DIGITAL SYSTEM DESIGN

UNIT 1 : LOGIC SIMPLIFICATION AND COMBINATIONAL LOGIC DESIGN

Today's Target

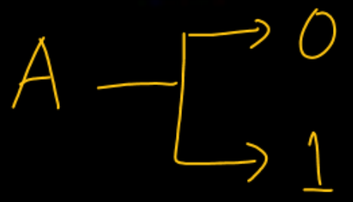
- Boolean Algebra Rules
- Boolean Algebra Law
- De-Morgan's Theorem
- Simplification Numerical
- DPP
- AKTU University Question

BOOLEAN ALGEBRA

- used to analyze and simplify the digital (logic) circuits
- uses only the binary numbers i.e. 0 and 1
- called as **Binary Algebra** or **logical Algebra**
- invented by **George Boole** in 1854

Rule in Boolean Algebra

- Variable used can have only two values.



- Binary 1 = HIGH and Binary 0 = LOW.
- Complement of a variable is represented by an overbar (-)/(‘). $\bar{A} = A'$
- Thus if B = 0 then B’= 1 and if B = 1 then B’= 0.

$A + B = Y = 1$

- ORing of the variables is represented by a plus (+) sign between them. Ex- A + B
- Logical ANDing of the two or more variable is represented by a dot between them. Ex- A.B.C. or ABC.

Boolean Laws

- There are six types of Boolean Laws.

Addition | Multiplication

1) **Commutative law:** $A+B = B+A$ | $A \cdot B = B \cdot A$

2) **Associative law:** $A(B+C) = AB + AC$

3) **Distributive law:** $A+(B+C) = (A+B)+C$ | $A \cdot (B \cdot C) = (A \cdot B) \cdot C$

4) **AND law:** $A+0 = A$, $A+1 = 1$ | $A+A = A$, $A+\bar{A} = 1$

5) **OR law:** $A \cdot 0 = 0$, $A \cdot 1 = A$ | $A \cdot A = A$, $A \cdot \bar{A} = 0$

6) **INVERSION law:** $\bar{\bar{A}} = A$

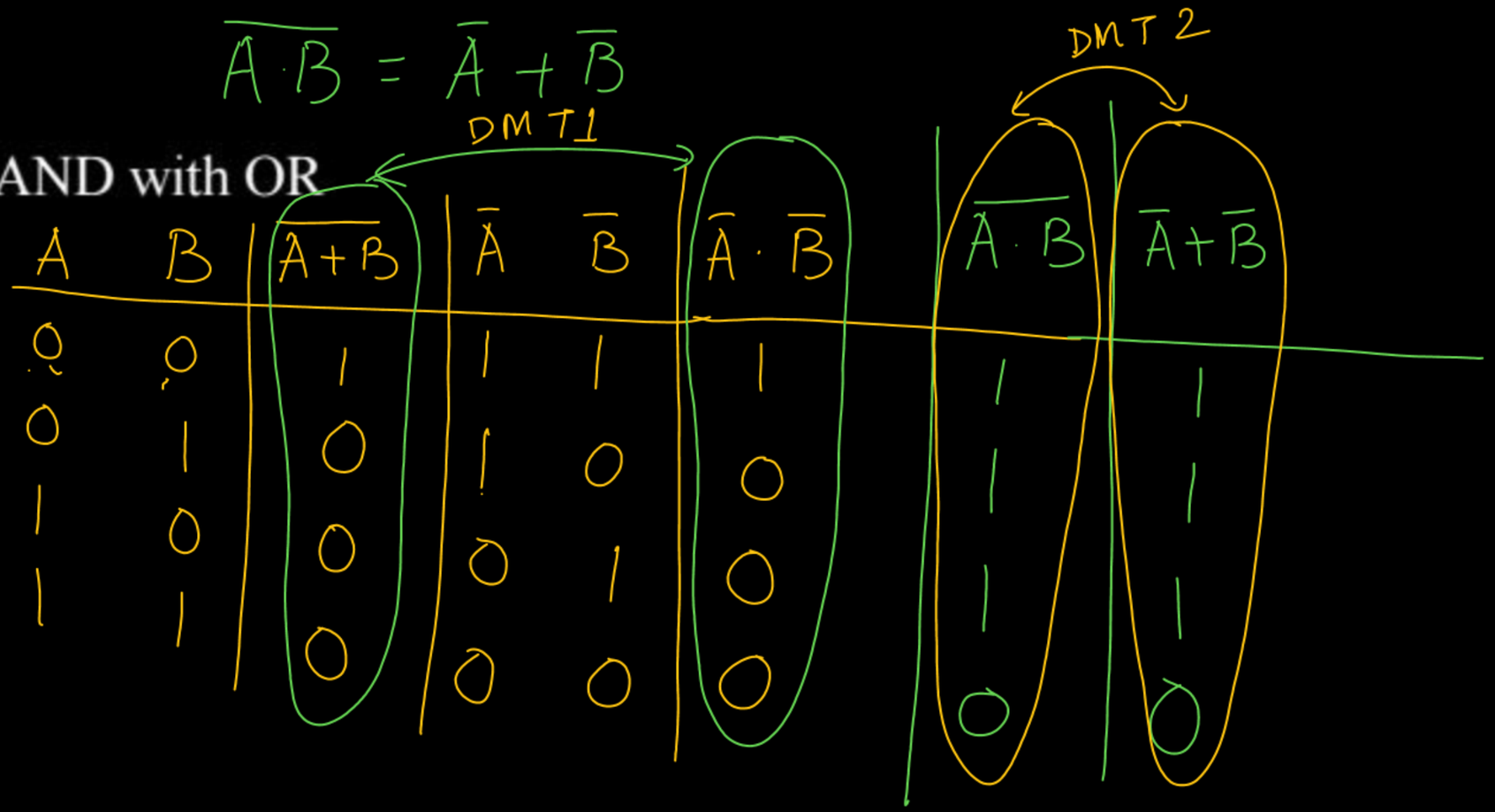
De- Morgan's Theorem

1) $(A+B)' = A'.B'$ ✓ $\quad \overline{A+B} = \bar{A} \cdot \bar{B}$

invert and replace OR with AND

2) $(A.B)' = A' + B'$ $\quad \overline{A \cdot B} = \bar{A} + \bar{B}$

invert and replace AND with OR



Using the above laws, simplify the following expression:
$(A + B)(A + C)$

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

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

$$A \cdot A + A \cdot C + A \cdot B + B \cdot C$$

$$A + AC + AB + BC$$

$$A(1+C) + AB + BC$$

$$A + AB + BC$$

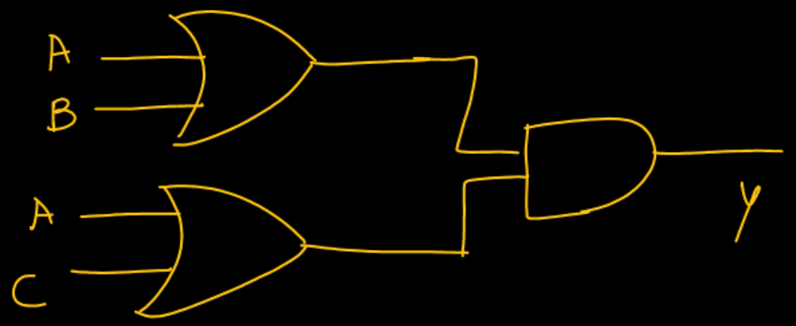
$$A(1+B) + BC$$

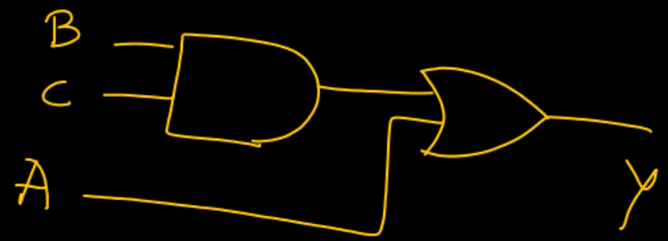
$$A + BC$$

AND Law
$A \cdot A = A$

OR Law
$1 + A = 1$

AND Law
$1 \cdot A = A$





AND



$Y = A \cdot B$

OR



$Y = A + B$

NOT



$\overline{A}$

NAND



$Y = \overline{A \cdot B}$

NOR



$Y = \overline{A + B}$

Ex-OR



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

Ex-NOR



$Y = AB + \bar{A}\,\bar{B}$

Simplify the following expression: C + (BC)'

$C + (\overline{BC})$

$\underline{C} + \bar{B} + \underline{\bar{C}}$

$\underline{1} + \bar{B}$

1

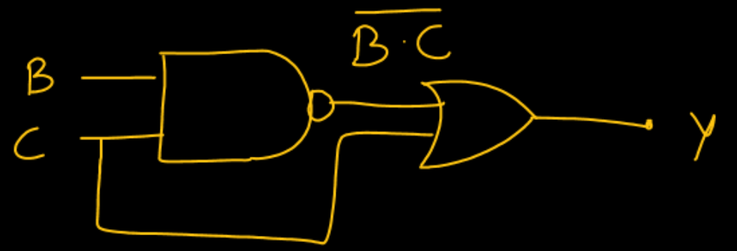
De-Morgan's Th^m

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

OR Law

$A + \bar{A} = 1$

$1 + A = 1$



$Y = 1$

Simplify the following expression: $(AB)'(A' + B)(B' + B)$

$\overline{AB}\,(\bar{A}+B)(B+\bar{B})$

Demorgan's th^{m}

$(\bar{A}+\bar{B})(\bar{A}+B)\,1$

$(\bar{A}+\bar{B})(\bar{A}+B)$

$\bar{A}(\bar{A}+B)+\bar{B}(\bar{A}+B)$

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

$\bar{A}+\bar{A}B+\bar{A}\bar{B}+0$

$\bar{A}(1+B)+\bar{A}B$

$\bar{A}+\bar{A}B$

$\bar{A}(1+B)$

$\bar{A}$



OR law

$A+\bar{A}=1$

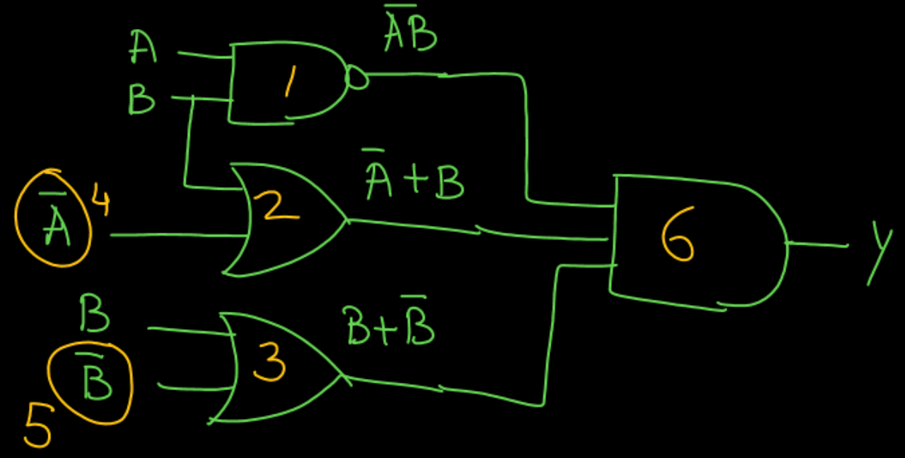
AND law

$1\cdot A=A$

AND law

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

$A+A=A$



Simplify the following expression: (A + C)(AD + AD') + AC + C

$(A+C)(AD+A\bar{D})+AC+C$

$(A+C)(A[D+\bar{D}])+C(A+1)$

$(A+C)(A)+C$

$A\cdot A+AC+C$

$A+AC+C$

$A(1+C)+C$

$A+C$

OR law

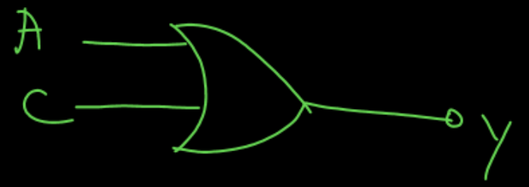
$A+1=1$

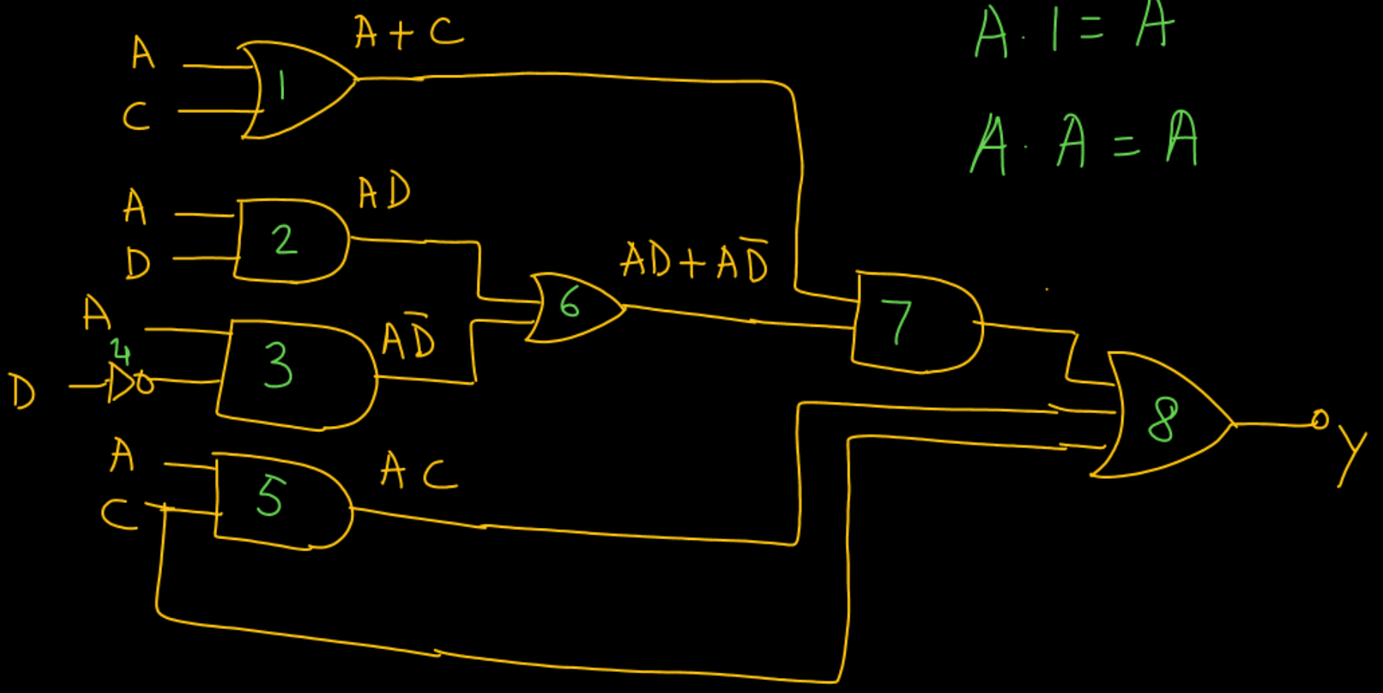
$A+\bar{A}=1$

AND law

$A\cdot 1=A$

$A\cdot A=A$





Simplify the following expression: A'(A + B) + (B + AA)(A + B')

$$\bar{A}(A+B)+(B+AA)(A+\bar{B})$$

$$A\bar{A}+\bar{A}B+(B+A)(A+\bar{B})$$

$$0+\bar{A}B+AB+B\bar{B}+AA+A\bar{B}$$

$$\underline{\bar{A}B+AB}+0+\underline{A+A\bar{B}}$$

$$B(\bar{A}+A)+A(1+\bar{B})$$

$$B(1)+A(1)$$

$$B+A$$

Simplify the following expression: A + B(A + C) + AC

$$A + B(A + C) + AC$$

$$A + AB + BC + AC$$

$$A(1 + B) + BC + AC$$

$$A + BC + AC$$

$$A(1 + C) + BC$$

$$A + BC$$

DPP

Simplify :

a) {(AB)' + C}'B

b) AB + BC(B + C)

c) AB(B'C + AC)

d) (A + B' + C')(A +B' + C)(A + B + C')

Results:

a) ABC'

b) B(A + C)

c) ABC

d) A + (B' C')

UNIVERSITY QUESTIONS

YEAR	QUESTION	MARKS	ANSWER
20-21	State and Prove Demorgan's theorem	10 marks	

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Thank You

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