

a)

$$F_1 \cdot F_2 = (AB + \bar{C})(\bar{A}\bar{C} + \bar{B}\bar{C}) = A\bar{A}B\bar{C} + A\bar{B}\bar{C}\bar{C} + \bar{A}\bar{C}\bar{C} + \bar{B}\bar{C}\bar{C} = \bar{A}\bar{C} + \bar{B}\bar{C}$$

$$F_1 + F_2 = AB + \bar{C} + \bar{A}\bar{C} + \bar{B}\bar{C} = AB + \bar{C}$$

2 Marks

b)

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

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

2 Marks

c)

$$F(A,B,C) = AB + A\bar{C} + BC = A\bar{C} + BC$$

NOR-NOR

	AB	00	01	11	10
C	0	0	1	1	1
	1	0	1	1	0

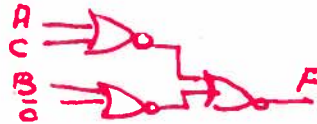
c i)

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

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

using De Morgan's

1.5 Marks



c ii)

	AB	00	01	11	10
C	0			1	1
	1		1	1	

F

	AB	00	01	11	10
C	0	1	1		
	1	1			1

F̄

1.5 Marks

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

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



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a)

N	(N-2) ²	N ₂	N ₁	N ₀	m	F ₄	F ₃	F ₂	F ₁	F ₀
0	4	0	0	0	0	0	0	1	0	0
1	1	0	0	1	1	0	0	0	0	1
2	0	0	1	0	2	0	0	0	0	0
3	1	0	1	1	3	0	0	0	0	1
4	4	1	0	0	4	0	0	1	0	0
5	9	1	0	1	5	0	1	0	0	1
6	16	1	1	0	6	1	0	0	0	0
7	X	X	X	X	7	X	X	X	X	X

$F_0 = N_0$ $F_1 = 0$

$F_2 =$

N ₂	N ₁	N ₀
1	1	1
0	X	1

$F_2 = \bar{N}_1 N_0$

$F_3 =$

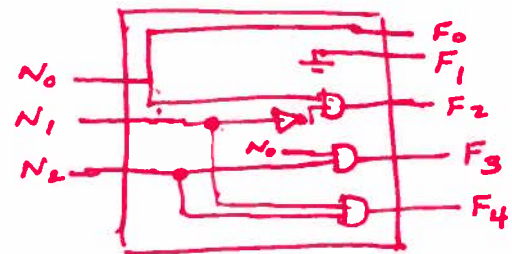
N ₂	N ₁	N ₀
0	0	1
0	X	1

$F_3 = N_2 N_0$

$F_4 =$

N ₂	N ₁	N ₀
0	0	1
0	X	1

$F_4 = N_2 N_1$



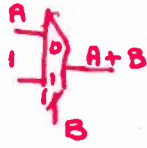
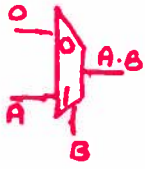
b) ROM SIZE = 2³ of 5 bits = 8 words of 5 bits each

The 8 words are fixed and necessary but the 5 bits can be reduced to 3 due to the fact that F₁ = 0 & F₀ = N₀

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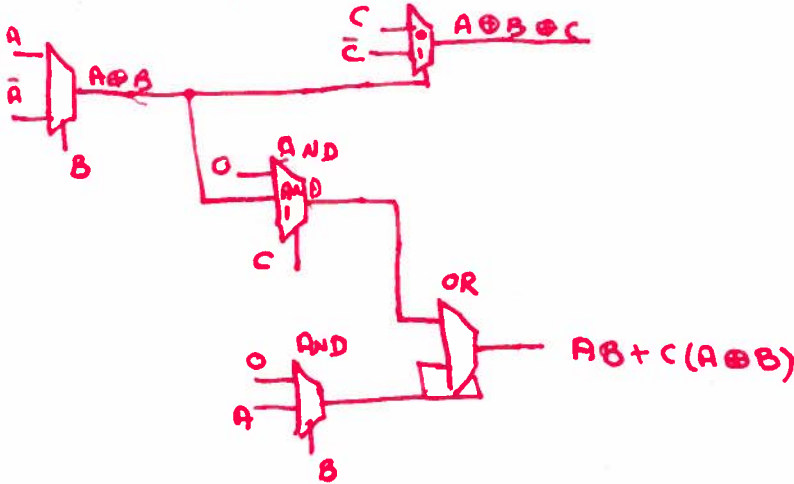
a)

A	B	AND	OR	Ex-OR
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	1	0



b) $S = A \oplus B \oplus C$

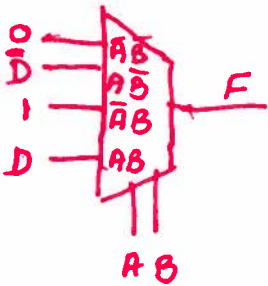
$C_{out} = AB + C(A \oplus B)$



c) $F = \bar{A}B + A\bar{B}D + A\bar{B}\bar{D}$

	AB 00	AB 01	AB 11	AB 10
D 0		1		1
D 1		1	1	

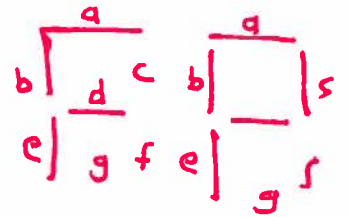
Use AB as Control Signal gives minimum logic



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4 inputs & 7 o/p's Truth Table representing the BCD input and the display o/p

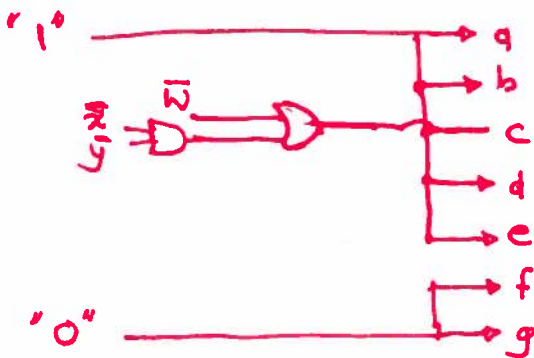
BCD	w	x	y	z	a	b	c	d	e	f	g
0000	0	0	0	0	1	1	0	1	1	0	0
0001	0	0	0	1	1	1	0	1	1	0	0
0010	0	0	1	0	1	1	0	1	1	0	0
0011	0	0	1	1	1	1	0	1	1	0	0
0100	0	1	0	0	1	0	1	1	0	0	0
0101	0	1	0	1	1	0	1	1	0	0	0
0110	0	1	1	0	1	0	1	1	0	0	0
0111	0	1	1	1	1	0	1	1	0	0	0
1000	1	0	0	0	1	0	0	0	0	0	0
1001	1	0	0	1	1	0	0	0	0	0	0
1010	1	0	1	0	1	0	0	0	0	0	0
1011	1	0	1	1	1	0	0	0	0	0	0
1100	1	1	0	0	1	0	0	0	0	0	0
1101	1	1	0	1	1	0	0	0	0	0	0
1110	1	1	1	0	1	0	0	0	0	0	0
1111	1	1	1	1	1	0	0	0	0	0	0



$a = b = d = e = 1$
 $f = g = 0$
 $c = 1$ } all the time

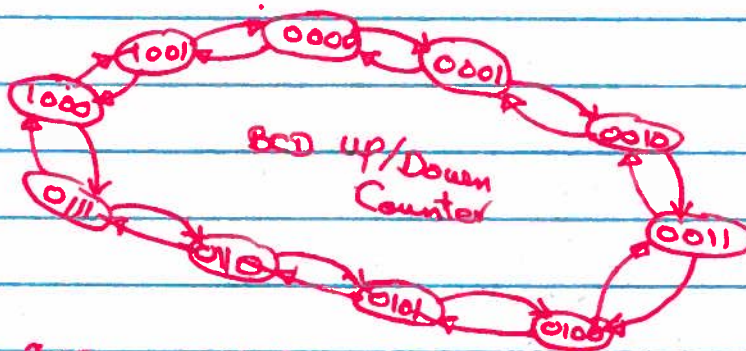
wx	yz	00	01	11	10
00	0	1	1	0	1
01	0	1	1	0	1
11	0	1	1	0	0
10	0	1	1	0	0

$e = \bar{w} + \bar{y}\bar{x}$



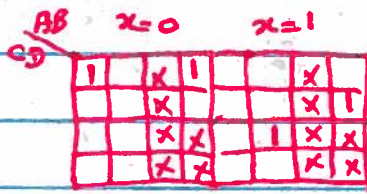
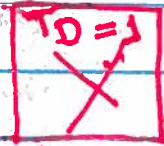
A B	A B	A B	A B
1 1	1 0	0 1	0 0
0 1	0 0	0 0	0 0
0 0	0 0	0 0	0 0
0 0	0 0	0 0	0 0

$x=0$ Down Count
 $x=1$ Up Count

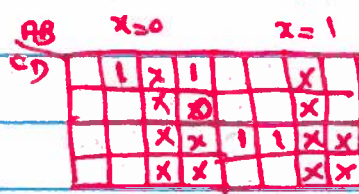


miniter

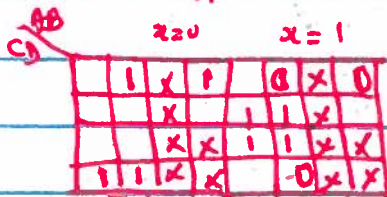
		$x=0$		$x=1$		$x=0$				$x=1$					
	A B C D	$A + B + C + D$		$A + B + C + D'$		T_A		T_B		T_C		T_D			
0	0 0 0 0	1	0	0	1	0	0	0	1	1	0	0	0	1	
1	0 0 0 1	0	0	0	0	0	0	1	0	0	1	1	0	0	1
2	0 0 1 0	0	0	0	1	0	0	1	0	0	0	1	0	0	1
3	0 0 1 1	0	0	1	0	0	1	0	0	1	0	0	1	1	1
4	0 1 0 0	0	0	1	1	0	1	0	1	0	1	0	0	0	1
5	0 1 0 1	0	1	0	0	0	1	1	0	0	1	1	0	0	1
6	0 1 1 0	0	1	0	1	0	1	1	0	0	1	1	0	0	1
7	0 1 1 1	0	1	1	0	1	0	0	0	1	1	1	1	1	1
8	1 0 0 0	0	1	1	1	1	0	0	1	1	1	0	0	0	1
9	1 0 0 1	1	0	0	0	0	0	0	0	1	1	0	0	0	1



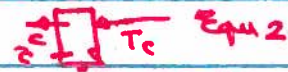
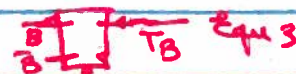
$\overline{B}\overline{C}\overline{D} + B\overline{C}D + AD$
 T_A



$A\overline{D} + B\overline{C}\overline{D} + CD$
 T_B



$D(A+B+C) + \overline{A}D$
 T_C



Eqn 1 $T_D = 1$

Eqn 2 $T_C = \overline{A}D + \overline{D}(A+B+C)$

Eqn 3 $T_B = A\overline{D} + B\overline{C}\overline{D} + CD$

Eqn 4 $T_A = \overline{B}\overline{C}\overline{D} + B\overline{C}D + AD$

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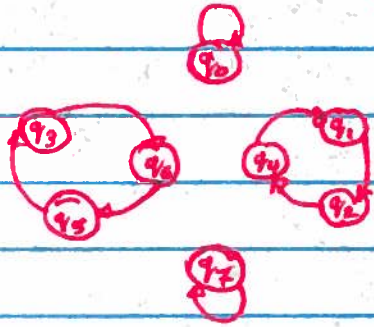
Excitation Equations:

$$D_0 = y_2 \quad D_1 = y_0 \quad D_2 = y_1$$

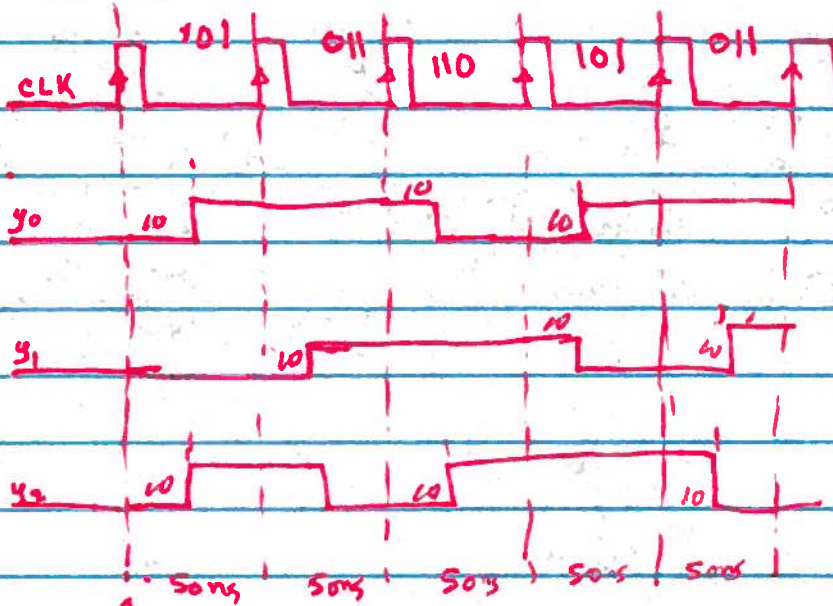
Transition Table:

y_2, y_1, y_0	y_2^+	y_1^+	y_0^+	state Assigned	stable
000	0	0	0	000 q_0	q_0 q_0
001	0	1	0	001 q_1	q_1 q_2
010	1	0	0	010 q_2	q_2 q_4
011	1	1	0	011 q_3	q_3 q_6
100	0	0	1	100 q_4	q_4 q_1
101	0	1	1	101 q_5	q_5 q_3
110	1	0	1	110 q_6	q_6 q_5
111	1	1	1	111 q_7	q_7 q_7

state diagram



edge triggered FF



the first edge will take the initial values?