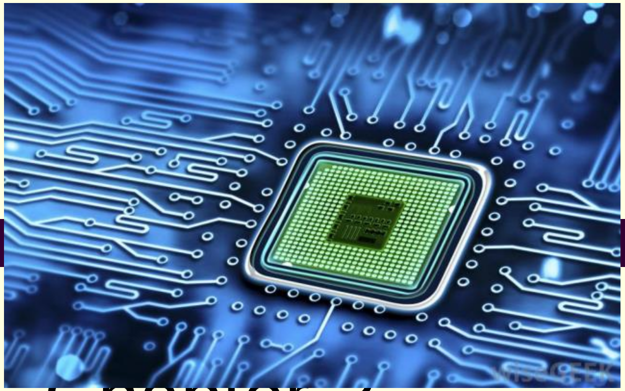
Information and Communication Technology

Class XI-XII



Chapter-3

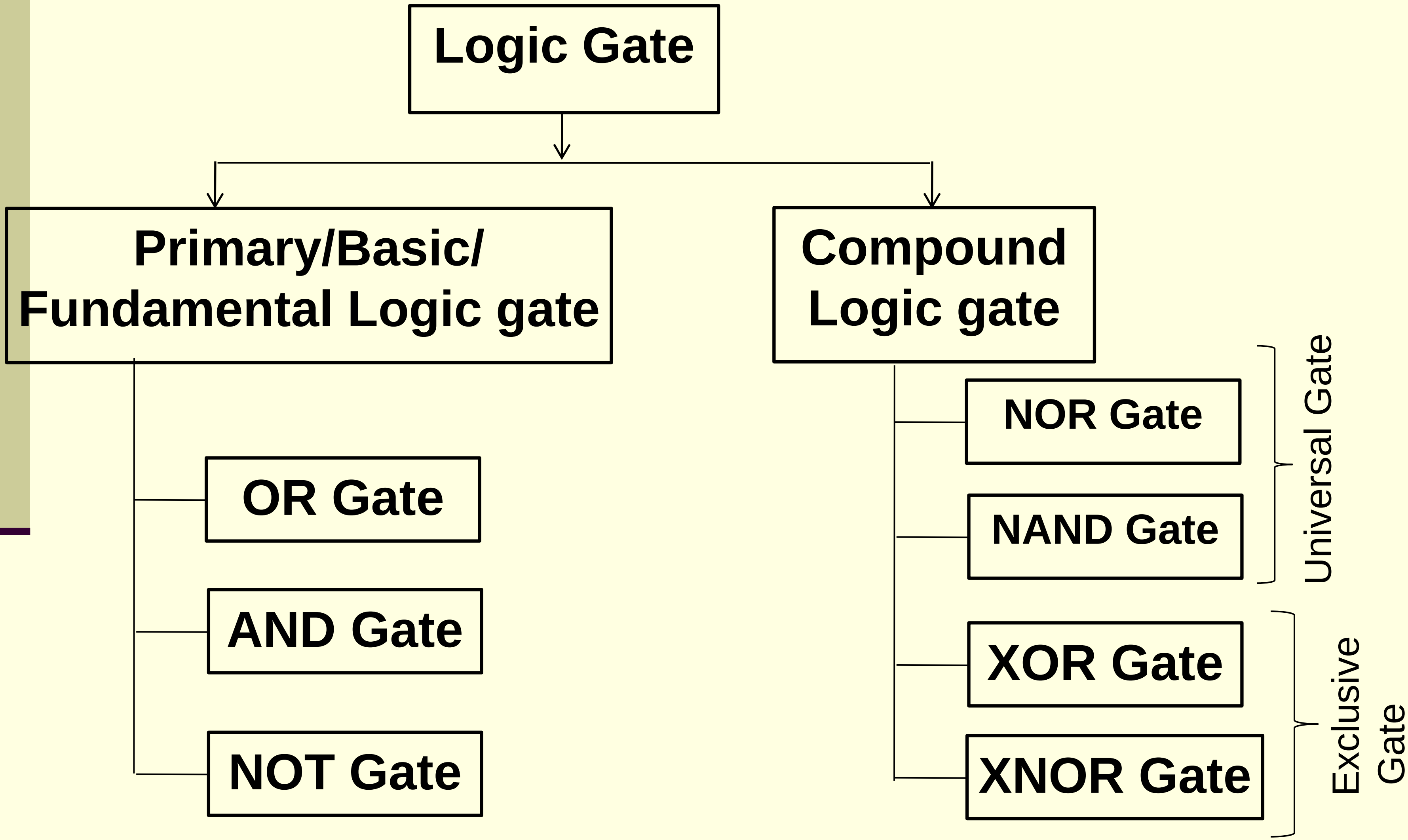
Digital devicer

Logic Gate

- Logic gate is used to implement Boolean algebra practically.

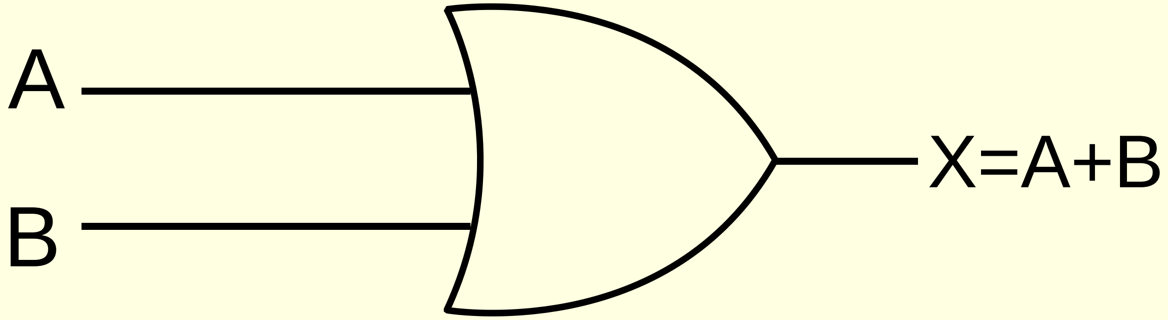
- Takes one or more inputs
- Produce only one output

Types of logic gate:



OR gate (Basic logic gate)

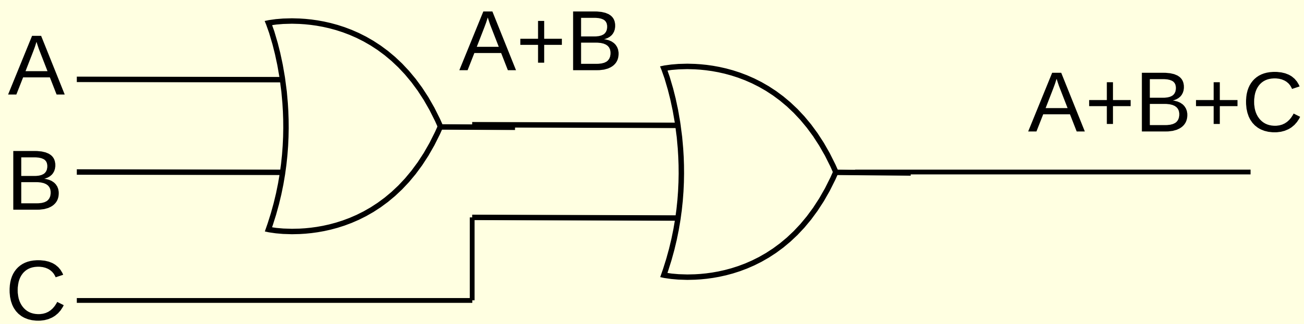
- performs logical addition of Boolean algebra
- A OR B
- =A+B

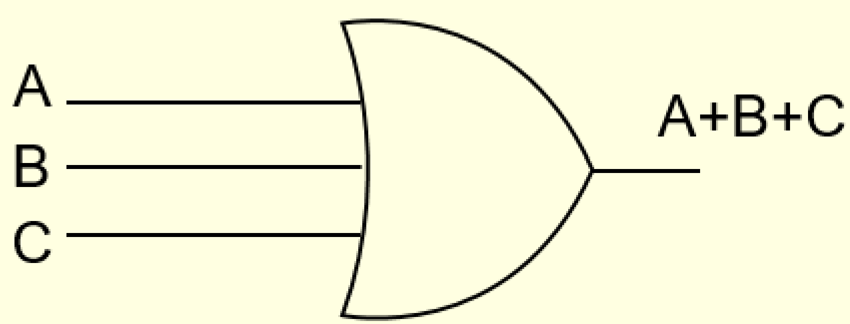


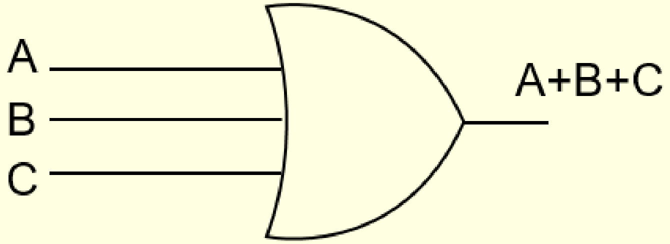
Truth table of OR gate

Input		Output
A	**B**	**X=A+B**
0	0	0
0	1	1
1	0	1
1	1	1

Truth behind 3 input OR gate

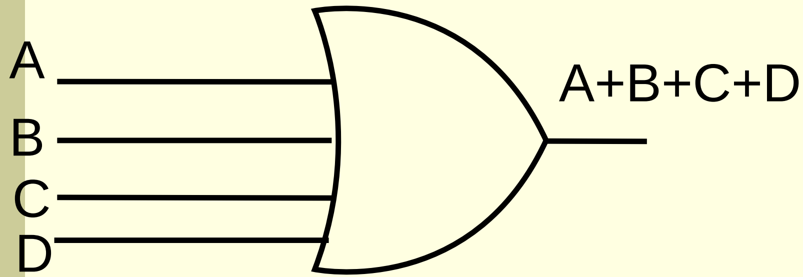


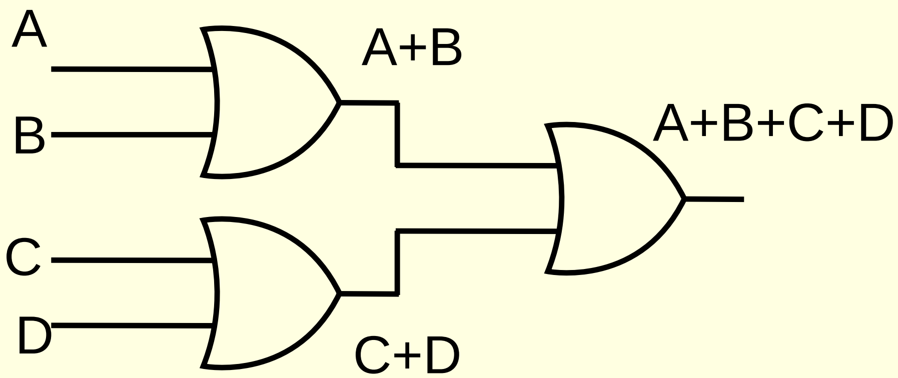




A	B	C	Y=A+B+C
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

4 input OR gate



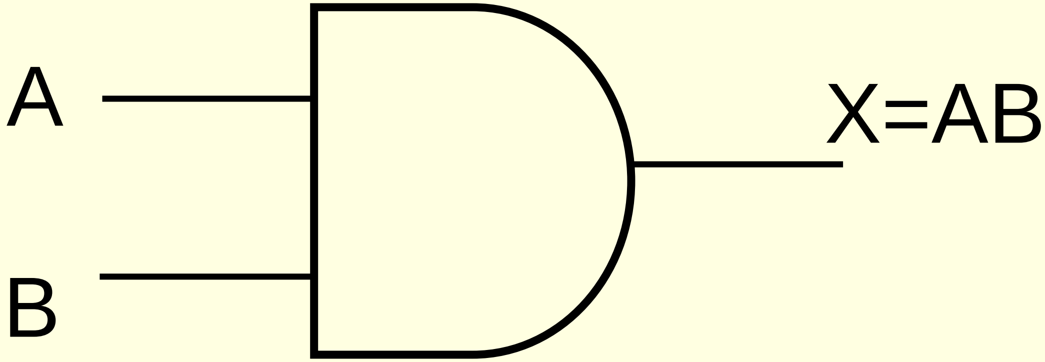


AND gate (Basic Logic gates)

AND gate: performs logical AND (multiplication) of Boolean algebra

A AND B

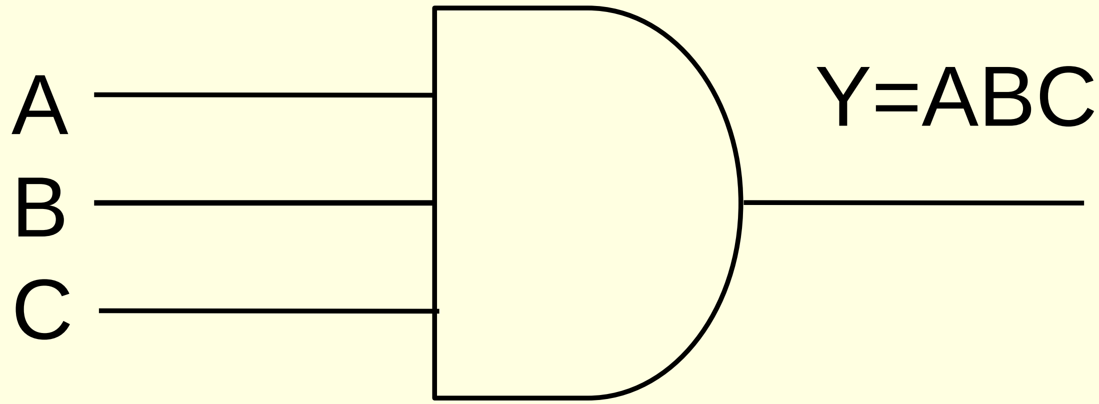
=A.B

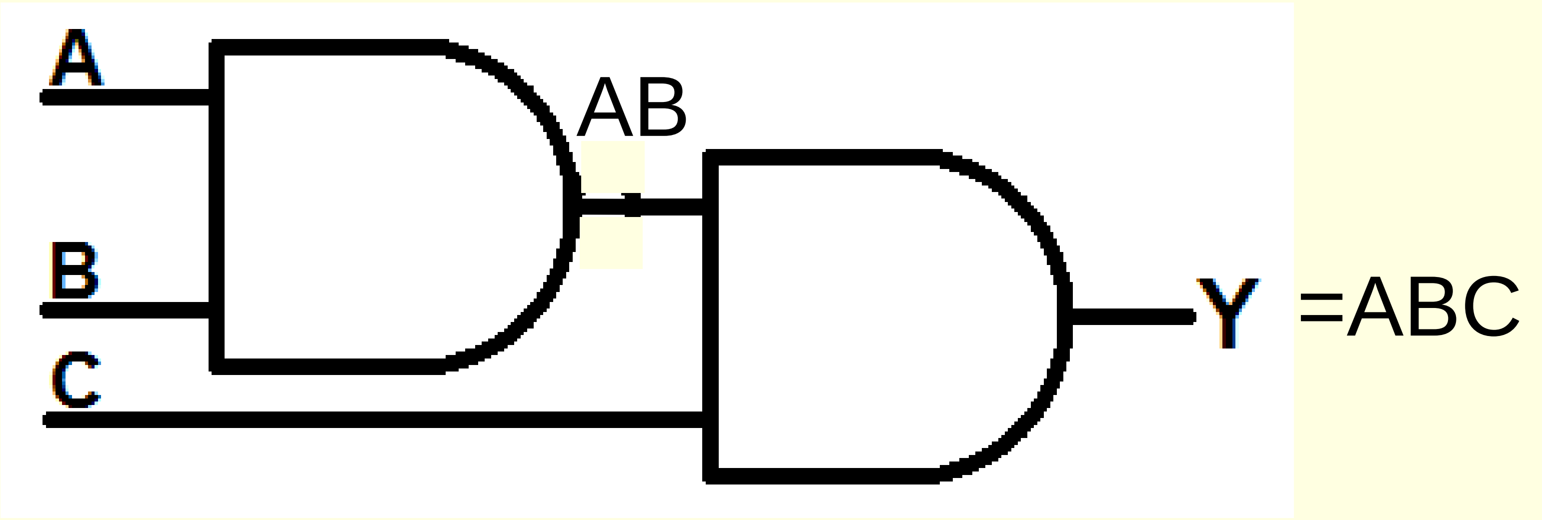


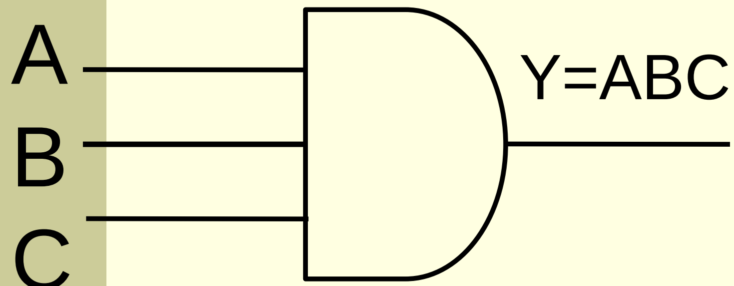
Truth table of AND gate

Input		Output
A	**B**	**X=AB**
0	0	0
0	1	0
1	0	0
1	1	1

3 input AND gate

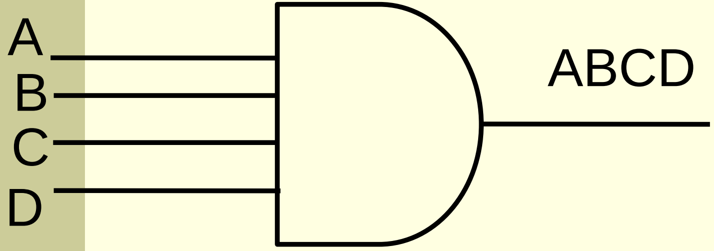


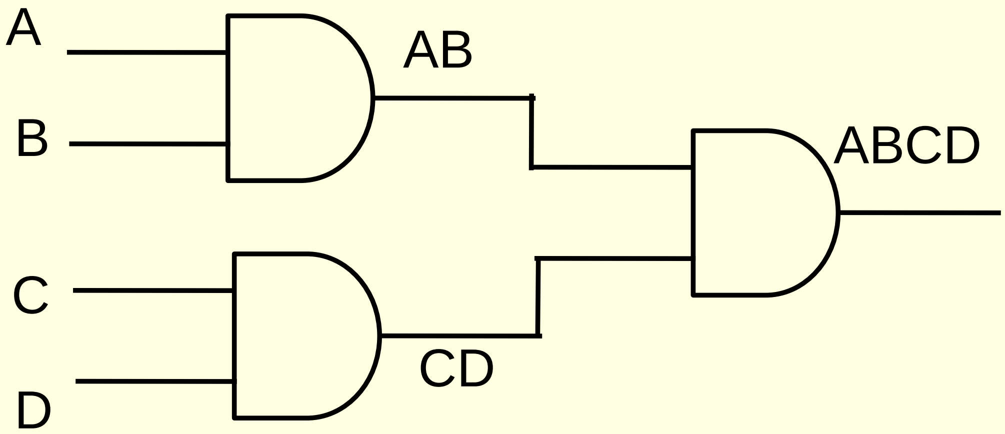




A	B	C	Y=ABC
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

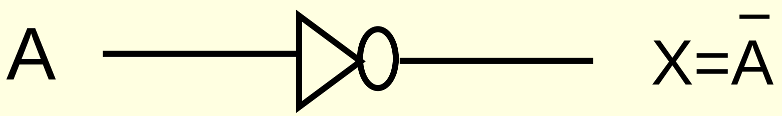
4 input AND gate





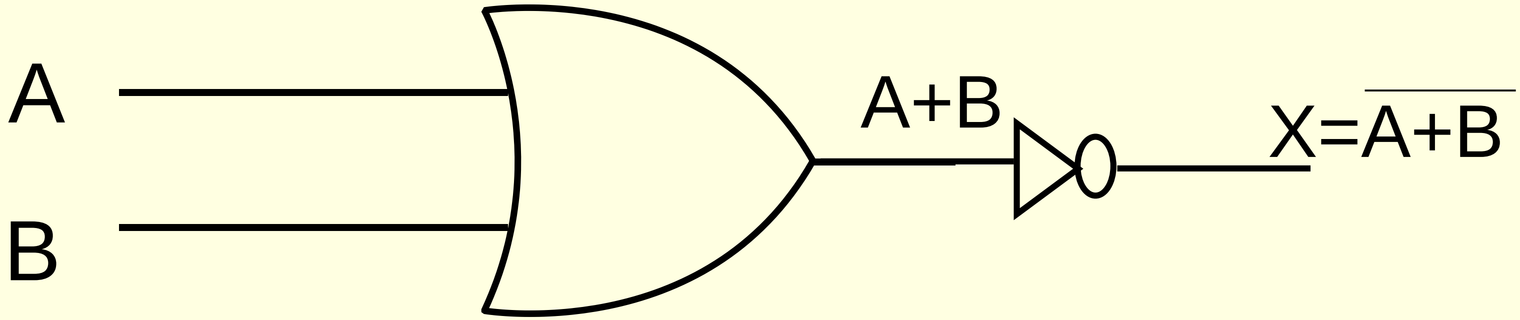
NOT gate

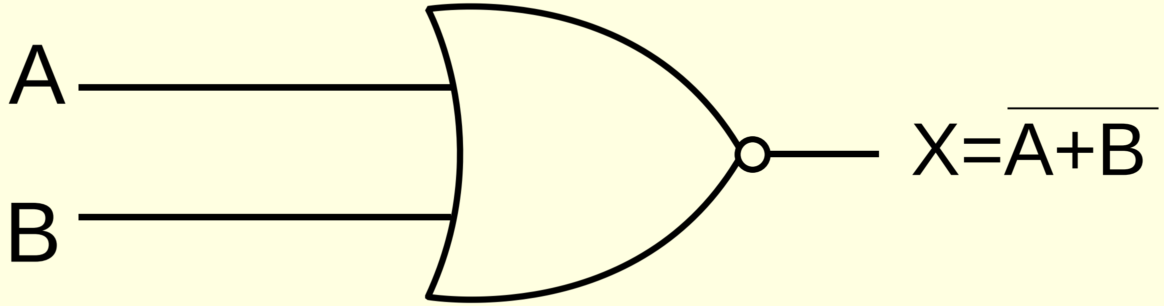
- performs Boolean complement



Input	Output
A	$X=\overline{A}$
0	1
1	0

NOR gate





Truth table of NOR gate

Input			Output
A	B	A+B	$X=\overline{A+B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

Truth table of NOR gate

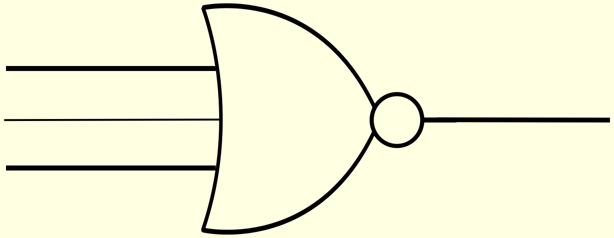
Input		Output
A	B	$X=\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

CQ22

Input		Output
A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

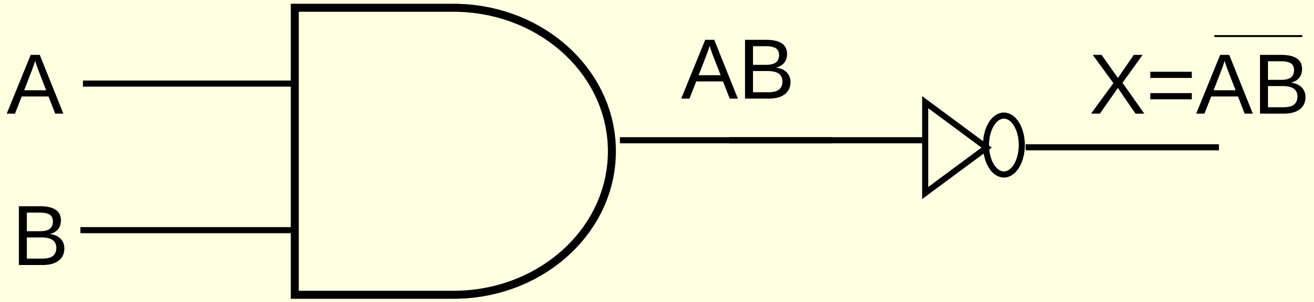
Input	Output
A	X
0	1
1	0

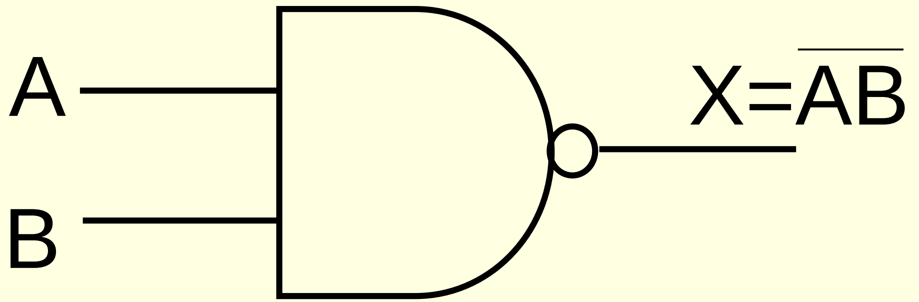
3 input NOR



A	B	C	A+B+C	$\overline{A+B+C}$
0	0	0	0	1
0	0	1	1	0
0	1	0	1	0
0	1	1	1	0
1	0	0	1	0
1	0	1	1	0
1	1	0	1	0
1	1	1	1	0

NAND gate





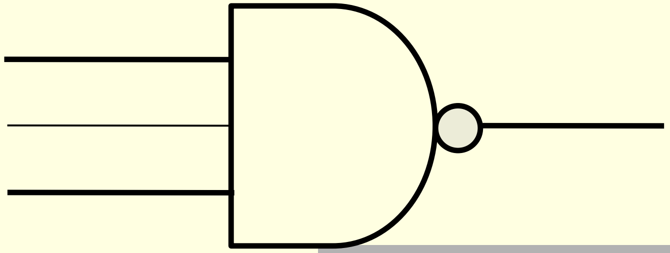
Truth table of NAND gate

Input			Output
A	B	AB	$X=\overline{AB}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

Truth table of NAND gate

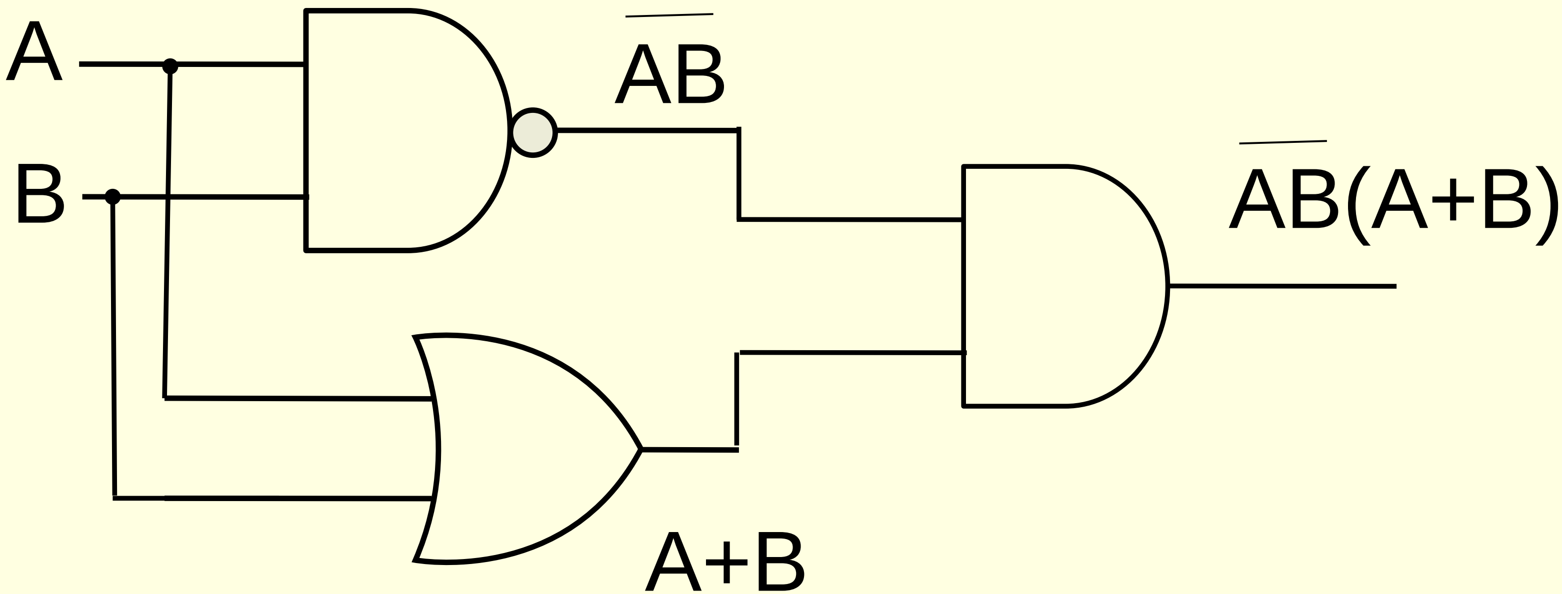
Input		Output
A	B	$X=\overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

3 input NAND

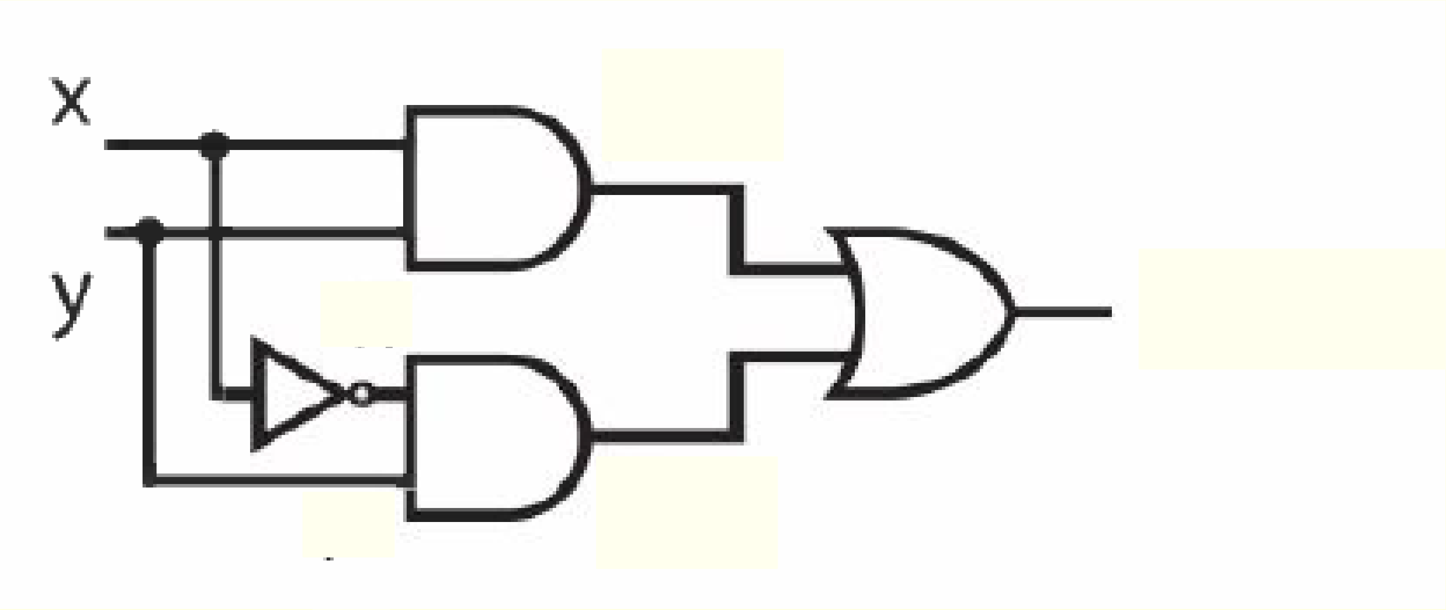


A	B	C	ABC	$\overline{ABC}$
0	0	0	0	1
0	0	1	0	1
0	1	0	0	1
0	1	1	0	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	1	0

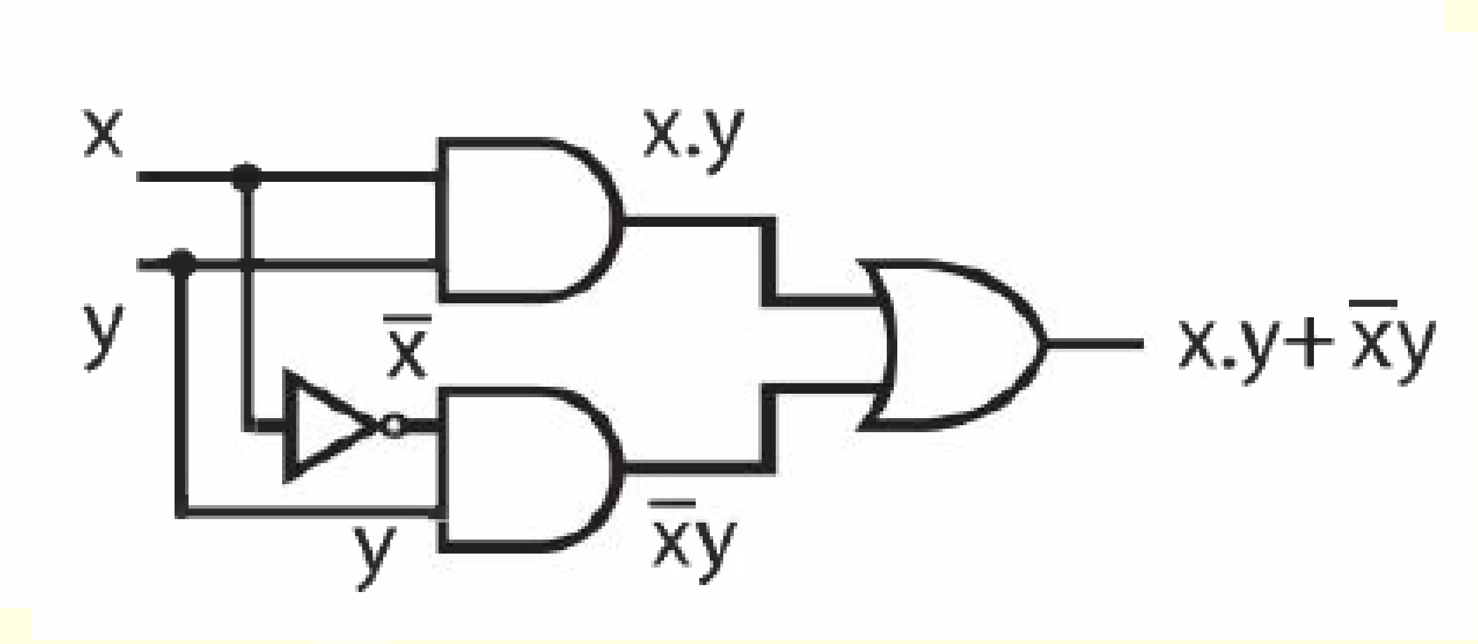
Determine output and simplify



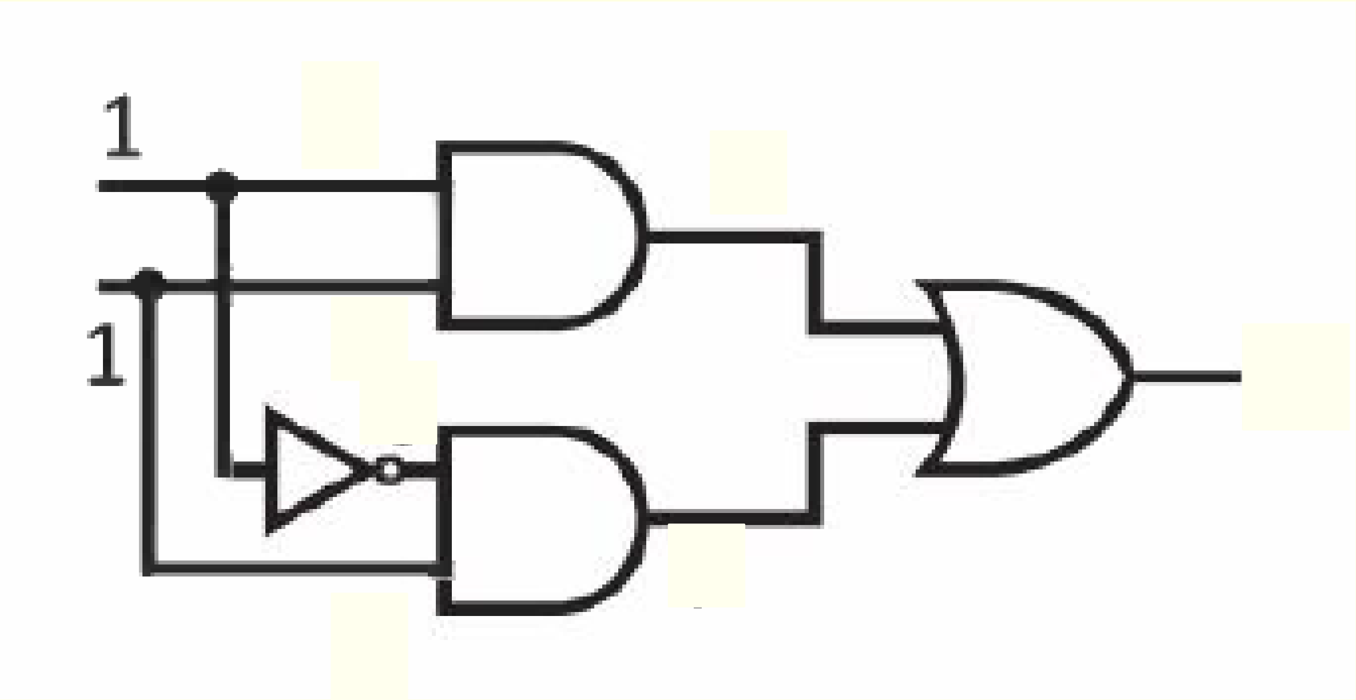
What will be the output if inputs are x and y

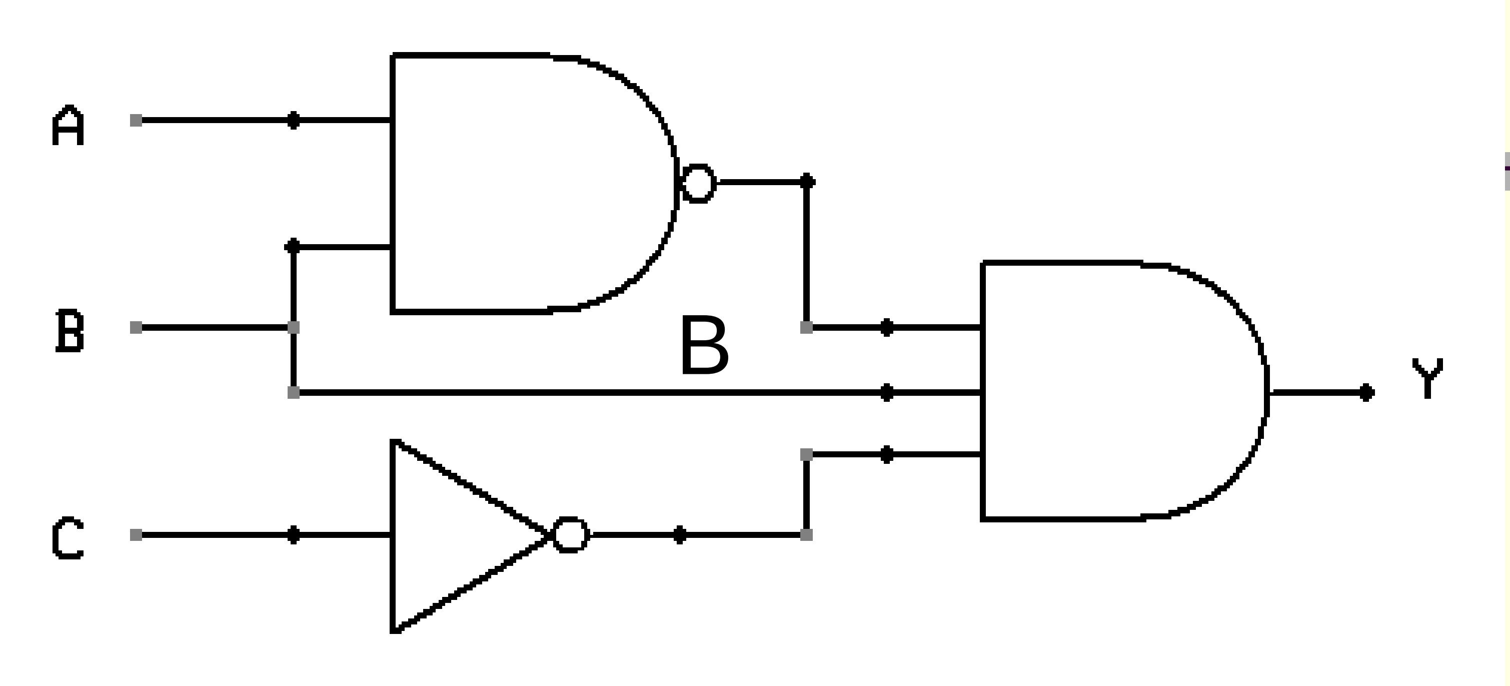


What will be the output if inputs are x and y



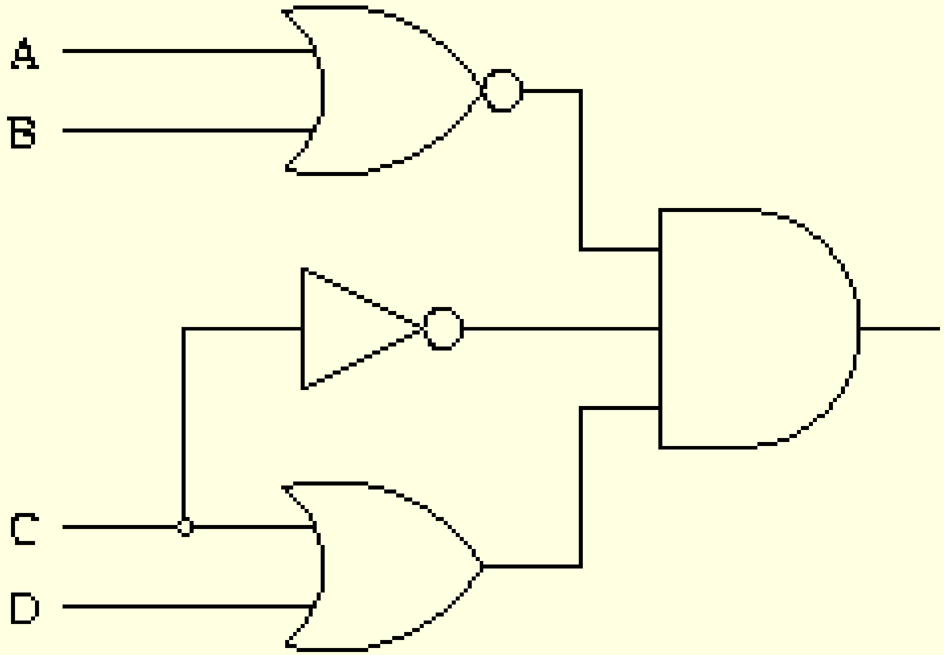
What will be the output if both inputs are 1





OUTPUT? SIMPLIFY

Output ?



Draw Circuit

$$F=\overline{\overline{A}+B}$$

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

$$F=\overline{A}B+A\overline{B}$$

$$F=\overline{A}.\overline{B}+AB$$

$$X=A\overline{B}C+B\overline{C}$$

$$Y=\overline{AB}+\overline{B}.\overline{C}$$

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

$$F=\overline{A\overline{C}B+\overline{B}}$$

$$F=\overline{(\overline{X}Y)\overline{(X\overline{Y})}}$$

$$X=AB+BC+AC$$

M-19

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

fig-1

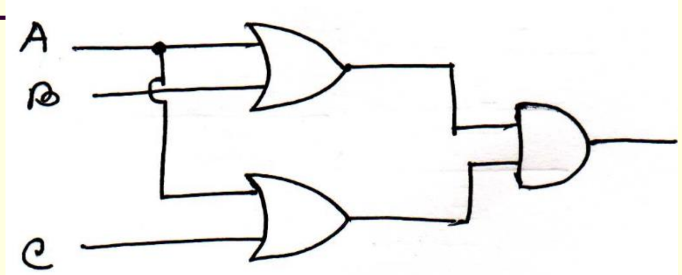
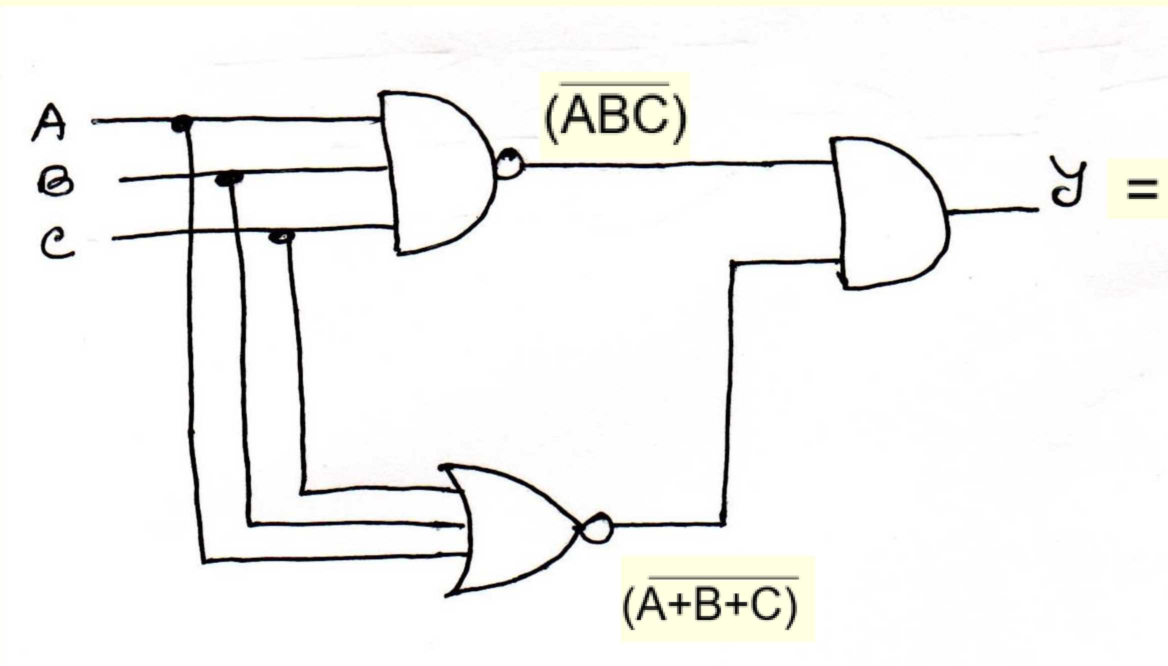


fig-2

- C) Draw circuit for the fig-1
- D) is there any similarity between fig-1 and fig-2

S-19

- Simplify output Y



$= (\overline{ABC})(\overline{A+B+C})$

Stem: Use only **Basic** gates to implement the following circuit also compare after simplification

$$F = \overline{\overline{PQ} + \overline{P}R}$$

$$Y = \overline{A}(\overline{B+C}) + \overline{A}.\overline{B}$$

C) Show that simplification of Y leads to draw easy circuit

D) Truth table of Y. When Y=1 ?

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

- C) Simplify the above expression
- D) if result is 1, what are input values for A,B and C?

d) How it’s possible to implement figure:1 by **minimum** number of **primary** gate. Show the circuit diagram.

$$\overline{AB + \overline{C}} + \overline{B}C$$

$Figure:1$

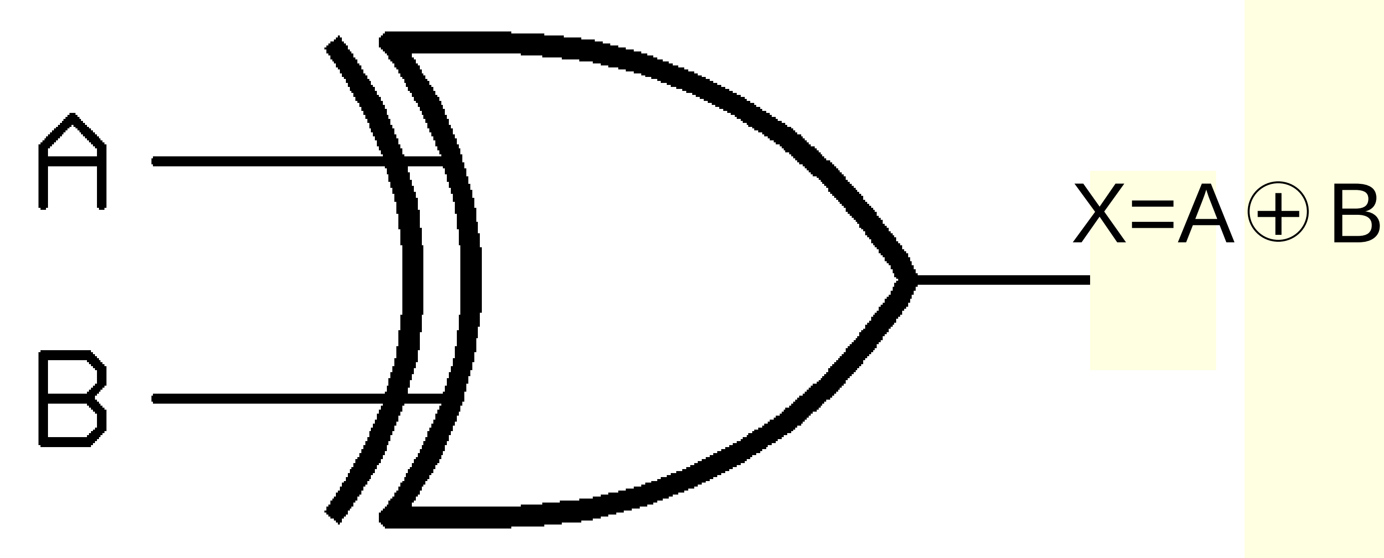
Stem: When F=1 ?

$$F=\overline{\overline{\overline{A}+B}+B+\overline{C}}$$

$\overline{\overline{X}(Y+\overline{Z})}$ draw using only basic gate

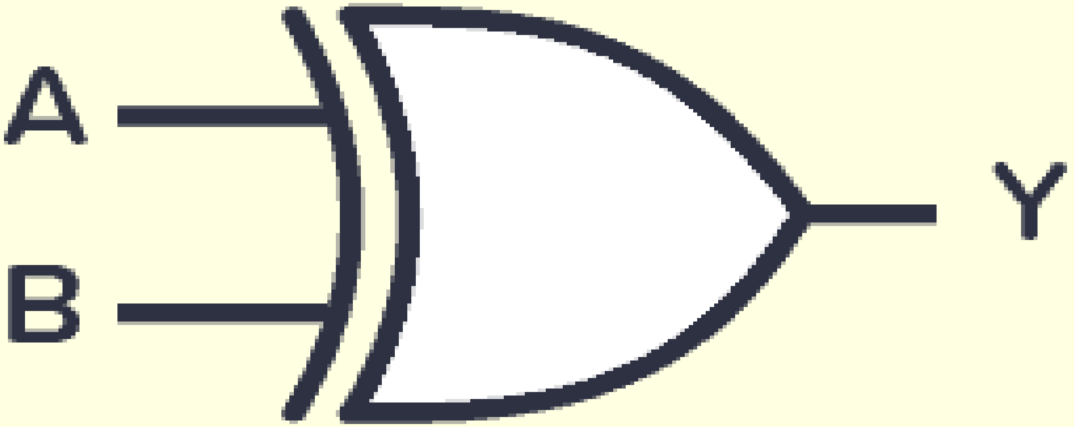
X-OR gate

- (Exclusive OR/Ex-OR)



X-OR gate

- (Exclusive OR/Ex-OR)



Truth table of X-OR gate

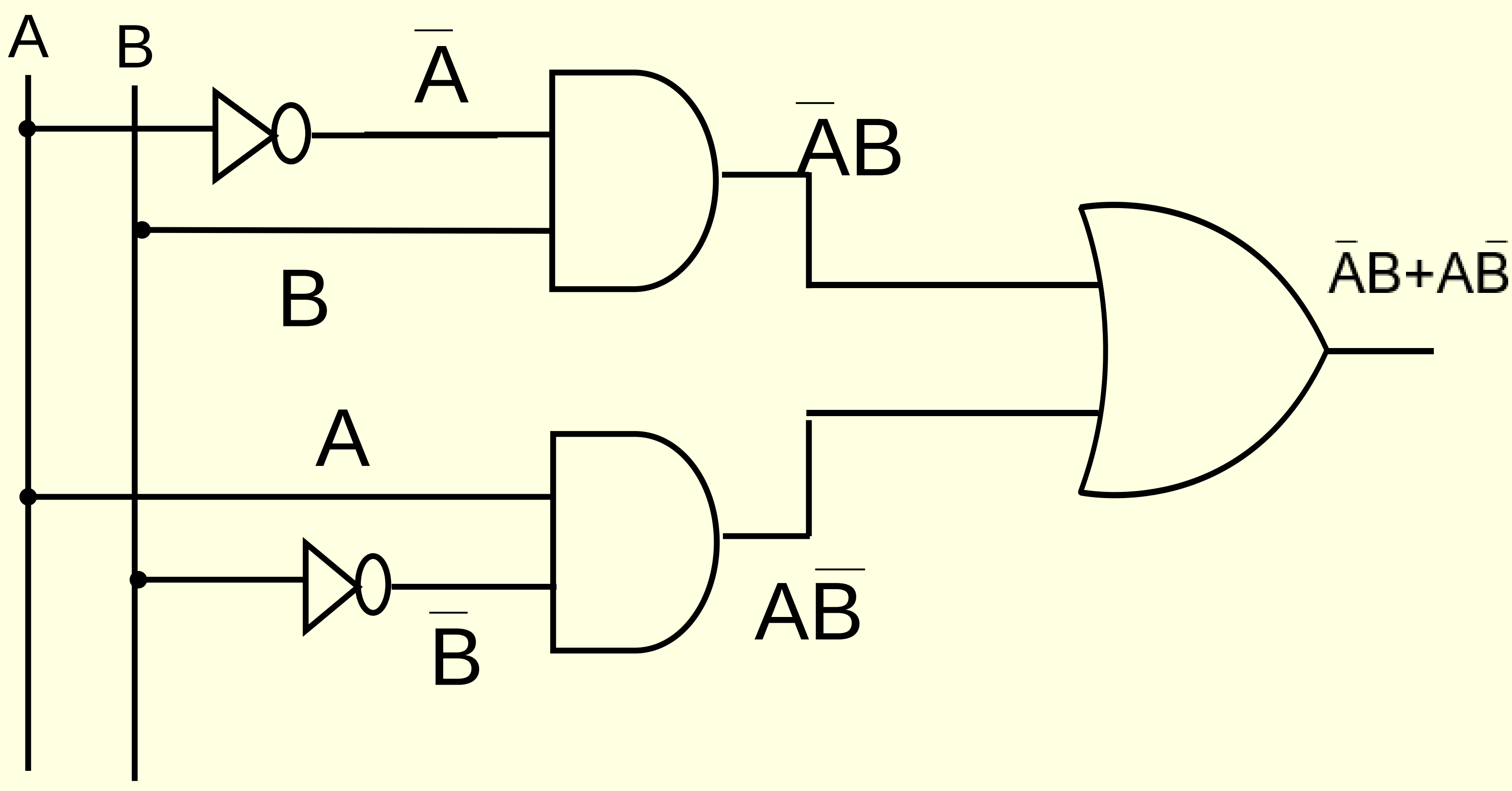
Produce 1 only if both inputs are different to each other

Input		Output
A	B	$X = A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

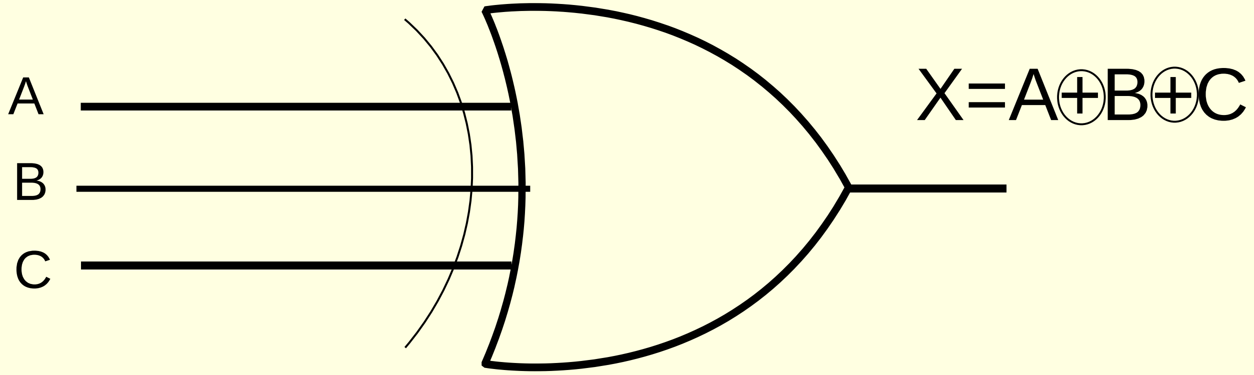
Produce 1 only if there are odd numbers of 1 is present in input. Otherwise produce always 0.

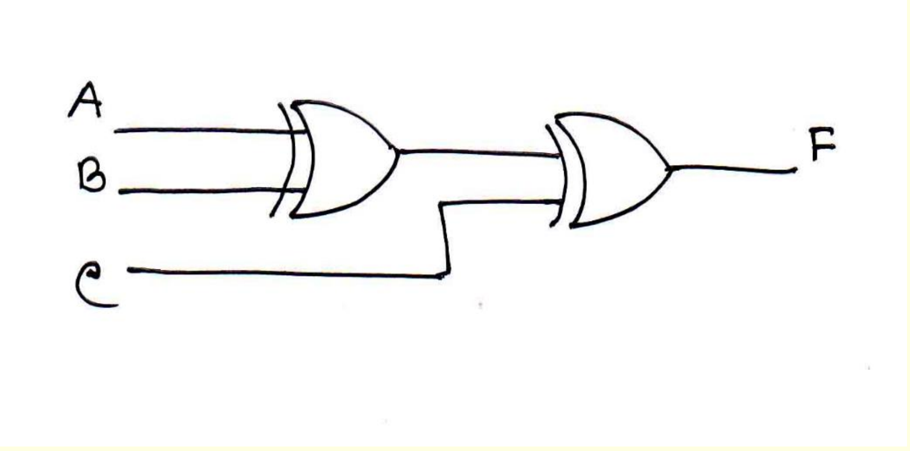
Implement X-OR by basic gate

- $A \oplus B = \bar{A}B + A\bar{B}$



3 input X-OR gate

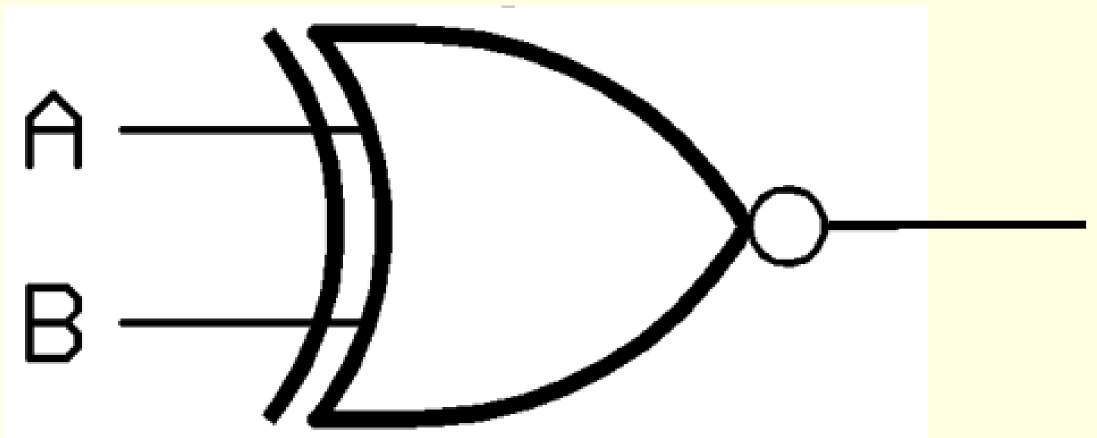




Truth table of a 3 input X-OR gate

Input			Output
A	**B**	**C**	**X**
0	0	0	**0**
0	0	1	**1**
0	1	0	**1**
0	1	1	**0**
1	0	0	**1**
1	0	1	**0**
1	1	0	**0**
1	1	1	**1**

X-NOR



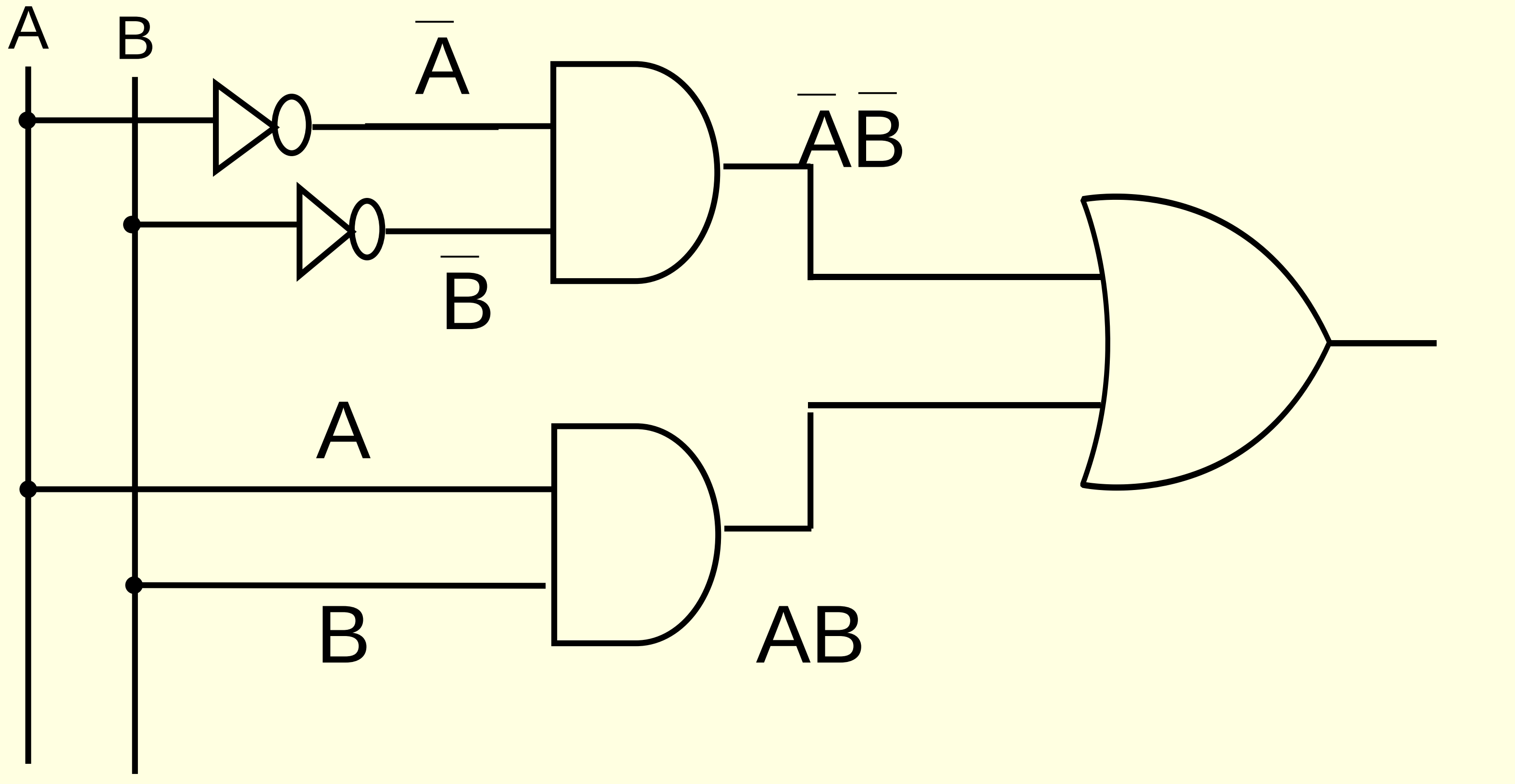
$$X = \overline{A \oplus B}$$

Input			
A	B	$A \oplus B$	$\overline{A \oplus B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

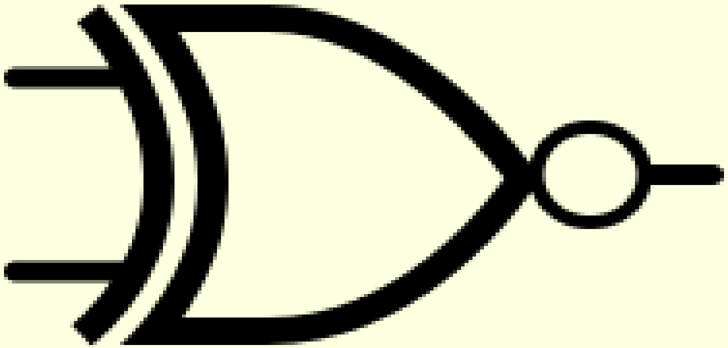
Input		Output
A	B	F
0	0	1
0	1	0
1	0	0
1	1	1

Implement X-NOR by basic gate

- $\overline{A \oplus B} = \overline{A}\,\overline{B} + AB$



Implement the figure by primary gate



Stem: Draw circuit for the TT below

Input		Output	
A	B	X	Y
0	0	1	0
0	1	0	1
1	0	0	1
1	1	0	0

Stem: Draw circuit for the TT below

Input		Output	
A	B	X	Y
0	0	1	1
0	1	0	1
1	0	0	1
1	1	1	0

Define X and simplify
draw circuit for Y by Basic gate

A	B	C	X	Y
0	0	0	**1**	**1**
0	0	1	**0**	**0**
0	1	0	**1**	**0**
0	1	1	**0**	**1**
1	0	0	**1**	**1**
1	0	1	**1**	**0**
1	1	0	**0**	**1**
1	1	1	**1**	**0**

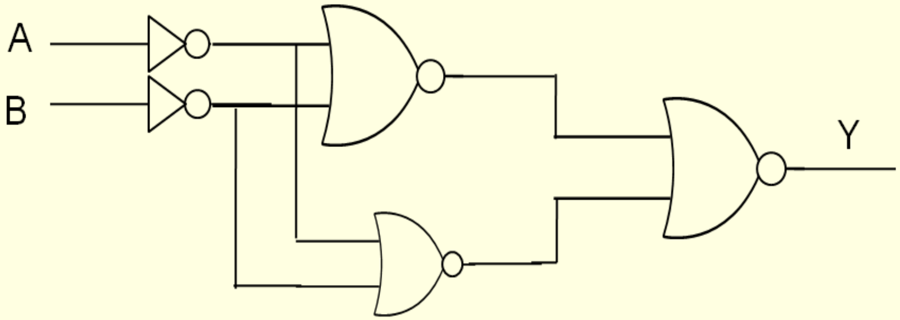
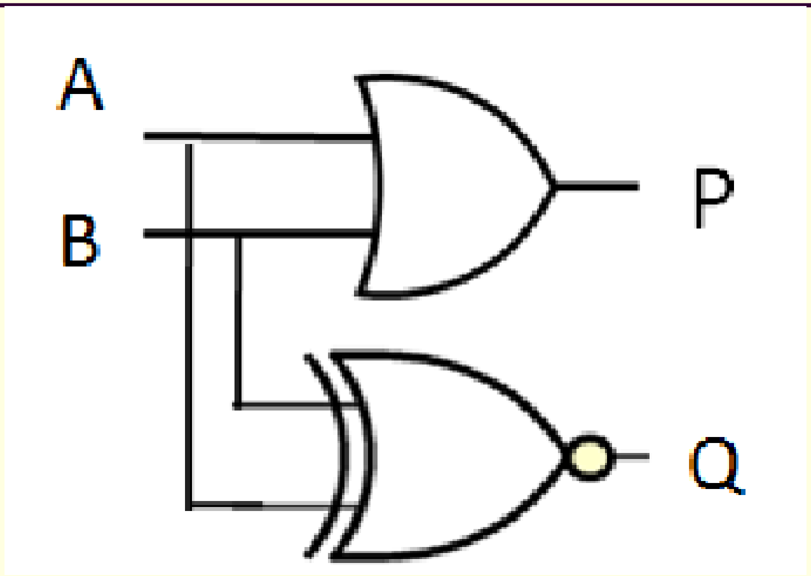


Figure-1

Fig-2		
P	**Q**	**X**
0	0	0
0	1	0
1	0	0
1	1	1

- C) in fig-1 , what is simplified value of Y=?
- d)Compare the gate of fig-2 with the output of fig-1



C) Draw a Truth Table for P and Q

D) proof PQ=AB by Boolean simplification

Stem: Out put of fig2 replaces the input A of Fig 1. then analyze the simplified logic circuit.

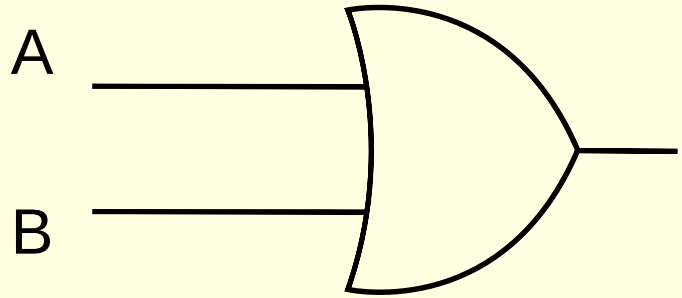


Fig1

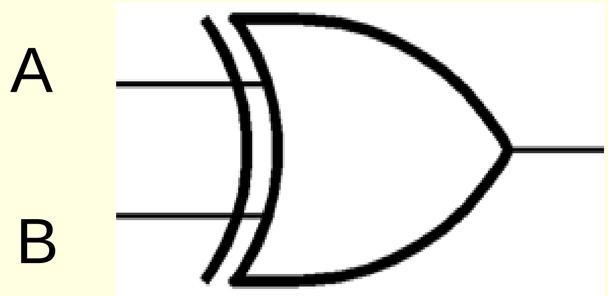
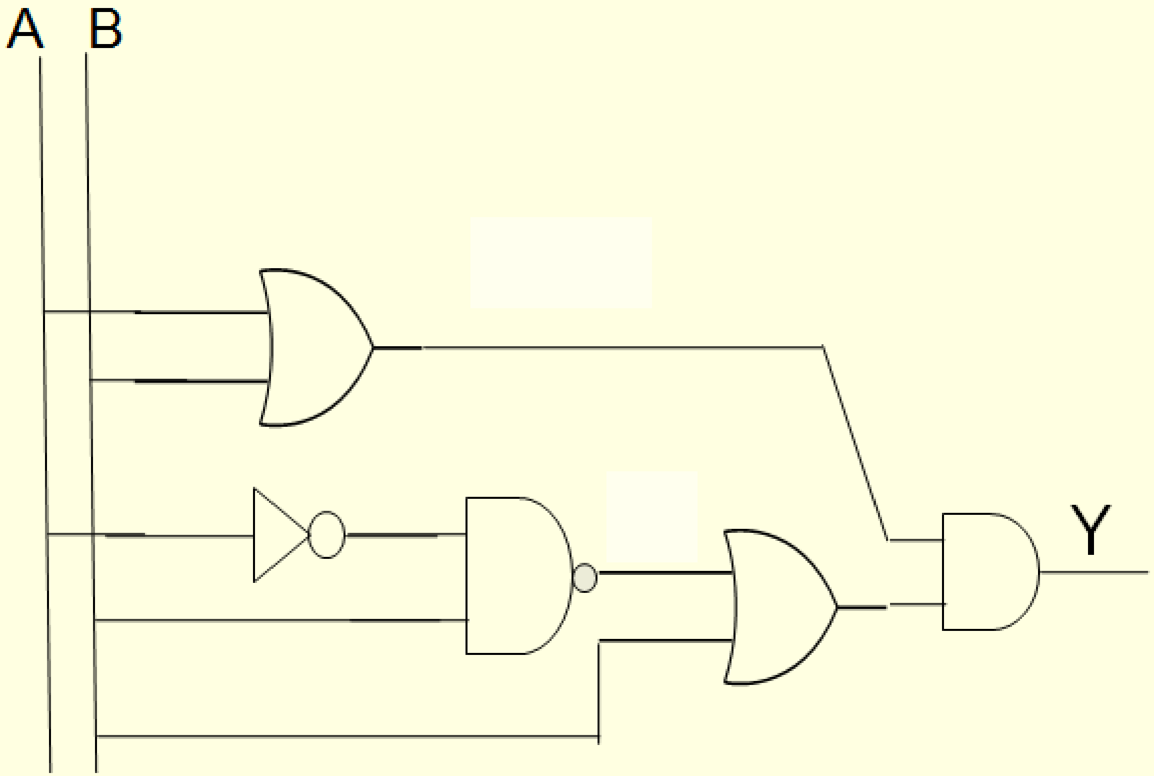


Fig2

C) Simplify Y

d) Compare R and Y



P	Q	R
0	0	1
0	1	0
1	0	0
1	1	0

Stem $F = A + \bar{A}B$

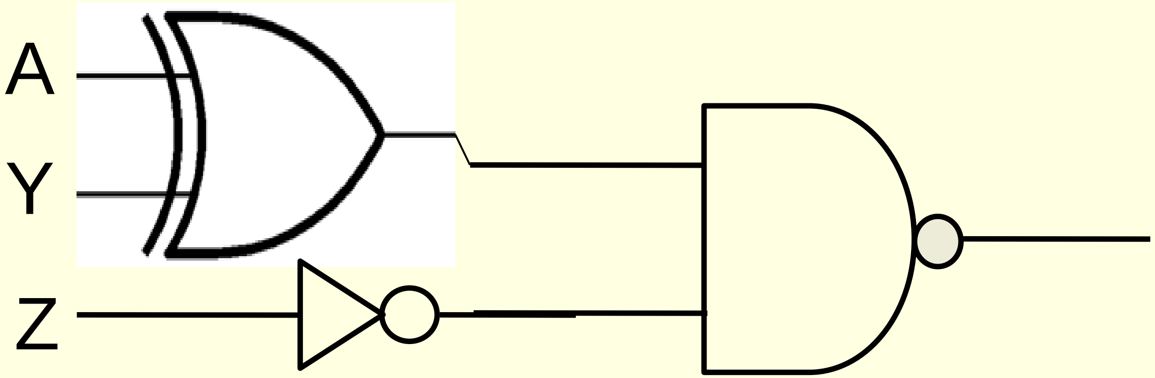
C) Draw TT for this expression

D) TT belongs to which basic gate

$$Y = \overline{P + \overline{Q}(\overline{P} + Q)} + PQ + \overline{Q}R$$

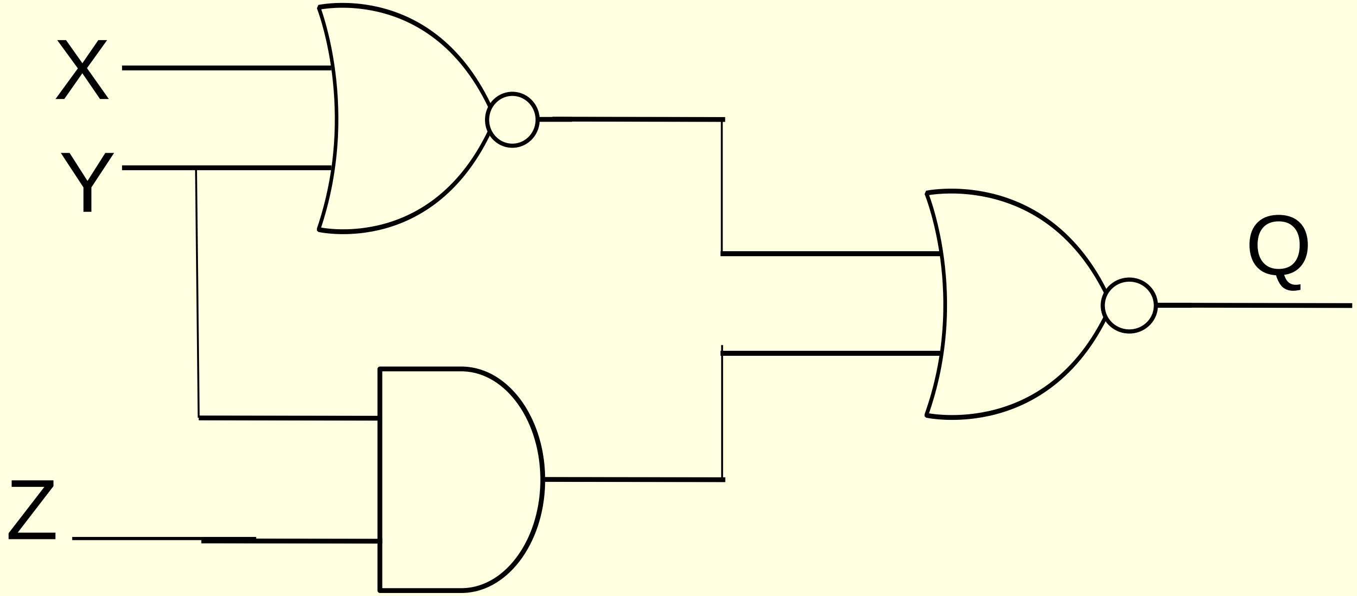
- (c) Simplify Y and draw the logic circuit of the simplified value of Y
- (d) For which values of P, Q and R, the value of Y will be 1? Analyze.

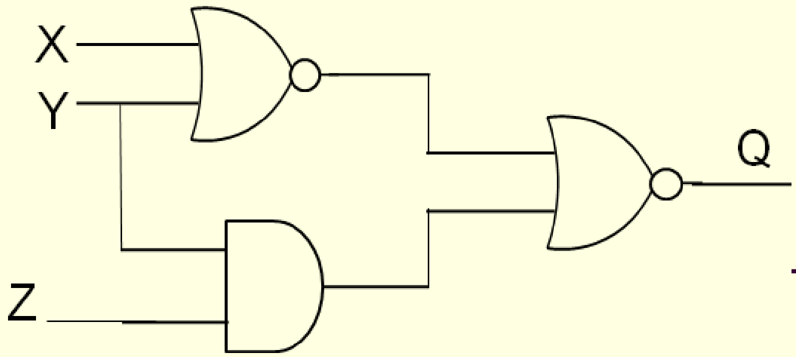
Simply the result and draw circuit by Primary gates only



c) Draw Truth Table for Q,

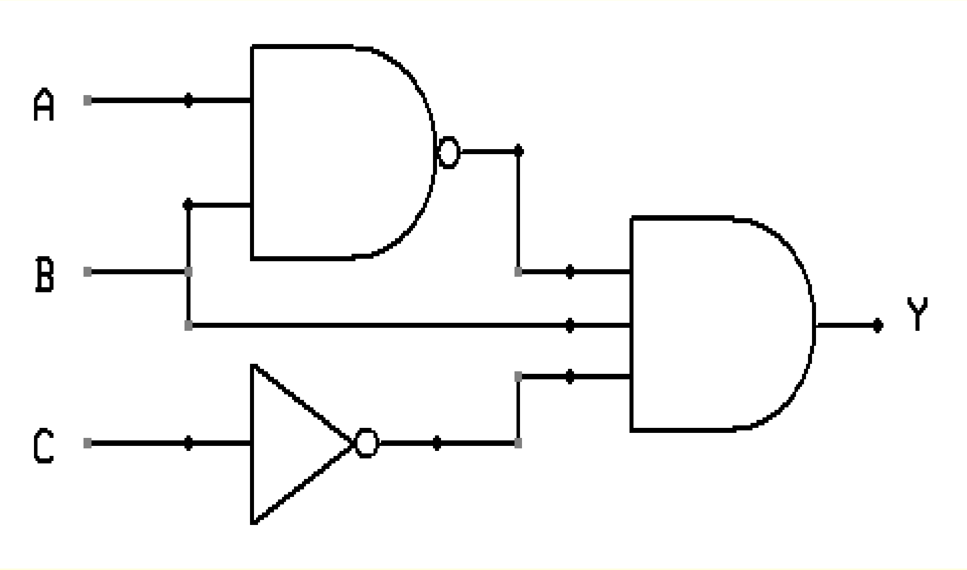
d) is it possible to implement Q by a single gate?





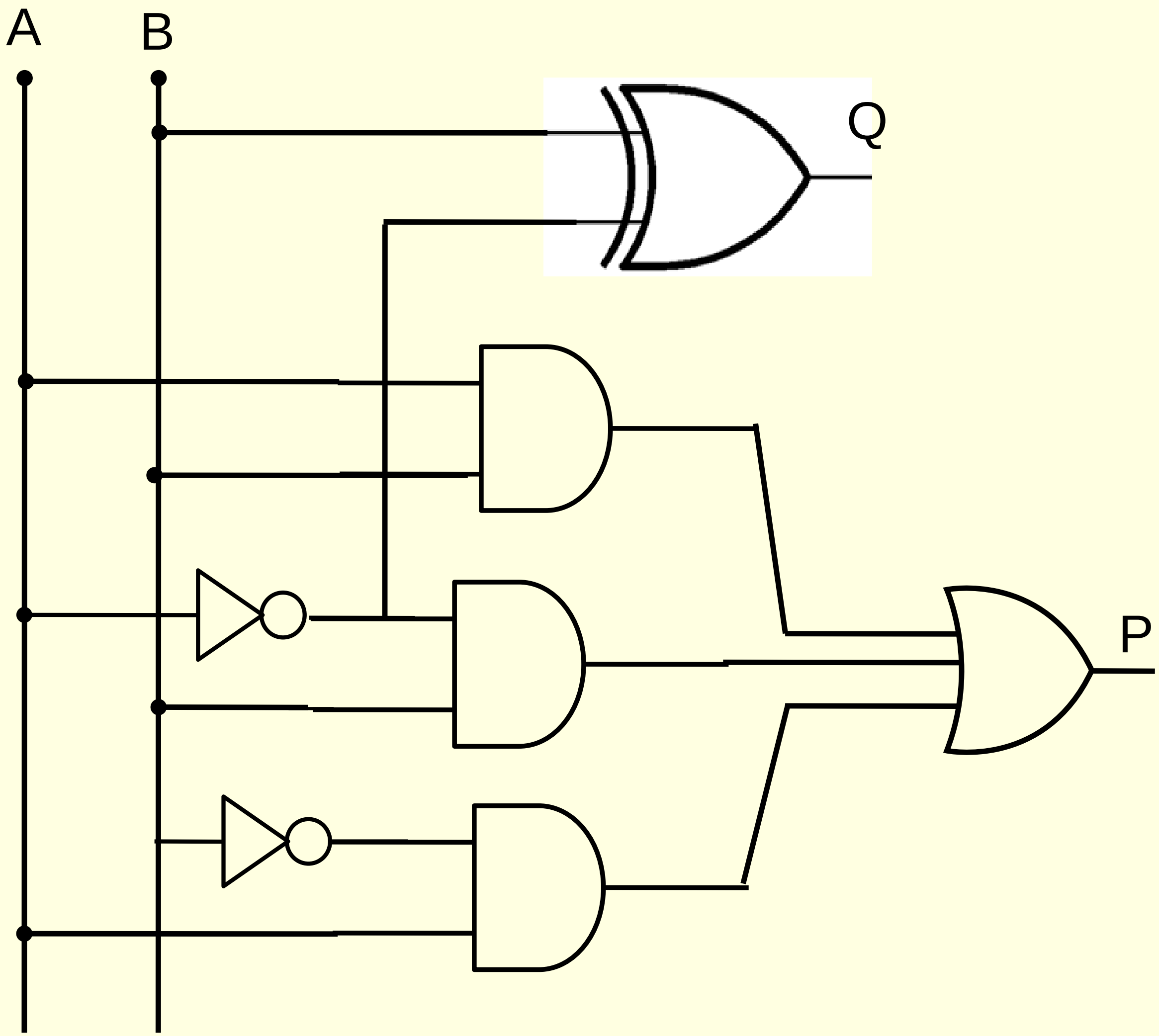
- $\overline{(\overline{X+Y})+(YZ)}$
- $(\overline{\overline{X+Y}})\ .\ (\overline{YZ})$
- $(X+Y)\ (\overline{Y}+\overline{Z})$
- $X\overline{Y}+ X.\overline{Z} + Y.\overline{Y} + Y.\overline{Z}$
- $X\overline{Y}+X\overline{Z}+0+Y\overline{Z}$
- $X\overline{Y}+X\overline{Z}+Y\overline{Z}$

Make a truth table of output Y of the logic circuit of the stem.



C) Stem: determine P and simplify ?

D) Prove that PQ=A.B

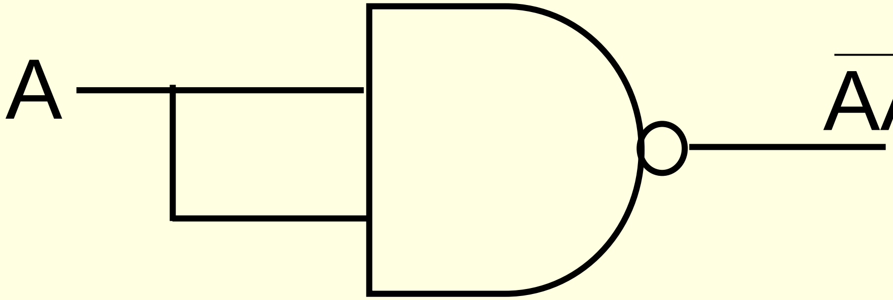


Universal logic gate

- The gate that can be used to implement all basic gates(AND,OR,NOT) called universal logic gate
- Example:
  - NAND gate
  - NOR gate

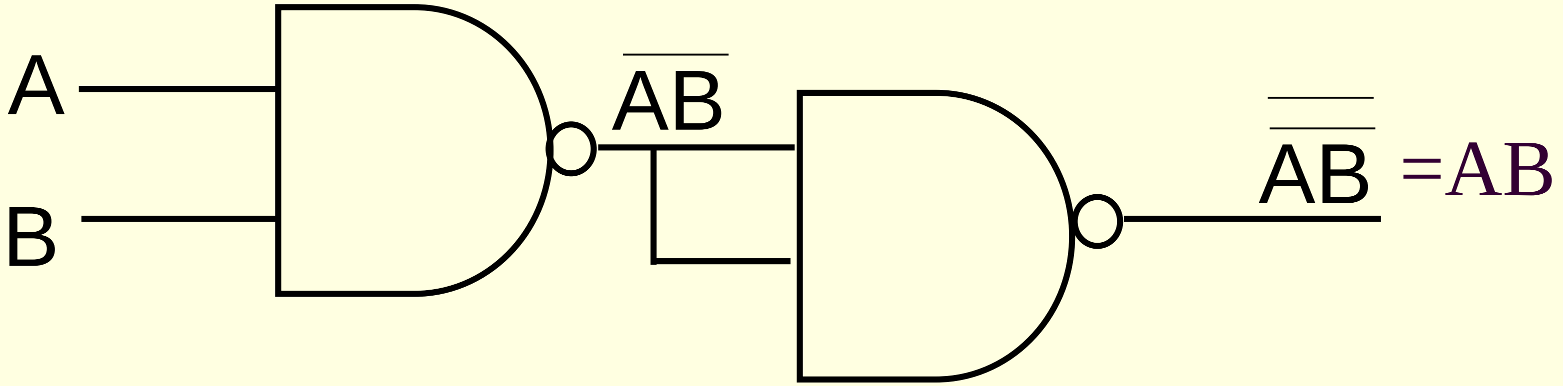
Prove that NAND is an universal gate
Prove the universality of NAND gate

1. Implementation of NOT gate by using NAND gate



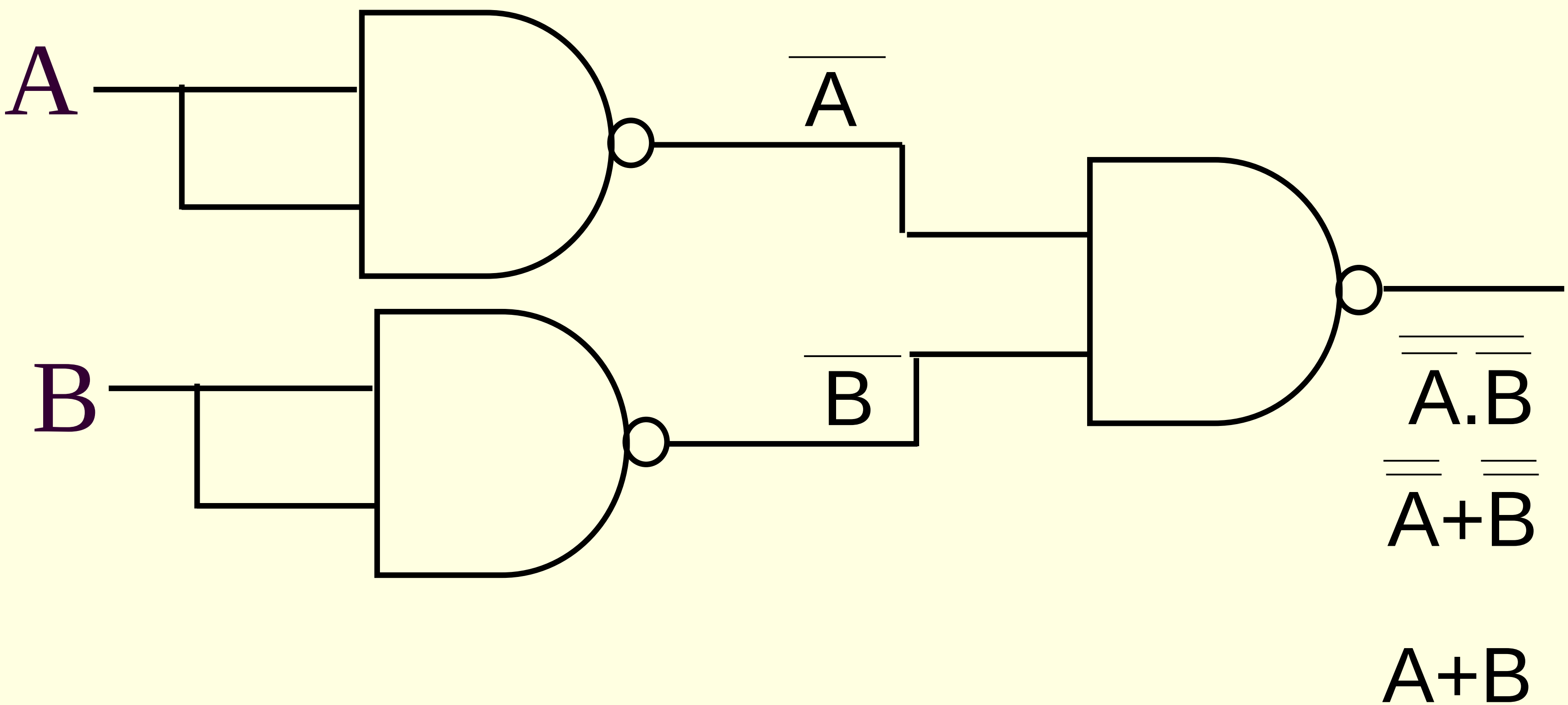
$$\overline{AA} = \overline{A}$$

2. Implementation of AND gate by using NAND gate

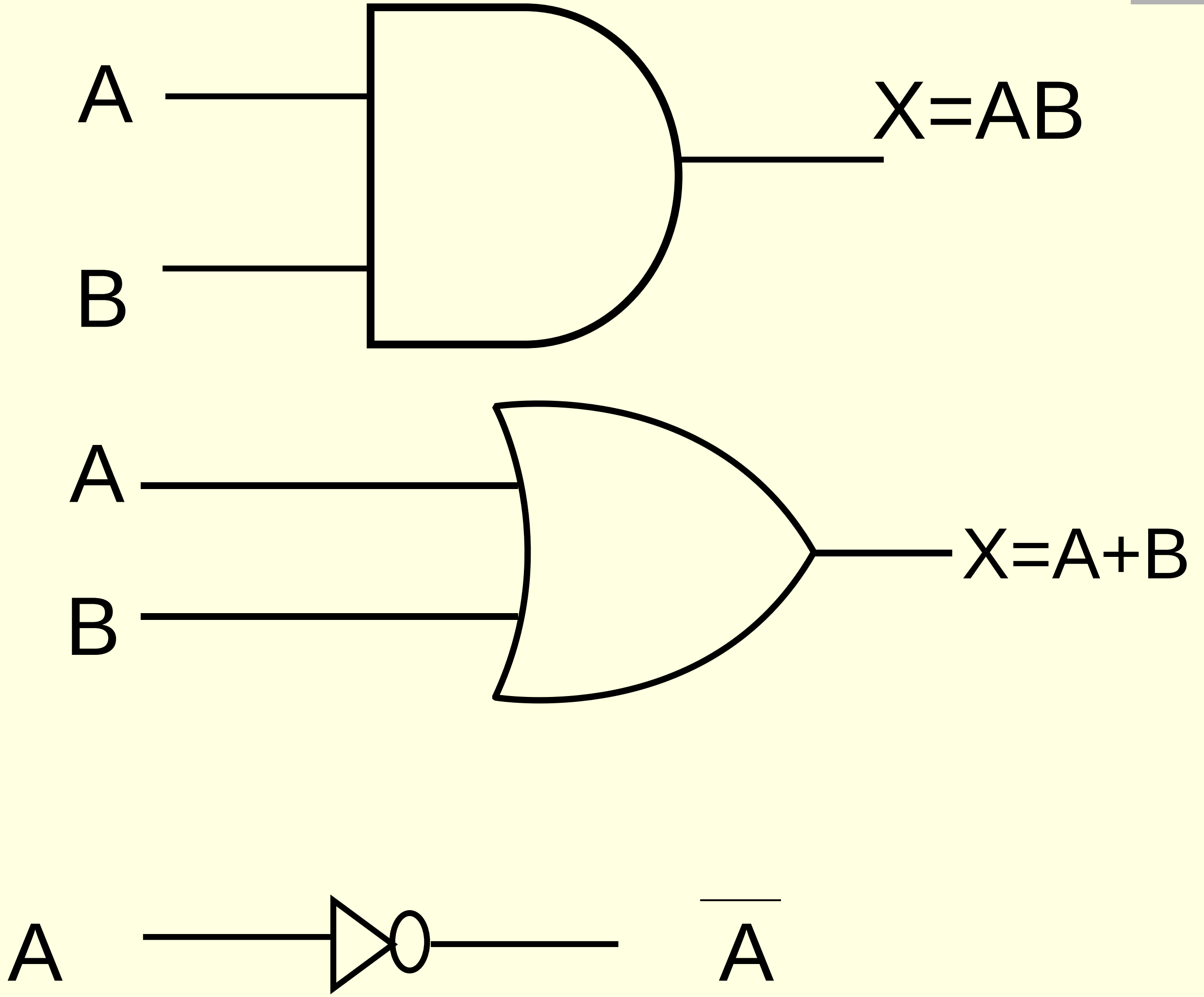


3. Implementation of OR gate by using NAND gate

- $= \overline{\overline{A}.\overline{B}}$



Can u implement by NAND



Implement figure 1 by figure2

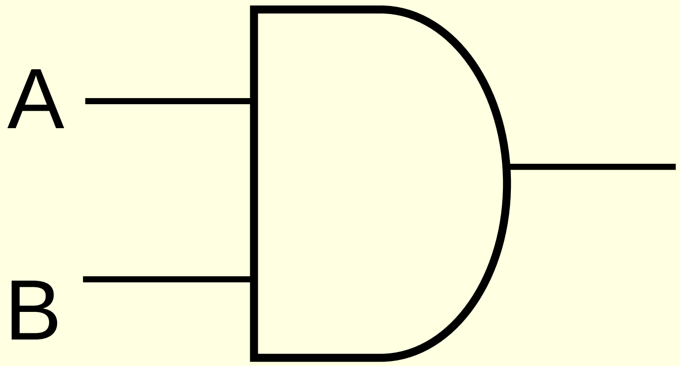


Figure1

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

Figure2

Implement figure 1 by figure2

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

Figure1

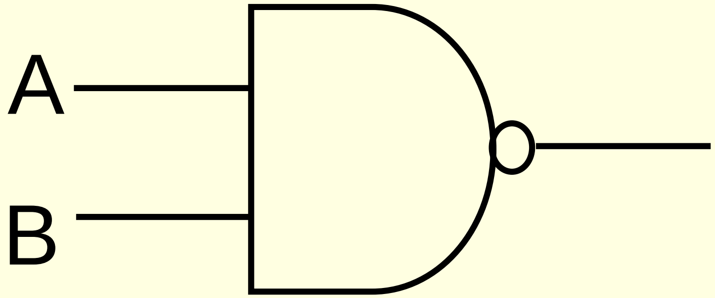


Figure2

Stem: implement Fig-2 by using fig-1

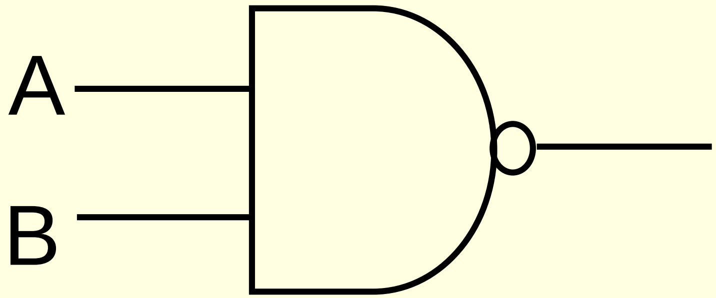


Fig-1

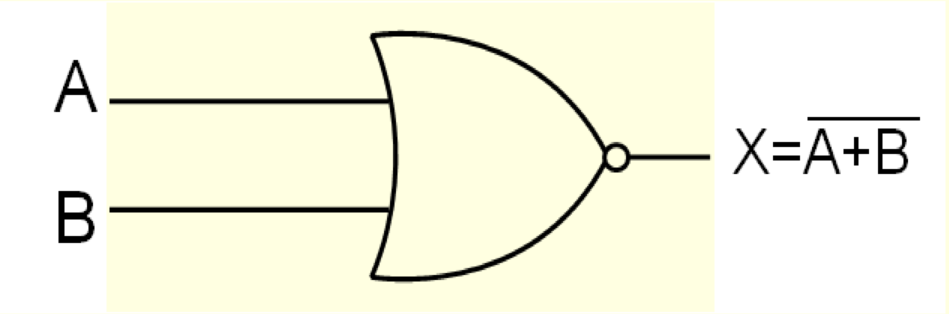


Fig-2

Implement fig1 by fig 2

- Fig-1

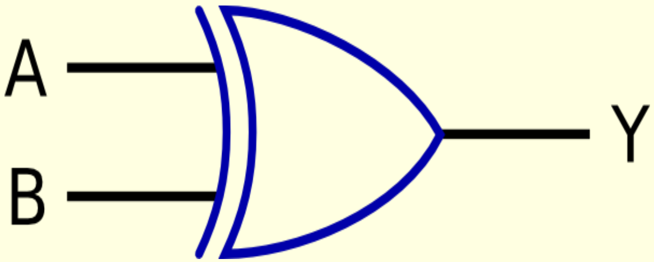
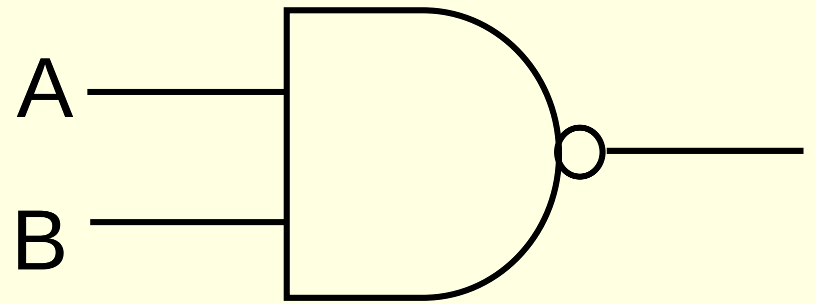


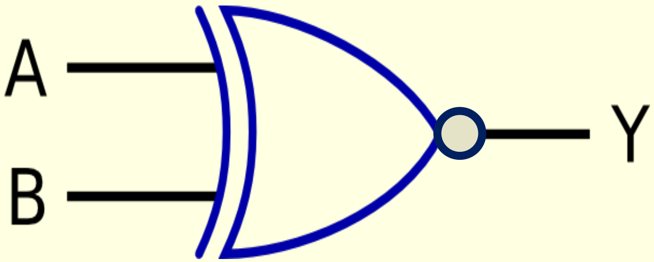
Fig-2

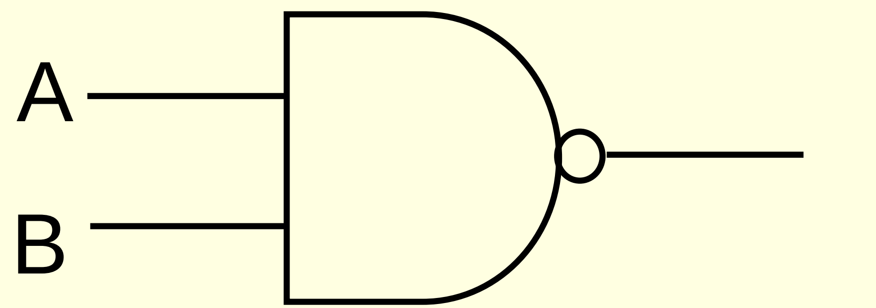


Implement fig1 by fig 2

- Fig-1

Fig-2





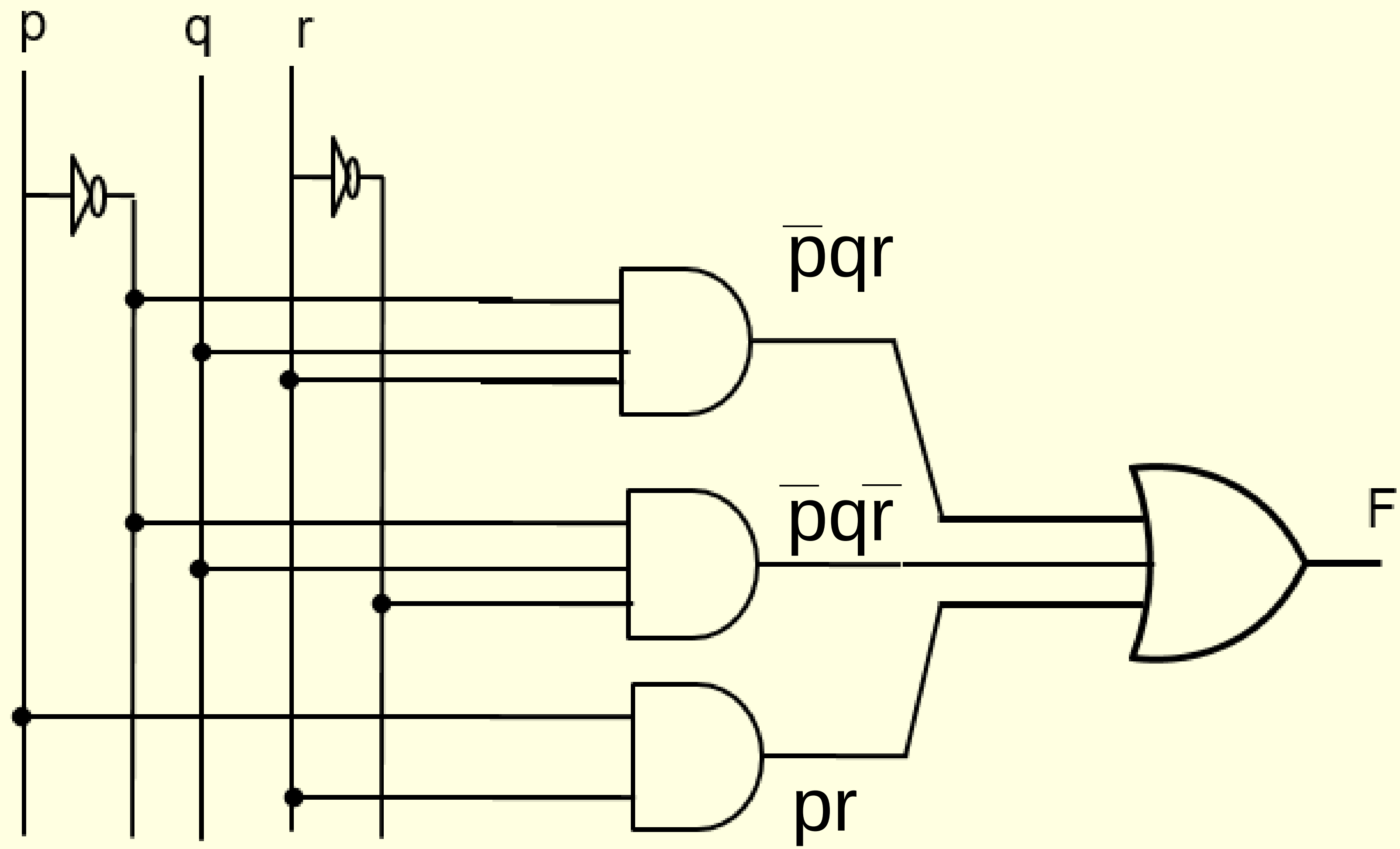
Implement fig-1 by fig-2

P	Q	T
0	0	1
0	1	0
1	0	0
1	1	1

Fig1

P	Q	T
0	0	1
0	1	0
1	0	0
1	1	0

Fig2

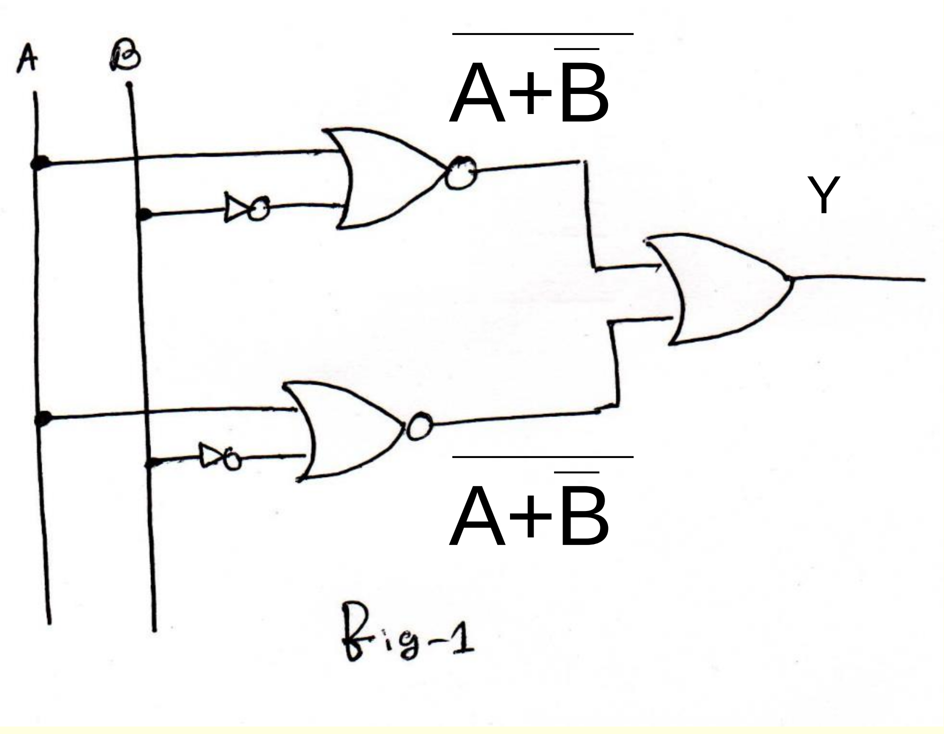


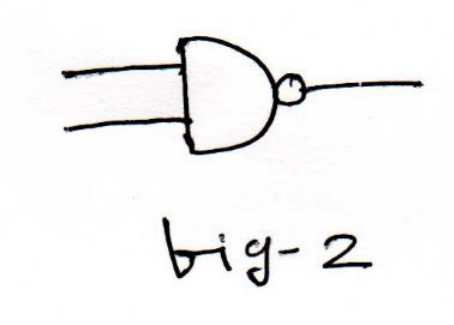
c) Simplify the output equation of logic circuit

d) Enumerate the importance of NAND gate of the simplified result of ‘F’ by absolutely through NAND gate

Cumilla 19

- Determine Y and Draw TT
- Is it possible to implement fig-1 by the gate represented by fig-2





Cumilla 19

- Determine Y and Draw TT
- Is it possible to implement fig-1 by the gate represented by fig-2

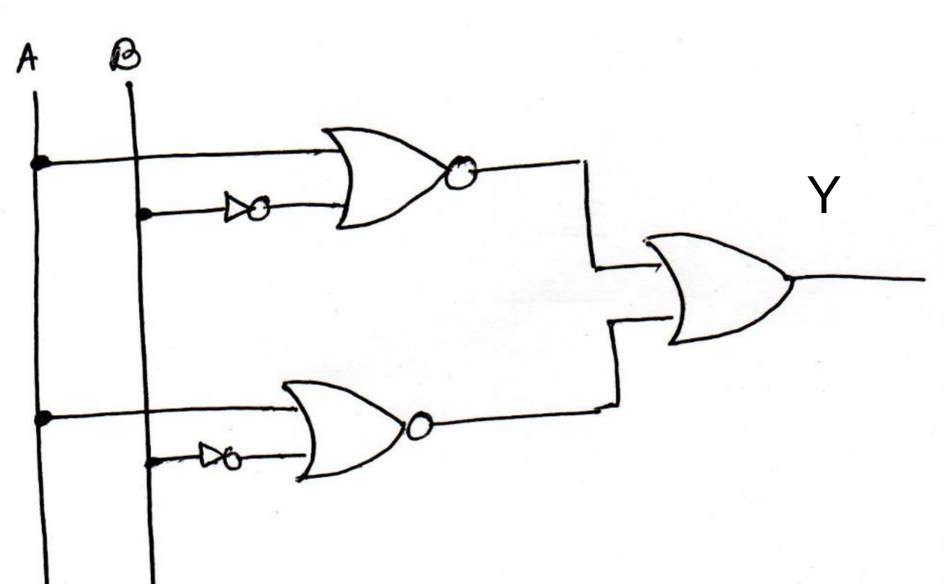


Fig-1

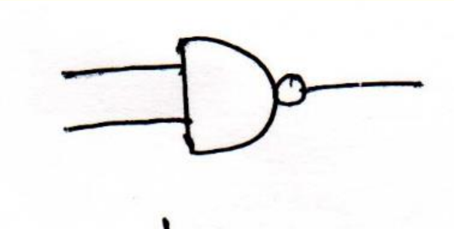
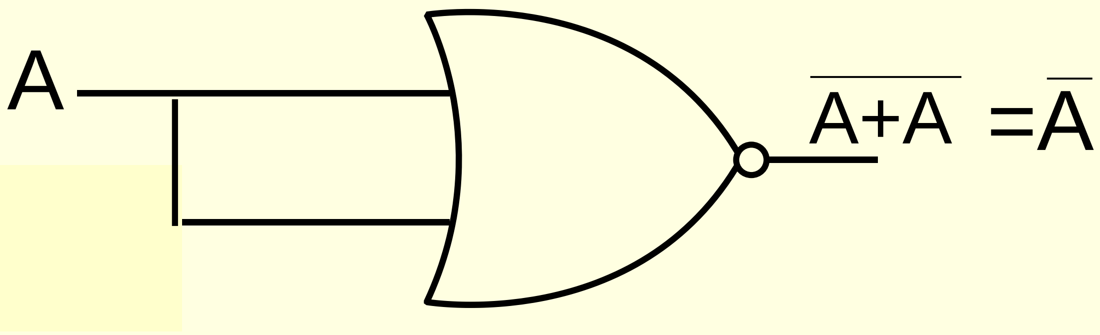
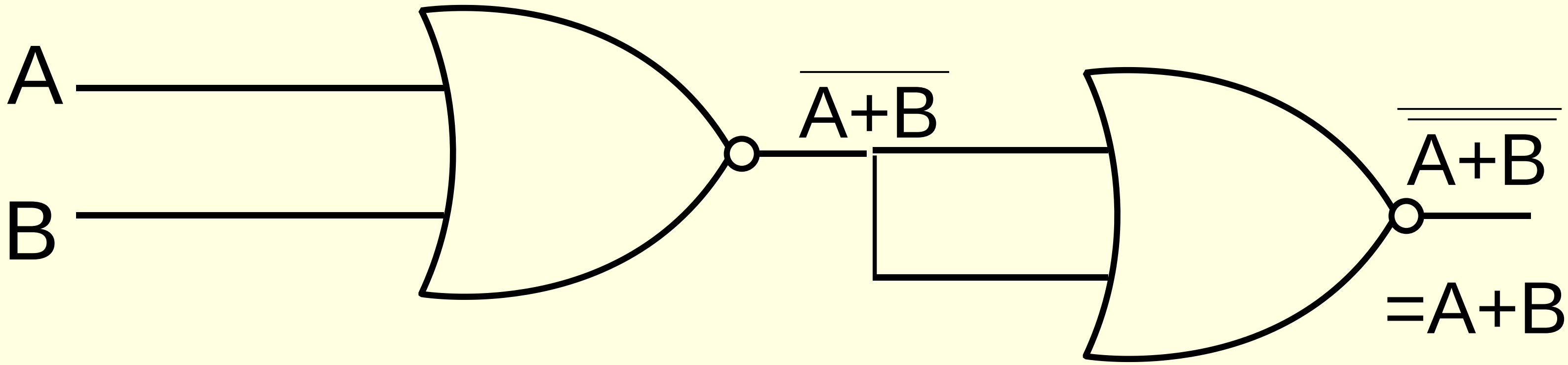


fig-2

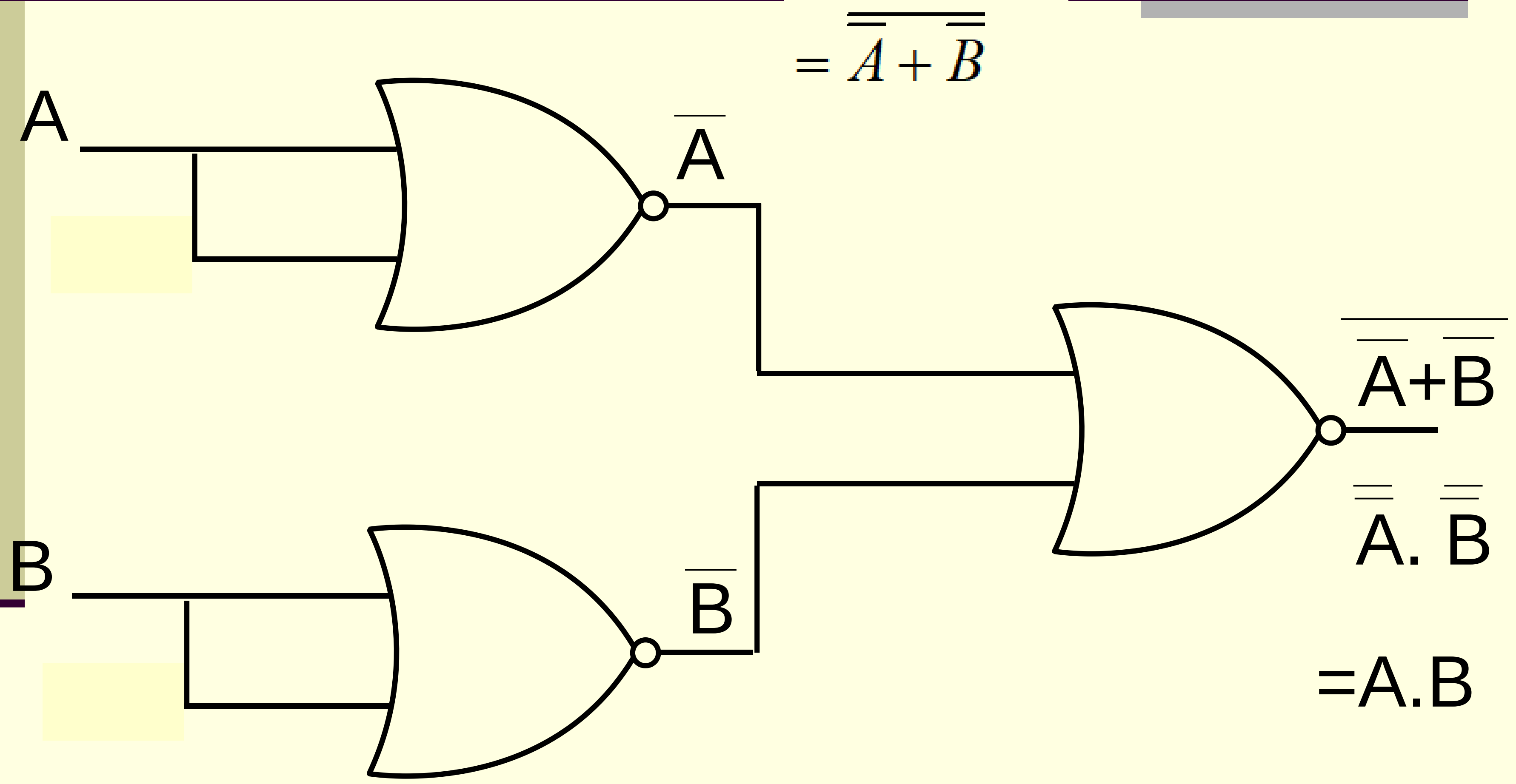
Universality of NOR
1. Implementation of NOT by NOR



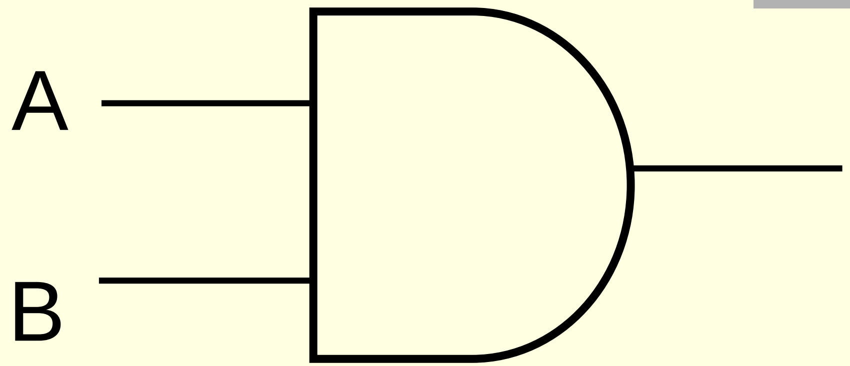
2. Implementation of OR by NOR

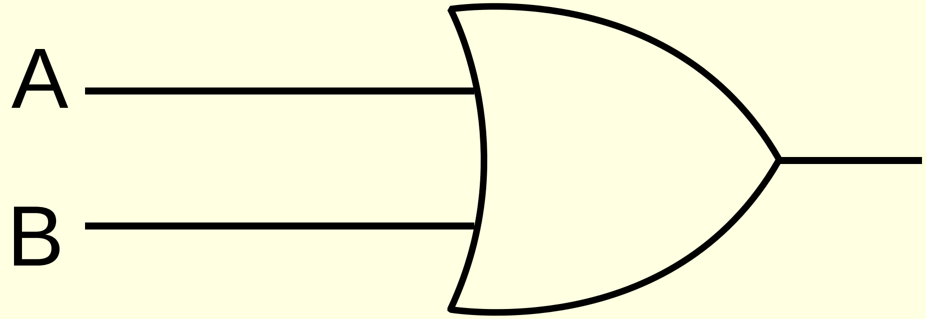


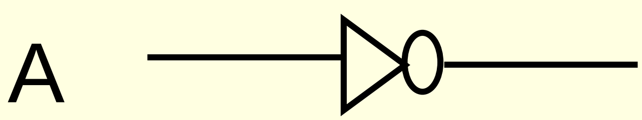
3. Implement AND by using NOR



Can u implement by NOR







Implement figure 1 by figure2

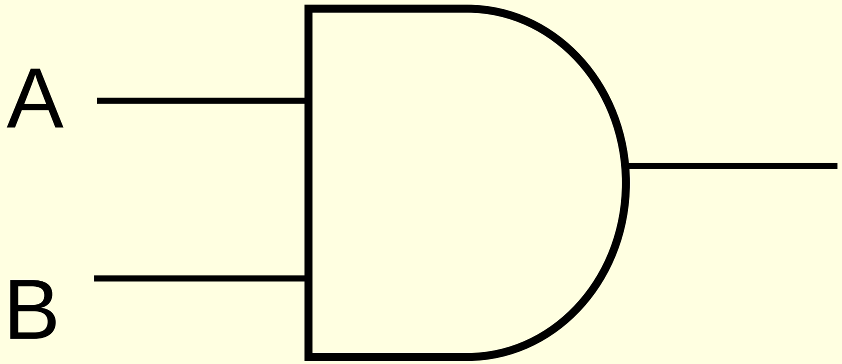


Figure1

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

Figure2

Implement figure 1 by figure2

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

Figure1

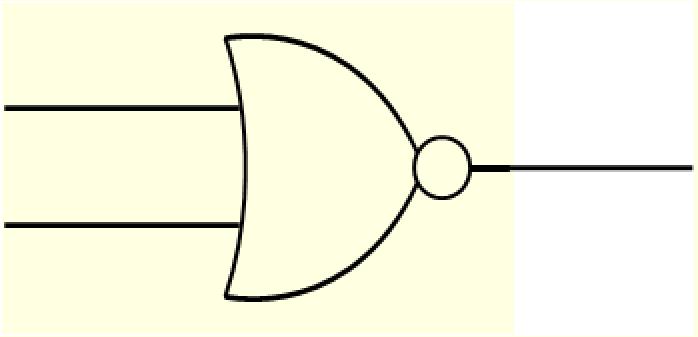


Figure2

Stem: implement Fig-1 by using fig-2

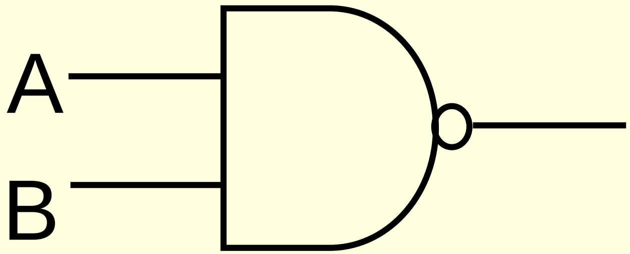


Fig-1

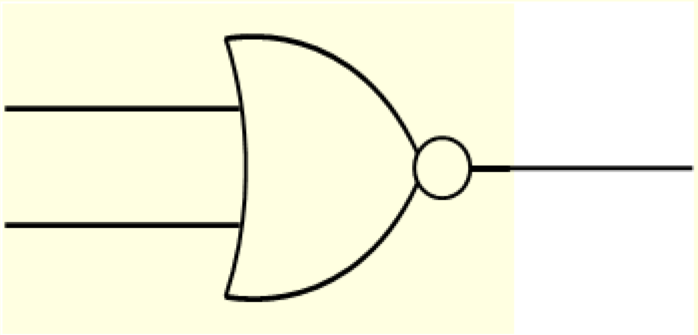
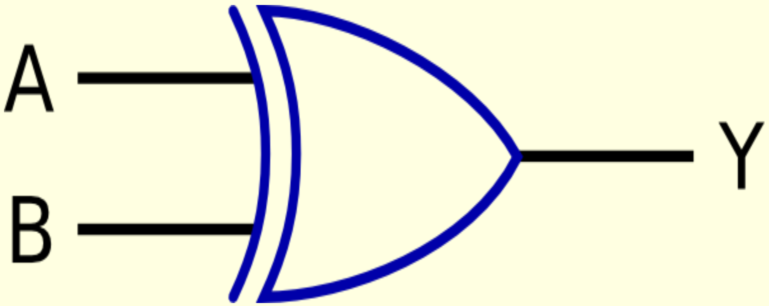


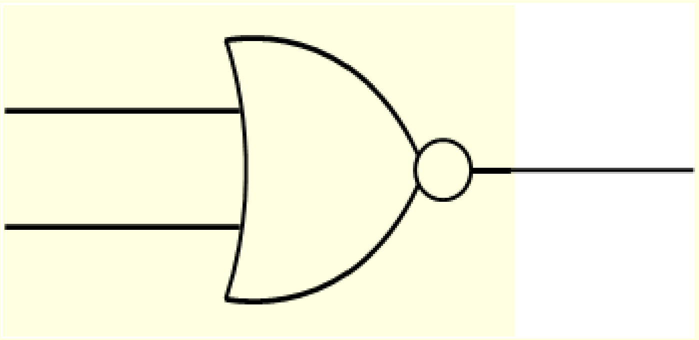
Fig-2

Implement fig1 by fig 2

- Fig-1

Fig-2





Implement fig1 by fig 2

- Fig-1

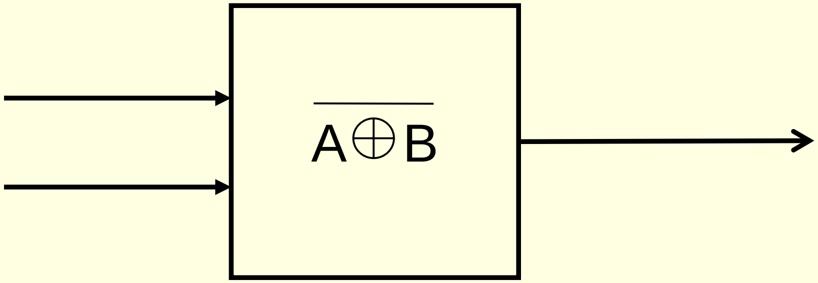
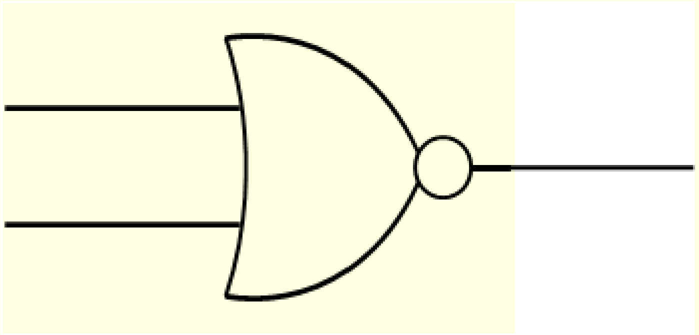
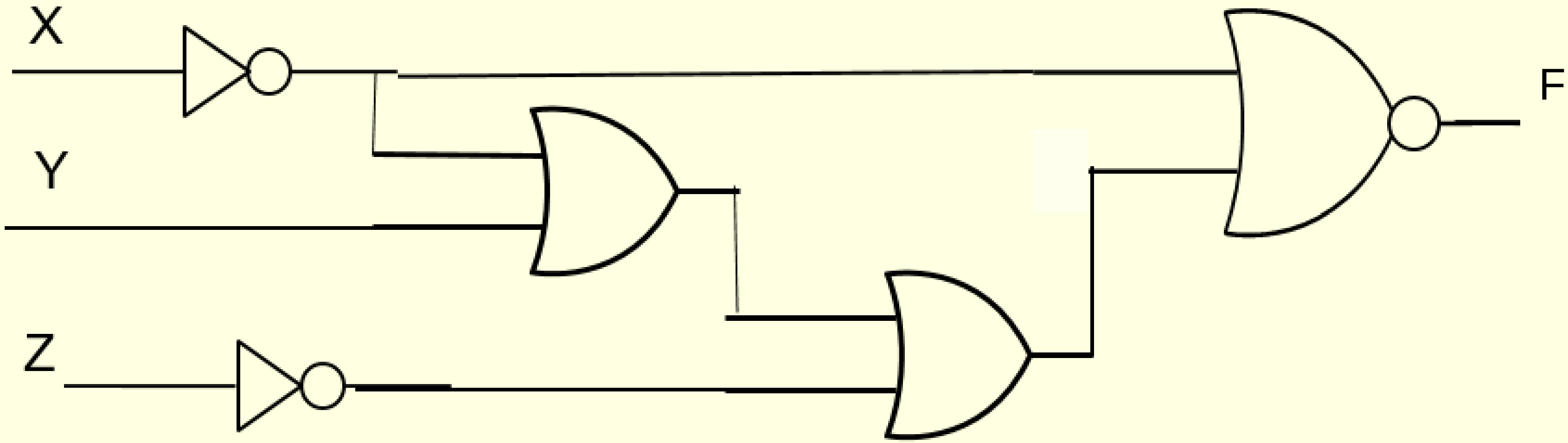


Fig-2



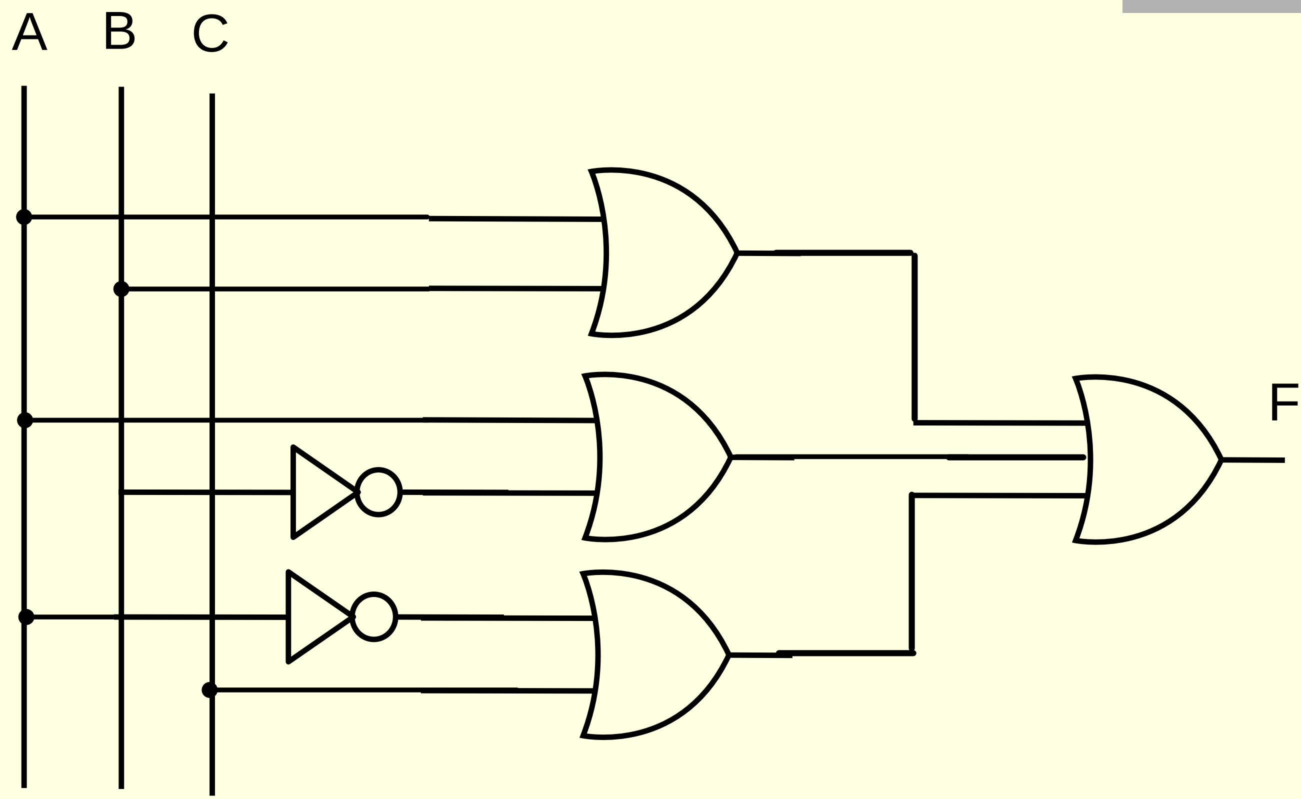


- Is it possible to implement the above circuit by NOR gate only? Analyze.

Implement F by NAND/NOR

$$F = A\overline{B} + B\overline{C}$$

Stem: DB 2017



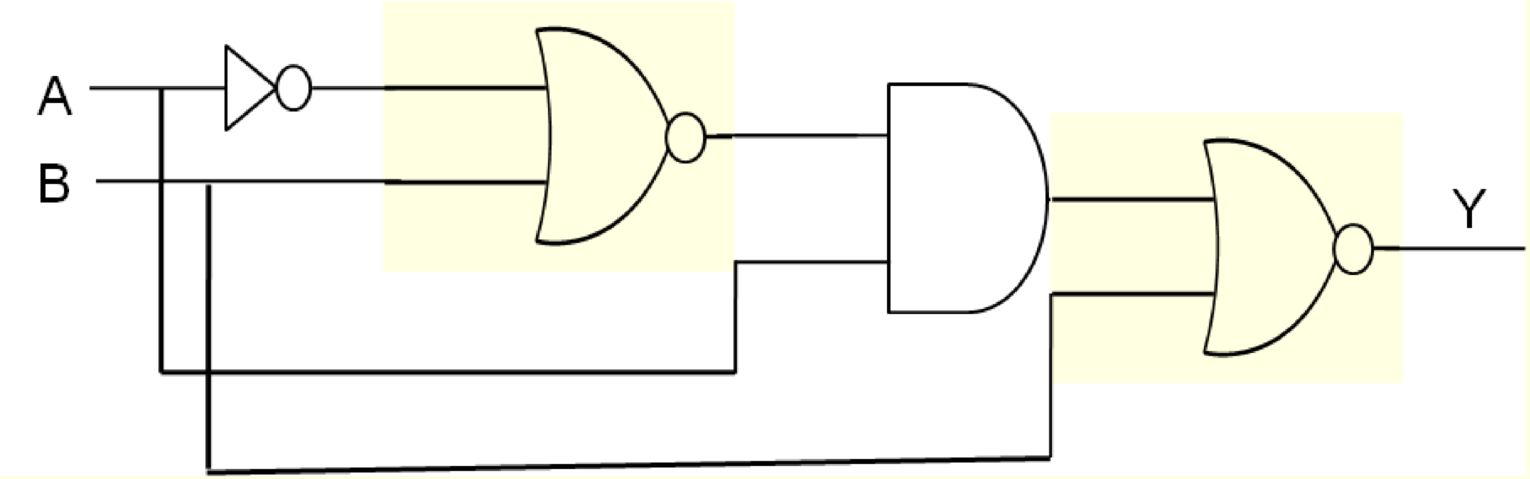
Determine F and simplify

it is possible to implement simplified value of F by NOR gate only-Justify

H/W

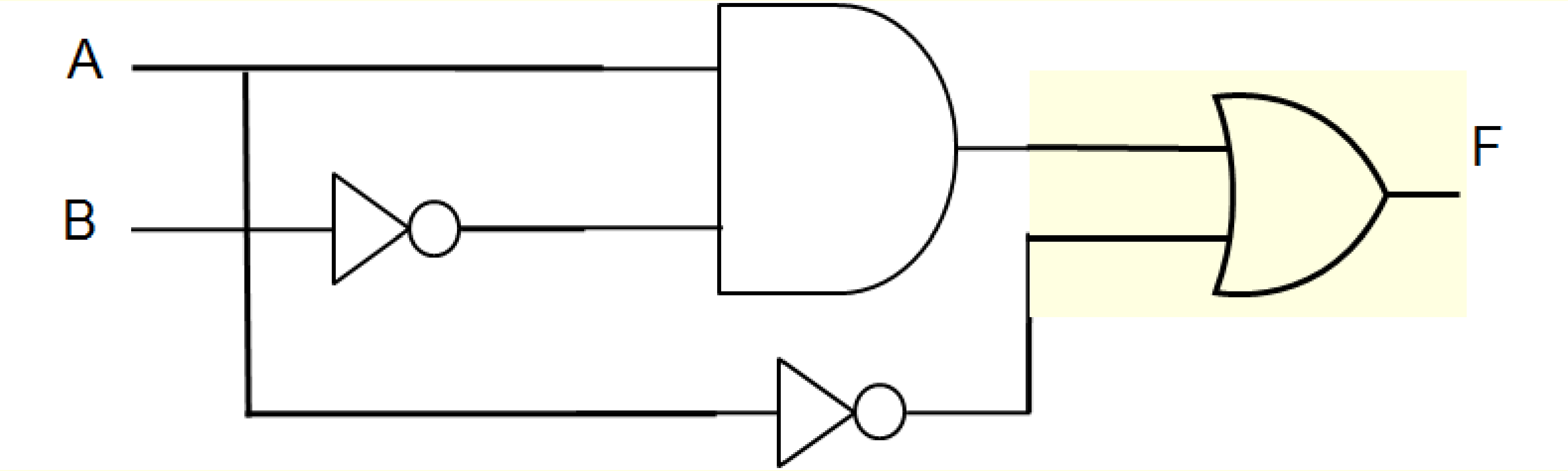
AB+BC+CA by NAND
AB+BC+CA by NOR

Stem: c) Find the output of the following circuit and simplify
d) proof that the output is a universal gate

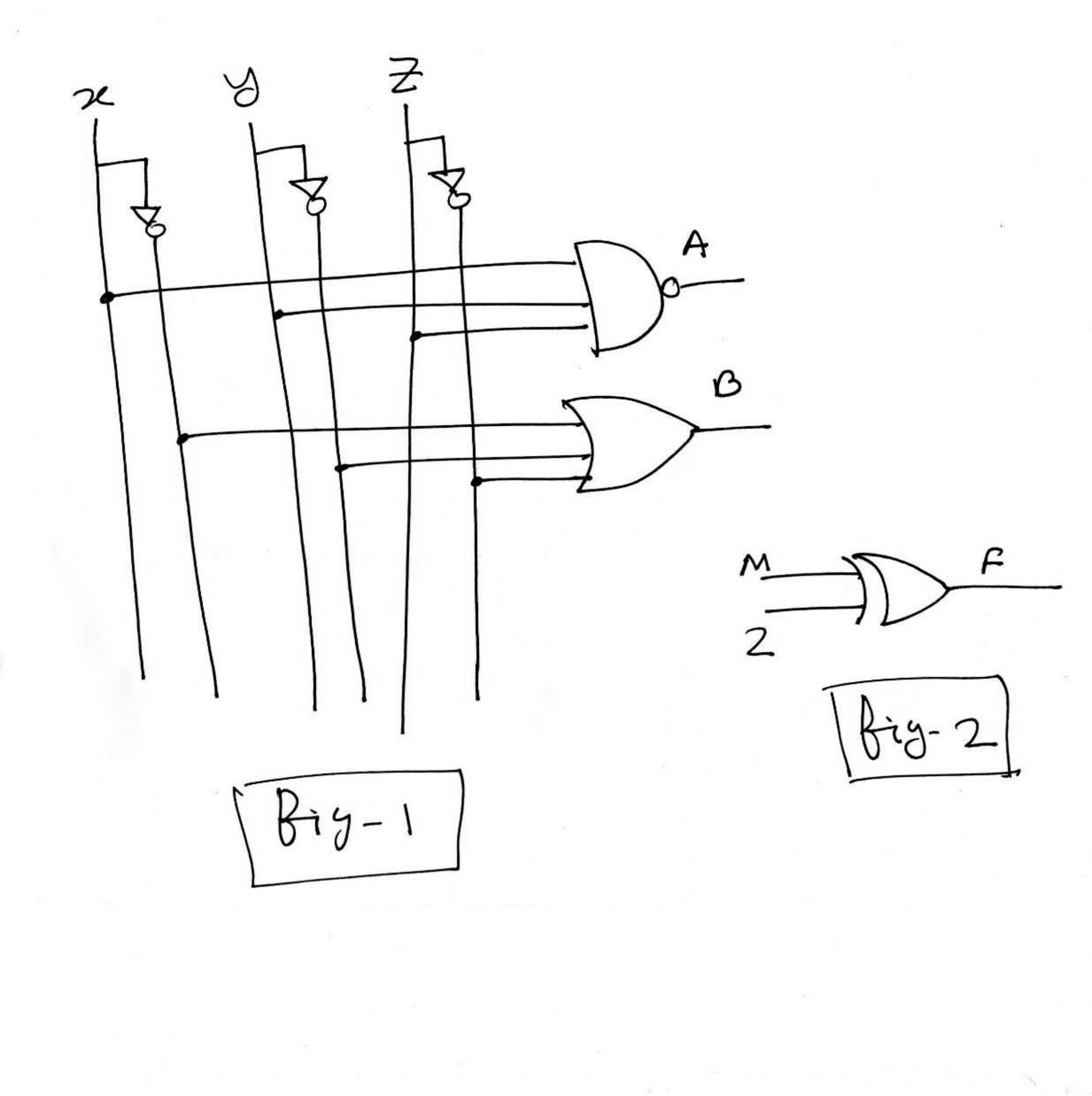


$$Ans : \overline{A}.\overline{B}$$

Stem: Stem: c) Determine the output and simplify it
d) Draw the TT after replacing the OR by NOR



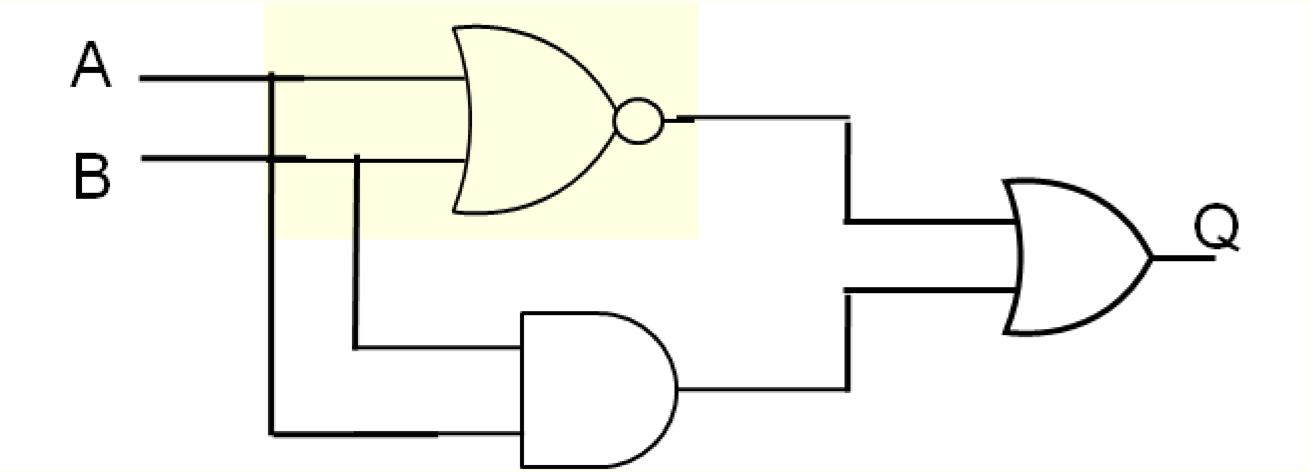
$$Ans : \overline{A} + \overline{B}$$



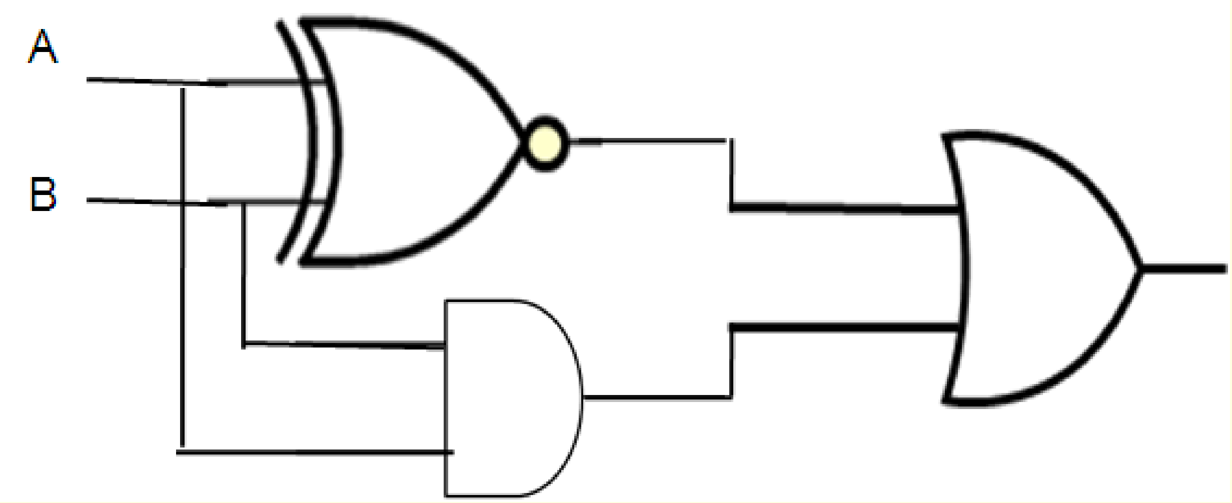
- C) Replace M of fig2 by output A then simplify
- D)proof A=B by TT

Stem: C) Determine Q and simplify and compare the simplified value with X-OR gate

D) Implement Q by using NAND gate only



c) Draw the Truth table for Figure after simplifying the expression .



Stem: C) draw circuit of fig1 then Simplify
D)implement fig1 by the gate represented by fig 2

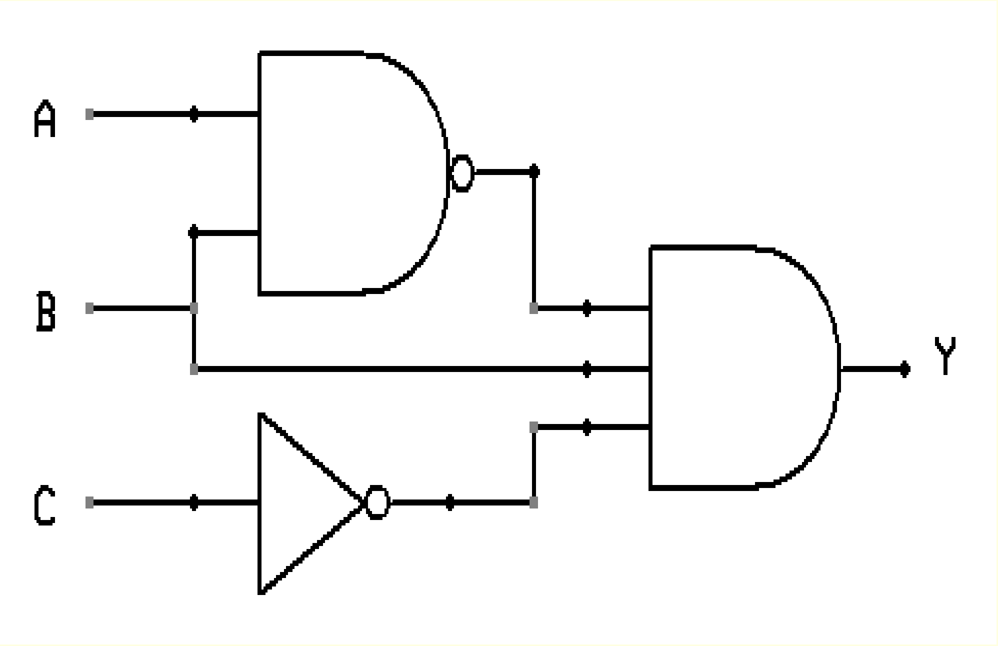
$$\overline{\overline{X}Y + XY\overline{Z}}$$

Fig 1

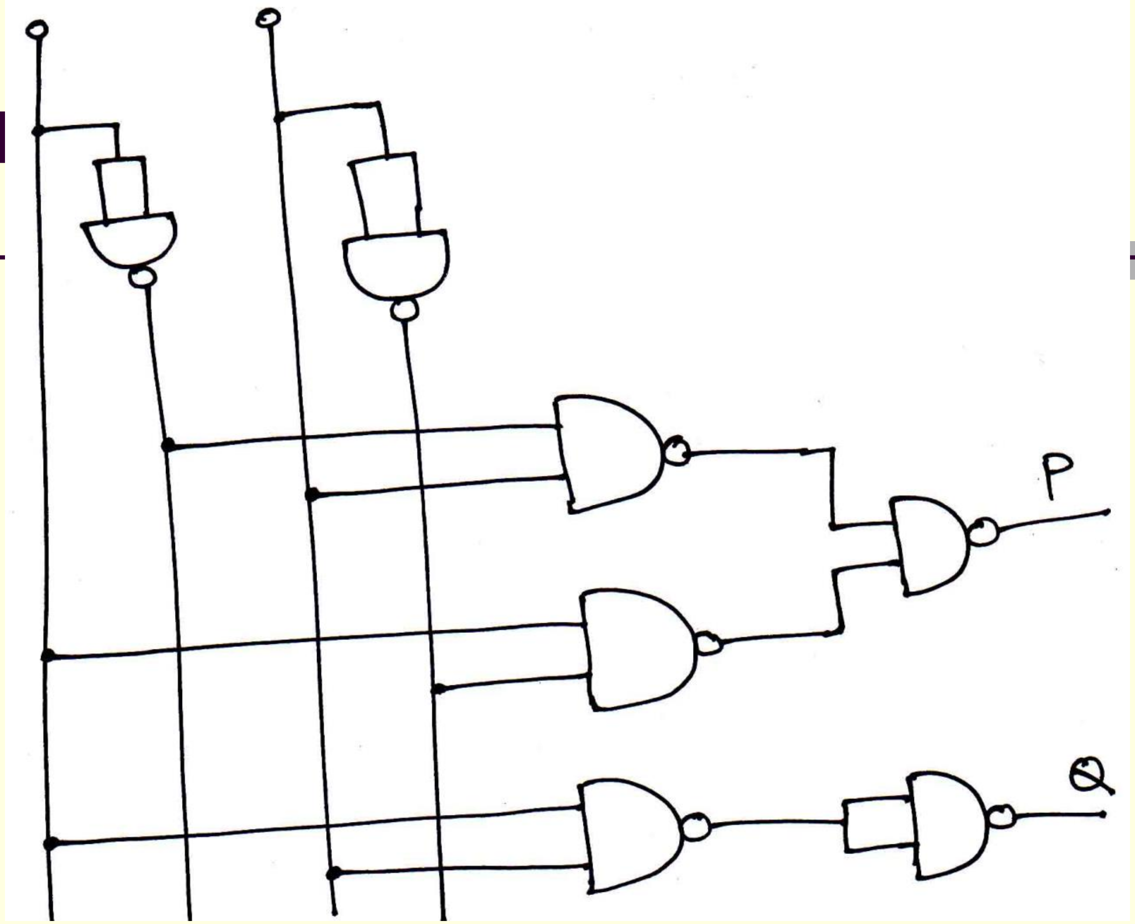
Fig-2		
A	**B**	**X**
0	**0**	**1**
0	**1**	**0**
1	**0**	**0**
1	**1**	**0**

$$Ans: \overline{Y} + XZ$$

Is it possible to implement the above logic circuit by only universal gate? Give your analytical opinion.



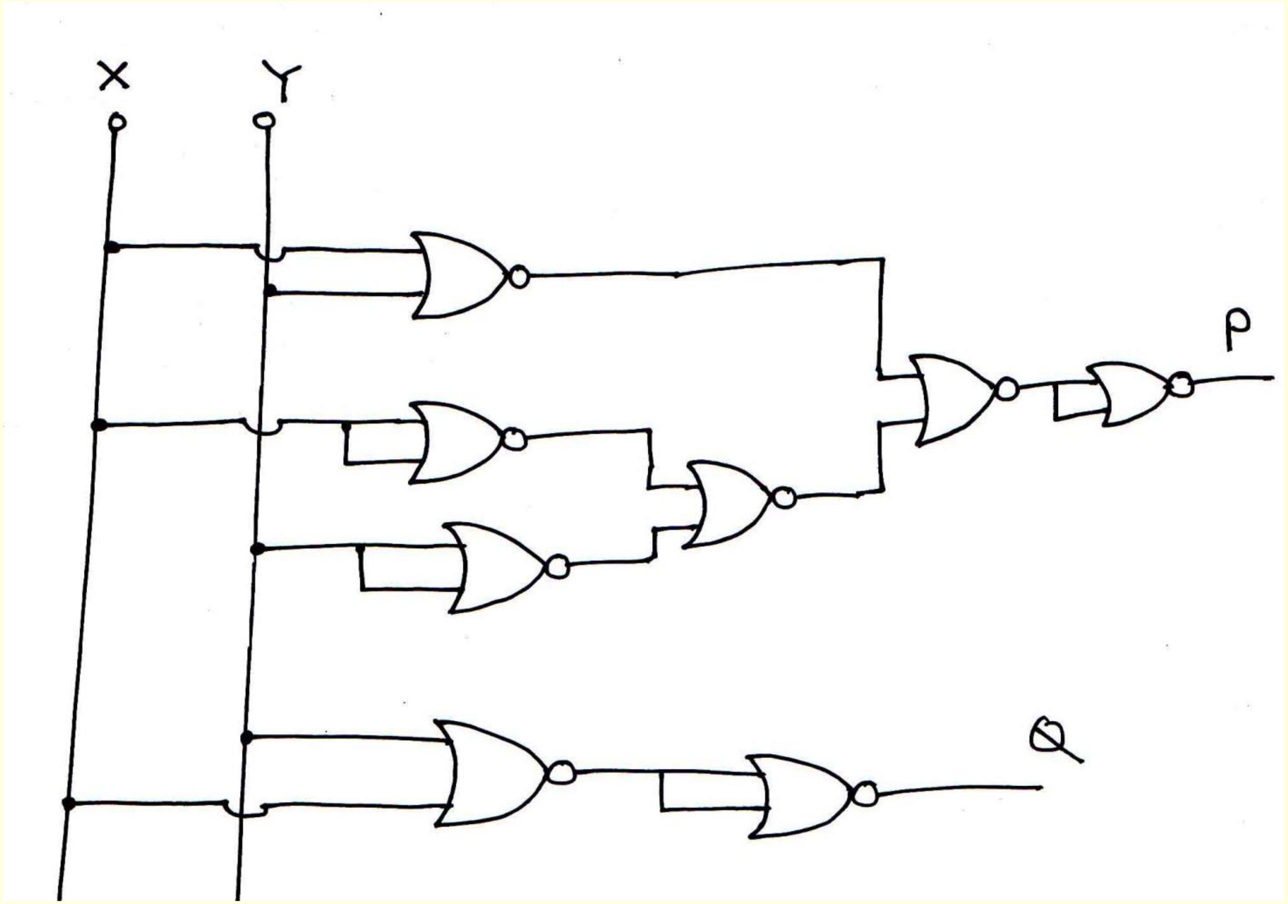
Ste

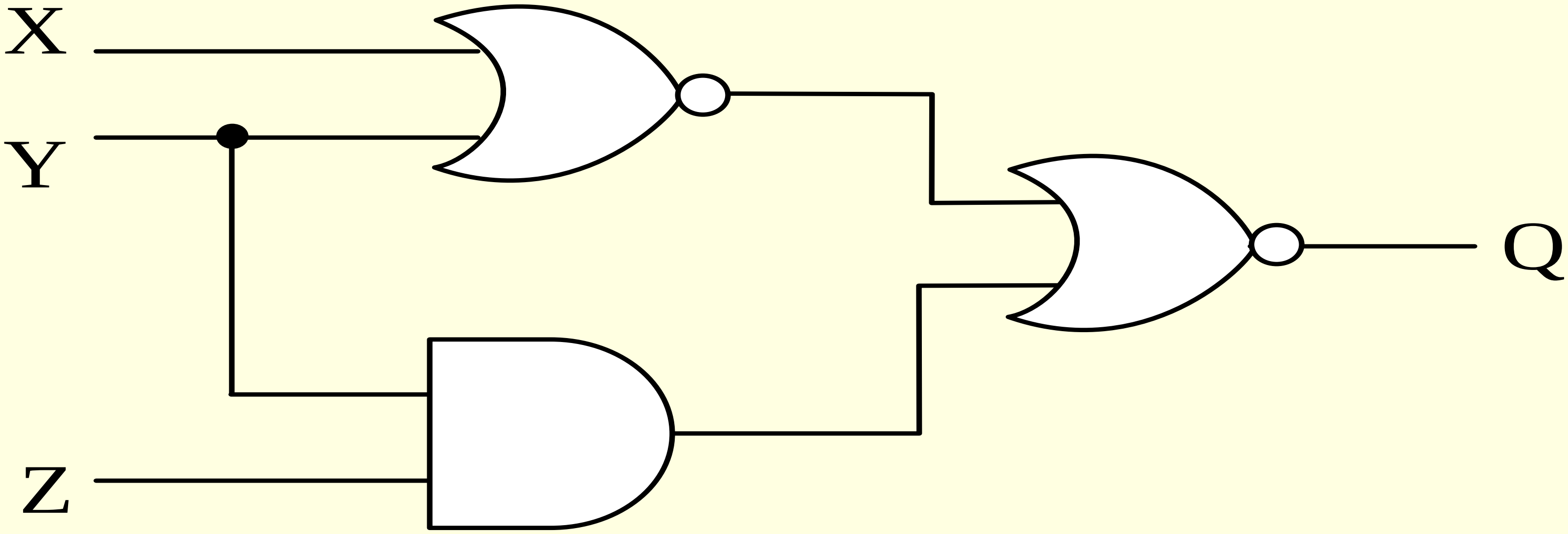


- C) Implement Q by using NOR gate.
- D) use fewest number of gates to implement the circuit above

C) Determine Q and implement by NAND gate only

d) Is it possible to implement P by a single gate? Justify your answer.





- Make a truth table of output Q of the logic circuit of the stem.
- Is it possible to implement the above logic circuit by only a **single** logic gate? Give your analytical opinion.

Stem

$$X = \overline{AB} + BC$$

$$Y = \overline{AB}C + ABC + AB + B\overline{C}$$

- C) Implement X by using NOR only
- D) Show that simplification of Y leads to easy implementation of the circuit

Stem:

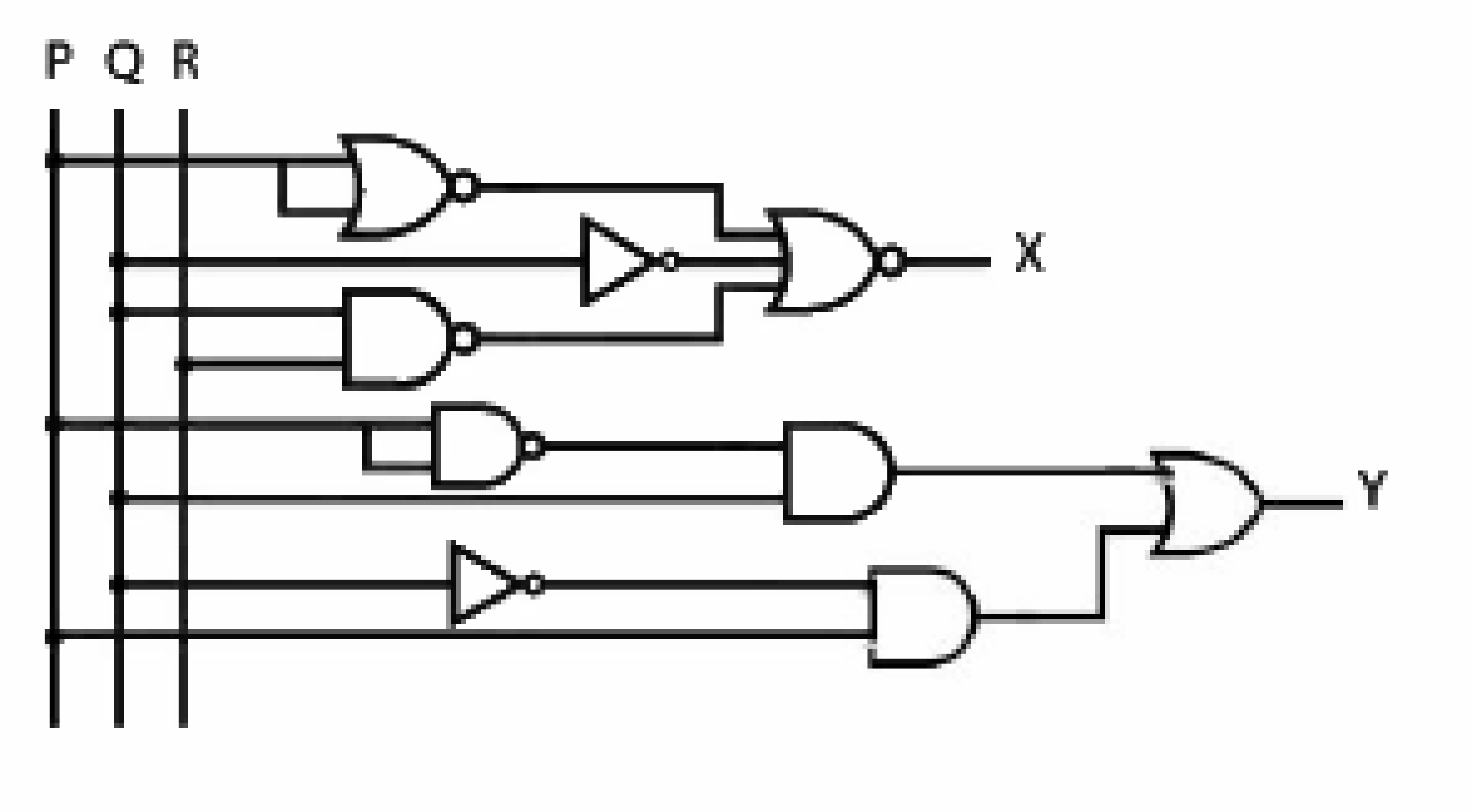
Figure–1

$$Q = \overline{(A + \overline{B})\overline{C}} + C$$

Figure-2		
A	**B**	**K**
0	0	1
0	1	1
1	0	1
1	1	0

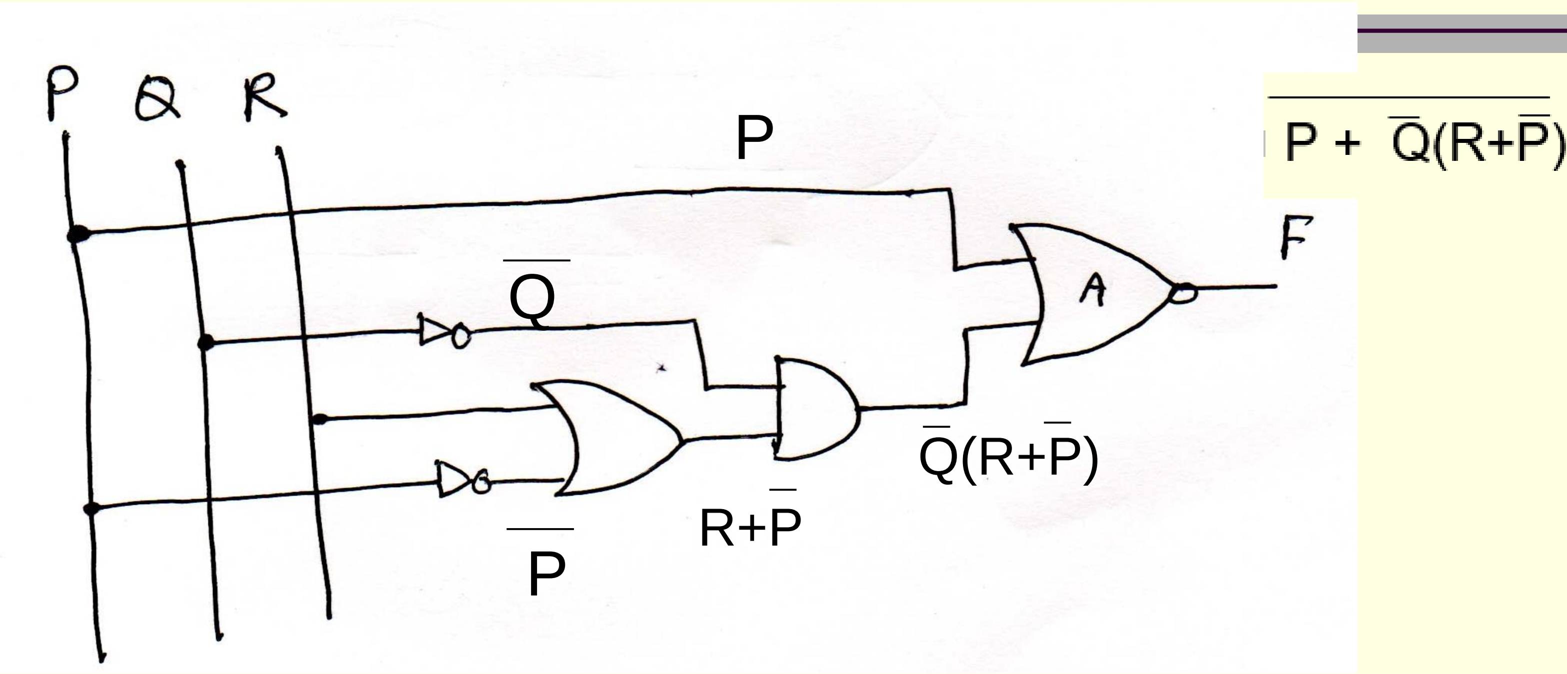
c) Draw truth table for Q

d) Is it possible to implement Figure1 by using the gate preseneted Figure-2. justify your answer.



- C) Show the simplified value of Y in truth table.
- D) Implement value of X by NOR gate

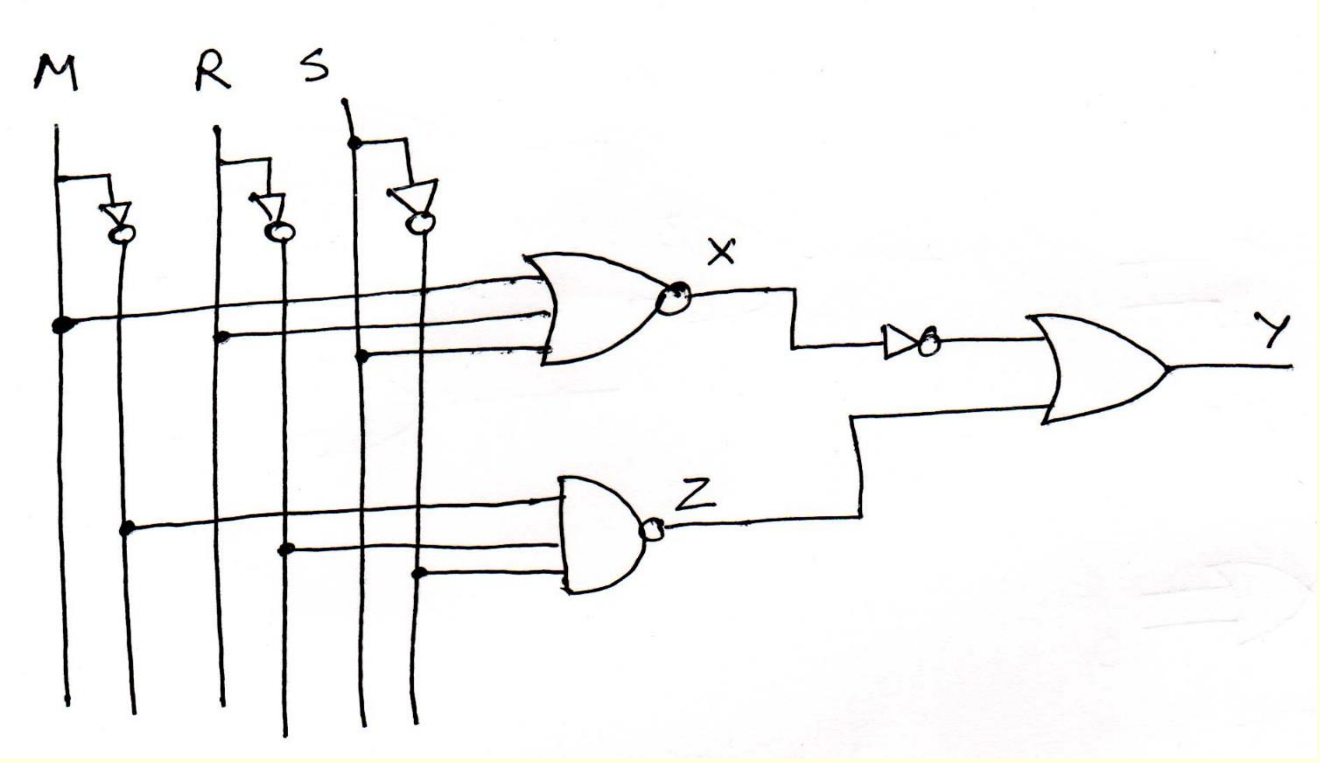
B-19



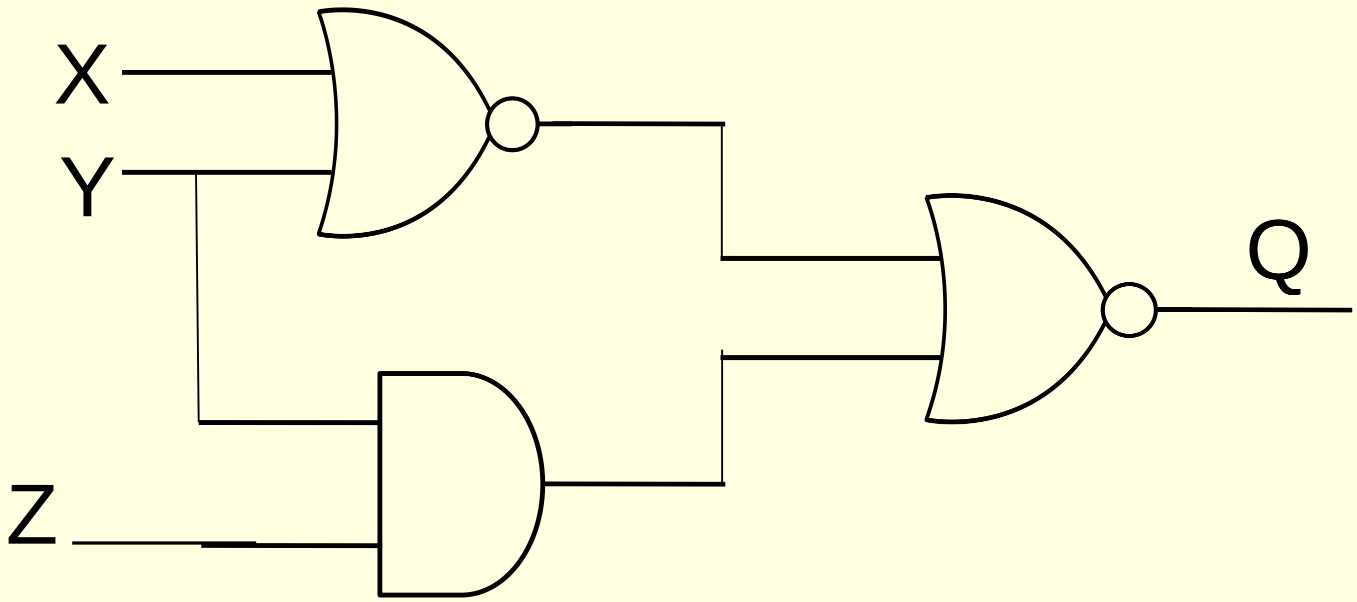
Determine F by TT
show that output F can be implemened by the gate signed as ‘A’

r19

- Determine Y
- Implement Y by NAND



d) is it possible to implement Q by a single gate?



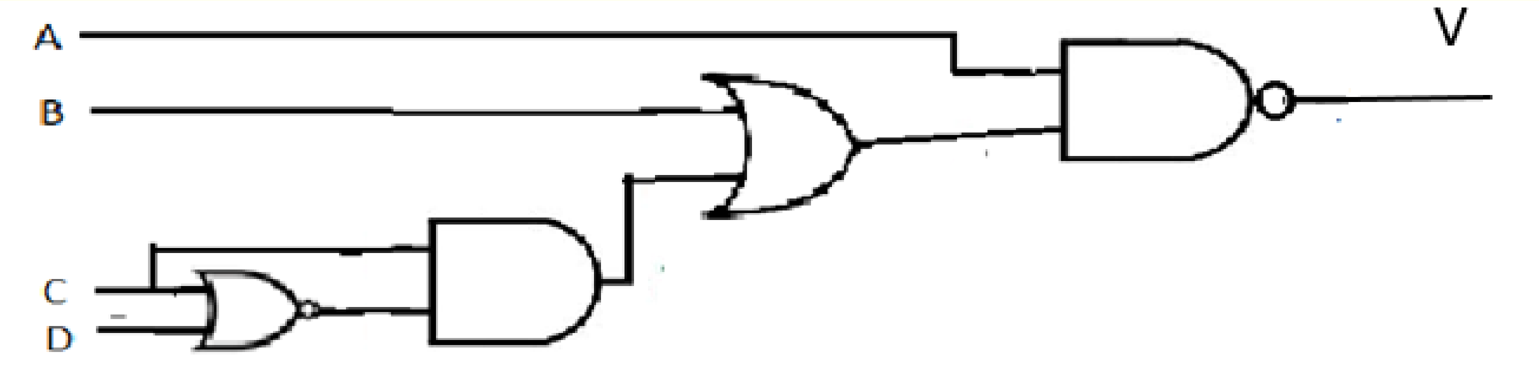


Figure-1

- (c) Determine the value of V of figure-1 of the stem.
- (d) Replace the basic gates of figure-1 by NAND gates and show that the entire circuit can be represented by basic gates.