Chapter 1

Digital Logic Circuit

Cont…

Computer architecture

is concerned with the way how the hard ware components are connected together to form a computer system.

example, instruction set, number of bits, I/O mechanism.

The digital computer

is a digital system that performs various computational tasks.

A digital implies that the information in the computer represented by the variables that take a limited number of discrete values.

Cont…

- Digital computer use the binary number system which has two digits 0 and 1.
- A binary digit is called a bit.
- Computer design is concerned with the development of hardware for the computer.
- Its although concerned with structure and function of computer system.
- Also it is called computer implementation.

Cont…

- The computer designer is concerned with structure and function characteristics of computer system:
- **Structure:** The way in which the components are interrelated
- **Function:** The operation of each individual component as part of the structure

Cont…

- Computers can perform four basic function
  - Data processing
  - Data storage
  - Data movement
  - Control
- There are four main structural components
  - Central processing unit (CPU)
  - Main memory:
  - I/O
  - System interconnection

two functional entities of computer system

System Hardware

- consists all of the electronic component and electro mechanical devices that comprises the physical entities of the devices.
- Hardware of the computer is divided in to three major parts.

1. **cpu** that contains
   a. Arithmetic and logic unit for manipulating data.
   b. number of Registers for storing data.
   c. control circuit for fetching and executing instr.

Cont…

2.RAM it contains storage for instruction and data.

3.Input output processor (Iop)

- contains electronic circuit for communicating and controlling transfer of information between the computer and outside world.
- The IP and OP devices connected to computer includes
  - ✓ key board
  - ✓ printer
  - ✓ terminals
  - ✓ magnetic disk drive

Cont…

System software

- consists all instructions and data that the computer manipulate to perform various data processing task.
- it consists all collection of the program whose purpose is to make effective use of the computer.
- It compensate for the difference between user need and capability of computer hardware.

Cont…

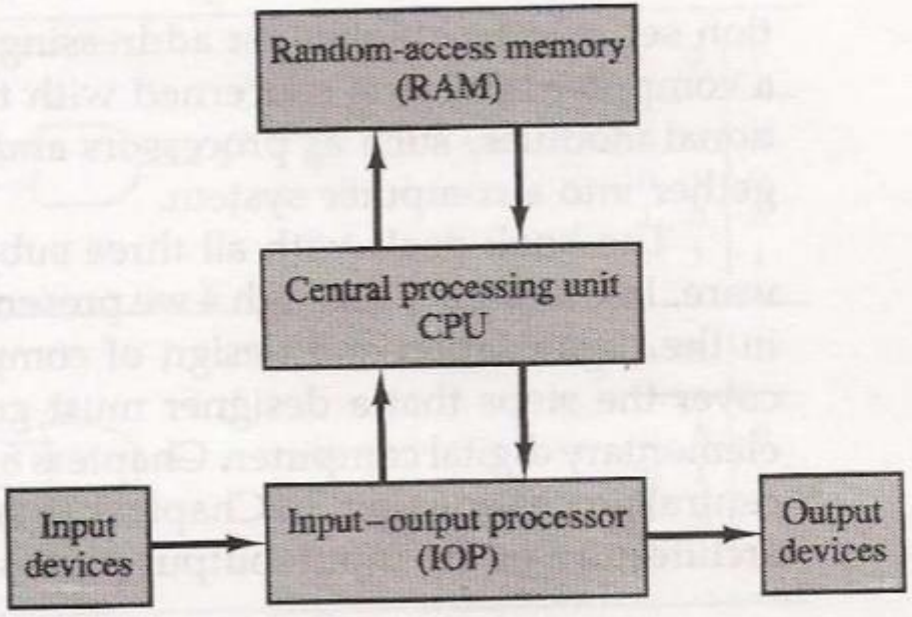


Figure 1-1 Block diagram of a digital computer.

Logic Gates

- Binary information in digital computers represented by physical quantities called signal.
- The manipulation of binary information is done by logic circuit called gate.
- **gate** is The fundamental building block of Hardware that produce signal of binary 1 or 0.
- The basic gates used in digital logic are AND, OR, NOT, NAND, NOR, and XOR.

Cont…

1.AND gate

- ✓ produce the AND logic function.
- ✓ It concatenate variables.
- ✓ the output is 1 if and only if both i
- ✓ nput A and B are 1.otherwise, the output is 0.

2.OR gate

- ✓ Produce the inclusive or function.
- ✓ The output is 1 if input A or B or both inputs are 1.
- ✓ Algebraic symbol is ‘+’ similar to Arithmetic addition.

Cont…

3.Inverter

- ✓ the inverter circiut inverts the logic sense of a binary signal.
- ✓ It produce the NOT or complement function.

4.NAND gate

- ✓ Is the complement of AND function,is NOT-AND.

5.NOR gate

- ✓ Is the complement of OR gate.

Cont…

6.Exclusive-OR(XOR)

- ✓ Is called odd function.
- ✓ The output of XOR is 1 if any input is 1,but exclude the combination when both inputs are 1.

7.Exclusive-NOR gate

- ✓ Is called equivalence
- ✓ it is complement of Exclusive –OR
- ✓ The output is 1only if both input are 1 or both input are 0.

Cont…

X=(A EX-OR B)'or

X=A'B'+AB

- ✓ Inverter and Buffer are unary gates which are take a single input.

Cont…

Name	Graphical Symbol	Algebraic Function	Truth Table
AND		$F = A \cdot B$ or $F = AB$	A B | F 0 0 | 0 0 1 | 0 1 0 | 0 1 1 | 1
OR		$F = A + B$	A B | F 0 0 | 0 0 1 | 1 1 0 | 1 1 1 | 1
NOT		$F = \overline{A}$ or $F = A'$	A | F 0 | 1 1 | 0
NAND		$F = \overline{AB}$	A B | F 0 0 | 1 0 1 | 1 1 0 | 1 1 1 | 0
NOR		$F = \overline{A + B}$	A B | F 0 0 | 1 0 1 | 0 1 0 | 0 1 1 | 0
XOR		$F = A \oplus B$	A B | F 0 0 | 0 0 1 | 1 1 0 | 1 1 1 | 0

Boolean Algebra

Boolean algebra

- is an algebra that deals with binary variables and logic operations.
- The possible values for a logical variable are either TRUE or FALSE.
- The logical operators of Boolean algebra are AND, OR, and NOT, which are symbolically represented by dot (·), plus sign (+), and over bar ($\bar{}$).
- Boolean algebra is used to facilitate the analyse and design of digital circuits.

Cont…

Boolean Expressions

- are made up of Boolean constants 0,1 and the three operations.

Boolean Variables

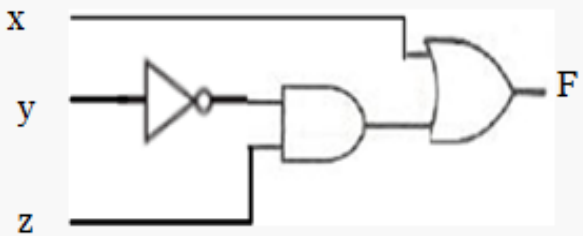
- are Boolean quantities whose values are not yet known. They can take the values 0 or 1 only.

Cont…

A Boolean function can be represented by a truth table and a logic diagram.

Example, $F = x + y'z$

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



Properties(basic Identities of Boolean Algebra)

1.Idempontency

$x+x = x$

$x.x = x$

2.Identity Properties:

$x+0=x$

$x.1=x$

3.Dominance Laws:

$x+1=1$

$x.0=0$

Cont…

4.Involution Property

$(x')'=x$

5.Commutativity

$x+y=y+x$

$y.x=x.y$

6.Associativity

$(x+y)+z=x+(y+z)=x+y+z$

$(x.y).z=x.(y.z)=x.y.z$

7.Complemetation

$x+x'=1$

$x.x'=0$

Cont…

8.Distributive property

$x.(y+z)=x.y+x.z$

$x+(y.z)=(x+y).(x+z)$

9.Absorption

$x+xy=x$

$x(x+y)=x$

Cont…

10.Adsorption

$x+x'y=x+y$

$x.(x'+y)=xy$

11.De Morgan's laws

$(x+y)'=x'y'$

$(xy)'=x'+y'$

K-MAP Simplification

Rules for K-map simplification

we use sop form

1. Group may not contain zero.
2. We can group by 1, 2, 4and8 grouping:2^n cells.
3. Each group should be large as possible.
4. Cell contain 1 must be grouped.
5. Groups may be overlap.
6. Opposite grouping and corner grouping are allowed.
7. There should be as few groups as possible.

Combinational Circuits

- A combinational circuit is an interconnected set of gates whose output at any time is a function only of the input at that time
- They serve as a basic building blocks for the construction of more complicated arithmetic circuits.
- a combinational circuit consists of n binary inputs and m binary outputs.
- Combinational circuits have no feedback

Cont…

- Common combinational circuit are, Adders (Half Adder & Full Adder)

Half Adder

- A digital arithmetic circuit that carries out the addition of two bits is called a **half adder**.
- It has two input variables and two outputs variables (sum & carry).

Cont…

Full Adder

- add two n-bit numbers along with a carry from a previous bitwise addition (performs addition of three bits).
- A combination of two half adders creates a ***full adder.***

Cont…

Multiple-Bit Adder

- By combining a number of full adders, we can have the necessary logic to implement a multiple-bit adder.
- The output from each adder depends on the carry from the previous adder.

1.5 Sequential Circuits

- In case of combinational circuits, the value of each output depends on the values of signals applied to the inputs.
- However, in case of Sequential Circuits, the values of the outputs depend not only on the present values of the inputs but also on the past behaviour of the circuit.
- Such circuits include storage elements that store the values of logic signals.E.g flip-flops

Flip-Flops

- The simplest form of sequential circuit is the flip-flops.
- The flip-flop is a bistable device, i.e. has two stable states.
- It exists in one of two states and, in the absence of input- function as a 1-bit memory.
- E.g S-R, J-K & D flip-flops