ECE213: Digital Electronics

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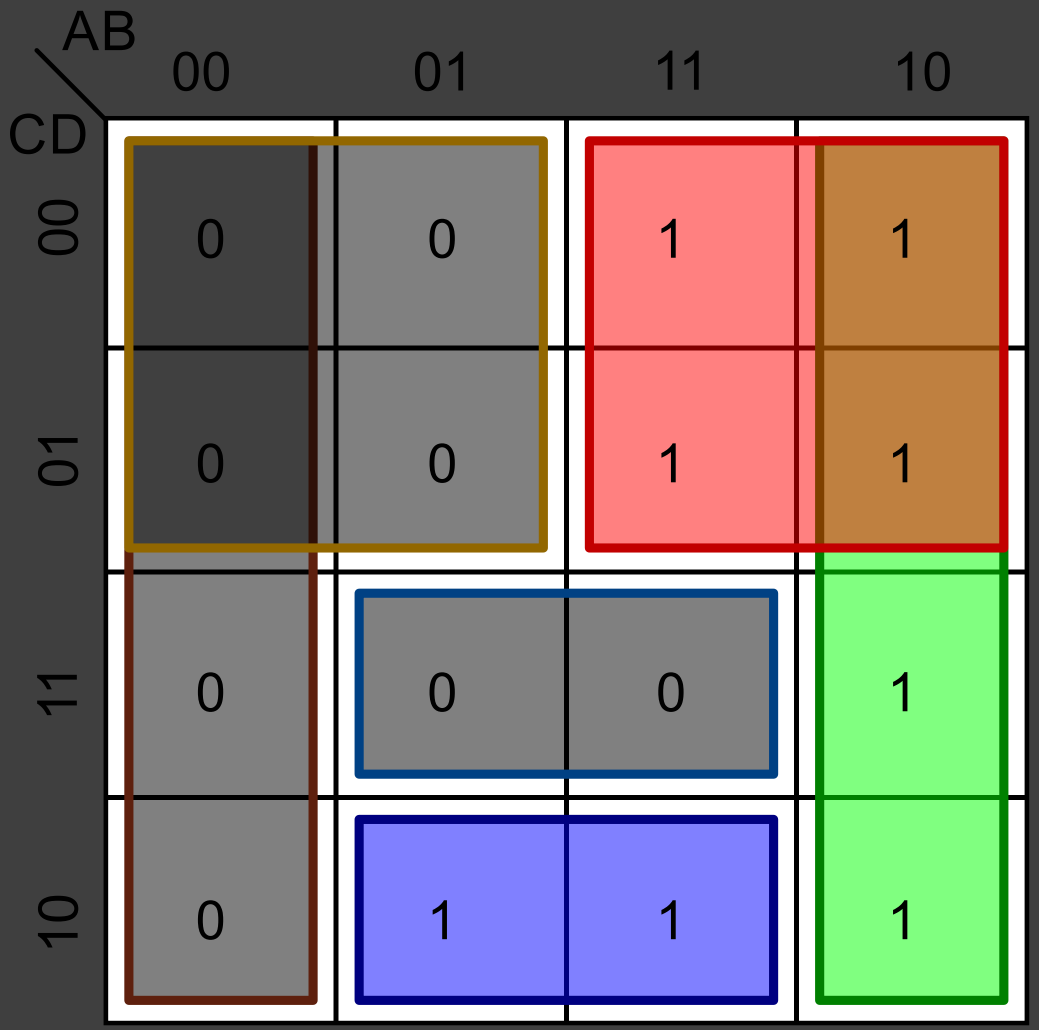
The Course Contents

Unit II

Combinational Logic System : Truth table, Basic logic operation, Boolean Algebra, Basic postulates, Standard representation of logic functions -SOP forms, Simplification of switching functions - K-map, Synthesis of combinational logic circuits, Logic gates, Fundamental theorems of Boolean algebra, Standard representation of logic functions POS forms

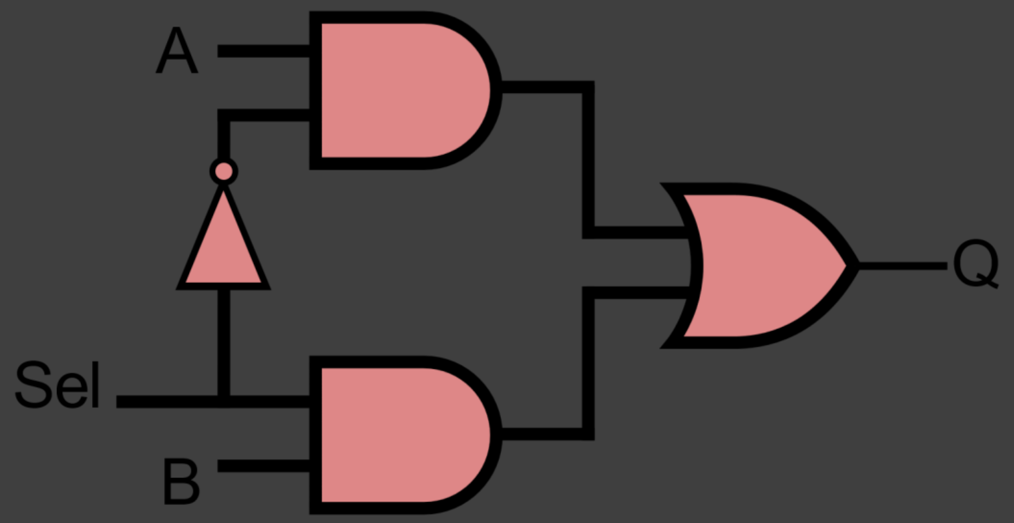


The Course Contents

Unit III

Introduction to Combinational Logic Circuits : Adders, Subtractors, Comparators, Multiplexers and Demultiplexers, Decoders, Encoders, Parity circuits

Introduction to Logic Families : Introduction to different logic families, Structure and operations of TTL, MOS and CMOS logic families



Combinational Logic System

Simplification of switching functions - K-map

4-Var K-map

MSB LSB

AB \ CD	00	01	11	10
00	0 0000	1 0001	3 0011	2 0010
01	4 0100	5 0101	7 0111	6 0110
11	12 1100	13 1101	15 1111	14 1110
10	8 1000	9 1001	11 1011	10 1010

1-bit

1-bit

- Possible Group size in 4-Var K-map
- 1 cell, 2 cell, 4 cell, 8 cell, 16 cell.

Ex

AB \ CD	00	01	11	10
00	1	1	0	0
01	0	1	1	0
11	0	1	1	1
10	0	0	1	1

$$Y = BD + AC + \bar{A}\bar{B}\bar{C}$$

Combinational Logic System

Simplification of switching functions - K-map

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

$$Y_1 = BD + A\bar{B} + \bar{B}\,\bar{D}$$

$$= \overline{B \oplus D} + A\bar{B}$$

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

$$Y_2 = \bar{B}\,\bar{C} + \bar{A}BD + ABC$$

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

$$Y = \bar{C}\bar{D} + ABD + \bar{A}CD$$

Combinational Logic System

Simplification of switching functions – K-map

y_4

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

y_5

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

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

$$y_4 = \bar{A}\bar{C} + AC$$
$$= \overline{A \oplus C}$$

$$y_5 = \bar{A}\bar{B}C + \bar{A}B\bar{C}$$
$$+ ABC + A\bar{B}\bar{C}$$

$$y_6 = B$$

Combinational Logic System

Simplification of switching functions - K-map

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

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

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

Combinational Logic System

Simplification of switching functions – K-map

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

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

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

Combinational Logic System

Don't Care conditions

Ex

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	X

Don't care

Y

A \ B	0	1
0	0	0
1	1	X

$Y = A\bar{B}$ $\neq$

Y

A \ B	0	1
0	0	0
1	1	X

$Y = A$

A	B	Y
0	0	0
0	1	X
1	0	1
1	1	X

Y

A \ B	0	1
0	0	X
1	1	X

$\cancel{Y = A + B}$

Y

A \ B	0	1
0	0	X
1	1	X

$Y = A$

Ex

A \ BC	00	01	11	10
0	0	1	1	0
1	0	0	1	1

Not req.

$\bar{A}C + AB = \bar{A}C + AB + BC$

Combinational Logic System

Don't Care conditions

Ex: Reduce the boolean fxn.

$$Y = \sum m(0,1,3,4) + d(2)$$

Sol

A \ BC	00	01	11	10
0	1	1	1	X
1	1	0	0	0

$$Y = \bar{A} + \bar{B}\bar{C}$$

Combinational Logic System

Don't Care conditions

Ex: Reduce the following function

$$Y = \sum m(1, 2, 4, 7, 8, 10, 11, 12) + d(3, 9, 15)$$

AB \ CD	00	01	11	10
00	0	1	X	1
01	1	0	1	0
11	1	0	X	0
10	1	X	1	1

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

Combinational Logic System

Don't Care conditions

Ex Reduce the following function

$$Y = \prod M(0,1,5,8,9,12) \cdot d(2,3,14,15)$$

AB \ CD	00	01	11	10
00	0	0	X	X
01	1	0	1	1
11	0	1	X	X
10	0	0	1	1

$$Y = C + ABD + \bar{A}B\bar{D}$$

Unit 3

Combinational Logic System

~~2-bit~~ Comparator

1-bit

A	B	Y_1: A=B	Y_2: A>B	Y_3: A<B
0	0	1	0	0
0	1	0	0	1
1	0	0	1	0
1	1	1	0	0

for Y_1

A \ B	0	1
0	1	0
1	0	1

$$Y_1 = \bar{A}\bar{B} + AB = \overline{A \oplus B}$$

for Y_2

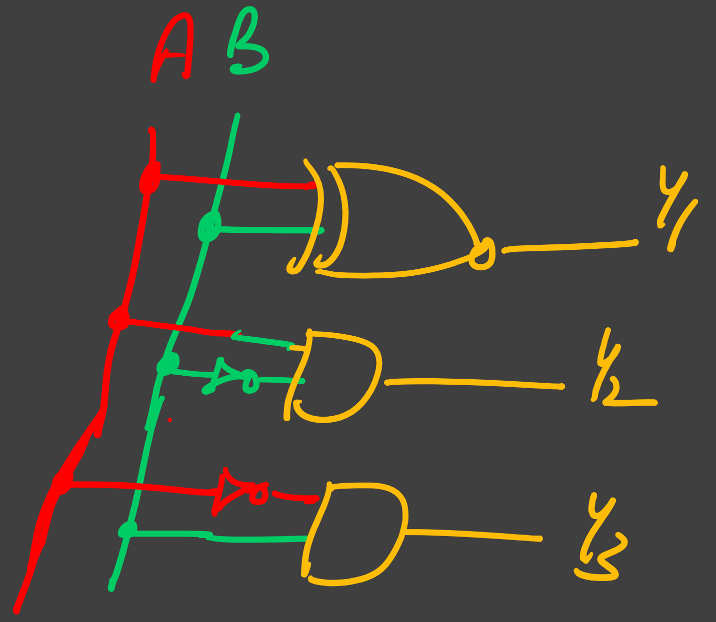
A \ B	0	1
0	0	0
1	1	0

$$Y_2 = A\bar{B}$$

for Y_3

A \ B	0	1
0	0	1
1	0	0

$$Y_3 = \bar{A}B$$



1-bit Comparator

Combinational Logic System

2-bit Comparator

	A		B		Y_1	Y_2	Y_3
	A_1	A_0	B_1	B_0	A=B	A>B	A<B
A=0	0	0	0	0 (0)	1	0	0
	0	0	0	1 (1)	0	0	1
	0	0	1	0 (2)	0	0	1
	0	0	1	1 (3)	0	0	1
A=1	0	1	0	0	0	1	0
	0	1	0	1	1	0	0
	0	1	1	0	0	0	1
	0	1	1	1	0	0	1
A=2	1	0	0	0	0	1	0
	1	0	0	1	0	1	0
	1	0	1	0	1	0	0
	1	0	1	1	0	0	1
A=3	1	1	0	0	0	1	0
	1	1	0	1	0	1	0
	1	1	1	0	0	1	0
	1	1	1	1	1	0	0

for Y_1

$A_1A_0 \backslash B_1B_0$	00	01	11	10
00	1	0	0	0
01	0	1	0	0
11	0	0	1	0
10	0	0	0	1

$$Y_1 = \bar{A}_1 \bar{A}_0 \bar{B}_1 \bar{B}_0 + \bar{A}_1 A_0 \bar{B}_1 B_0 + A_1 A_0 B_1 B_0 + A_1 \bar{A}_0 B_1 \bar{B}_0$$

$$= \bar{A}_1 \bar{B}_1 (\bar{A}_0 \bar{B}_0 + A_0 B_0) + A_1 B_1 (\bar{A}_0 \bar{B}_0 + A_0 B_0)$$

$$= \overline{A_0 \oplus B_0}\, (\bar{A}_1 \bar{B}_1 + A_1 B_1)$$

$$= \overline{A_0 + B_0} \cdot \overline{A_1 \oplus B_1}$$

for Y_2

$A_1A_0 \backslash B_1B_0$	00	01	11	10
00	0	0	0	0
01	1	0	0	0
11	1	1	0	1
10	1	1	0	0

$$Y_2 = A_1 \bar{B}_1 + A_0 \bar{B}_1 \bar{B}_0 + A_1 A_0 \bar{B}_0$$

for Y_3 (H.W)

$A_1A_0 \backslash B_1B_0$	00	01	11	10
00	0	1	1	1
01	0	0	1	1
11	0	0	0	0
10	0	0	1	0

$$Y_3 = \bar{A}_1 B_1 + \bar{A}_1 \bar{A}_0 B_0 + \bar{A}_0 B_1 B_0$$

Combinational Logic System

2-bit Comparator

Ckt diag (HW)