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

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

Combinational Logic System

Truth table — It is set of all the possible inputs and outputs.

2-Variable

	A	B	Y
0	0	0	0
1	0	1	0
2	1	0	0
3	1	1	0

0 0 0

0 0 0

0 1 1

0 0 1

1 0 1

$2^2 = 4$

How many 2-Var Boolean function exist?

$2^{2^n} = 16$ MCQ

$= 2^{2^2}$ when $\boxed{n=2}$

3-Variable

	A	B	C	Y
0	0	0	0	
1	0	0	1	
2	0	1	0	
3	0	1	1	
4	1	0	0	
5	1	0	1	
6	1	1	0	
7	1	1	1	

How many 3-Var fn.

$2^{2^n} = 2^{2^3} = 2^8 = 256$ MCQ

4-Variable

A	B	C	D
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1

How many 4-Var fun

$2^{2^4} = 65536$ MCQ

Combinational Logic System

★ **Basic logic operation** AND, OR, NOT

AND: Both or all the inputs need to be true for true o/p.

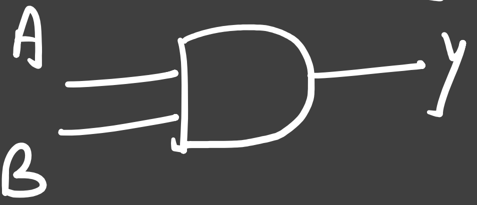
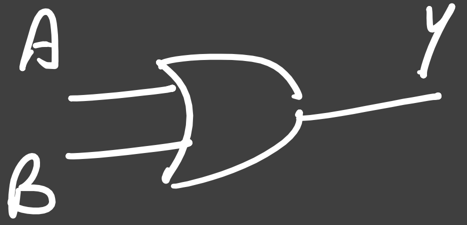
OR: Any one of the input need to be true for true o/p.

NOT: Input needs to be false for true o/p.

Combinational Logic System

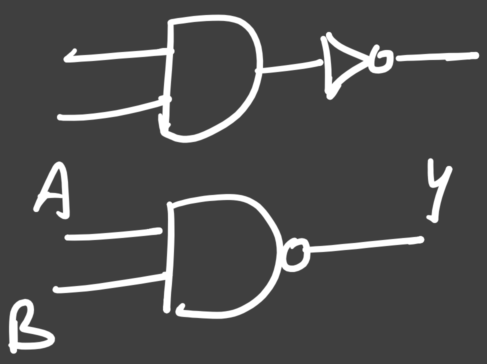
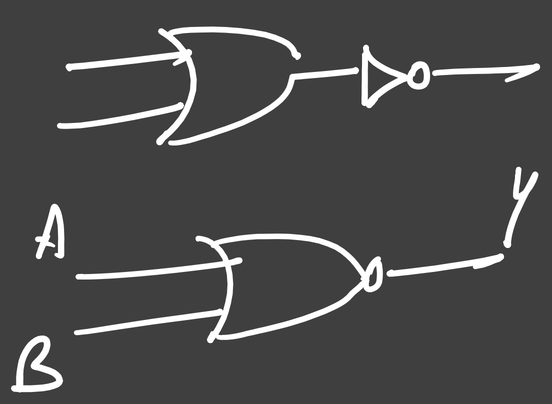
Basic logic operation - Logic gates

- Basic logic Gates (AND, OR, NOT)
- Universal logic Gates (NAND, NOR)
- Drived logic gates (XOR, XNOR)

Gate	logic	Truth Table	Equation	Symbol
AND	If any of the input is low the o/p is low, and if all the inputs are high the o/p is high	A | B | Y 0 | 0 | 0 0 | 1 | 0 1 | 0 | 0 1 | 1 | 1	$Y = AB$	
OR	If any of the input is high the o/p is high, and if all the inputs are low the o/p is low	A | B | Y 0 | 0 | 0 0 | 1 | 1 1 | 0 | 1 1 | 1 | 1	$Y = A + B$	

Combinational Logic System

Basic logic operation -Logic gates

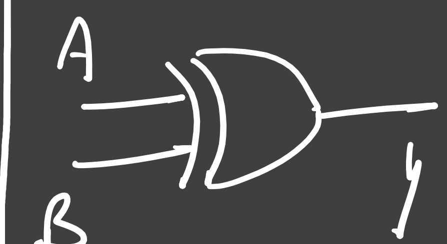
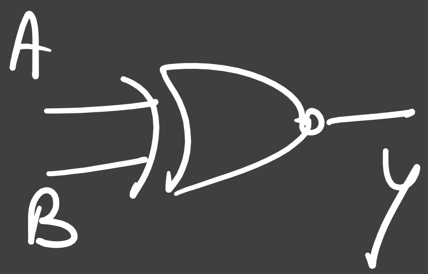
Gate	logic			
NAND	If any of the input is low the o/p is high. and if all the inputs are high the o/p is low.	A | B | y 0 | 0 | 1 0 | 1 | 1 1 | 0 | 1 1 | 1 | 0	$y = \overline{AB}$	
NOR	If any of the input is high the o/p is low, and if all the inputs are low the o/p is high.	A | B | y 0 | 0 | 1 0 | 1 | 0 1 | 0 | 0 1 | 1 | 0	$y = \overline{A+B}$	

Combinational Logic System

Basic logic operation - Logic gates

Q: if any of the input is high the o/p is low.

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

Gate	logic			
XOR	if both the inputs are same the o/p is low. otherwise the o/p is high	A B Y 0 0 0 0 1 1 1 0 1 1 1 0	$Y = A\bar{B} + \bar{A}B$ $Y = A \oplus B$ $Y = \overline{AB + \bar{A}\bar{B}}$ $Y = \overline{A \odot B}$	
XNOR	if both the inputs are same the o/p is high, otherwise the o/p is low.	A B Y 0 0 1 0 1 0 1 0 0 1 1 1	$Y = AB + \bar{A}\bar{B}$ $Y = A \odot B$ $Y = \overline{A\bar{B} + \bar{A}B}$ $Y = \overline{A \oplus B}$	

Combinational Logic System

Boolean Algebra - Basic postulates

- AND

$0.0 = 0$
$0.1 = 0$
$1.0 = 0$
$1.1 = 1$

- OR

$0 + 0 = 0$
$0 + 1 = 1$
$1 + 0 = 1$
$\boxed{1 + 1 = 1}$

Boole

OR operator

Binary Nums

$1 + 1 = 10$

Sum operator

- Invert / NOT

$\bar{0} = 1 \quad ; \quad \bar{1} = 0$

Combinational Logic System

Boolean Algebra - Fundamental theorems of Boolean algebra

Ex $A+1=1$

$0+1=1$

$1+1=1$

① Complementation laws

$\bar{0}=1$

$\bar{1}=0$

If $A=0$ then $\bar{A}=1$

If $A=1$ then $\bar{A}=0$

$\bar{\bar{A}}=A$

② AND Law

$A \cdot 0=0$

$A \cdot 1=A$

$A \cdot A=A$

$A \cdot \bar{A}=0$

③ OR Law

$A+0=A$

$A+1=1$

$A+A=A$

$A+\bar{A}=1$

④ Commutative law

$A+B=B+A$

$AB=BA$

⑤ Associative Law

$(A+B)+C=A+(B+C)$

$(AB)C=A(BC)$

Combinational Logic System

Boolean Algebra - Fundamental theorems of Boolean algebra

6 Distributive Law

$$A.(B+C) = AB+AC$$

$$\boxed{A + BC = (A+B)(A+C)}$$

7 Absorption Law

$$A + AB = A$$

$$A + AB$$

$$\Rightarrow A(1+B)$$

$$= A \cdot 1$$

$$= A$$

Combinational Logic System

Boolean Algebra - Fundamental theorems of Boolean algebra

8. De Morgan's Th.

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

$$\overline{A+B} = \bar{A} \cdot \bar{B}$$

Break the line, change the sign

9. Duality

- Change all '+' to '.'
- change all '.' to '+'
- Complement all '0' and '1'
- Don't complement the variable.

Ex $A \cdot \bar{A} = 0 \xrightarrow{\text{Duality}} \underline{A + \bar{A} = 1}$

Combinational Logic System

Boolean Algebra - Fundamental theorems of Boolean algebra

Ex Reduce the Boolean exp.

$$Y = A + B\left(AC + (B+\bar{C})D\right)$$

$$= A + BAC + B(B+\bar{C})D$$

$$= A + BAC + BBD + B\bar{C}D$$

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

$$= A(\underline{1+BC}) + BD(\underline{1+\bar{C}})$$

$$\boxed{Y = A + BD}$$