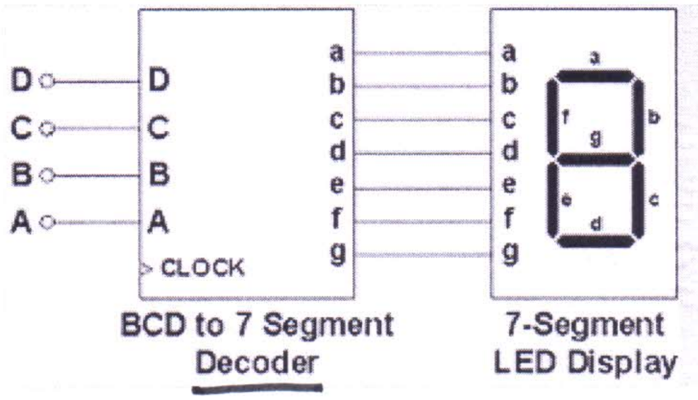
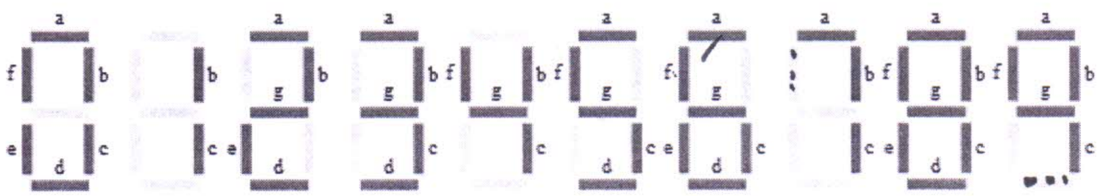
Don't-Care Conditions:

In some digital systems, certain input conditions never occur during normal operation. For those inputs, the corresponding outputs can take any value- '0' or '1'. In K-map these outputs are marked as 'X'.

Example:

0-9





TT

A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	X	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	X	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	X	0	1	1
1	0	1	0	X	X	X	X	X	X	X
1	0	1	1	X	X	X	X	X	X	X
1	1	0	0	X						
1	1	0	1	X						
1	1	1	0	X						
1	1	1	1	X	X	X	X	X	X	X

Ex. For LED 'a' $\sum m(0,2,3,5,7,8,9) + \sum d(6,10,11,12,13,14,15)$

Without don't-care

AB \ CD	00	01	11	10
00	1		1	1
01		1	1	
11				
10	1	1		

$$a = \bar{A}\bar{B}\bar{D} + A\bar{B}\bar{C} + \bar{A}CD + \bar{A}BD$$

With don't-care

AB \ CD	00	01	11	10
00	1		1	1
01		1	1	X
11	X	X	X	X
10	1	1	X	X

$$a = A + C + \bar{B}\bar{D} + BD$$

Product of Sums Simplification using K-map:

Ex. $F(X,Y,Z) = \sum m(0,1,2,3,6,7)$

$= \prod M(4,5) = \cancel{(X+Y+Z)}$

$(\overline{X}+Y+Z)(\overline{X}+Y+\overline{Z})$

$= (\overline{X}+Y+Z\overline{Z}) = (\overline{X}+Y)$

X \ YZ	00	01	11	10
0				
1	0	0		

$(\overline{X}+Y)$

OR

Ex. Find minimal SOP and minimal POS for the following Boolean function:

$$F(A,B,C,D) = \sum m(2,10,14) + \sum d(6)$$

SOP

AB \ CD	00	01	11	10
00				1
01				X
11				1
10				1

$F = C\overline{D}$

POS

AB \ CD	00	01	11	10
00	0	0	0	
01	0	0	0	X
11	0	0	0	
10	0	0	0	

$F = (C)(\overline{D})$

Ex. Find minimal SOP and minimal POS for the following Boolean function:

$$F(A,B,C,D) = \sum m(2,10,14) + \sum d(3,11)$$

SOP

AB \ CD	00	01	11	10
00			X	1
01				
11				1
10			X	1

$F = \overline{B}C + AC\overline{D}$

POS

AB \ CD	00	01	11	10
00	0	0	X	
01	0	0	0	0
11	0	0	0	
10	0	0	X	

$F = C\overline{D}\,(A+\overline{B})$

Digital Circuits:

1. Combinational Circuits

It consists of logic gates whose outputs at any time are determined by current inputs using logic operations.

Ex.

a) Arithmetic circuits like binary adder, BCD adder etc
b) Multiplexer and Demultiplexer
c) Encoder and Decoder

2. Sequential Circuits

It consists of combinational circuits and storage elements. Therefore, its ouputs depends on current inputs and previous outputs or states.

Ex.

a) Flip-flops
b) Registers
c) Counters

Combinational Circuits

Binary Adders:

1. Half Adder

Inputs		Outputs	
X	Y	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

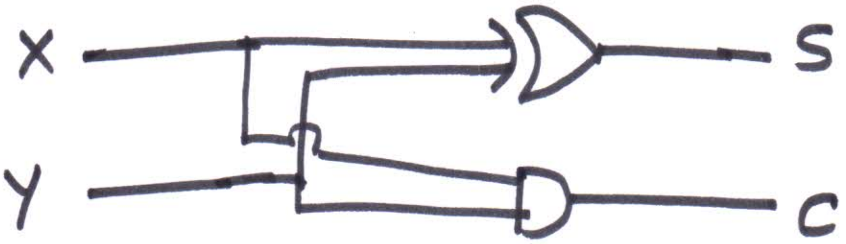
S

x \ y	0	1
0		1
1	1	

$$S = \bar{x}y + x\bar{y}$$
$$= x \oplus y$$

C

$$C = xy$$



2. Full Adder

Inputs			Output	
X	Y	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

X \ YC_{in}	00	01	11	10
0		1		1
1	1		1	

$$S = X\bar{Y}\bar{C}_{in} + \bar{X}\bar{Y}C_{in} + XYC_{in} + \bar{X}Y\bar{C}_{in}$$

$$= \bar{Y}(X\bar{C}_{in} + \bar{X}C_{in}) + Y(XC_{in} + \bar{X}\bar{C}_{in})$$

$$= \bar{Y}(X \oplus C_{in}) + Y\overline{(X \oplus C_{in})}$$

$$= Y \oplus X \oplus C_{in}$$