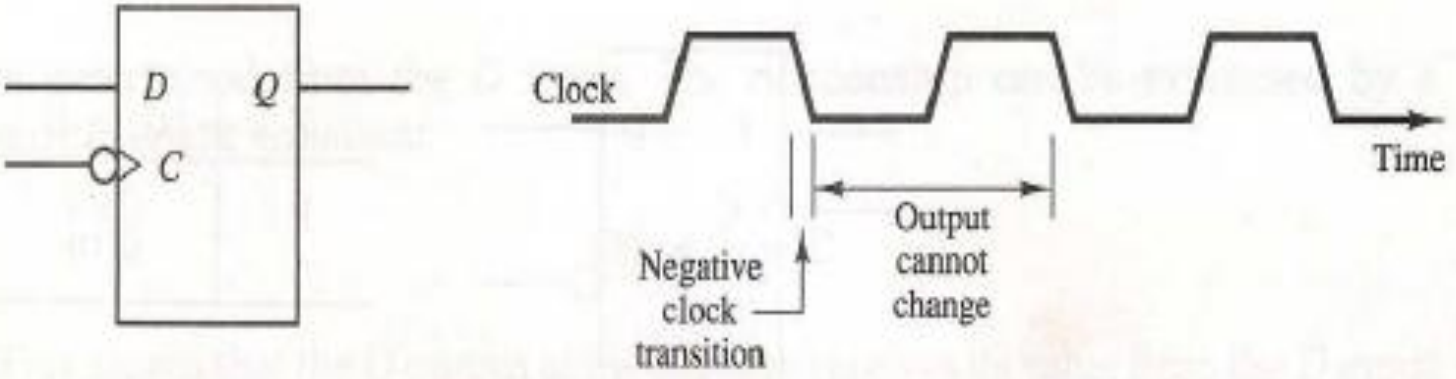
operates when clock is low

Edge Triggered Flip Flops

State transition occurs at the rising edge or falling edge of the clock pulse



(a) Positive-edge-triggered *D* flip-flop.

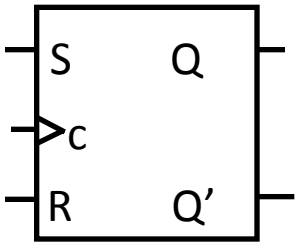
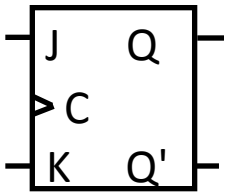


(b) Negative-edge-triggered *D* flip-flop.

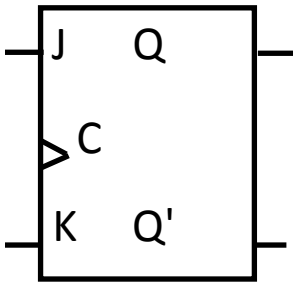
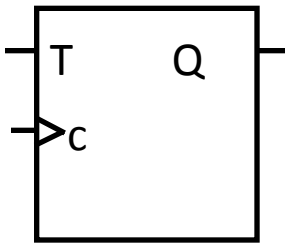
- …… Circuits contains memory elements?

a) Combinational Circuits
b) Sequential Circuits

Flip Flops

Flip Flop	Graphical Symbol	Characteristic Table
SR (Set Reset)		S R | Q(t+1) 0 0 | Q(t) 0 1 | 0 1 0 | 1 1 1 | indeterminate (forbidden)
D (Data)		D | Q(t+1) 0 | 0 1 | 1

Flip Flops

Flip Flop	GraphicalSymbol	Characteristic Table
J-K		J K | Q(t+1) 0 0 | Q(t) 0 1 | 0 1 0 | 1 1 1 | Q'(t)
T (Toggle)		T | Q(t+1) 0 | Q(t) 1 | Q'(t)