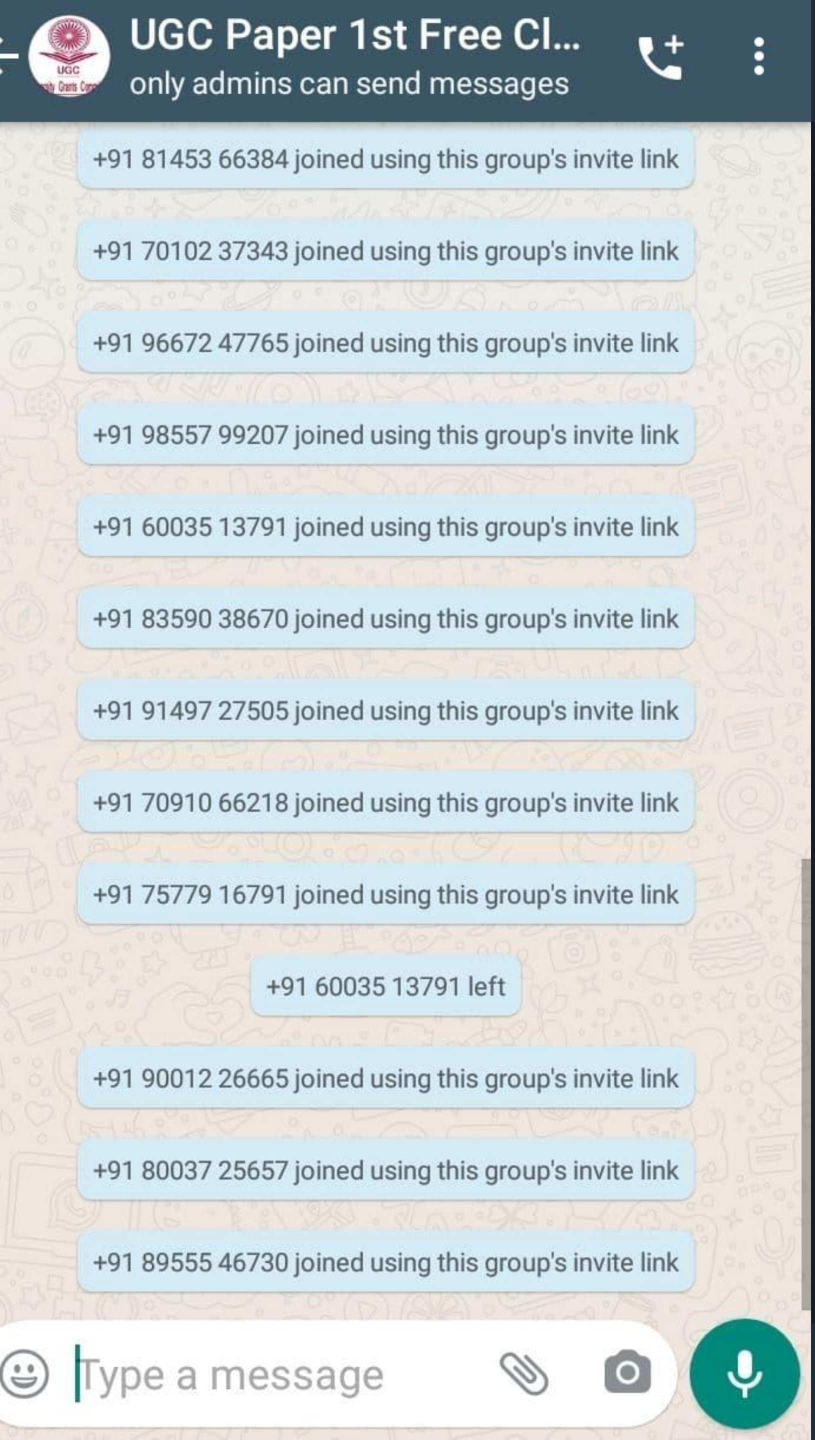
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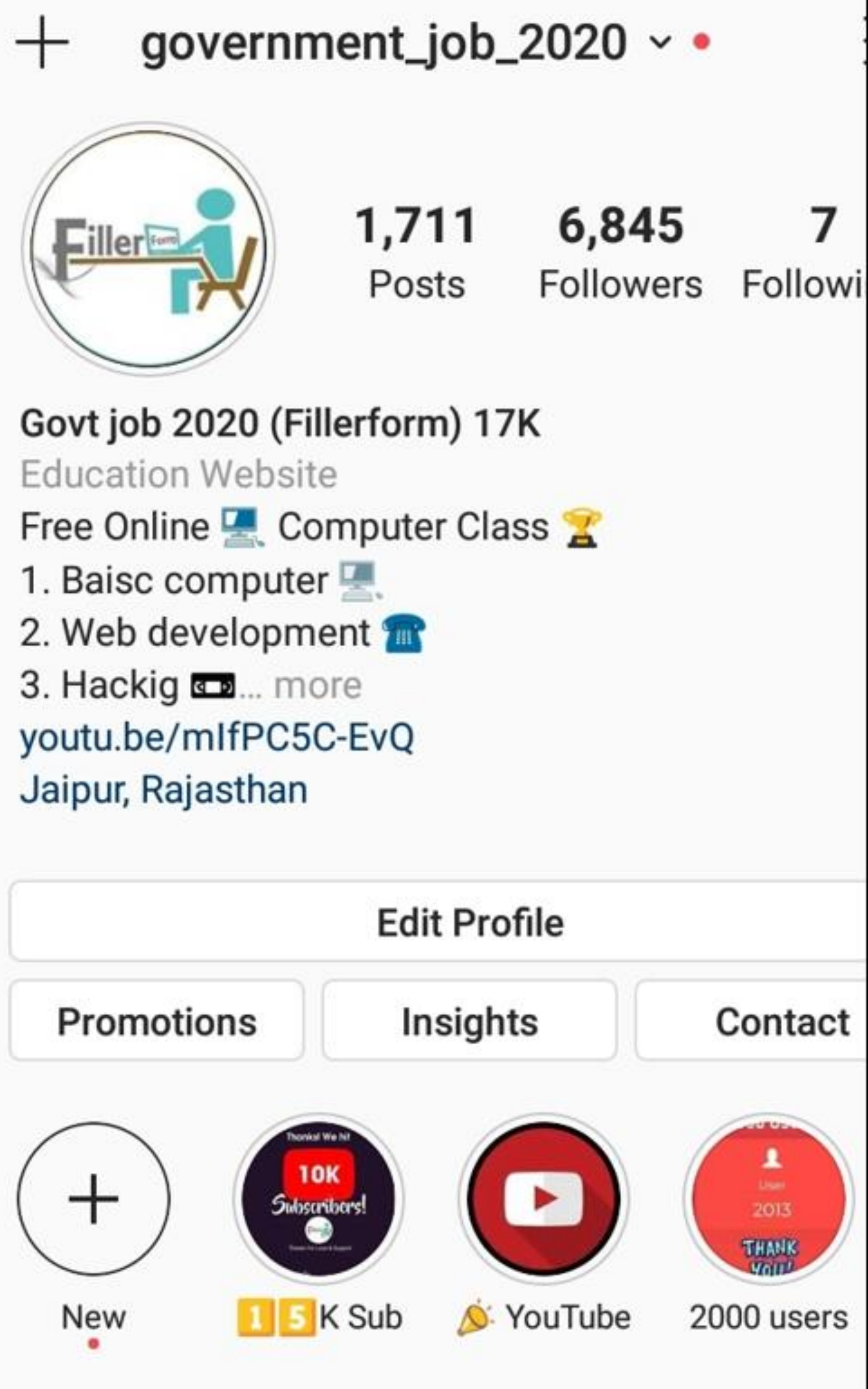
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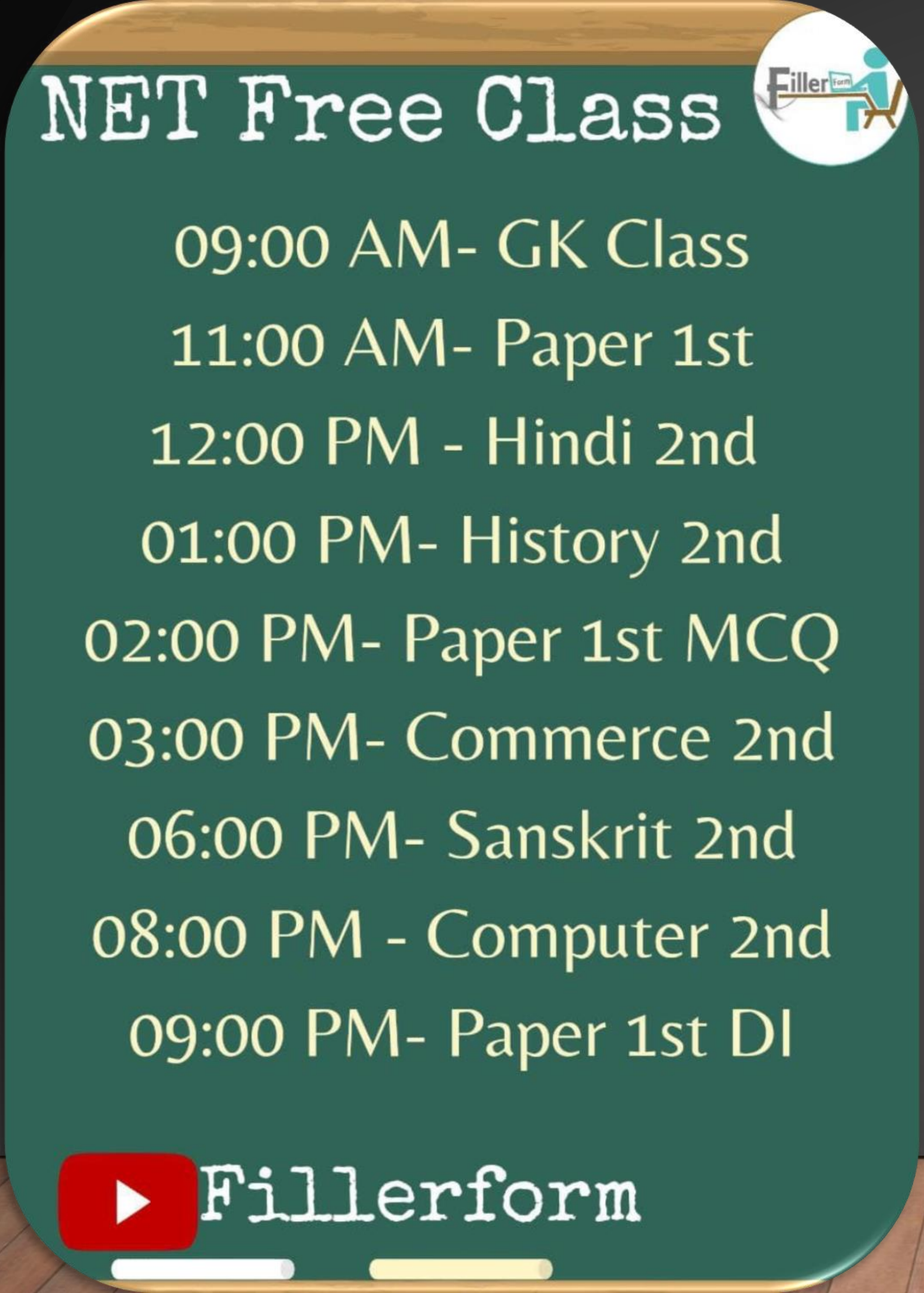
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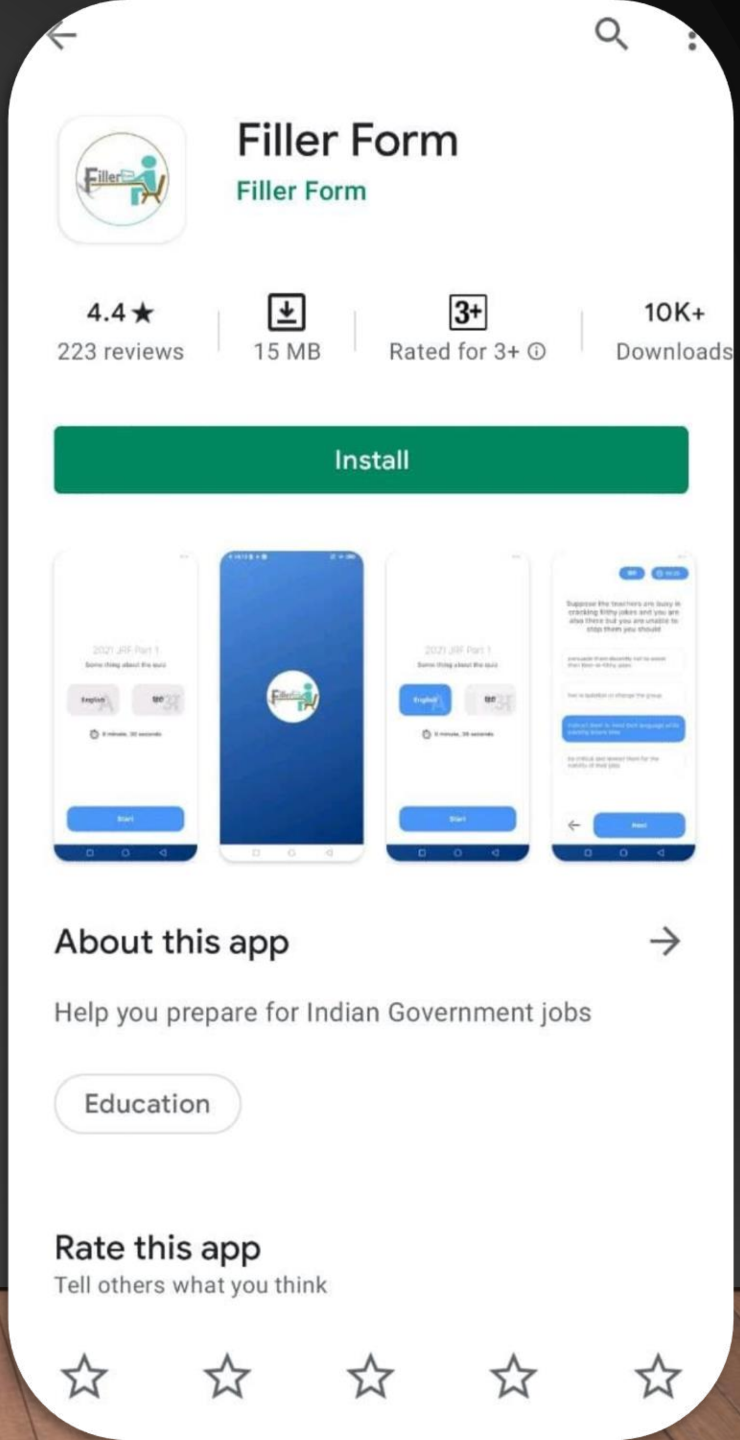
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❑ Discrete Structure and Optimization

Content:

1) Boolean Algebra (part 1)
2) Basic operation
3) Logic gates
4) Duality

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Properties of Boolean Algebra

1. Commutative Properties:

(i)a+b = b+a

(ii)a*b=b *a

2. Distributive Properties

(i) a+(b*c)=(a+b)*(a+c)

(ii)a*(b+c)=(a*b)+(a*c)

3. Identity Properties

(i) a+0=a

(ii) a *1=a

4. Complemented Laws:

(i) a+a'=1

(ii)a * a'=0

Idempotent Laws

(i) $a+b=a$

(ii) $a * a = a$

Absorption Laws

(i) $a+(a*b)=a$

(ii) $a*(a+b)=a$

Boundedness laws

$a + 1 = 1$

$a.0 = 0$

Associative laws:

(a + b) +c = a+(b+c)

(a.b).c =a.(b.c)

Uniqueness of complement:

a + x = 1 and ax = 0, then x = a'

De-Morgan's laws:

(a +b)' = a'.b'

(a.b) = a' +b'

Involution law:

a. a' = a

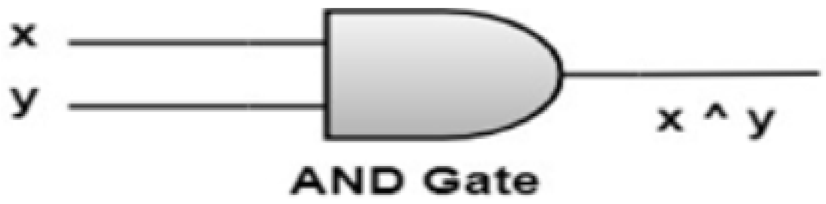
b. 0' = 1

c. 1' =0

Logic Gates and Circuits:

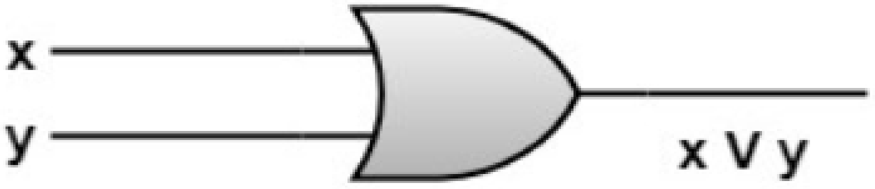
AND Gate: An AND gate receives inputs x and y and produces output denoted x ∧ y, as shown in logic table

x	y	x∧ y
0	0	0
0	1	0
1	0	0
1	1	1



OR Gate: An OR gate receives inputs x and y and produces output denoted x V y as shown in the logic table

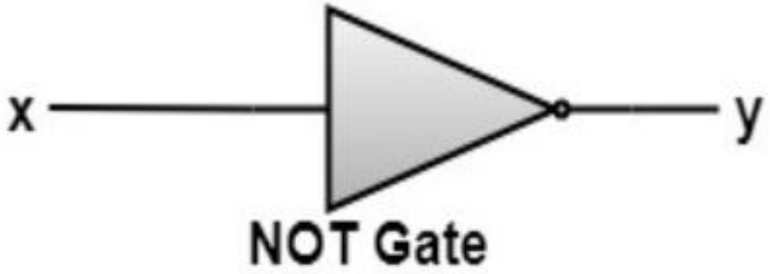
x	y	x∧ y
0	0	0
0	1	1
1	0	1
1	1	1



OR Gate

NOT Gate: A NOT Gate receives input x and produces output y denoted x' as shown in the logic table

x	x'
0	1
1	0

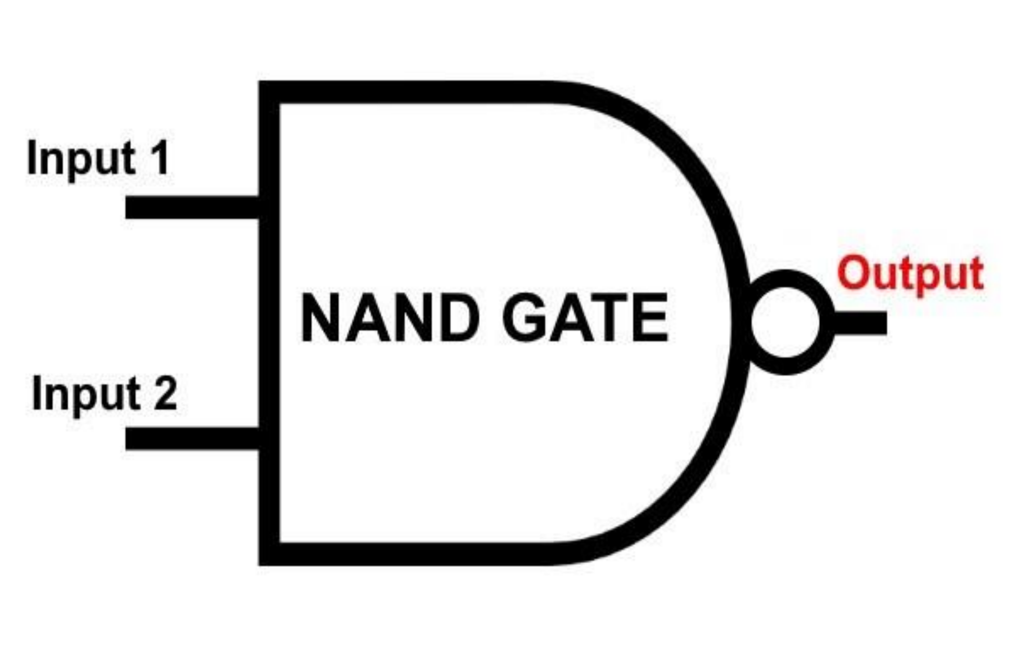


We can interconnect these devices to form an electronic circuit that realizes any given Boolean Expression.

NAND Gate

A NAND gate is a logic gate that gives a low output only if all its inputs are high, otherwise it gives high output.

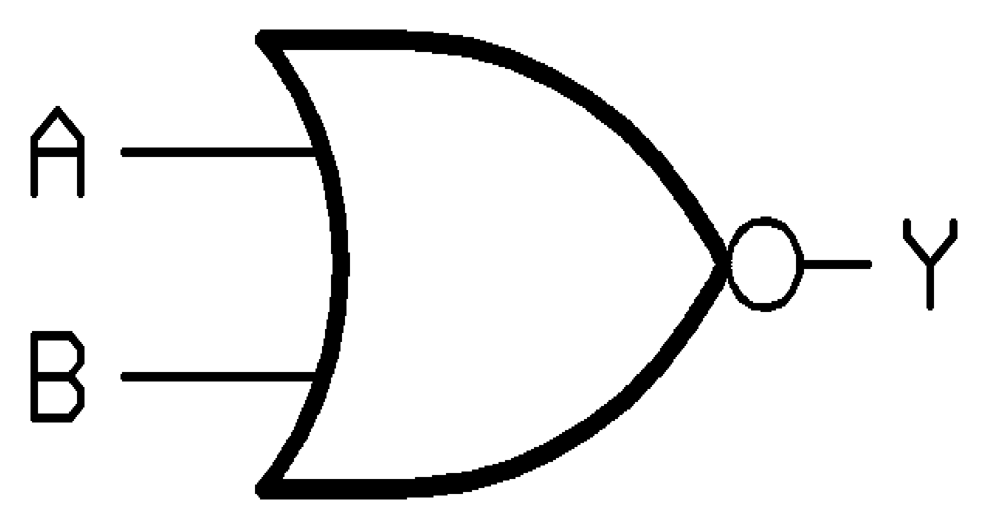
A	B	~(A.B)
0	0	1
0	1	1
1	0	1
1	1	0



NOR Gate

An NOR gate is a logic gate that gives high output if both the inputs are low, otherwise it gives low output.

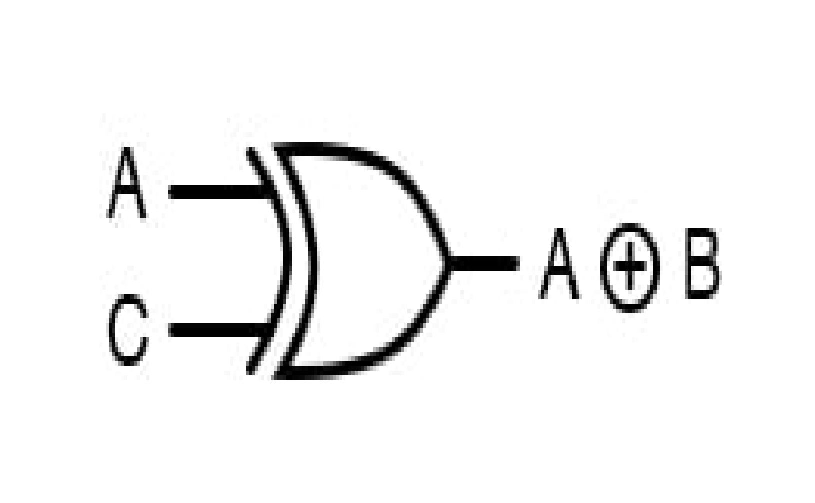
A	B	~(A+B)
0	0	1
0	1	0
1	0	0
1	1	0



XOR (Exclusive OR) Gate

An XOR gate is a logic gate that gives high output if the inputs are different, otherwise it gives low output.

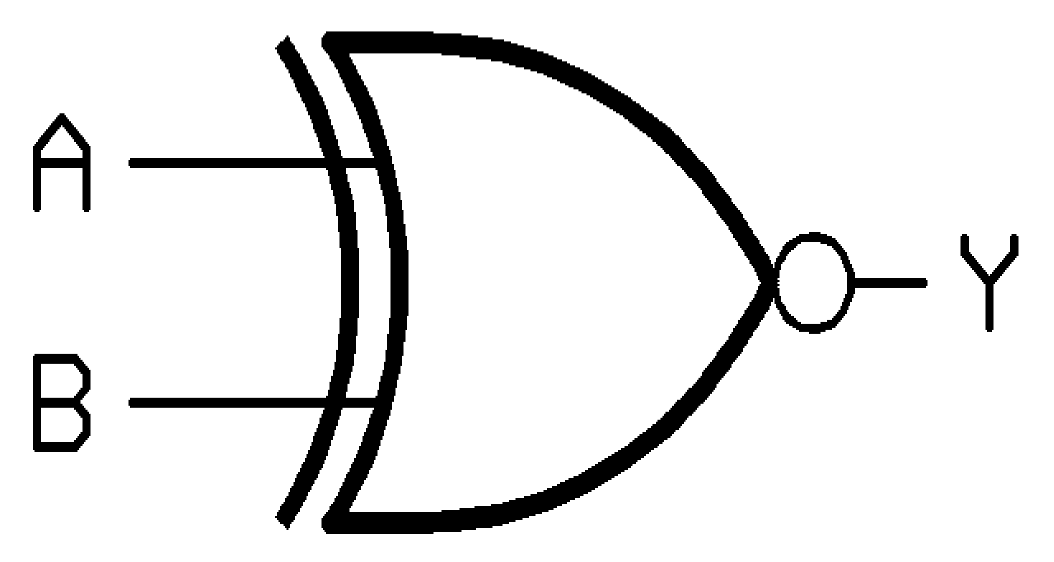
A	B	A⊕B
0	0	0
0	1	1
1	0	1
1	1	0



X-NOR (Exclusive NOR) Gate

An EX-NOR gate is a logic gate that gives high output if the inputs are same, otherwise it gives low output.

A	B	A X-NOR B
0	0	1
0	1	0
1	0	0
1	1	1



Theorems of Boolean Algebra

The following two theorems are used in Boolean algebra.

- Duality theorem
- DeMorgan's theorem

Duality Theorem

This theorem states that the **dual** of the Boolean function is obtained by interchanging the logical AND operator with logical OR operator and zeros with ones. For every Boolean function, there will be a corresponding Dual function.

Let us make the Boolean equations $relations$ that we discussed in the section of Boolean postulates and basic laws into two groups. The following table shows these two groups.

Group1	Group2
x + 0 = x	x.1 = x
x + 1 = 1	x.0 = 0
x + x = x	x.x = x
x + x' = 1	x.x' = 0
x + y = y + x	x.y = y.x
x + $y+z$ = $x+y$ + z	x. $y.z$ = $x.y$ .z
x. $y+z$ = x.y + x.z	x + $y.z$ = $x+y$. $x+z$

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Operator / Variable	Dual
AND	OR
OR	AND
1	0
0	1

REMEMBER THIS

1) 0 WILL BE CHANGE TO 1
2) 1 WILL BE CHANGE TO 0
3) AND WILL BE CHANGE TO OR
4) OR WILL BE CHANGE TO AND

DeMorgan's Theorem

This theorem is useful in finding the **complement of Boolean function**. It states that the complement of logical OR of at least two Boolean variables is equal to the logical AND of each complemented variable.

DeMorgan's theorem with 2 Boolean variables x and y can be represented as

$$x + y\ ' = x'.y'$$

The dual of the above Boolean function is

$$x.y\ ' = x' + y'$$

Therefore, the complement of logical AND of two Boolean variables is equal to the logical OR of each complemented variable. Similarly, we can apply DeMorgan's theorem for more than 2 Boolean variables also.

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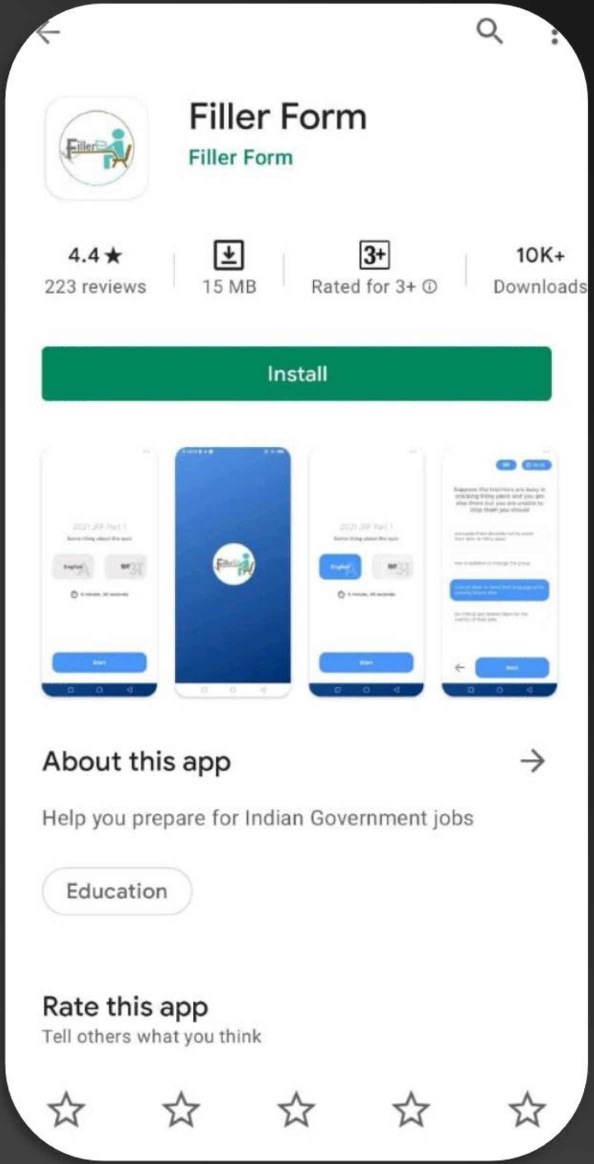


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