GANDHI SCHOOL OF ENGINEERING,BHABANDHA,BERHAMPUR

TEACHING AND LEARNING MATERIAL

SUBJECT:DIGITAL ELECTRONICS& MICROPROCESSOR

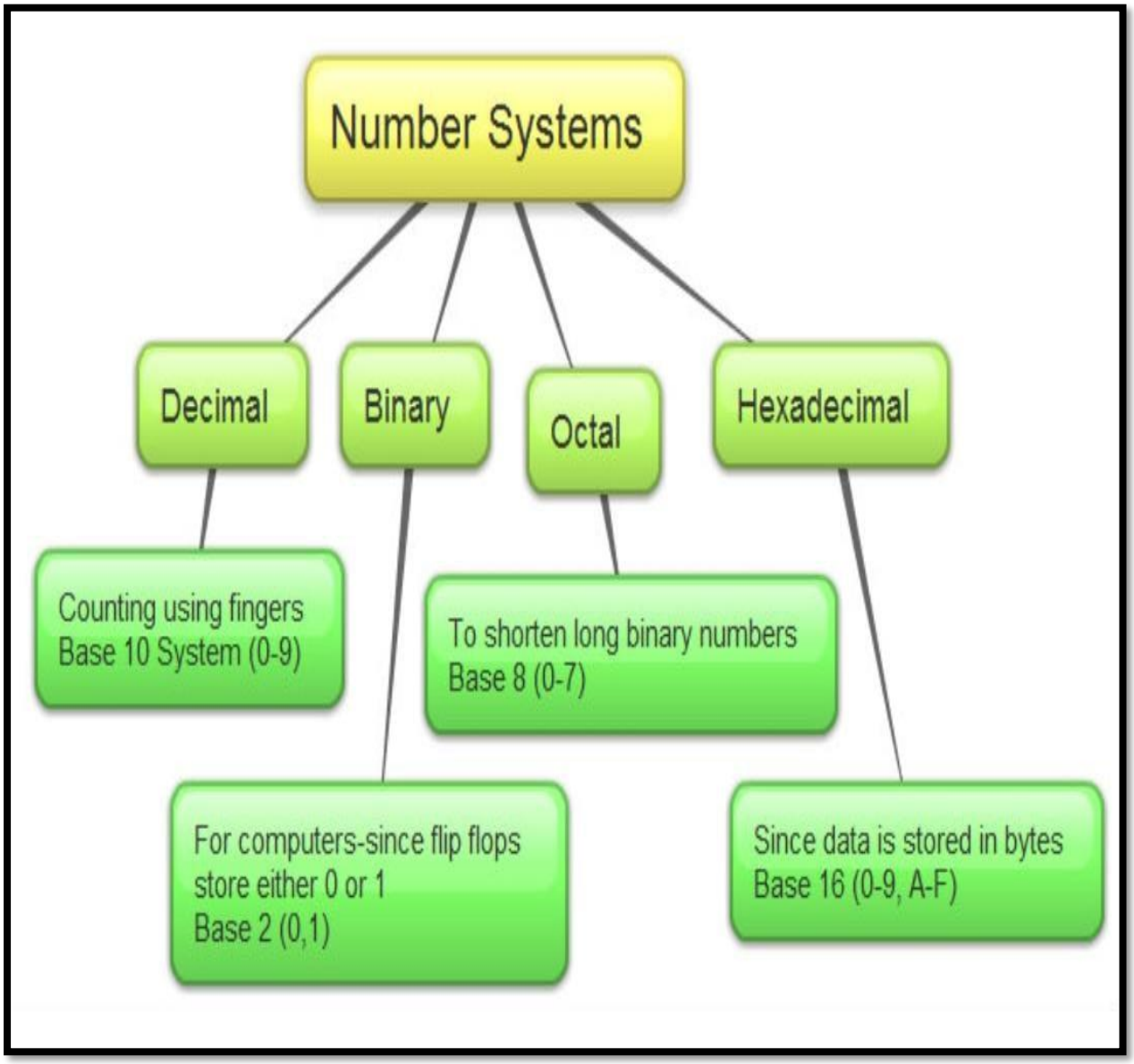
SEMESTER:5TH

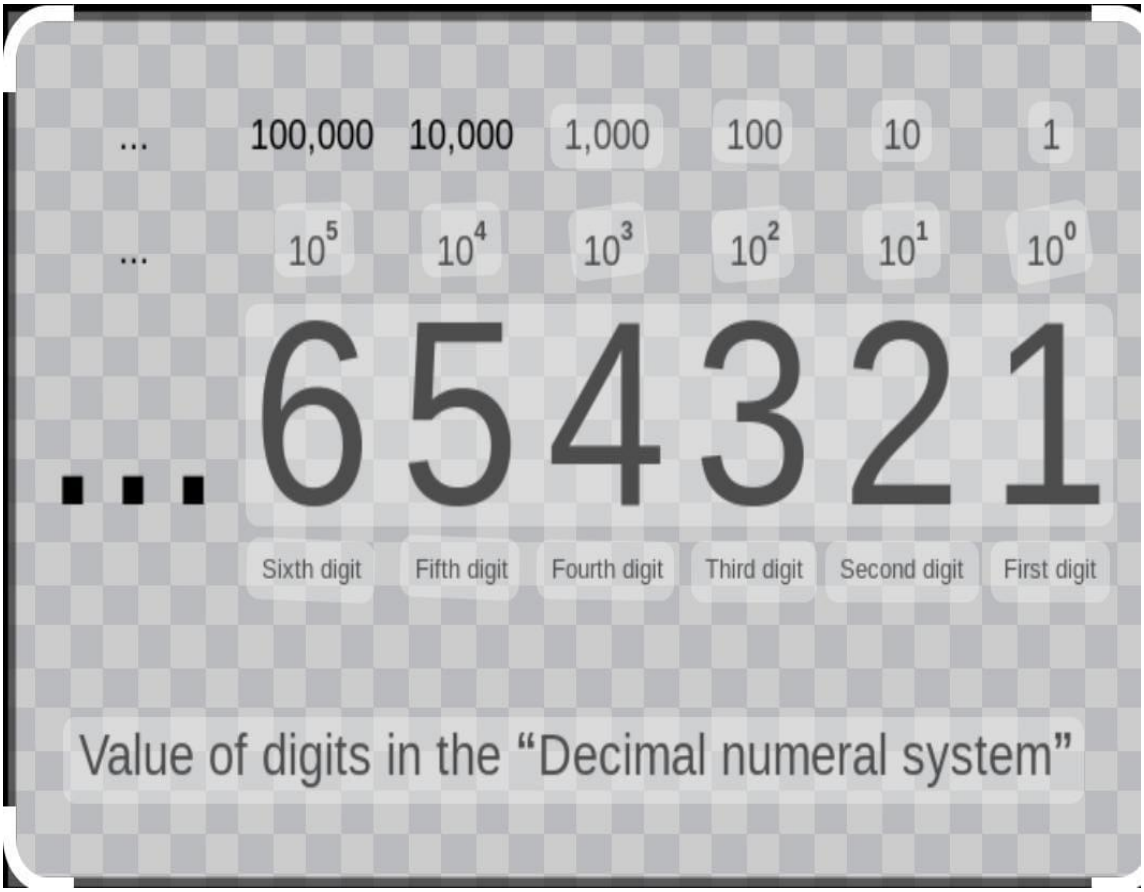
SUBMITTED BY:-

ER. LALIT NAYAK &ER.PRAGYAN PARMITA MAHUNTA

UNIT-1

NUMBER SYSTEM & CODES





Binary Number	1	0	1	1	0	1	Decimal Number
Power of base	2^5	2^4	2^3	2^2	2^1	2^0	
Decimal equivalent	32	16	8	4	2	1	
Magnitude of each term	32	0	8	4	0	1	45

Octal Number System

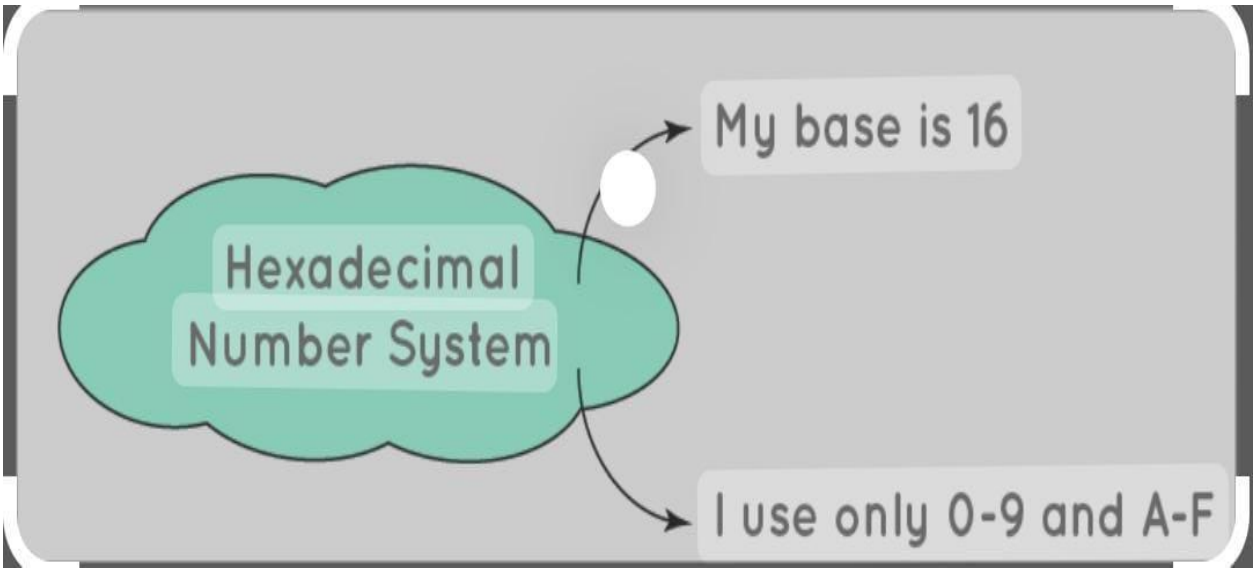
- The base is 8.
- Symbols : 0, 1, 2, 3, 4, 5, 6, and 7.
- Positional weights :

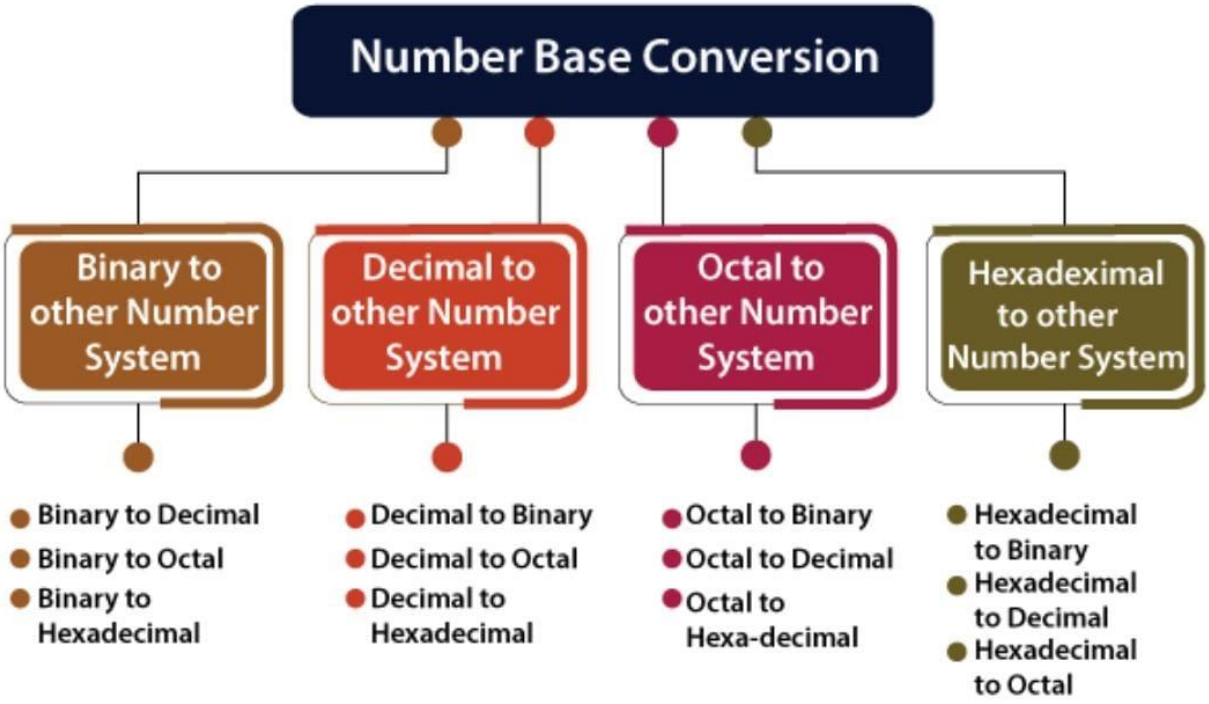
$8^0 = 1$ $\quad$ $8^{-1} = 1/8$

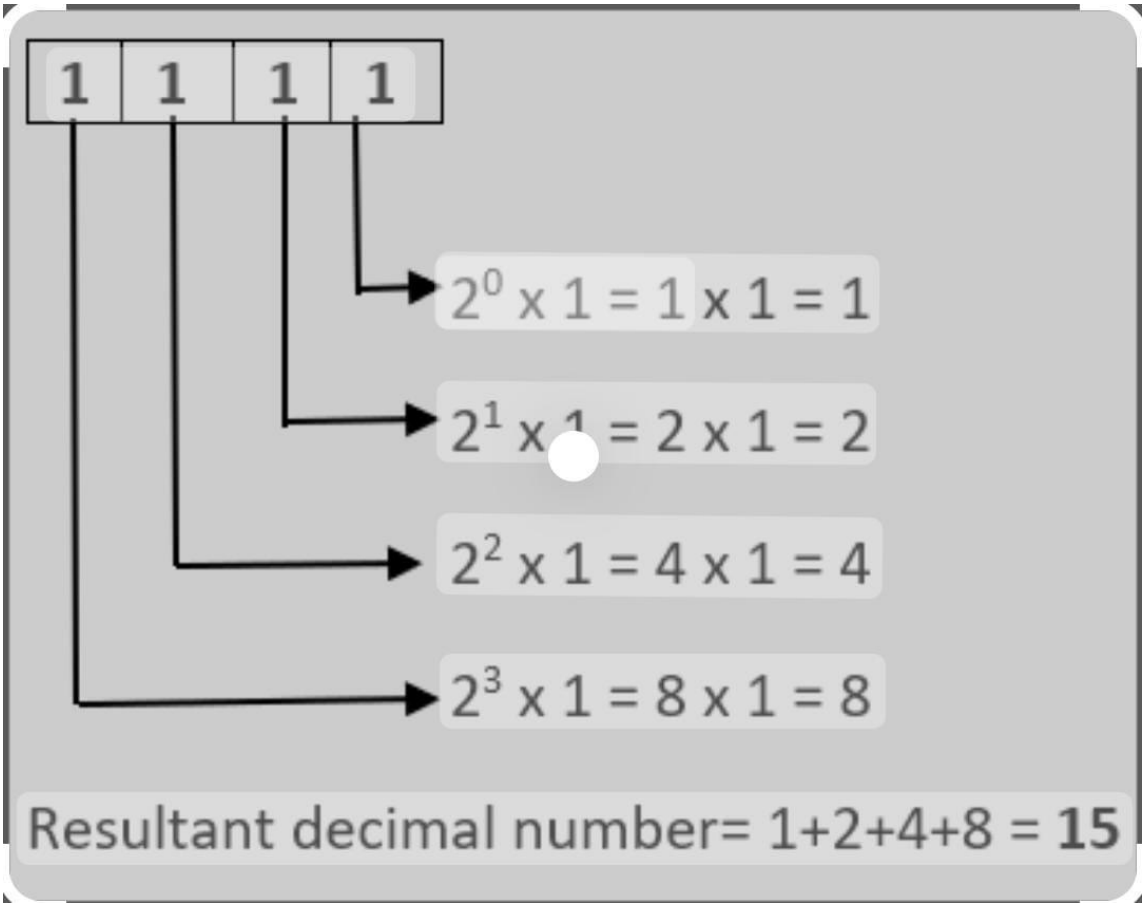
$8^1 = 8$ $\quad$ $8^{-2} = 1/64$

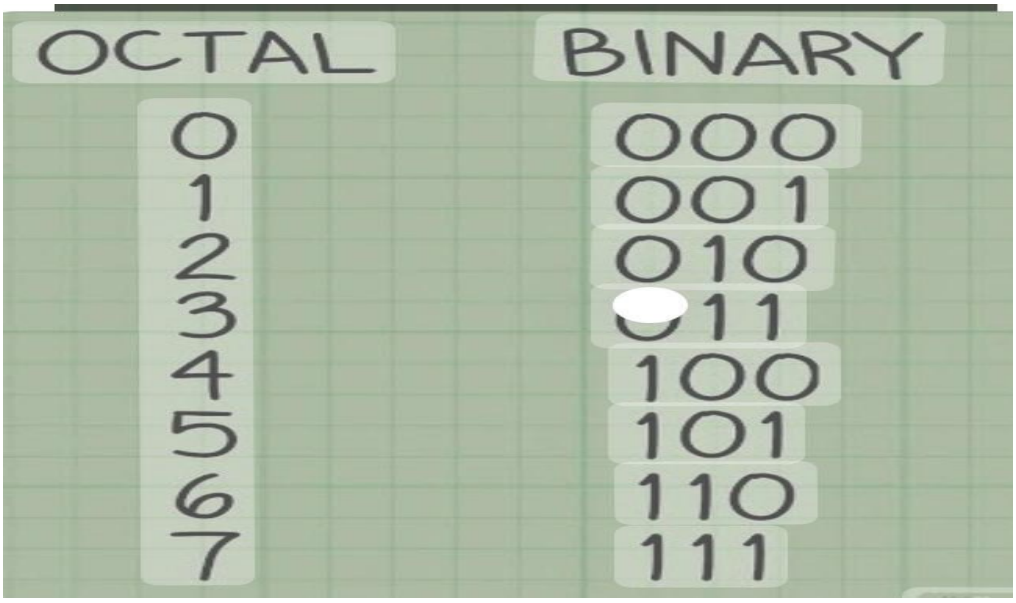
$8^2 = 64$ $\quad$ $8^{-3} = 1/256$

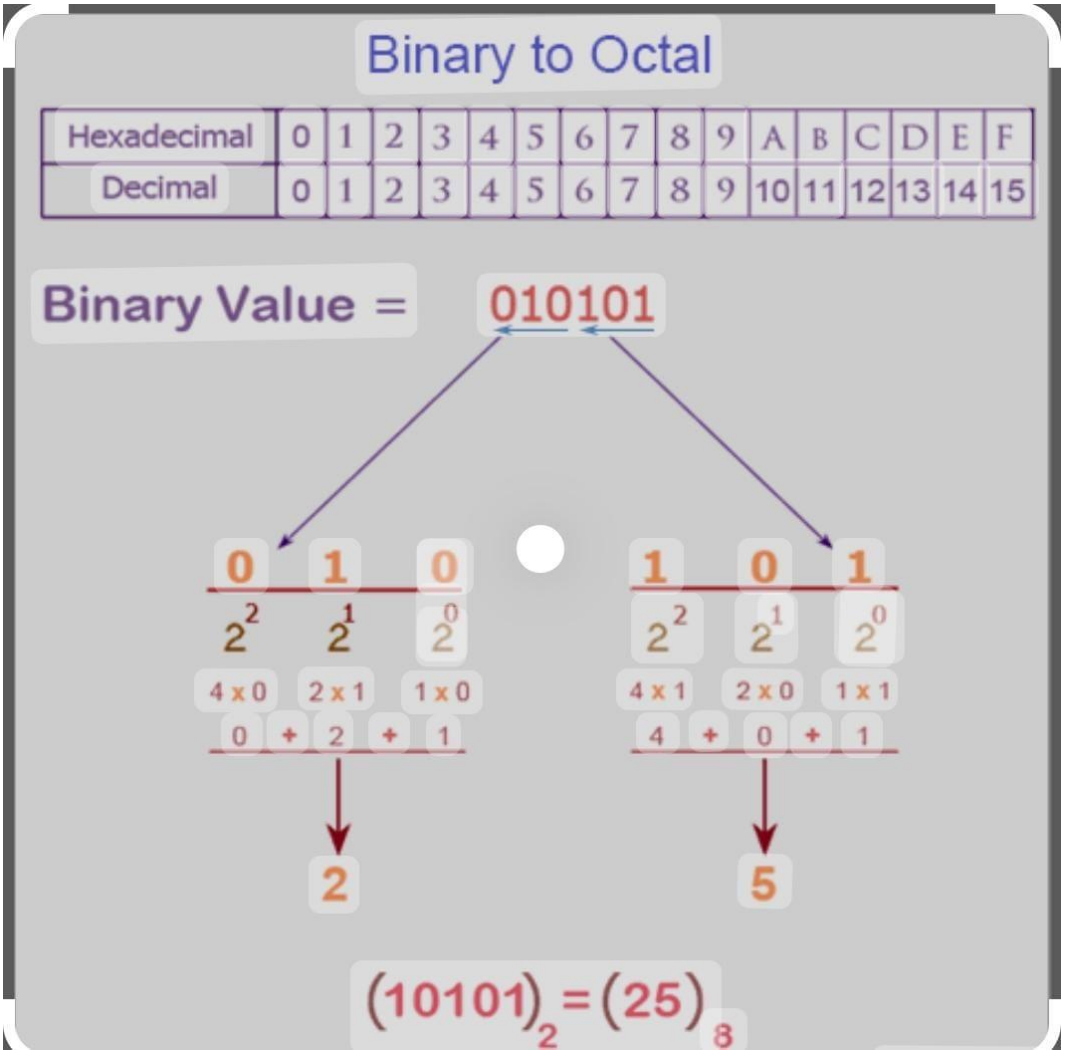
$8^3 = 256$



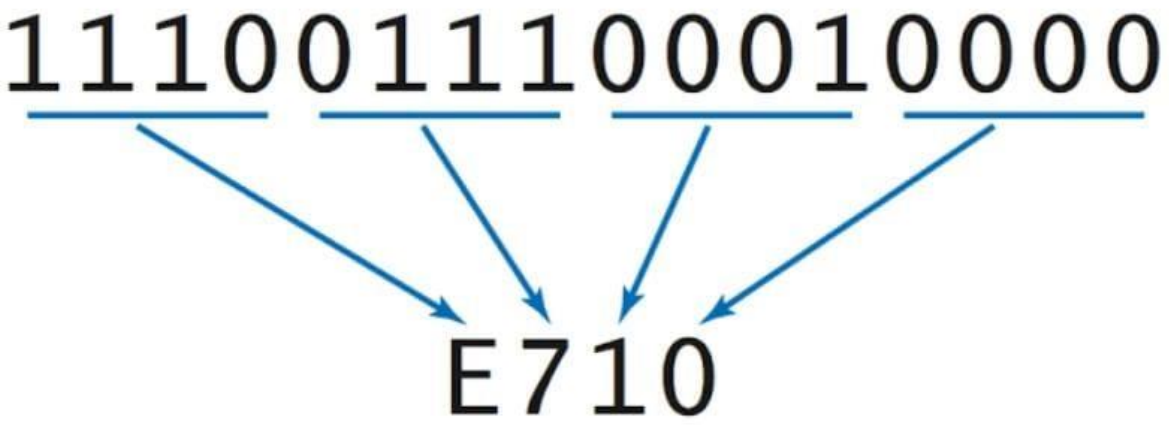

Number Base Conversion
Binary to other Number System
Decimal to other Number System
Octal to other Number System
Hexadeximal to other Number System
Binary to Decimal
Binary to Octal
Binary to Hexadecimal
Decimal to Binary
Decimal to Octal
Decimal to Hexadecimal
Octal to Binary
Octal to Decimal
Octal to Hexa-decimal
Hexadecimal to Binary
Hexadecimal to Decimal
Hexadecimal to Octal


1 1 1 1
$2^0 \times 1 = 1 \times 1 = 1$
$2^1 \times 1 = 2 \times 1 = 2$
$2^2 \times 1 = 4 \times 1 = 4$
$2^3 \times 1 = 8 \times 1 = 8$
Resultant decimal number= 1+2+4+8 = 15


OCTAL
BINARY
0 000
1 001
2 010
3 011
4 100
5 101
6 110
7 111

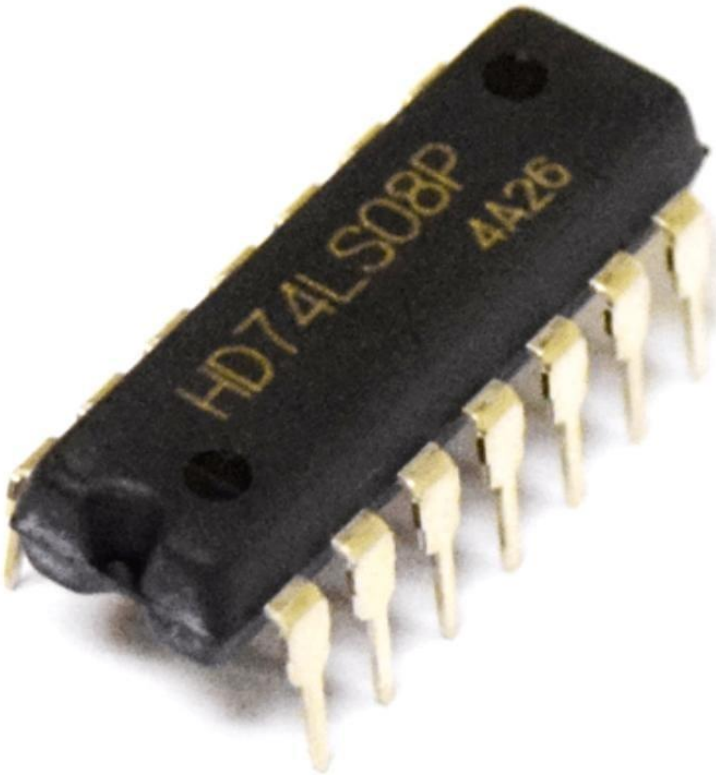

Binary to Octal
Hexadecimal 0 1 2 3 4 5 6 7 8 9 A B C D E F
Decimal 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Binary Value = 010101
0 1 0
2^2 2^1 2^0
4 x 0 2 x 1 1 x 0
0 + 2 + 1
2
1 0 1
2^2 2^1 2^0
4 x 1 2 x 0 1 x 1
4 + 0 + 1
5
$(10101)_2 = (25)_8$

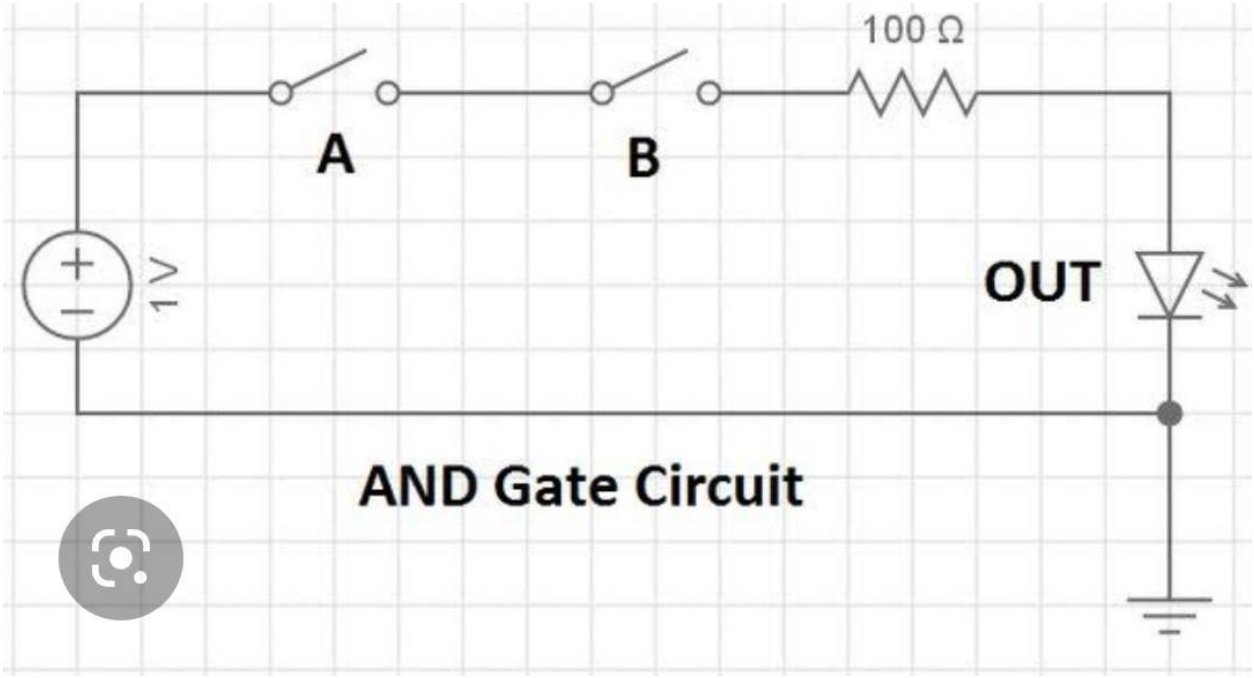
Decimal	Binary	Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F



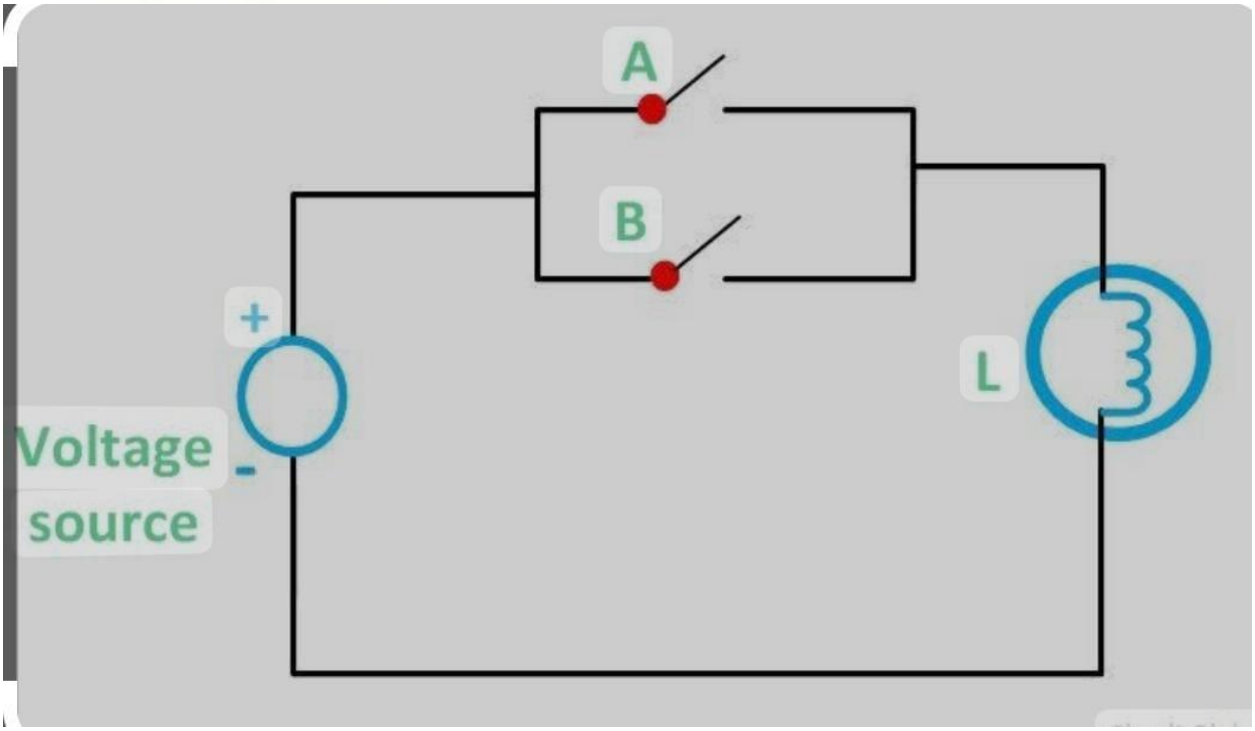
Name	Graphic symbol	Algebraic function	Truth table
AND		$F = x \cdot y$	x y | F 0 0 | 0 0 1 | 0 1 0 | 0 1 1 | 1
OR		$F = x + y$	x y | F 0 0 | 0 0 1 | 1 1 0 | 1 1 1 | 1
Inverter		$F = x'$	x | F 0 | 1 1 | 0
Buffer		$F = x$	x | F 0 | 0 1 | 1
NAND		$F = (xy)'$	x y | F 0 0 | 1 0 1 | 1 1 0 | 1 1 1 | 0
NOR		$F = (x + y)'$	x y | F 0 0 | 1 0 1 | 0 1 0 | 0 1 1 | 0
Exclusive-OR (XOR)		$F = xy' + x'y$ $= x \oplus y$	x y | F 0 0 | 0 0 1 | 1 1 0 | 1 1 1 | 0
Exclusive-NOR or equivalence		$F = xy + x'y'$ $= (x \oplus y)'$	x y | F 0 0 | 1 0 1 | 0 1 0 | 0 1 1 | 1

2-input AND gate



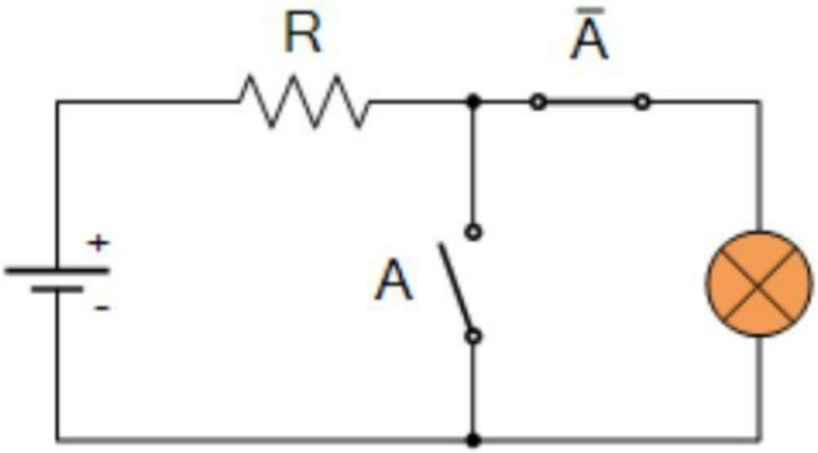


2-input OR gate



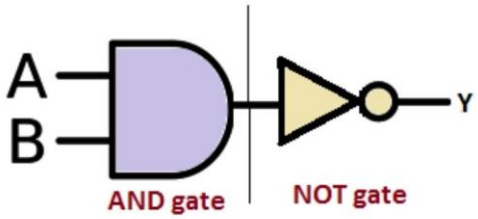
NOT gate

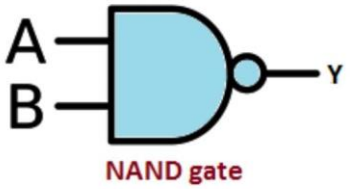
NOT Gate

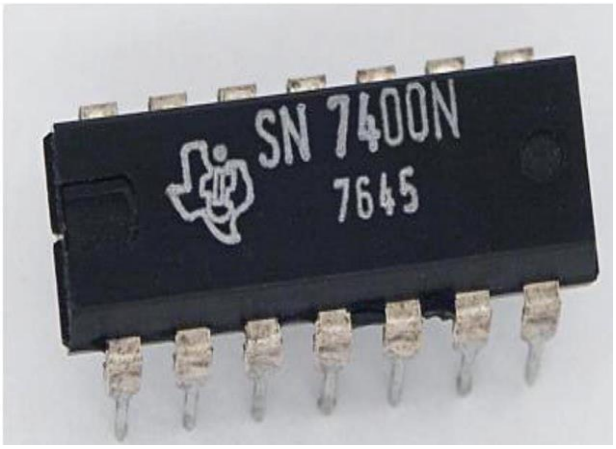


Switch A – Open = "0", Lamp – ON = "1"
Switch A – Closed = "1", Lamp – OFF = "0"

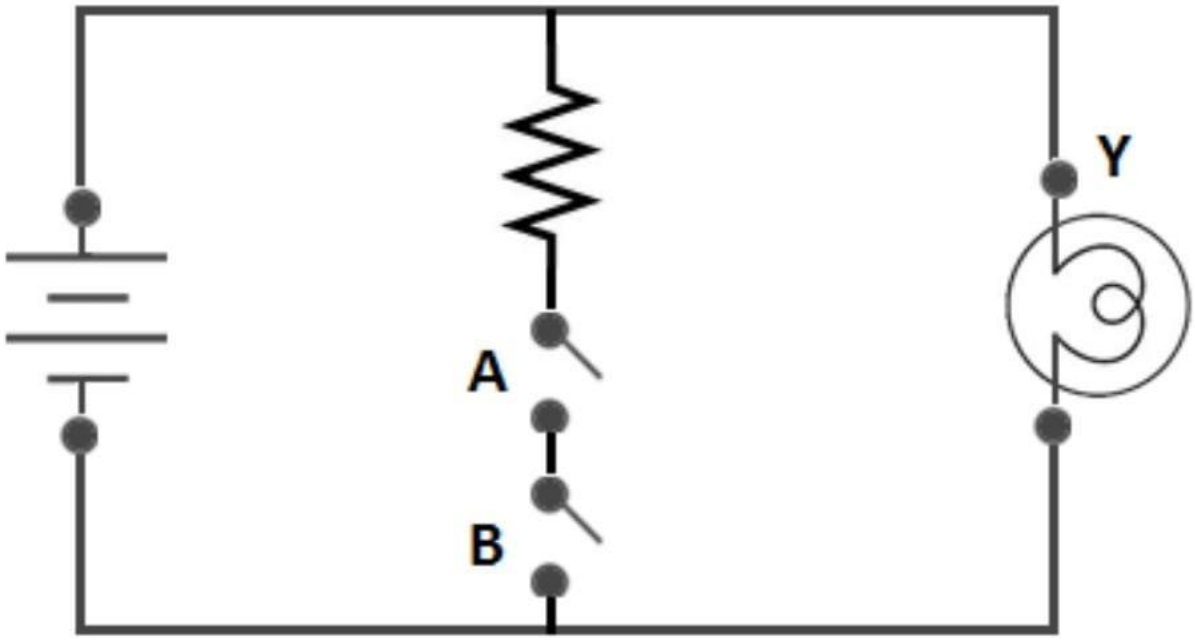
NAND GATE





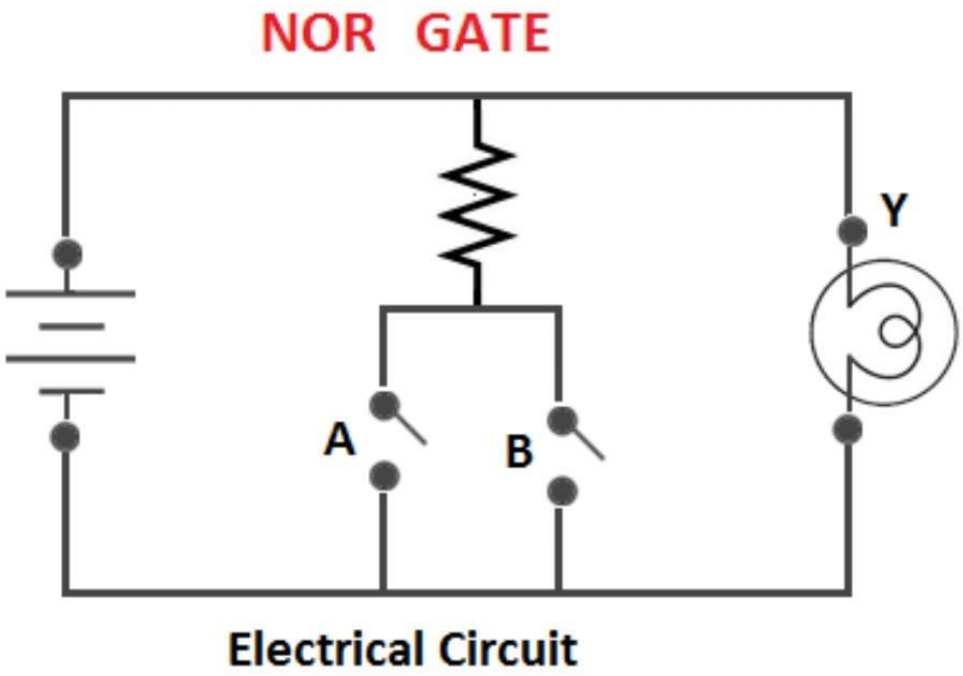


NAND GATE



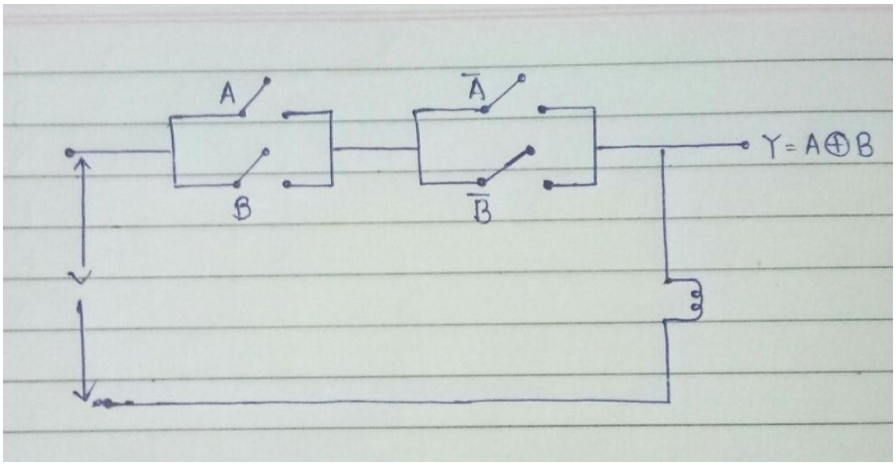
Electrical Circuit

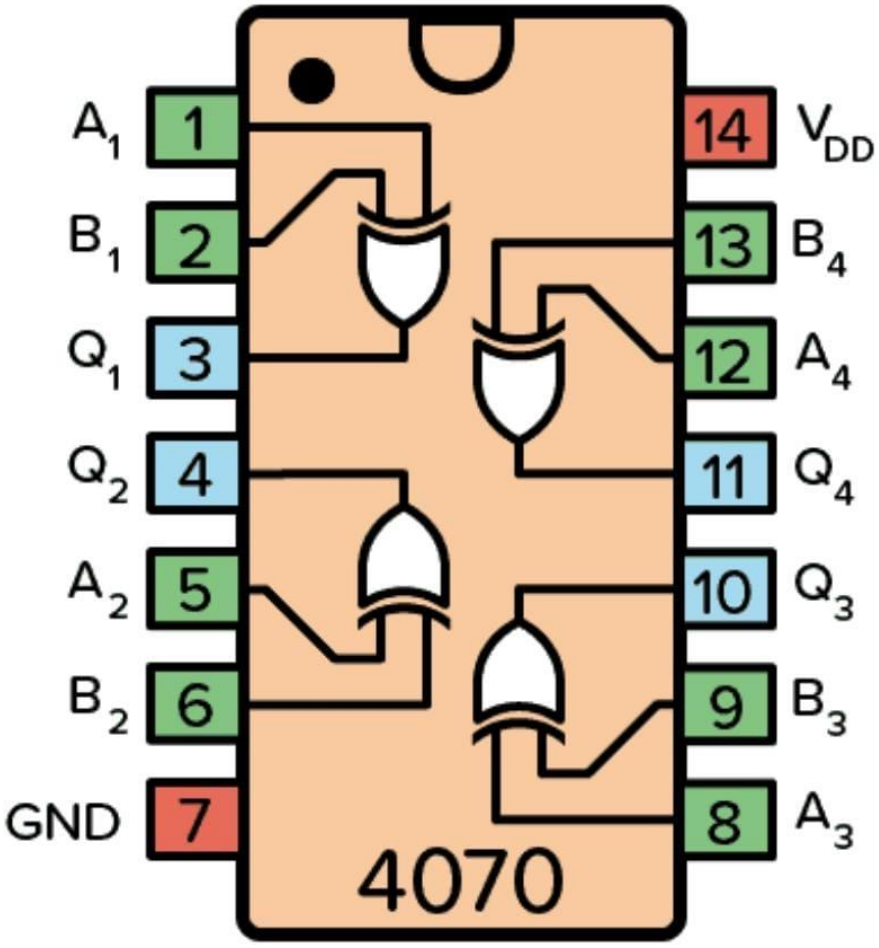
NOR GATE



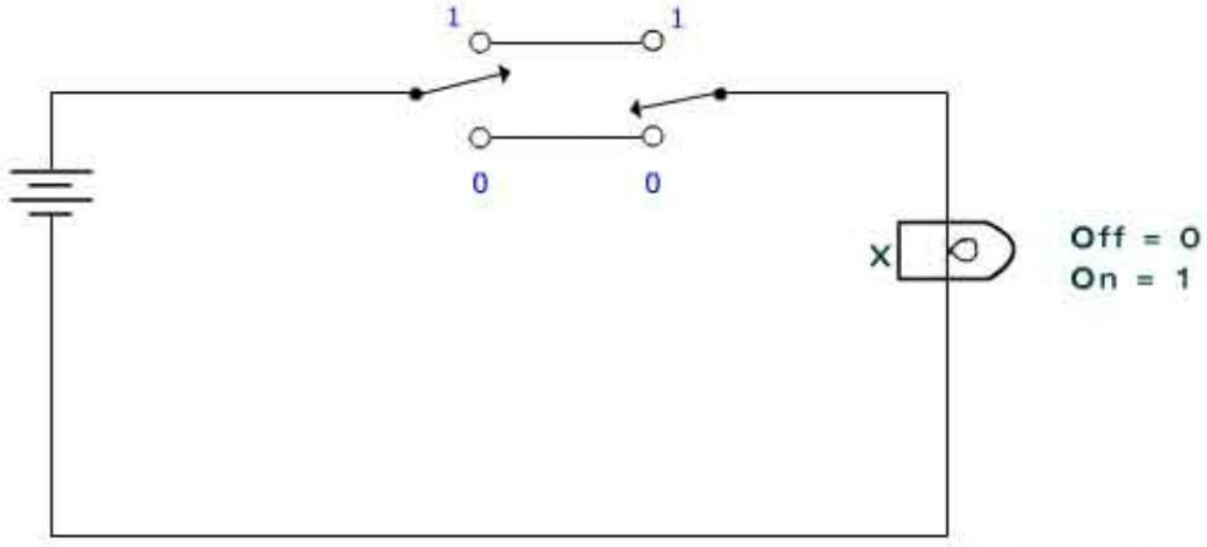
NOR Gate DIP14

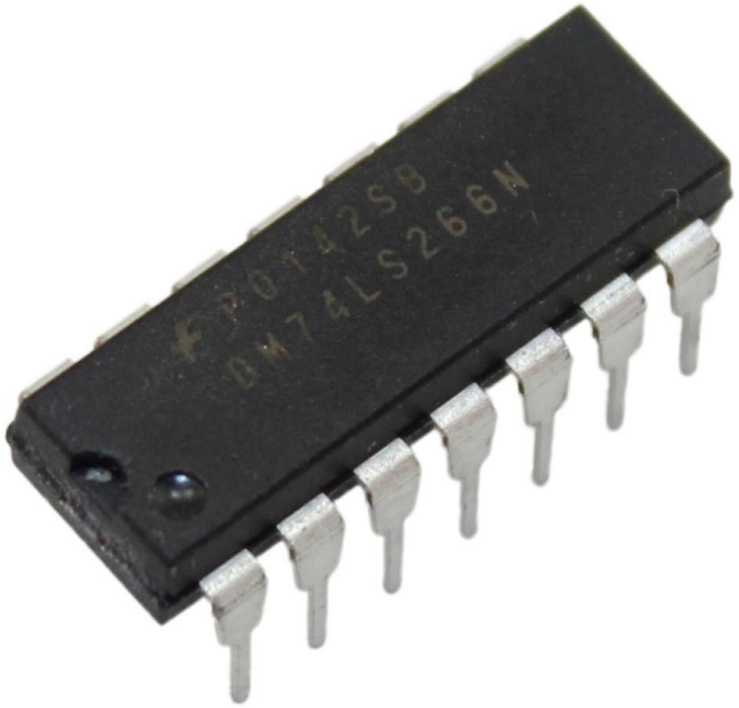
EX-OR GATE


A
B
$\bar{A}$
$\bar{B}$
Y = A⊕B


A1 1
B1 2
Q1 3
Q2 4
A2 5
B2 6
GND 7
14 VDD
13 B4
12 A4
11 Q4
10 Q3
9 B3
8 A3
4070

EX-NOR GATE





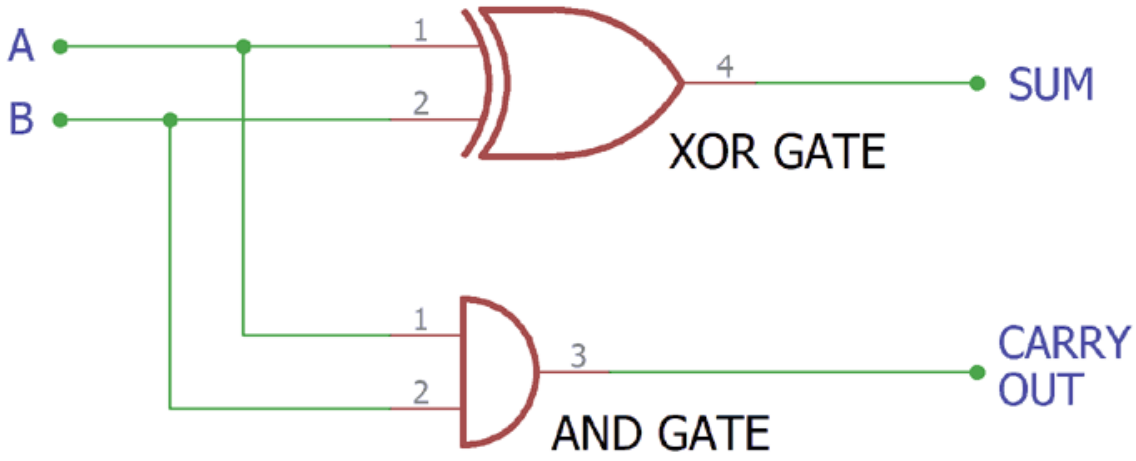
UNIT-2

COMBINATIONAL CIRCUITS

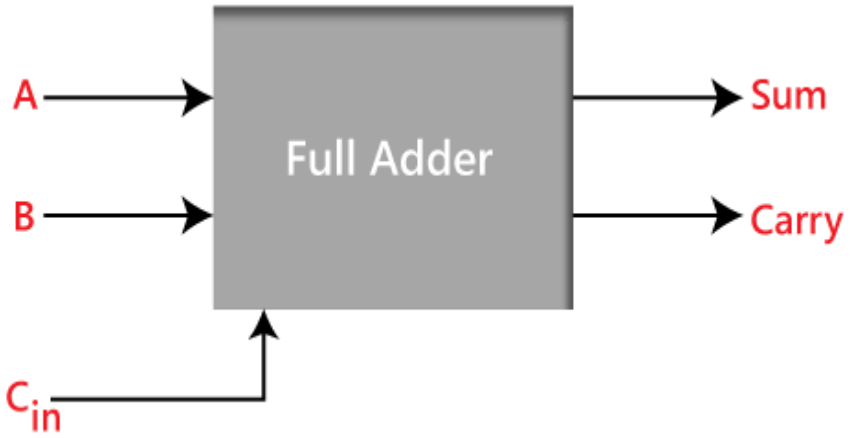

A
B
C
n
Combinational circuit
A'
B'
C'
m

HALF ADDER

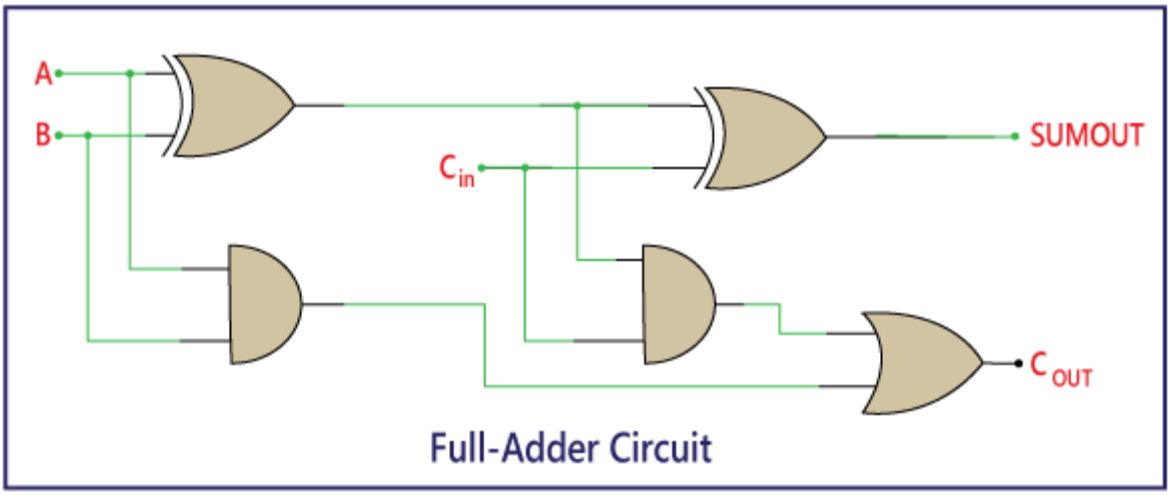

A
INPUT
B
Half-Adder Circuit
Sum
OUTPUT
Carry Out

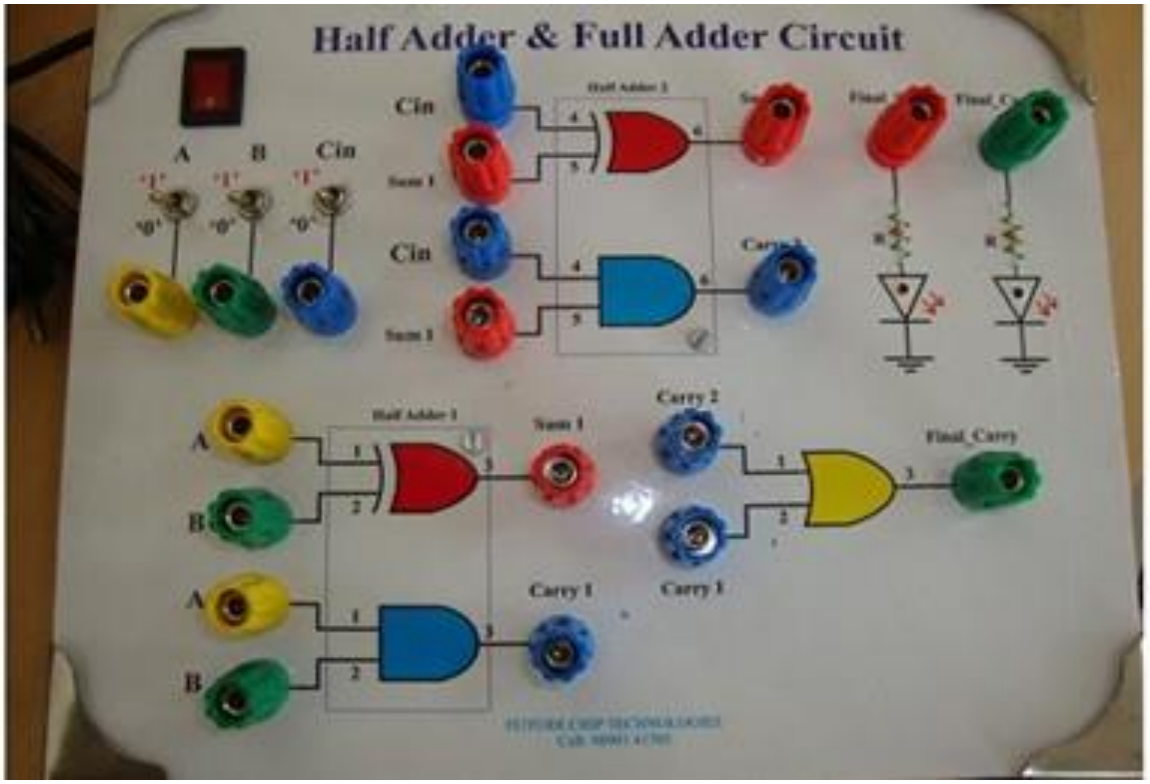

A
B
1
2
4
SUM
XOR GATE
1
2
3
CARRY OUT
AND GATE

Truth Table			
Input		Output	
A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

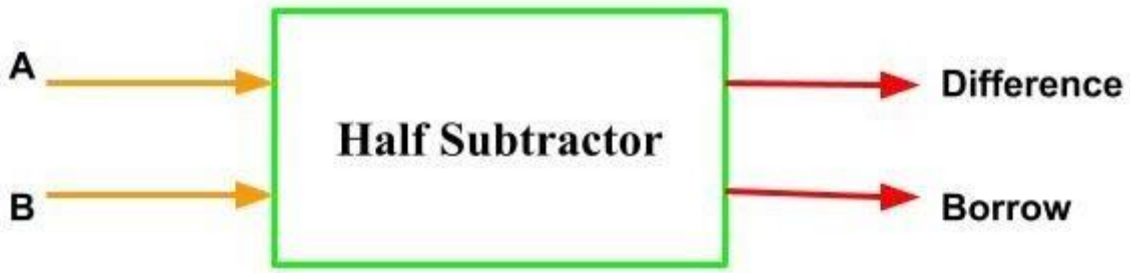


Inputs			Outputs	
A	B	C_{in}	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

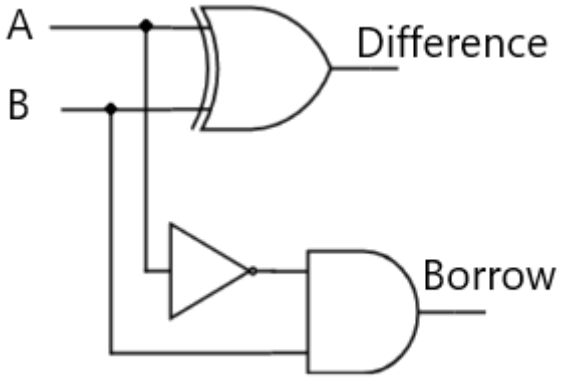




HALF SUBTRACTOR

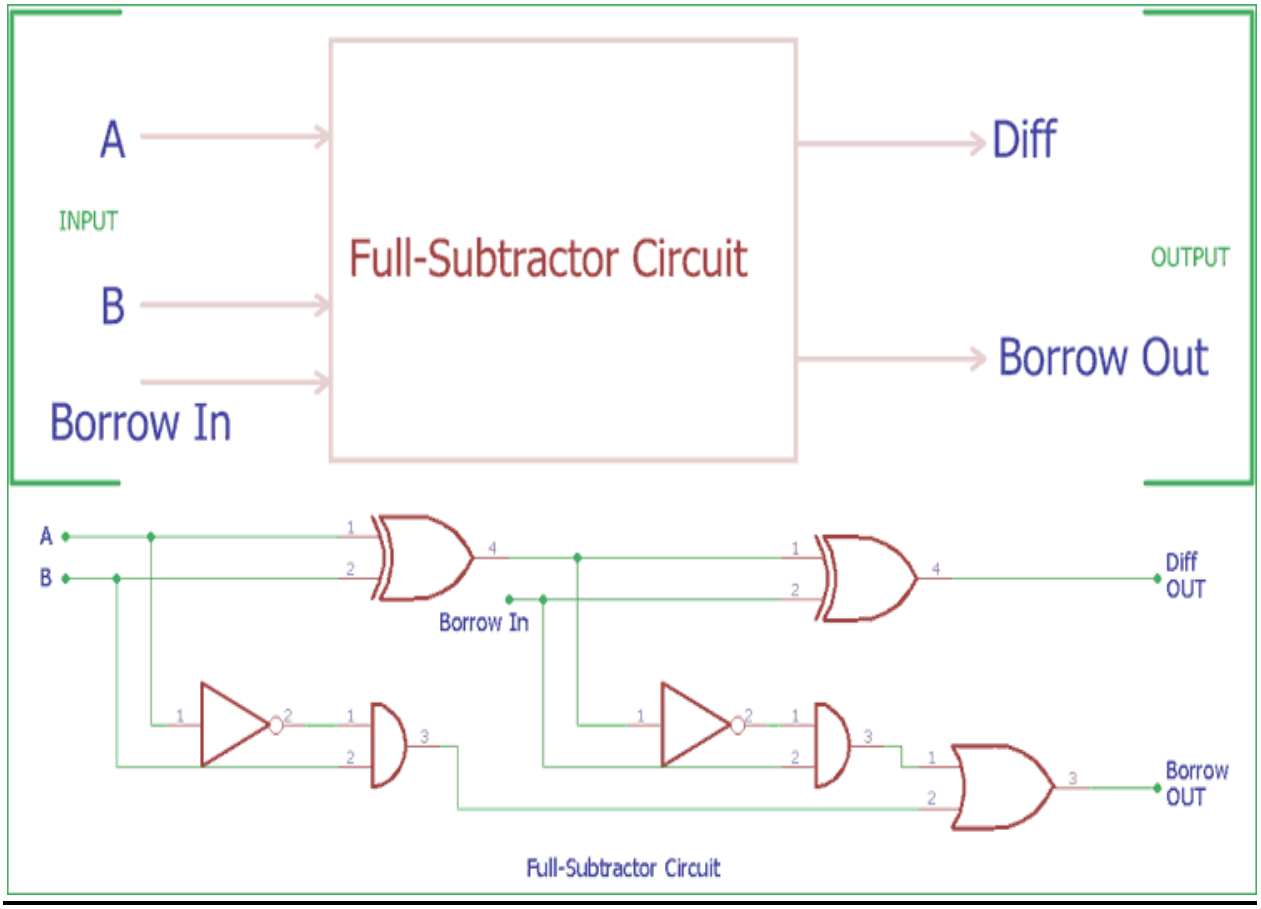


Inputs		Outputs	
A	B	Difference	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

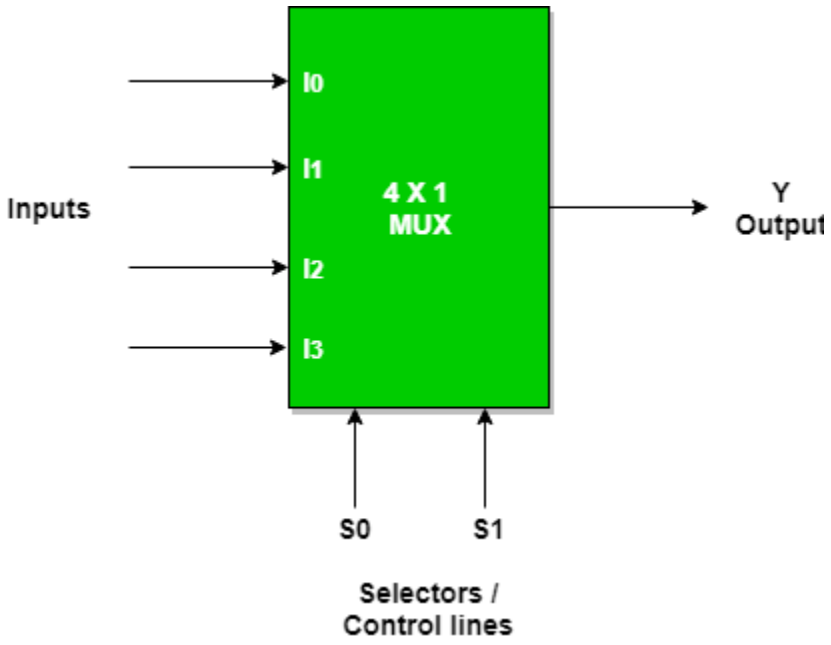


FULL SUBTRACTOR

Full Subtractor-Truth Table				
Input			Output	
A	B	C	Difference	Borrow
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1
www.flintgroups.com				

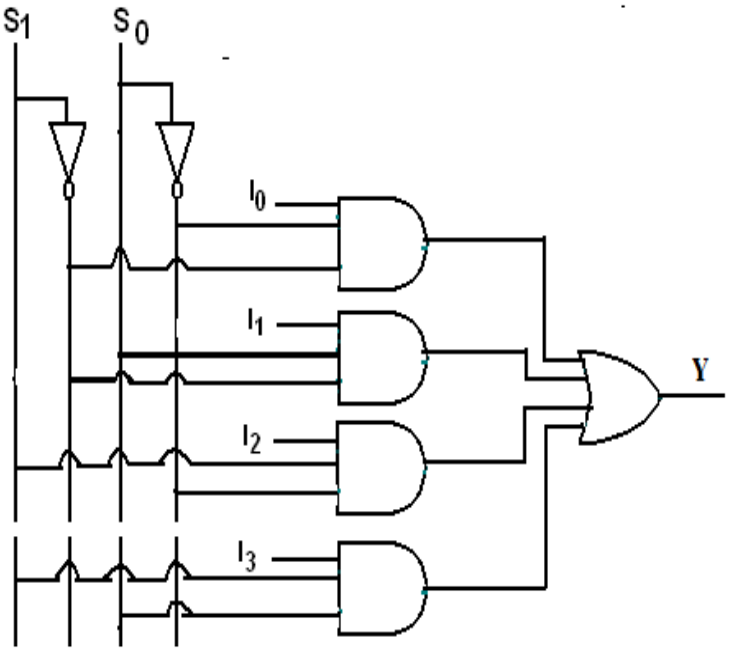


4:1 MULTIPLEXER



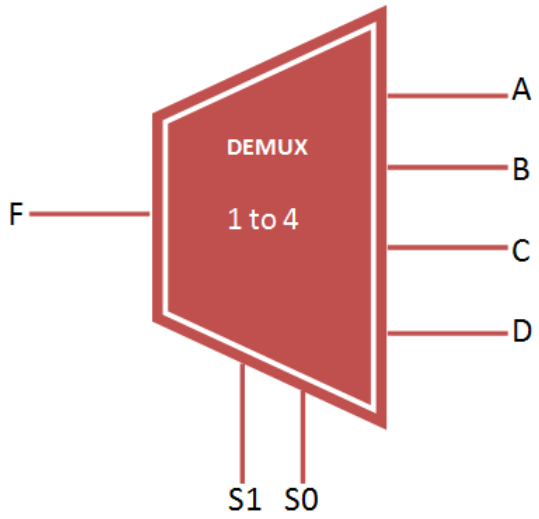
Input	S1	S0	Y
I_0	0	0	I_0
I_1	0	1	I_1
I_2	1	0	I_2
I_3	1	1	I_3

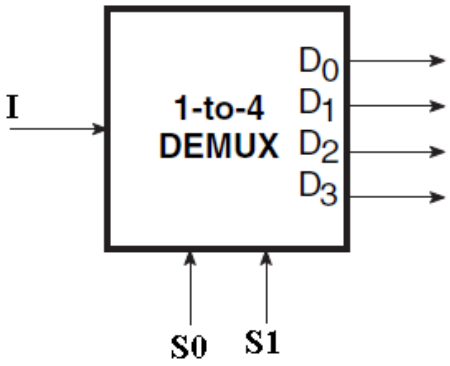
$$Y = S_1 S_0 I_3 + S_1 \overline{S_0} I_2 + \overline{S_1} S_0 I_1 + \overline{S_1}\,\overline{S_0} I_0$$



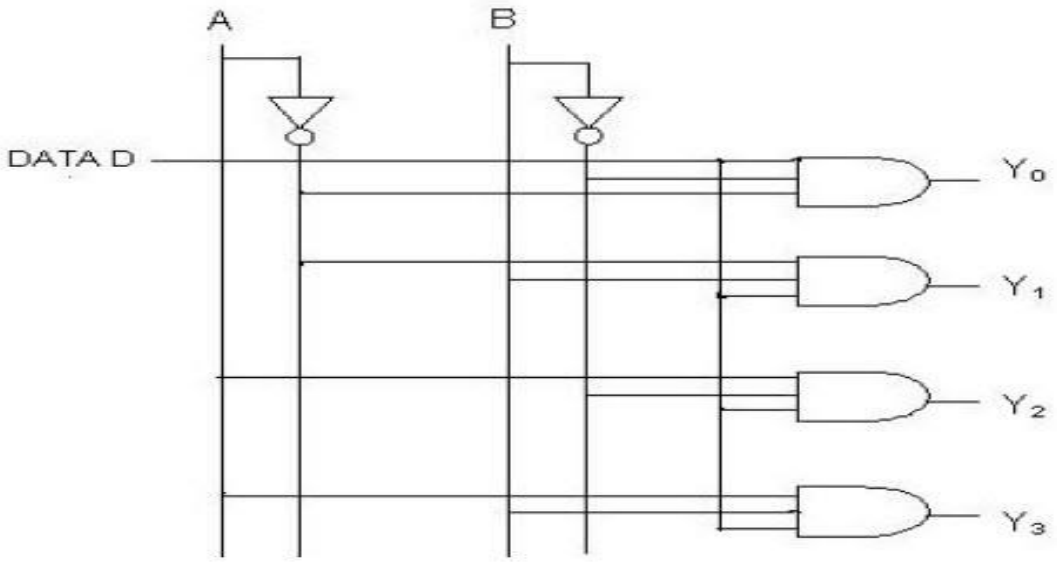
4 to 1 Multiplexer and its truth table

1:4 DEMULTIPLEXER

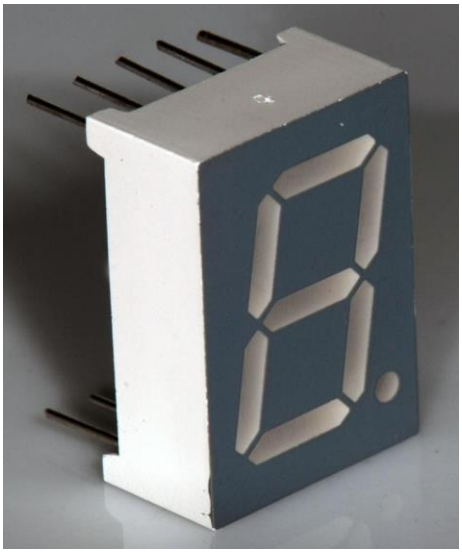


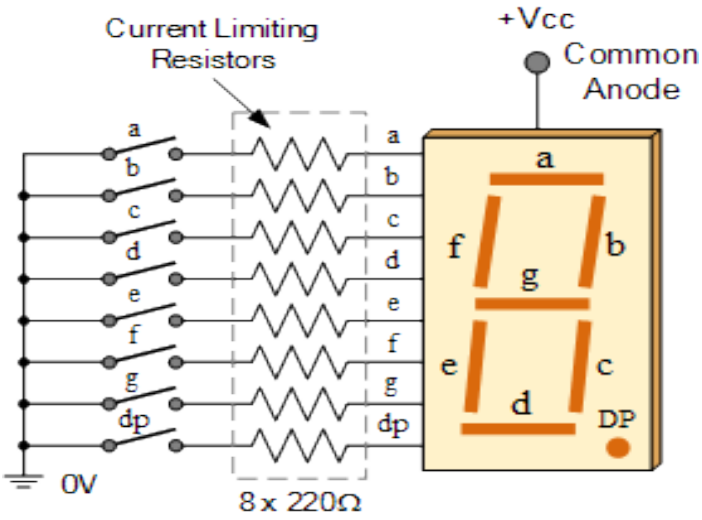


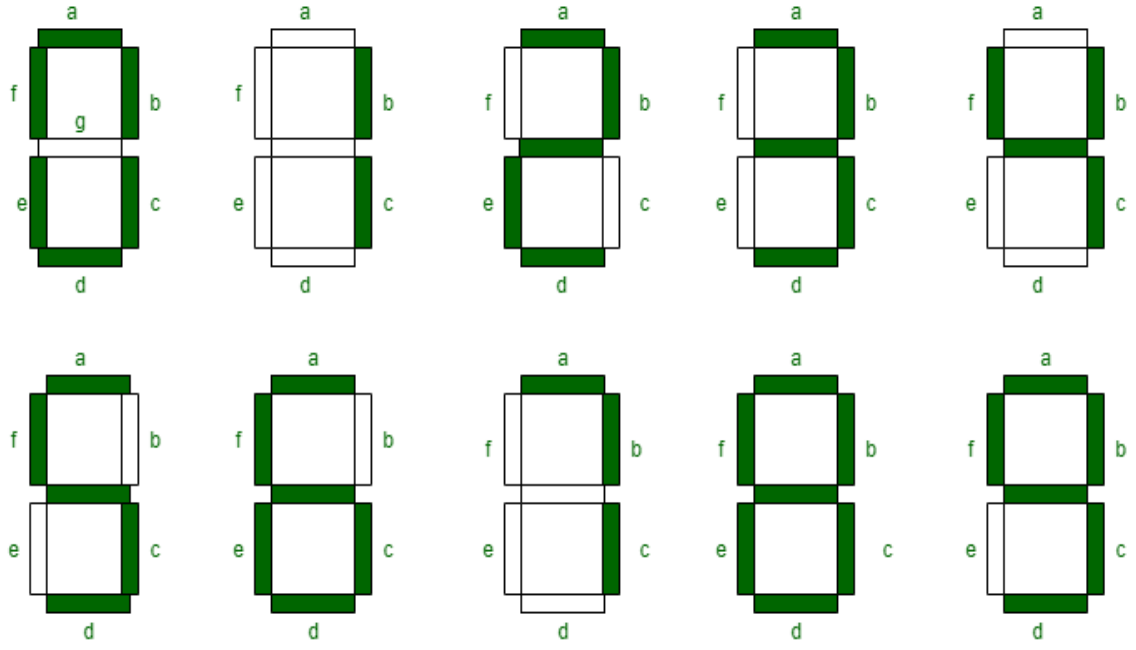
I	Select		O/P			
	S0	S1	D_0	D_1	D_2	D_3
1	0	0	1	0	0	0
1	0	1	0	1	0	0
1	1	0	0	0	1	0
1	1	1	0	0	0	1



7 SEGMENT DISPLAY

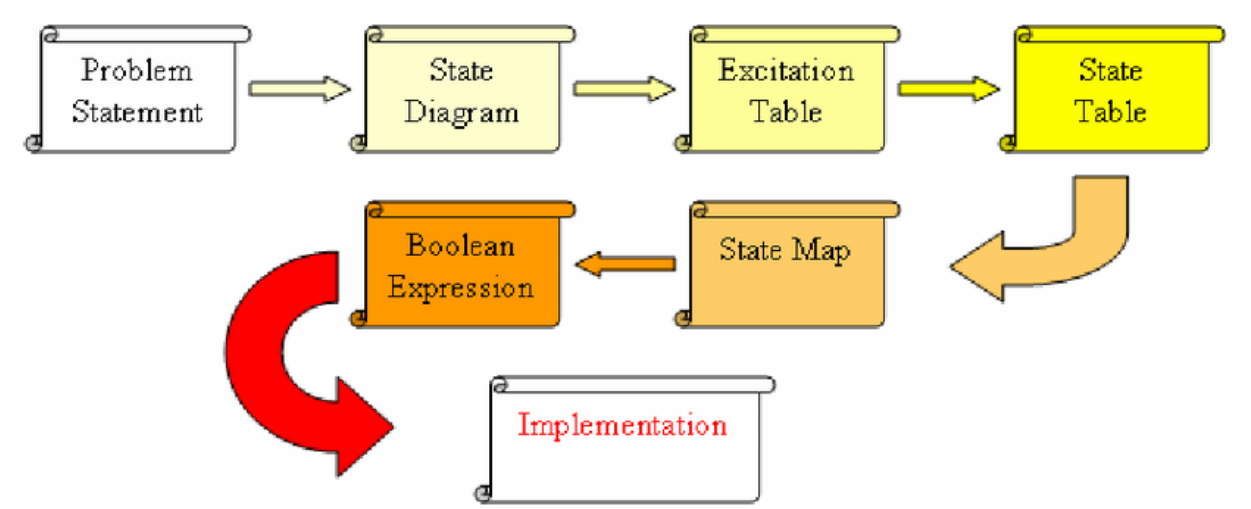


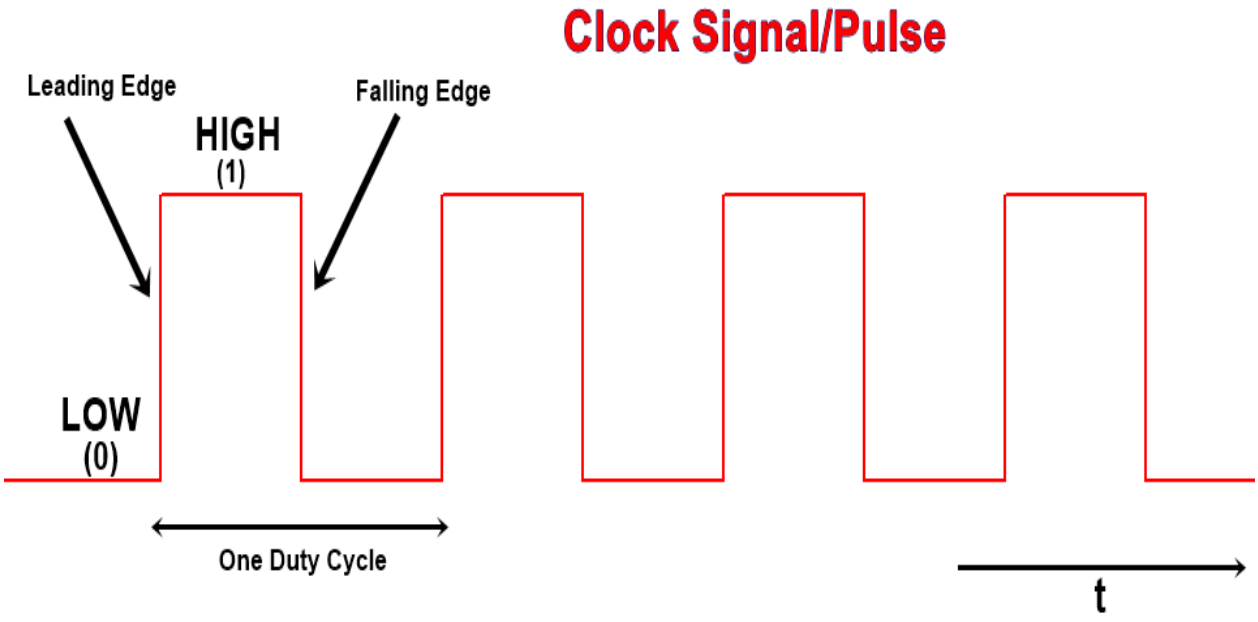




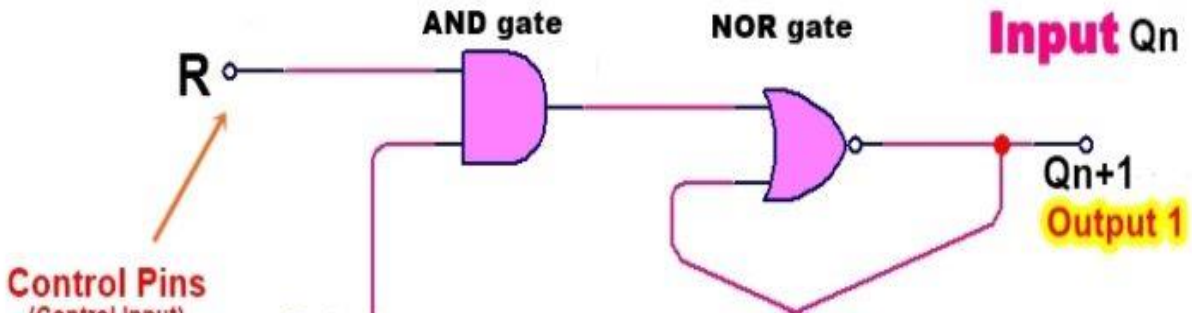
UNIT-3

SEQUENTIAL CIRCUIT



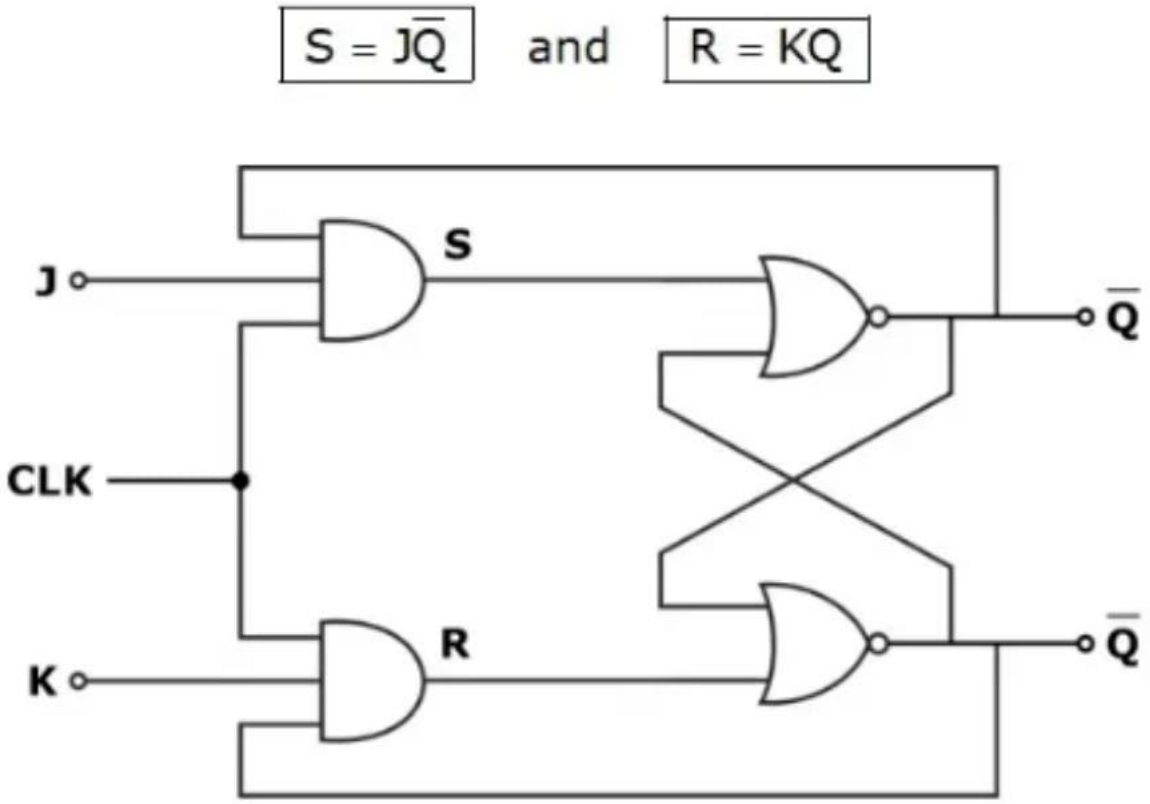


SR Flip-Flop

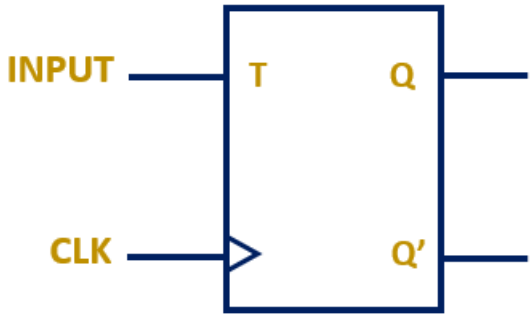


State	S	R	Q	Q'	Description
Set	1	0	0	1	Set Q'>>1
	1	1	0	1	No change
Reset	0	1	1	0	Reset Q'>>0
	1	1	1	0	No change
Invalid	0	0	1	1	Invalid Condition

JK Flip-Flop

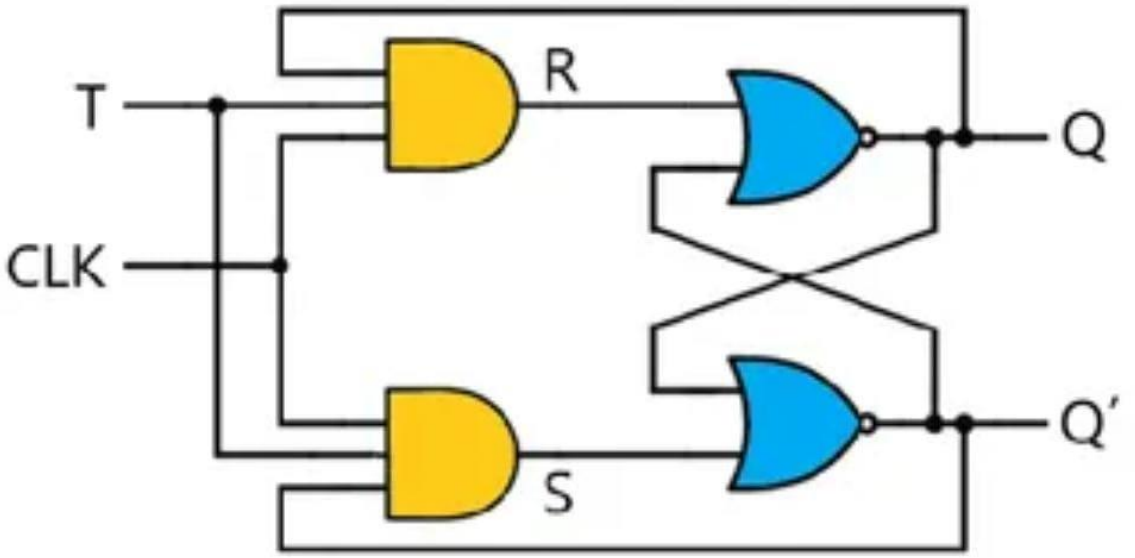


T Flip-Flop

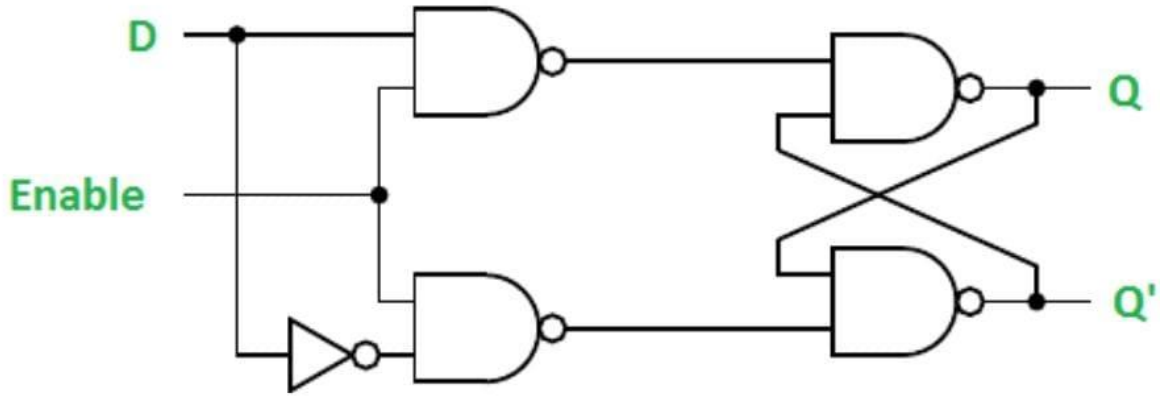


Clock	J	K	Q_{n+1}	State
0	x	x	Q_n	
1	0	0	Q_n	Hold
1	0	1	0	Reset
1	1	1	1	Set
1	1	1	$\overline{Q}_n$	Toggle

T FLIP-FLOP



D FLIP-FLOP



Truth Table for the D-type Flip Flop

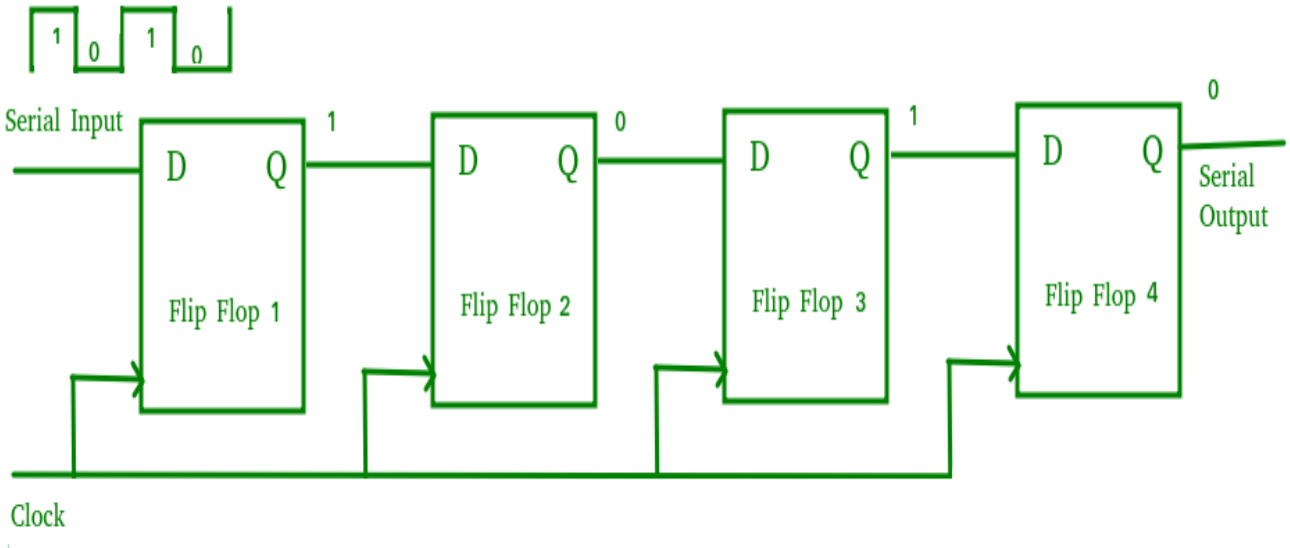
Clock	D	Q	Q'	Description
↓ » 0	X	Q	Q'	Memory no change
↑ » 1	0	0	1	Reset Q » 0
↑ » 1	1	1	0	Set Q » 1

Symbols ↓ and ↑ indicates the direction of the clock pulse. D-type flip flop assumed these symbols as edge-triggers.

UNIT-4:

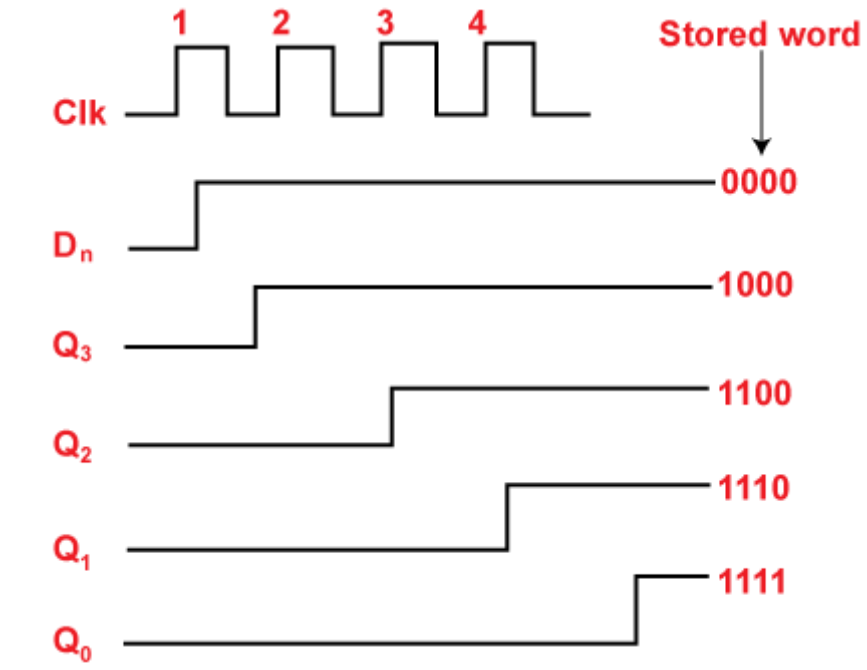
REGISTERS, MEMORIES & PLD

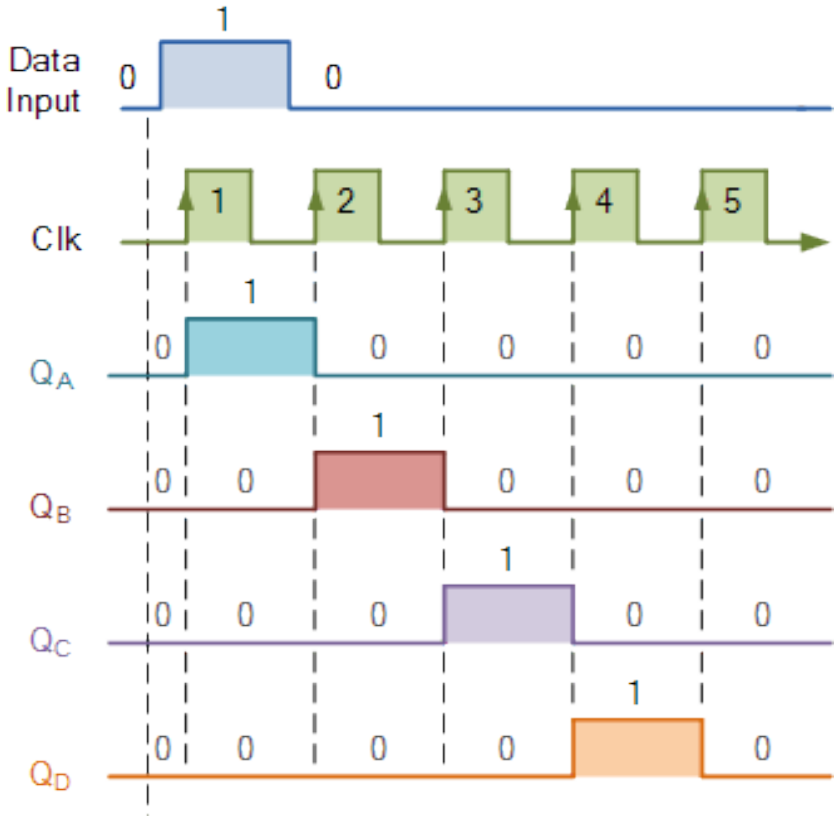
SERIAL IN SERIAL OUT



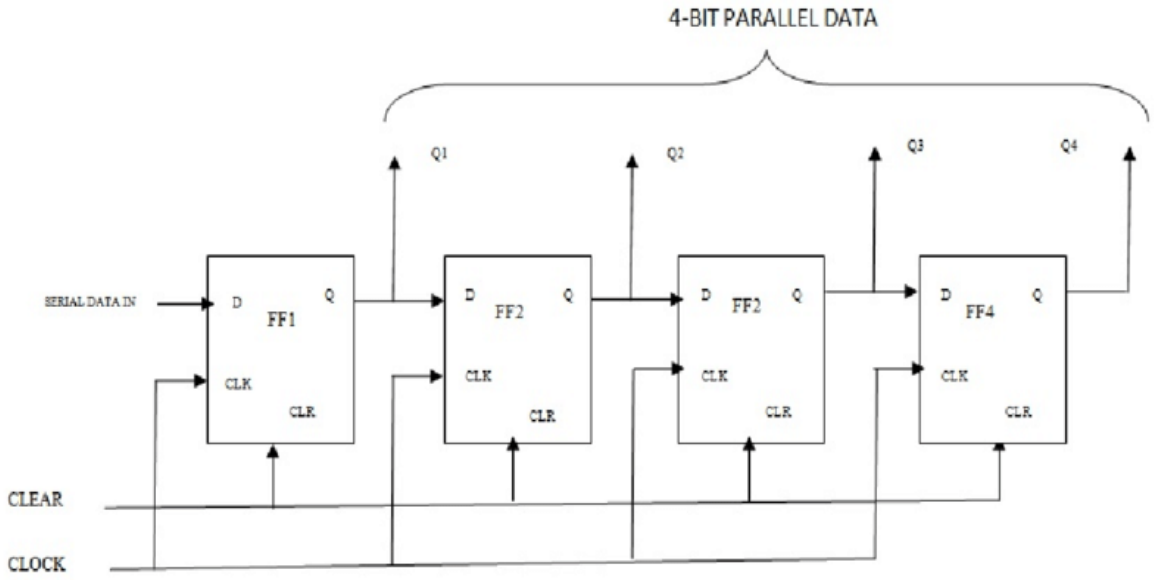
	Clk	$D_n=Q_3$	$Q_3=D_2$	$Q_2=D_1$	$Q_1=D_0$	Q_0
Initially			0	0	0	0
(1)	↓	1 →	1	0	0	0
(2)	↓	1 →	1	1	0	0
(3)	↓	1 →	1	1	1	0
(4)	↓	1 →	1	1	1	1

→ Direction of data travel

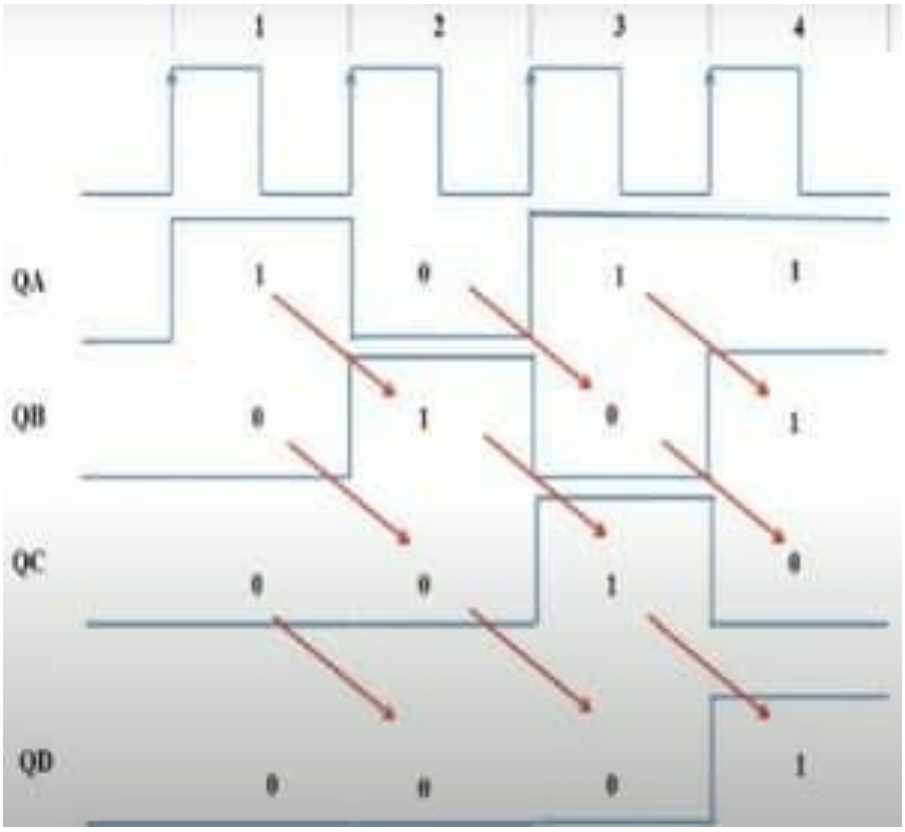




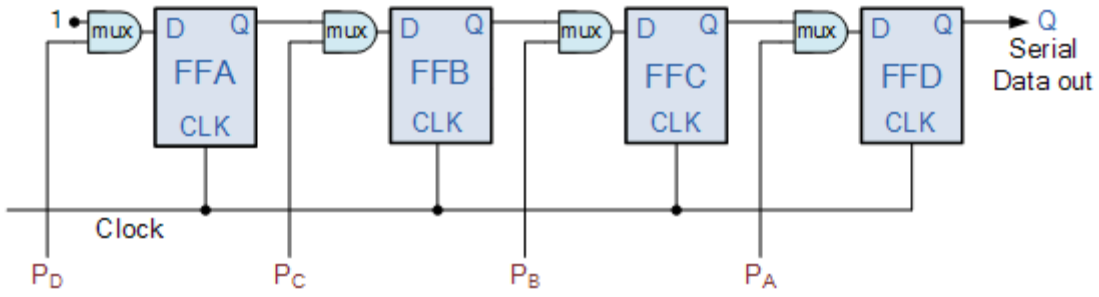
SERIAL- IN PARALLEL-OUT

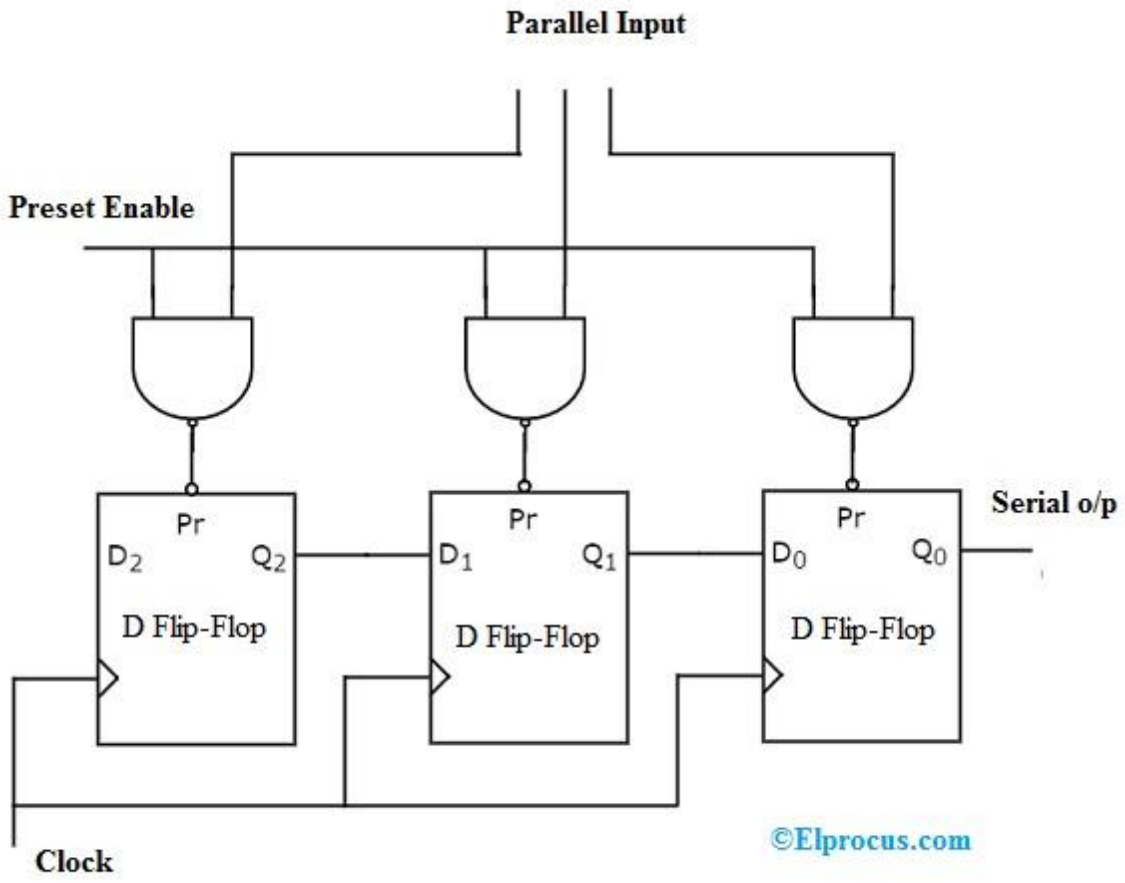


CLK Pulse	QA	QB	QC	QD
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	0	1	0
4	1	1	0	1



PARALLEL IN SERIAL OUT





PARALLEL IN PARALLEL OUT

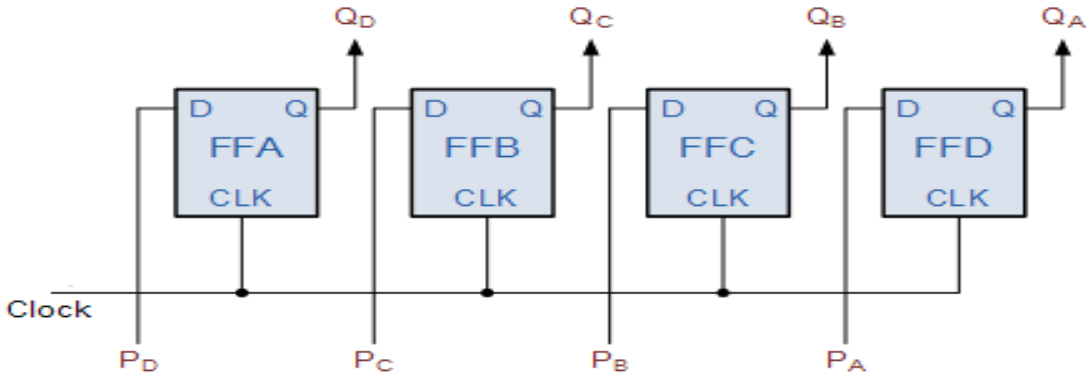


Table I Data Movement in Right-Shift PIPO Shift Register

Clock Cycle	SH / $\overline{LD}$	Q_1	Q_2	Q_3	...	Q_{n-1}	Q_n
1	0	B_1	B_2	B_3		B_{n-1}	B_n
2	1	0	B_1	B_2	...	B_{n-2}	B_{n-1}
3	1	0	0	B_1	...	B_{n-3}	B_{n-2}
.		.	.	.	...	.	.
.		.	.	.		.	.
.		.	.	.		.	.

Parallel Data Loading

Parallel Data Retrieval

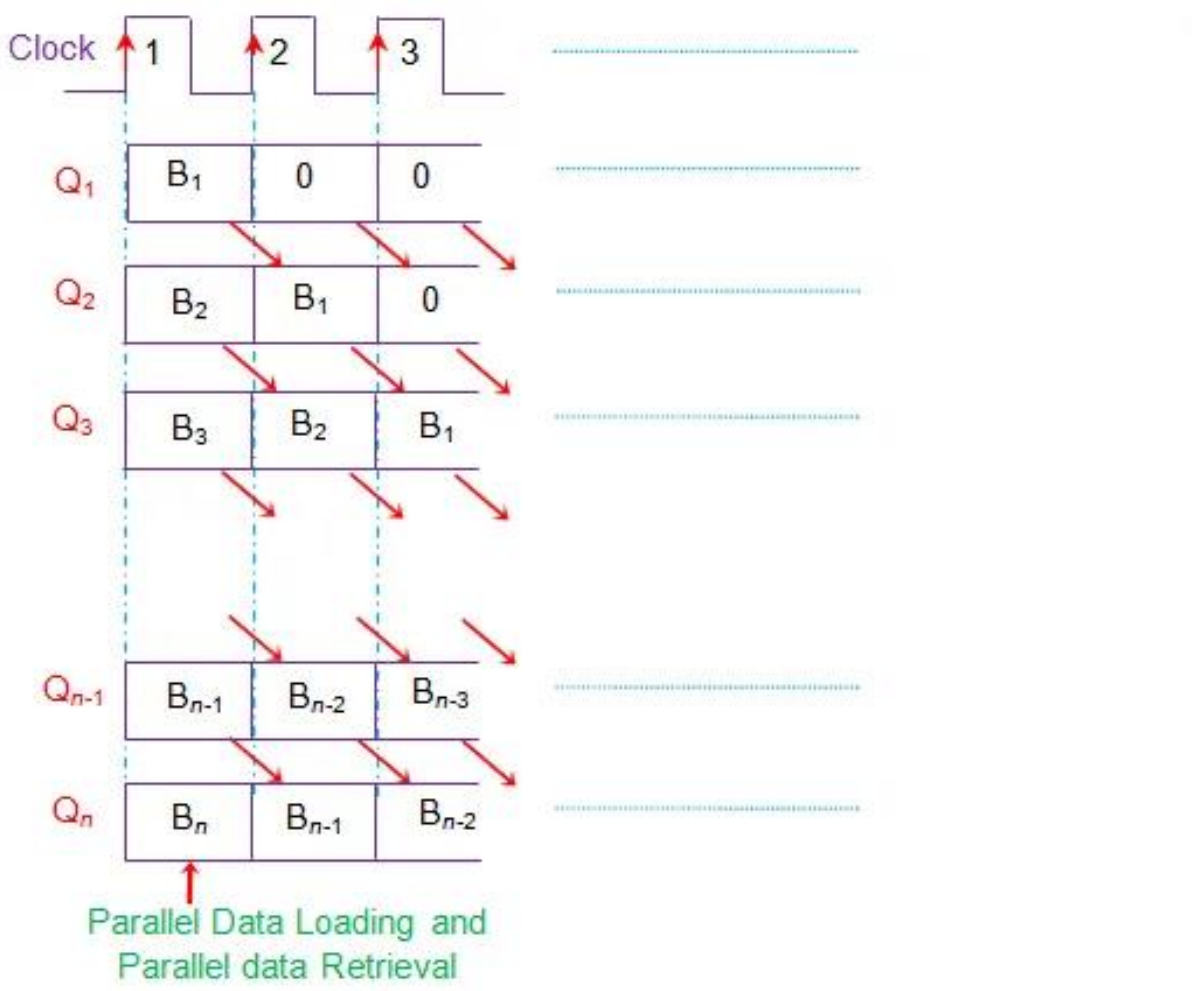
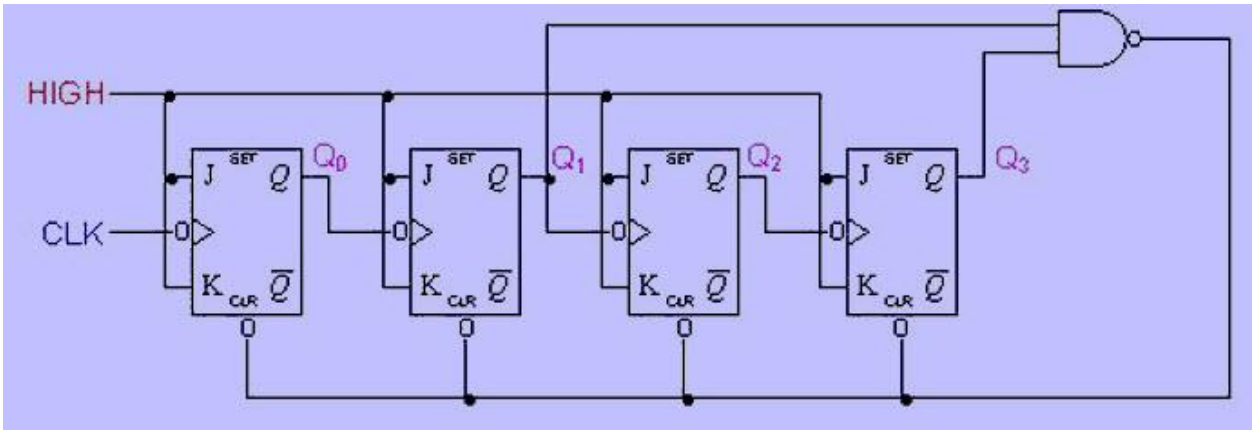


Figure 3 Output Waveform of *n*-bit Right-Shift PIPO Shift Register

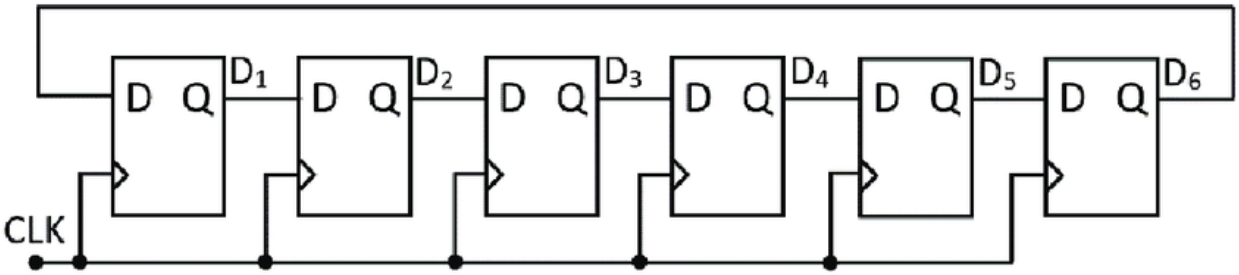
DECADE COUNTER



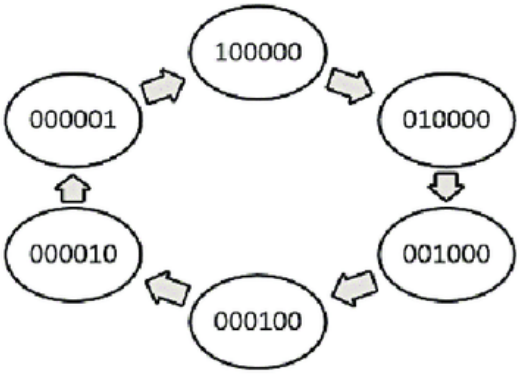
TRUTH TABLE

Clock Pulse	Q3	Q2	Q1	Q0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

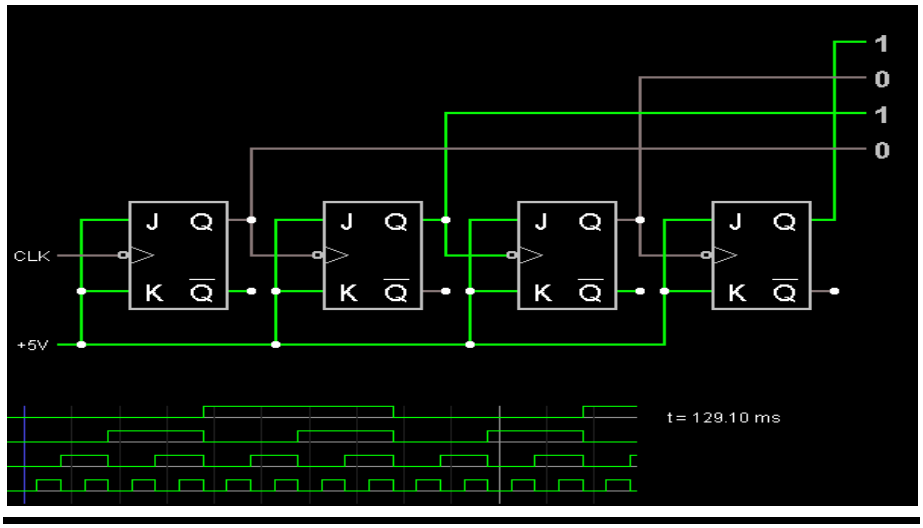
RING COUNTER



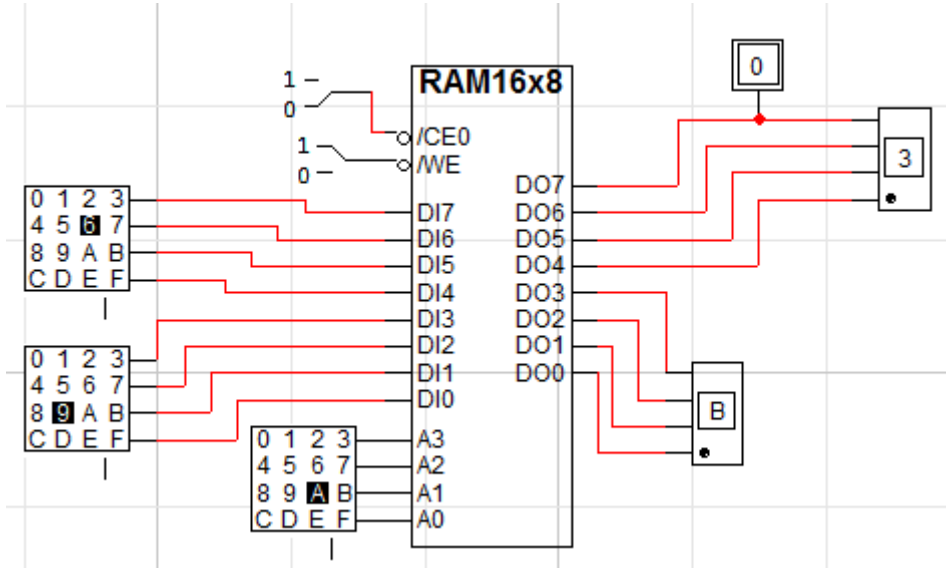
CLK	D_1	D_2	D_3	D_4	D_5	D_6
1	1	0	0	0	0	0
2	0	1	0	0	0	0
3	0	0	1	0	0	0
4	0	0	0	1	0	0
5	0	0	0	0	1	0
6	0	0	0	0	0	1

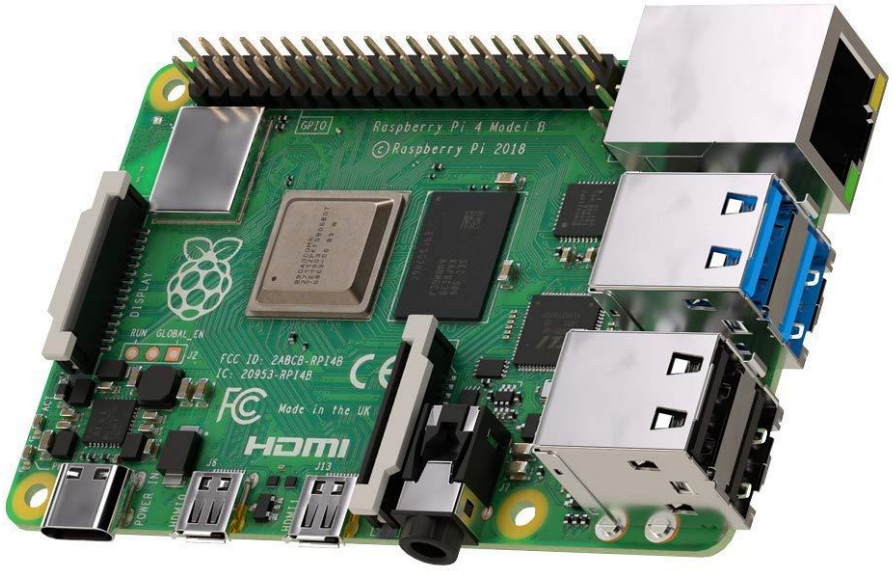


RIPPLE COUNTER

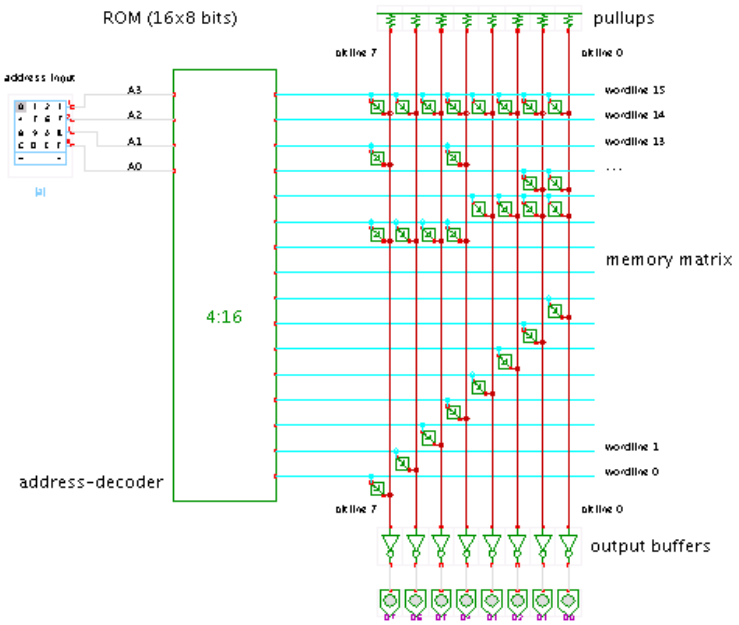


RAM

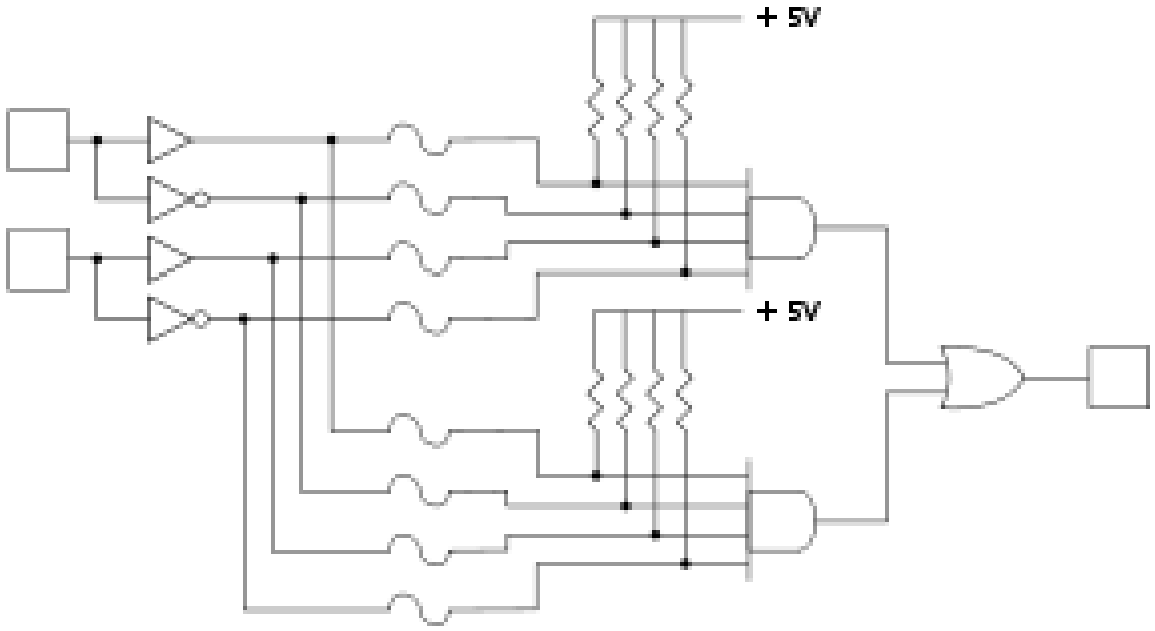

RAM16x8
1
0
/CE0
1
/WE
0
DI7
DI6
DI5
DI4
DI3
DI2
DI1
DI0
A3
A2
A1
A0
DO7
DO6
DO5
DO4
DO3
DO2
DO1
DO0
0
3
B
0 1 2 3
4 5 6 7
8 9 A B
C D E F


GPIO
Raspberry Pi 4 Model B
©Raspberry Pi 2018
DISPLAY
RUN_GLOBAL_EN
J2
FCC ID: 2ABCB-RPI4B
IC: 20953-RPI4B
Made in the UK
HDMI
J13
J6
POWER IN

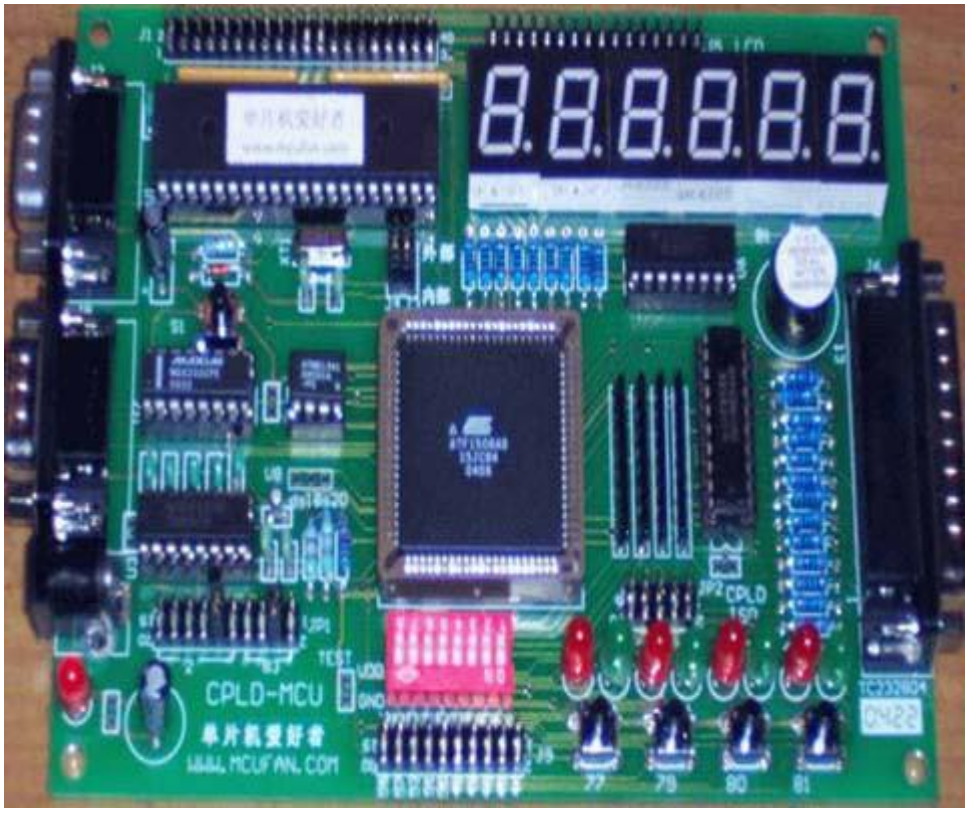
ROM


ROM (16x8 bits)
pullups
address input
A3
A2
A1
A0
bitline 7
bitline 0
wordline 15
wordline 14
wordline 13
...
memory matrix
4:16
wordline 1
wordline 0
address-decoder
bitline 7
bitline 0
output buffers

PLD

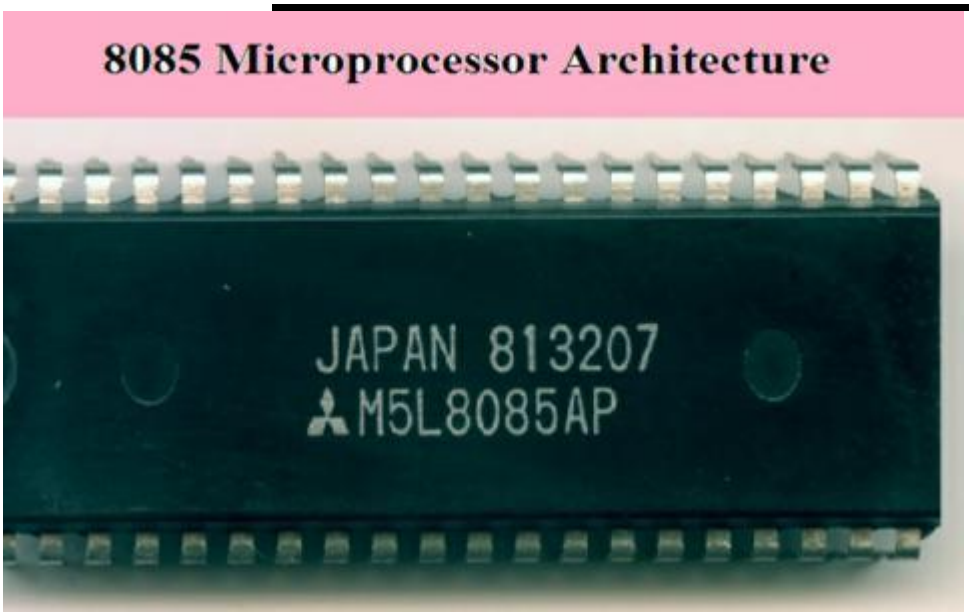


Simplified programmable logic device

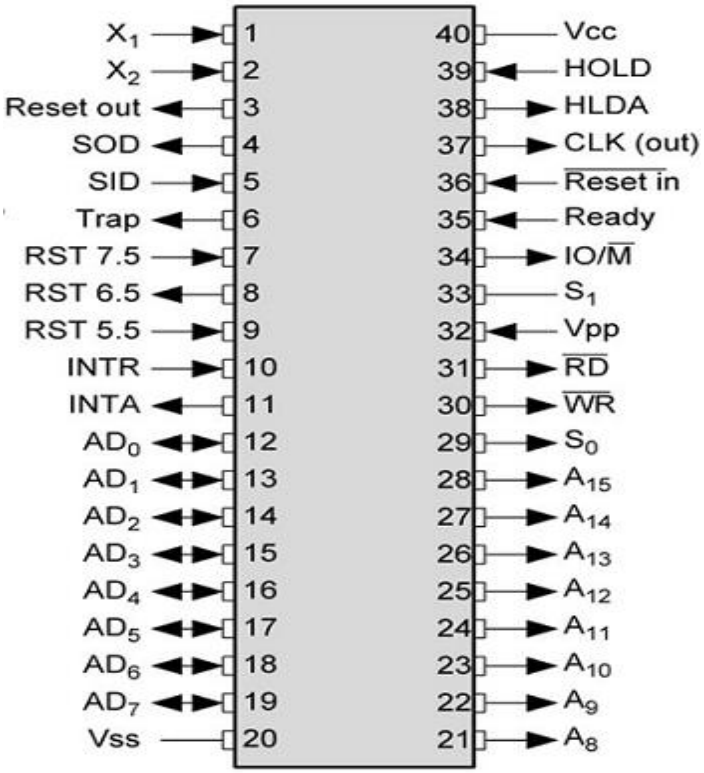


UNIT-4:

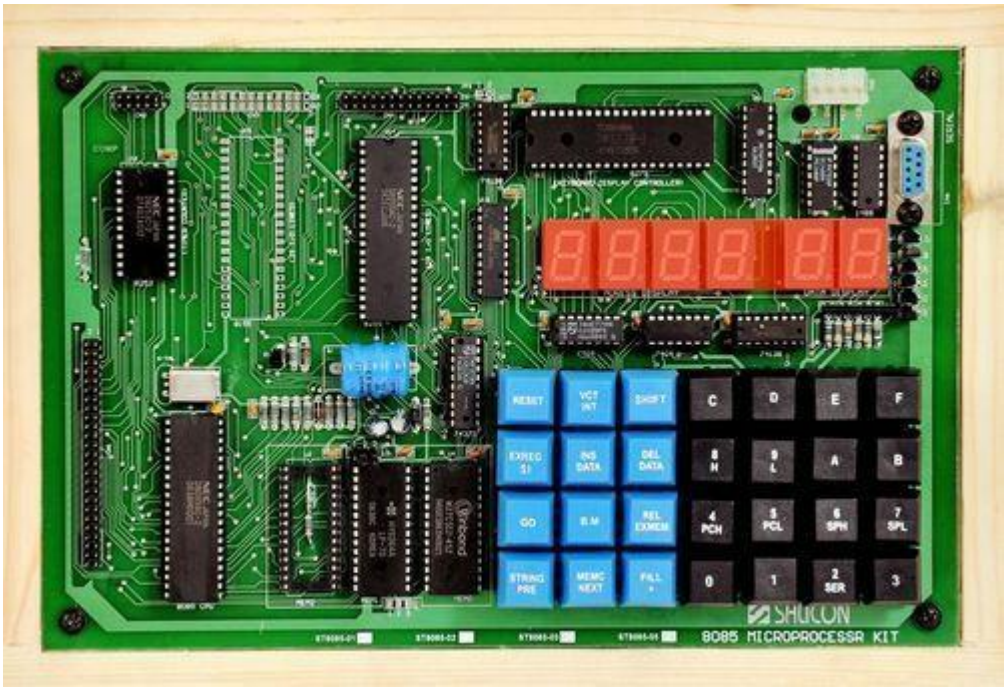
8085 MICROPROCESSOR

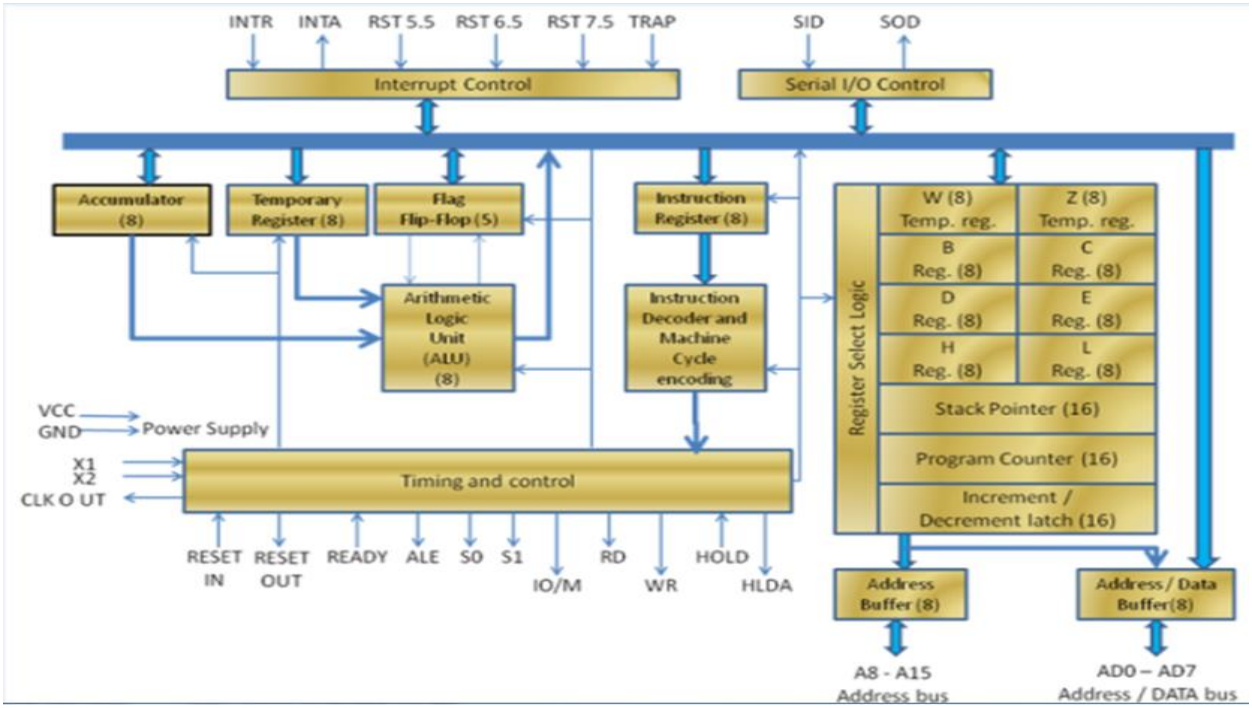


PIN DIAGRAM



ARCHITECTURE OF INTEL 8085A MICROPROCESSOR





UNIT-5:

INTERFACING AND SUPPORT CHIPS
Intel 8255

FUNCTIONAL BLOCK DIAGRAM