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EXAM : ENDSEM

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* BCD to 7 segment decoder requires 5 input and 7 output.

4 inputs specify 32 (2^5) so the ROM size must be 32×7.

4-bit adder sub:-

Inputs								Outputs					Decimal
A_3	A_2	A_1	A_0	B_3	B_2	B_1	B_0	C_4	C_3	C_2	C_1	C_0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	1	1	1	1	1	1	1	1	1	1	1	0	30
1	0	0	0	0	0	0	0	0	0	0	0	0	0
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	1	1	1	1	1	1	1	0	0	0	0	0	0

where selection input $S = 0$

$\therefore$ size $= 512 \times 5$.

{ 9 inputs
5 outputs }

$= 512 \, (2^9)$

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(*) $(24)_5 = (2\times5^1+4\times5^0)_{10}$
$= (10+4)_{10}$
$= (14)_{10}$
$= (010100)_{BCD}$

$(100100110001)_{BC5} = (100\ 010\ 011\ 001)_{BC4}$
$= (4231)_5$

(*) In always block, the clk signal will remain 0 for (X+3) time units and will remain 1 for 4 time units in loop.

Duty cycle will be given by
$4/(X+7)$

Solving, $\frac{4}{X+7} = 0.25$
$\Rightarrow X = 9$

(*) frequency of clk = f.
Here, T-flipflop acts as frequency divider. Frequency of $Q = \frac{f}{2}$.

$Y = clk \oplus Q$.
Freq of $Y = \frac{f}{2}$

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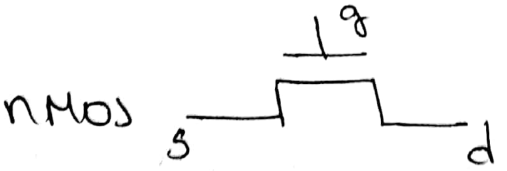
- In the given circuit, the 3 bit counter converts the given decimal into gray code.

The output of gray code is connected to the selection lines of multiplexer.

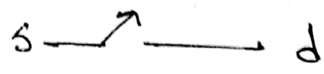
The output of multiplexer is pulled low. Therefore the output is 0 when multiplexer is not enabled.

Decimal	Binary	Gray code	$S_1 S_0 E$	Output
0	0 0 0	0 0 0	0 0 0	I_0
1	0 0 1	0 0 1	0 0 1	0
2	0 1 0	0 1 1	0 1 1	0
3	0 1 1	0 1 0	0 1 0	I_1
4	1 0 0	1 1 0	1 1 0	I_3
5	1 0 1	1 1 1	1 1 1	0
6	1 1 0	1 0 1	1 0 1	0
7	1 1 1	1 0 0	1 0 0	I_2

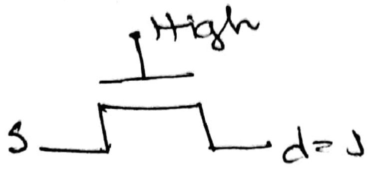
- Pass transistor logic



if $g = 0 \Rightarrow d = \bar{s}$



if $g = 1 \Rightarrow d = s$



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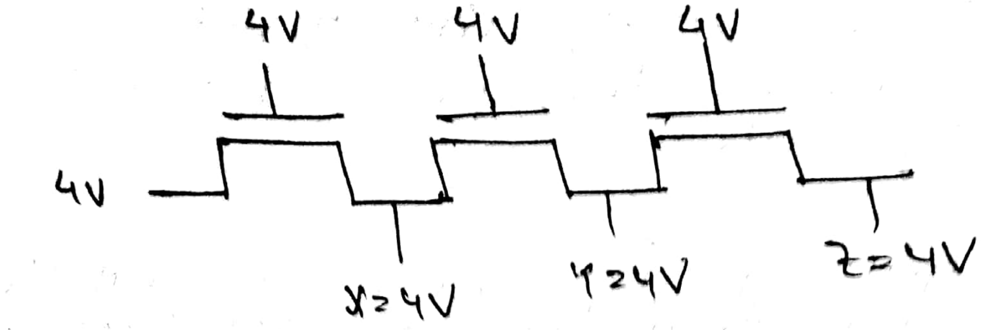

$X = 4V$
$Y = 4V$
$Z = 4V$

(*) Since it is non-blocking assignment,

$d = 5 + 17$
$= 22$

(*) From the code,

if $b = 00 \Rightarrow a = 0$;
if $b = 11 \Rightarrow a = 0$;
if b is other than 00 & 11
$\Rightarrow a = 1$

Truth table :

b[1]	b[0]	a
0	0	0
0	1	1
1	0	1
1	1	0

$\Rightarrow a = b[1] \oplus b[0]$

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A combination circuit implementing a XOR function will be generated!

From circuit diagram,

$$Y = AX_1 + \bar{A}X_0$$

$$\& \; X_1 = Q, \; \& \; X_0 = \bar{Q}$$

$$\Rightarrow Y = AQ + \bar{A}\bar{Q}$$

Excitation table of D-flip-flop is

$$Q(t+1) = D$$

$$\Rightarrow Q(t+1) = Y$$

$$\Rightarrow Q(t+1) = AQ + \bar{A}\bar{Q}$$

if $Q = 0$,

$$Q(t+1) = \bar{A} + 0$$
$$= \bar{A}$$

if $A = 0$,

$$Q(t+1) = 1 \Rightarrow A = Y = 0$$

if $A = 1$,

$$Q(t+1) = 0 \Rightarrow A = W = 1.$$

if $Q = 1$,

$$Q(t+1) = 0 + A$$
$$= A$$

if $A = 0$,

$$Q(t+1) = 0 \Rightarrow A = X = 0$$

if $A = 1$,

$$Q(t+1) = 1 \Rightarrow A = Z = 1.$$

$X = 0, Y = 0, W = 1, Z = 1$

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* Given $F(A,B,C,D) = \pi(1,5,12,15)$
in terms of minterms.

$F(A,B,C,D) = \Sigma(0,2,3,4,6,7,8,9,10,11,13,14)$

Truth table:-

A	B	C	D	minterms	F	
0	0	0	0	0	1	F=D'
0	0	0	1	1	0	
0	0	1	0	2	1	F=1
0	0	1	1	3	1	
0	1	0	0	4	1	F=D'
0	1	0	1	5	0	
0	1	1	0	6	1	F=1
0	1	1	1	7	1	
1	0	0	0	8	1	F=1
1	0	0	1	9	1	
1	0	1	0	10	1	F=1
1	0	1	1	11	1	
1	1	0	0	12	0	F=D
1	1	0	1	13	1	
1	1	1	0	14	1	F=D'
1	1	1	1	15	0	

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(*) $X = \overline{(Q \oplus \bar{Q})(\overline{Q \oplus \bar{Q}})}$

we know $Q \oplus \bar{Q} = 1$ $\therefore$ $\overline{Q \oplus \bar{Q}} = 0$

$\Rightarrow$ $X = 1$ always

If input = 1 always, then output will be changed only at ~~posedge~~ negedge of clock.

$$\boxed{f_1 = f/2 = 0.5\,kHz}$$

(*) $V_x = \overline{SOP}$

$= \overline{P_1 + P_2}$

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

$V_o = \overline{SOP}$

$= \overline{P_1}$

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

no. of product terms = no. of parallel paths from o/p to GND

literals present in pdt term = i/ps of those tr/ which present in that path.

Scanned with CamScanner

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(*) $V_{OL} = (V_{DD} - V_t)\left[1 - \sqrt{1-\frac{1}{\gamma}}\right] = (2.5-0.5)\left[1-\sqrt{1-\frac{1}{4}}\right]$

$= 2\left[1 - \frac{\sqrt{3}}{2}\right] = 0.268$

$V_{IL} = V_t + \frac{V_{DD} - V_t}{\sqrt{\gamma(\gamma+1)}} = 0.5 + \frac{2.5 - 0.5}{\sqrt{4 \times 5}}$

$= 0.947$

$V_M = V_t + \frac{V_{DD} - V_t}{\sqrt{\gamma + 1}} = 0.5 + \frac{2}{\sqrt{5}} = 1.394$

$V_{IH} = V_t + \frac{2}{\sqrt{3\gamma}}(V_{DD} - V_t) = 0.5 + \frac{2}{\sqrt{12}}(2)$

$= 1.654$

$V_{OH} = V_{DD} = 2.5V$

$NM_L = V_{IL} - V_{OL} = 0.679$

$NM_H = V_{OH} - V_{IH} = 0.846$

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(*) $\left(\frac{W}{L}\right)_n = \frac{0.325}{0.18}$

$r = 4 = \frac{40 \times 0.325/0.18}{120 \times (W/L)_p}$

$\left(\frac{W}{L}\right)_p = 1.35$

$k_p' = k_p \left(\frac{W}{L}\right)_p = 54$

$I_{stat} = \frac{1}{2} k_p' (V_{DD} - V_t)^2 = \frac{1}{2} \times 54 \times 4$

$= 108\ \mu A$

$= 0.108\ mA$

$D_p = (0.108) V_{DD} = 0.108 \times 2.5$

$= 0.270\ mW$

(*) At time $= t_1$

$W = 0110$

$A = 0110$ at posedge

The address will be 6.

$\therefore W = 1010$

$A = 1010$ at posedge

$\downarrow$

Address $= 10$

$\therefore W = 1000$ at time t_2.