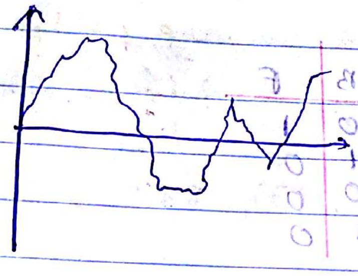
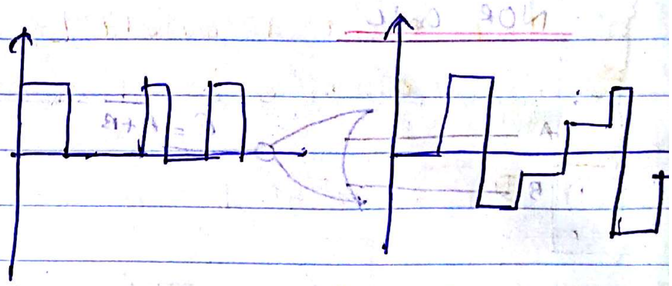
Importance of Digital systems

- Easy to use
- Trend
- Small in size
- High Accuracy
- High speed
- low cost

Analog



Digital



Boolean Algebra

Boolean varible — $A = 0 \Rightarrow \bar{A}$

$A = 1 \Rightarrow A$

Boolean Operators

(1) NOT

(2) OR

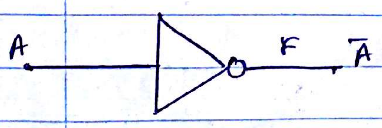
(3) AND

(4) NOR

(5) NAND

(6) Ex - OR

Not gate

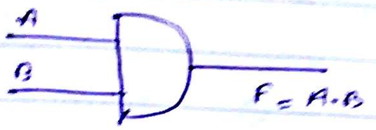


A	F
0	1
1	0

OR Gate

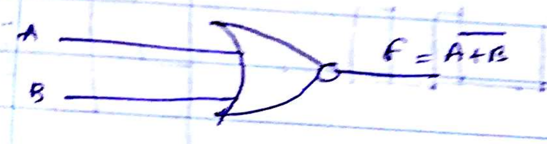
A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

And Gate



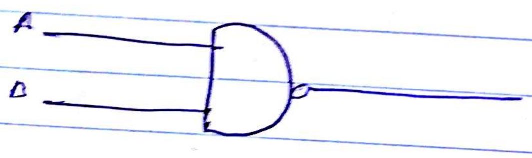
A	B	F
0	0	0
1	0	0
0	1	0
1	1	1

NOR Gate



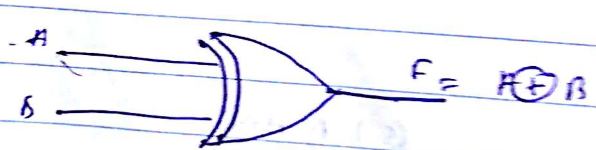
A	B	F
0	0	1
0	1	0
1	0	0
1	1	0

NAND Gate



A	B	F
0	0	1
0	1	1
1	0	1
1	1	1

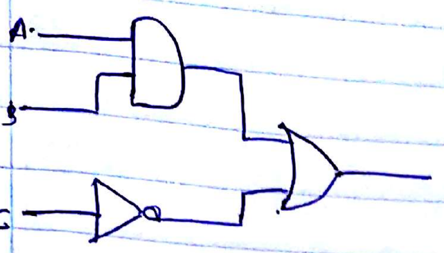
Ex-OR Gate



A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

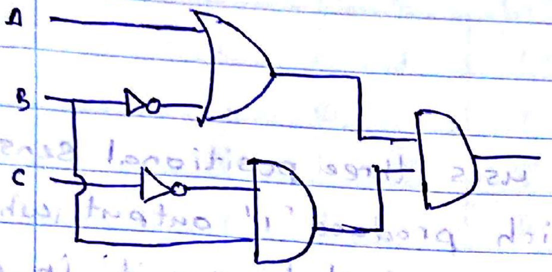
දෙකම එක සමාන වුණොත් 0 වෙනවා

(1)



$AB + C$

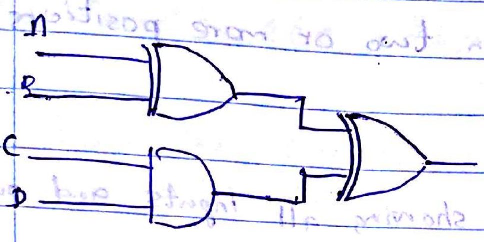
(2)



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

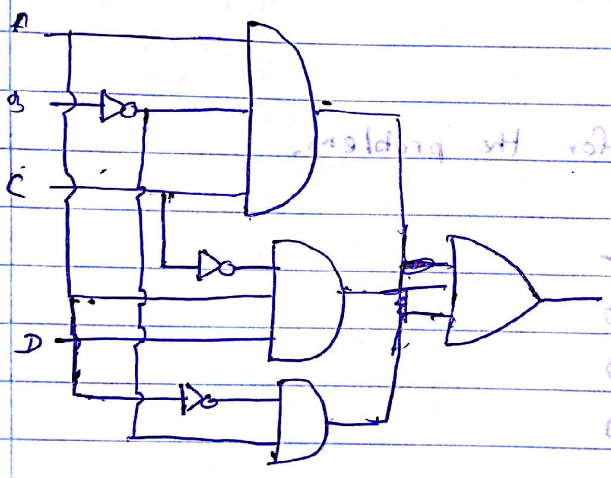
$(\bar{C}B)\cdot(\bar{B}+A)$

(3)

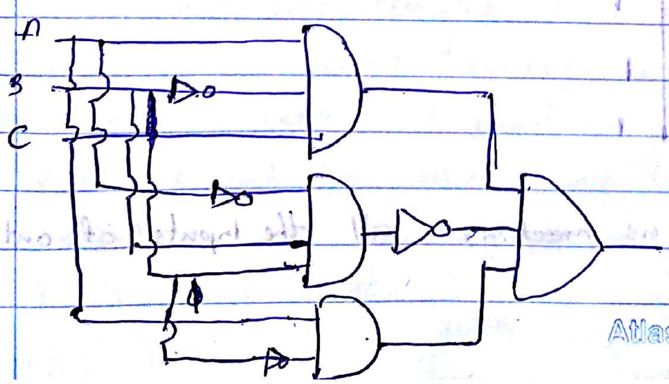


$(A\oplus B)\oplus C\cdot D$

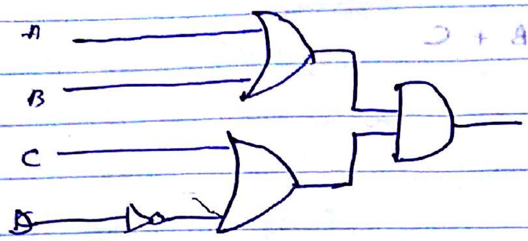
(4) $F = A\bar{B}C + A\bar{C}D + \overline{AB}$



(5) $G = A\bar{B}C + \bar{A}BC + A\bar{C}$

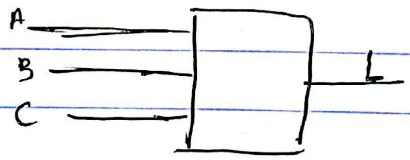


(6) $L = (A+B)(C+\bar{D})$



An Electrical control system uses three positional sensing devices. A, B, C, each of which produce '1' output when the position is detected. Design a digital circuit in order to produce an output L, when two or more positions are detected.

$\boxed{\text{① Step}}$ Draw ~~wer~~ a block ~~digr~~ diagram showing all inputs and outputs



$\boxed{\text{② Step}}$ Prepare a truth table for the problem.

A	B	C	L
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Truth table shows us ~~machine~~ all the inputs of outputs of a machine

Now we have converted our problem to a table.

③ step

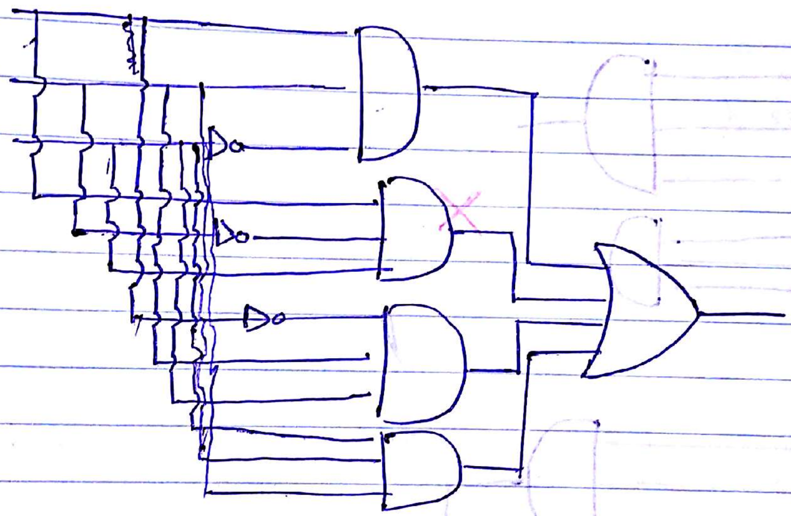
Writ Output Boolean equ for the output

A	B	C	L	
0	1	1	1	$\longrightarrow \bar{A}BC$
1	0	1	1	$\longrightarrow A\bar{B}C$
1	1	0	1	$\longrightarrow AB\bar{C}$
1	1	1	1	$\longrightarrow ABC$

$L = AB\bar{C} + A\bar{B}C + \bar{A}BC + ABC$

④ Step

Draw the Circuit using basic logic gates

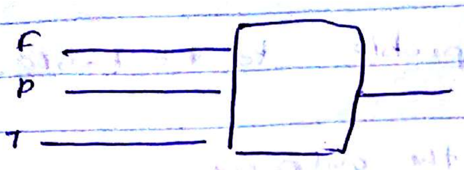


(Q2) One step in a manufacturing process depends on the flow rate F, pressure P and tempreature T of the material, safety conditions require that an alorm A be sounded before the process become dangerous. Danger conditions occur when flow rate and pressure are low and also when pressure and tempreature are high. Write the Boolean equations for sounding the alarm and implement it using basic logic gates

$\overline{FPT} \neq \bar{F}\cdot\bar{P}\cdot\bar{T}$

6

1 Step



2 Step

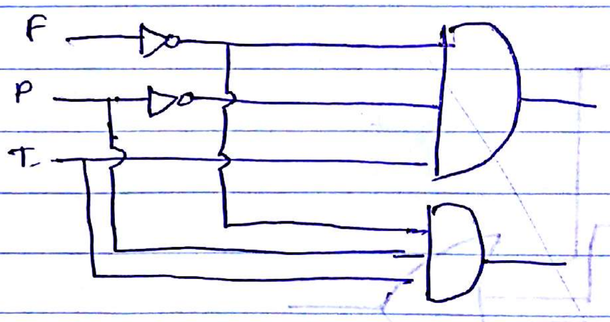
F	P	T	L	
0	0	1	1	← ~~$\overline{ABC}$~~ $\overline{FP}T$
0	1	0	0	
1	0	0	0	
1	1	0	0	
0	1	1	1	← $\bar{F}PT$
1	0	1	0	
1	1	1	0 ✗ 1	
0	0	0	0 ✗ 1	

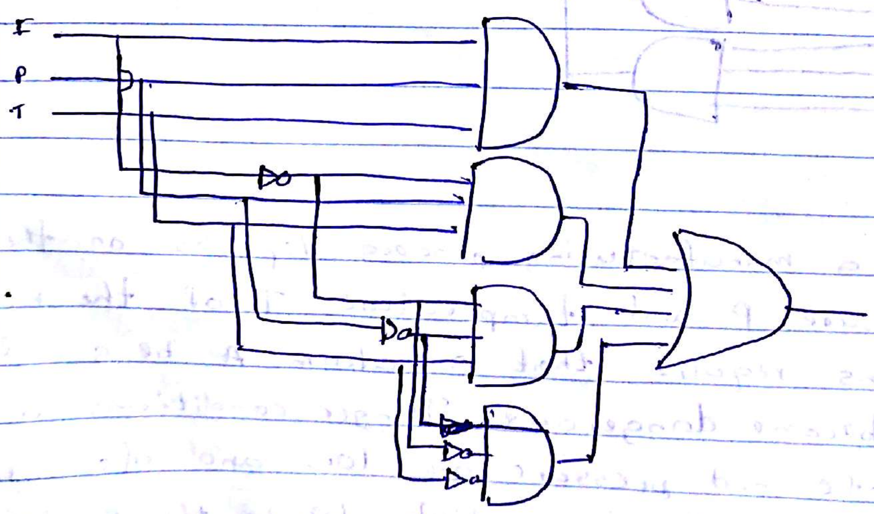
3 Step

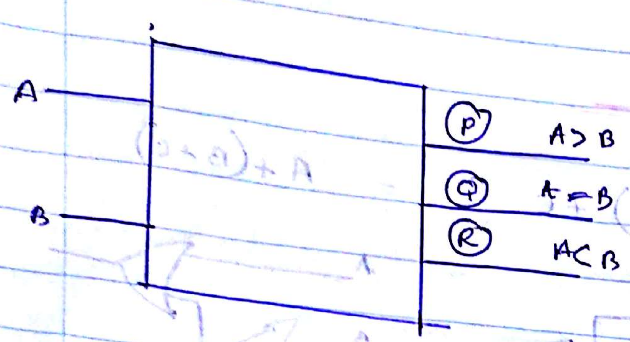
4 Step

$L = \overline{FP}T + \bar{F}PT$

✗ $L = \bar{F}\cdot\overline{PT} + \overline{FP}T + \bar{F}PT + \ldots$





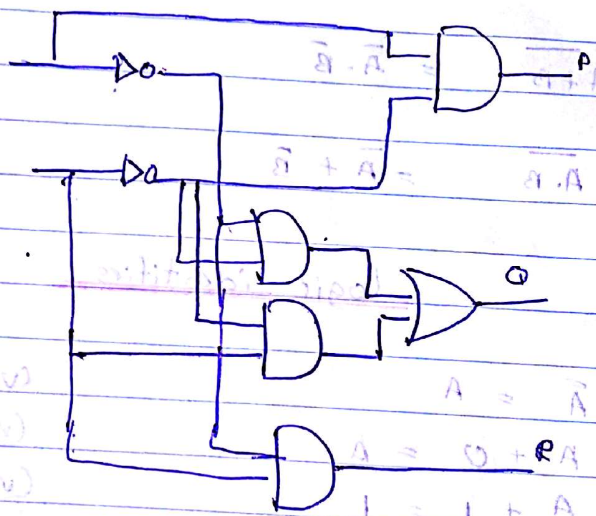


A	B	A > B (P)	A = B (Q)	A < B (R)
0	0	0	1	0
0	1	0	0	1
1	0	1	0	0
1	1	0	1	0

$P = A\bar{B}$

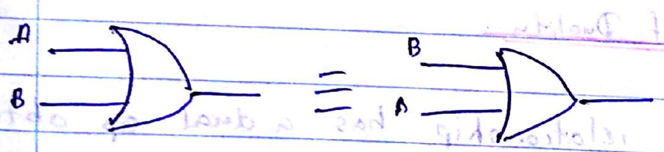
$Q = \bar{A}\bar{B} + AB$

$R = \bar{A}B$

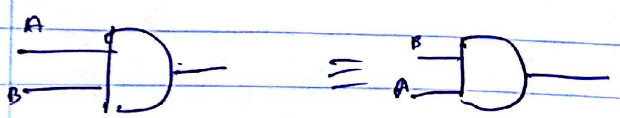


Commutative law

① $A + B = B + A$

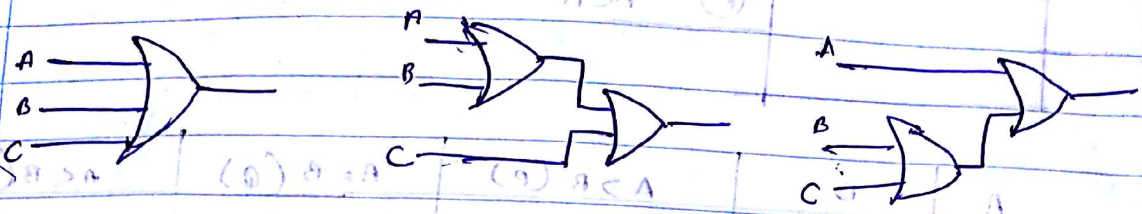


② $A \cdot B = B \cdot A$



Associate law

① $A + B + C = (A+B) + C = A + (B+C)$



Distributive law

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

De morgans Theory

① $\overline{A+B} = \bar{A} \cdot \bar{B}$

② $\overline{A \cdot B} = \bar{A} + \bar{B}$

Logic identifies

(1) $\bar{\bar{A}} = A$

(2) $A + 0 = A$

(3) $A + 1 = 1$

(4) $A + A = A$

(5) $A + \bar{A} = 1$

(vi) $A \cdot 0 = 0$

(vii) $A \cdot 1 = A$

(viii) $A \cdot A = A$

(ix) $A \cdot \bar{A} = 0$

Principal of Duality

Any theorm, law or relationship has a dual ~~op~~ obtain by replacing every occurance "+" by ".", "." by "+", "1" by "0" and "0" by "1".

Atlas

$A + 0 = A$ $\quad$ $A \cdot 0 = 0$ $\quad$ $\overline{A+B} = \bar{A} \cdot \bar{B}$

$A \cdot 1 = A$ $\quad$ $A + 1 = 1$ $\quad$ $\overline{A \cdot B} = \bar{A} + \bar{B}$

- **Boolean minimization**

$$A = \bar{F}\bar{P}\bar{T} + \bar{F}\bar{P}T + \bar{F}PT + FPT$$

$$= \bar{F}\bar{P}(\bar{T} + T) + PT(\bar{F} + F)$$

$$= \bar{F}\bar{P} + PT$$

3 - NOT
4 - Not
1 - OR

2 - NOT
2 - NOT
1 - OR

1. Using Boolean Algebra
2. Using Karnaugh Map

$AB\bar{C} + A\bar{B}C + \bar{A}BC + ABC$

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

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

$A \oplus B + AB$

Special

A	B	F
0	0	0
1	0	1
0	1	1
1	1	0

$F = A \oplus B$

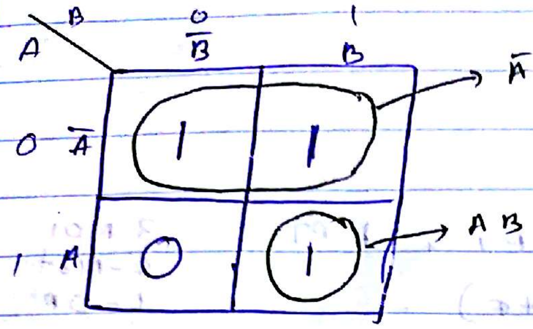
$F = \bar{A}B + \bar{B}A = A \oplus B$

A	B	F
0	0	1
1	0	0
0	1	0
1	1	1

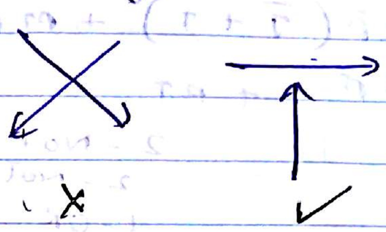
$F = \bar{A}\bar{B} + AB = \overline{A \oplus B}$

K' map method

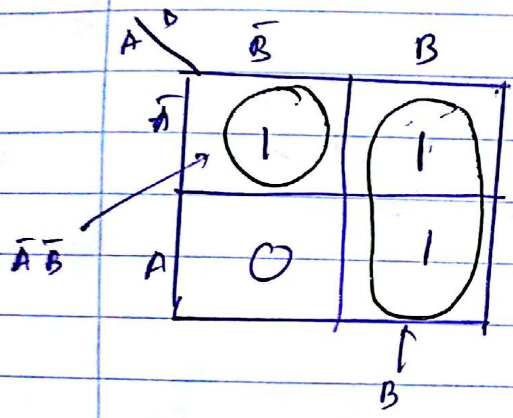
2 - varible map



• $F = \bar{A}\bar{B} + \bar{A}B + AB$



$F = \bar{A} + AB$

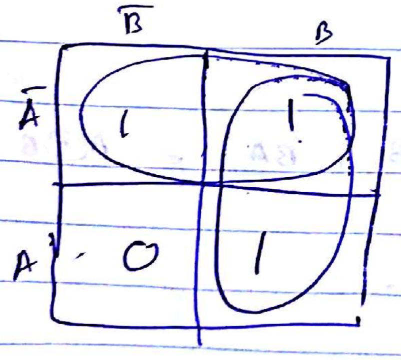


$F = B + \bar{A}\bar{B}$

Special $A + A = A$

$A + A + A = A$

In ~~Orger~~ ~~order~~ or gate we can add one ~~thing~~ thing many th..



$F = \bar{A} + B$

$F = \underbrace{\bar{A}\bar{B} + \bar{A}B}_{\bar{A}} + \underbrace{AB + \bar{A}B}_{B}$

3-variable

BC / A	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	000			
A				

- One term can cover many times, If they tell minization
- Don't cover many times, If they don't tell to do minimization

3 - varibles

① $F = \bar{A}\bar{B}\bar{C} + A\bar{B}C + \bar{A}\bar{B}C + ABC + A\bar{B}\bar{C}$

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	1	1		
A	1	1	1	

without minimization

$$F = \bar{B} + ABC$$

minization

$$F = \bar{B} + AC$$

② $F = A\bar{B}\bar{C} + \bar{A}B\bar{C} + ABC + AB\bar{C} + \bar{A}\bar{B}\bar{C}$

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	1	0	0	1
A	1	0	1	1

Consider this diagram as a cilinder

Scanned by CamScanner

(3) $F = \bar A \bar B \bar C + \bar A B \bar C + \bar A B C + \bar A \bar B C + A \bar B C + A B C$

	$\bar B \bar C$	$\bar B C$	$B C$	$B \bar C$
$\bar A$	1	1	1	1
A	0	1	1	0

$F = C + \bar A$

(4) $H = \bar A \bar B \bar C + A \bar B C + \bar A B C + A B \bar C$

	$\bar B \bar C$	$\bar B C$	$B C$	$B \bar C$
$\bar A$	1	0	1	0
A	0	1	0	1

- Cannot minimize
- Algibra method

$H = \bar A \bar B \bar C + \bar A B C + A \bar B C + A B \bar C$

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

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

4-varibles

(1) $F = \bar A \bar B \bar C \bar D + A \bar B \bar C \bar D + A B \bar C \bar D + \bar A B C \bar D + A B C \bar D$
$+ A \bar B \bar C D + \bar A B \bar C \bar D$

	$\bar C \bar D$	$\bar C D$	$C D$	$C \bar D$
$\bar A \bar B$	1	0	0	0
$\bar A B$	1	0	0	1
$A B$	1	0	0	1
$A \bar B$	1	1	0	0

$F = B\bar{D} + \bar{C}\bar{D} + A\bar{B}\bar{C}$

(2) $F = \bar{A}BCD + ABCD + ABC\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D}$
$\bar{A}\bar{B}C\bar{D} + \bar{A}B\bar{C}D$

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1	0	0	1
$\bar{A}B$	0	1	1	0
AB	0	1	1	0
$A\bar{B}$	1	0	0	1

$F = BD + \bar{B}\bar{D}$

(3) $F = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}BC + B\bar{C} + A\bar{B}C\bar{D} + ABCD$

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1	0	0	0
$\bar{A}B$	1	1	1	1
AB	1	1	1	0
$A\bar{B}$	0	0	0	1

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

4

past paper

A logic circuit has four inputs A, B, C and D had two outputs R and S simplify the output functions and S using the karnaugh map and draw the logic circuits for the simplified functions

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

CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	0	1	0
$\bar{A}B$	0	0	1	0
AB	1	1	1	0
$A\bar{B}$	1	1	1	0

$S = A\bar{C} + CD$

edges could be connected
Larger the group simpler the logic
look for groups of 2, 4, 8
Minimize using