Solution

Digital circuit Design.

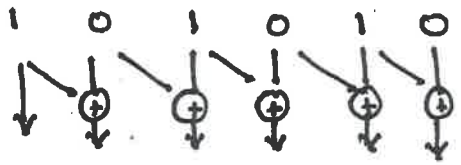
Paper-1.

QP code: 27584

Q1 a) 1.

$(42)_{10} = (101010)_2$

Binary : 1 0 1 0 1 0

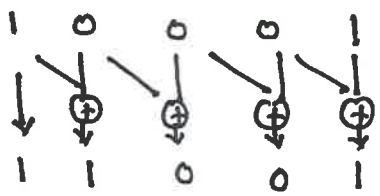


Gray : 1 1 1 1 1 1

$(42)_{10} = (111111)_{Gray}$. ---- 2½ marks

2. $(17)_{10} = (10001)_2$

Binary : 1 0 0 0 1



Gray : 1 1 0 0 1

$(17)_{10} = (11001)_{Gray}$. ---- 2½ marks.

Q1 d)

Step 1) Write the truth table for conversion. The required truth table is obtained from excitation table is obtained from excitation table of JK & T flip flop.

Inputs			Outputs	
T	Present state Q_n	Next state Q_{n+1}	J	K
0	0	0	0	X
1	0	1	1	X
1	1	0	X	1
0	1	1	X	0

← Excitation Table of TFF →

← Excitation Table of JK FF →

--- 2 marks

Step2) K Map and simplification.

T \ Q_n	0	1
0	0	X
1	1	X

J output

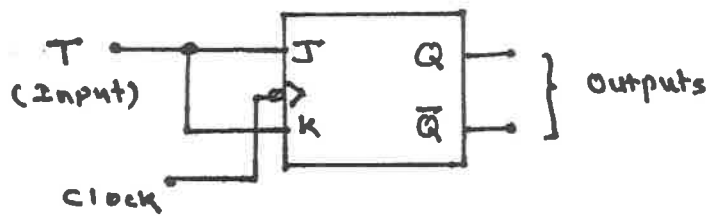
J = T

T \ Q_n	0	1
0	X	0
1	X	1

K output

K = T

Step 3 : Logic Diagram --- 2 marks



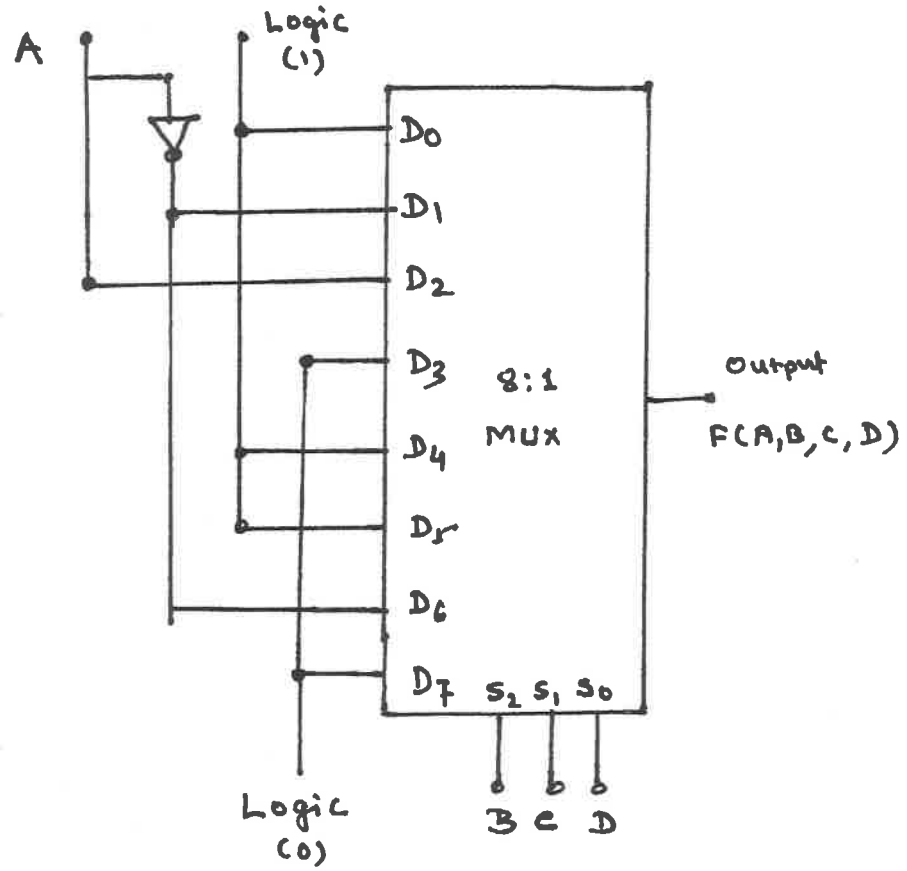
---- 1 mark.

Q 2 b)

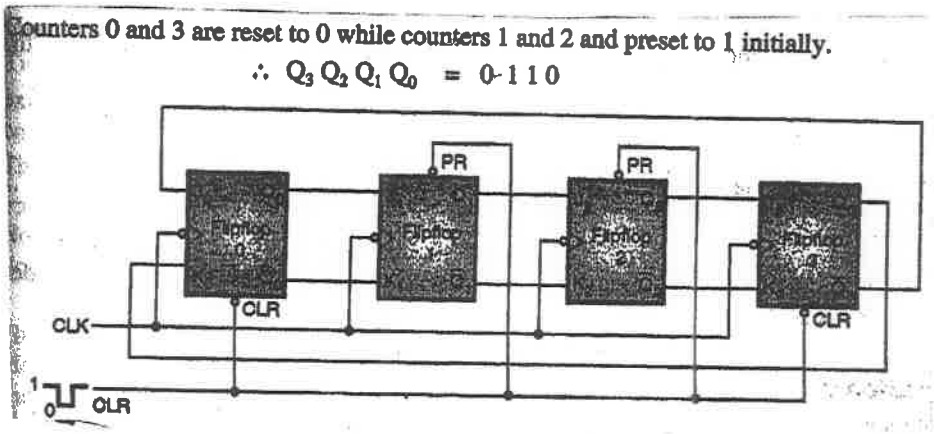
$$F(A,B,C,D) = \sum m(0,1,4,5,6,8,10,12,13)$$

Design Table:

Inputs	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
$\bar{A}$	(0)	(1)	2	3	(4)	(5)	(6)	7
A	(8)	9	(10)	11	(12)	(13)	14	15
Input Mux	1	$\bar{A}$	A	0	1	1	$\bar{A}$	0



Q3 a) Johnson Counter :



The other possible states of this Johnson's counter are given below.

Clear	CLK	Q_3	Q_2	Q_1	Q_0
⊓	X	0	1	1	0
1	↓	1	1	0	1
1	↓	1	0	1	0
1	↓	0	1	0	0
1	↓	1	0	0	1

Q 3 b)

Step 1) Group minterms --- number of 1's.

Group	Minterms	Binary Representation			
		A	B	C	D
0	0	0	0	0	0
1	1	0	0	0	1
	2	0	0	1	0
2	3	0	0	1	1
	5	0	1	0	1
	9	1	0	0	1
3	7	0	1	1	1
	11	1	0	1	1

Step 2) Form Pairs

Group	Minterms Pairs	Binary Representation				
		A	B	C	D	
0	0, 1	0	0	0	-	
	0, 2	0	0	-	0	
1	1, 3	0	0	-	1	
	1, 5	0	-	0	1	
	1, 9	-	0	0	1	
	2, 3	0	0	1	-	$\bar{A}\bar{B}C$
2	3, 7	0	-	1	1	
	3, 11	-	0	1	1	$\bar{B}CD$
		0	1	-	1	
		1	0	-	1	

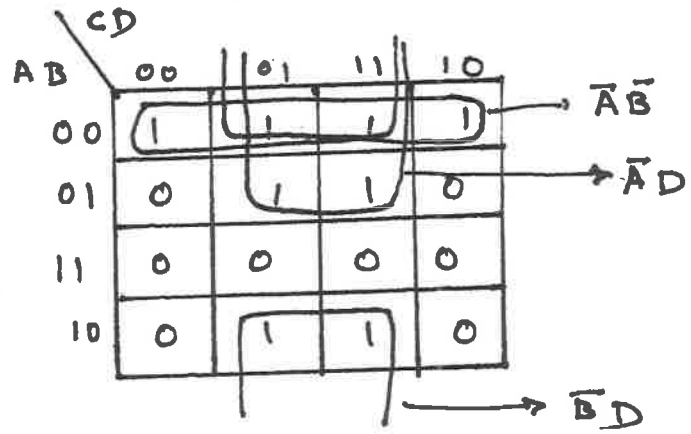
Step 3) Group of four

Group	Minterms Quads	Binary Representation				
		A	B	C	D	
0	0,1,2,3	0	0	-	-	$\bar{A}\bar{B}$
	0,2,1,3	0	0	-	-	
1	1,3,5,7	0	-	-	1	$\bar{A}D$
	1,5,3,7	0	-	-	1	
	1,3,9,11	-	0	-	1	$\bar{B}D$
	1,9,3,11	-	0	-	1	

Step4) Prime implicants

Prime Implicants	Decimal Number	Given Minterms							
		0	1	2	3	5	7	9	11
$\bar{A}\,\bar{B}\,C$	2, 3			X	X				
$\bar{B}\,C\,D$	3, 11				X				X
$\bar{A}\,\bar{B}$	0, 1, 2, 3	(X)	X	X	X				
$\bar{A}\,D$	1, 3, 5, 7		X		X	(X)	(X)		
$\bar{B}\,D$	1, 3, 9, 11		X		X			(X)	X

Step 5) K map. verification.



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

Q4 b).

1. Prove That.

$$\bar{Y}\bar{Z} + \bar{W}\bar{X}\bar{Z} + \bar{W}XY\bar{Z} + WY\bar{Z} = Z$$

Solution:

L.H.S. $= \bar{Y}\bar{Z} + \bar{W}\bar{X}\bar{Z} + \bar{W}XY\bar{Z} + WY\bar{Z}$

$= \bar{Y}\bar{Z} + \bar{W}\bar{X}\bar{Z}(1+Y) + \bar{W}XY\bar{Z} + WY\bar{Z}$

$= \bar{Y}\bar{Z} + \bar{W}\bar{X}\bar{Z} + \bar{W}\bar{X}Y\bar{Z} + \bar{W}XY\bar{Z} + WY\bar{Z}$

$= \bar{Y}\bar{Z} + \bar{W}\bar{X}\bar{Z} + \bar{W}Y\bar{Z}(\bar{X} + X) + WY\bar{Z}$

$= \bar{Y}\bar{Z} + \bar{W}\bar{X}\bar{Z} + \bar{W}Y\bar{Z} + WY\bar{Z}$

$= \bar{Y}\bar{Z} + \bar{W}\bar{X}\bar{Z} + Y\bar{Z}(\bar{W} + W)$

$= \bar{Y}\bar{Z} + \bar{W}\bar{X}\bar{Z} + Y\bar{Z}$

$= \bar{Y}\bar{Z} + Y\bar{Z} + \bar{W}\bar{X}\bar{Z}$

$= \bar{Z}(\bar{Y} + Y) + \bar{W}\bar{X}\bar{Z}$

$= \bar{Z} + \bar{W}\bar{X}\bar{Z}$

$= \bar{Z} + (1 + \bar{W}\bar{X})$

$= \bar{Z} \cdot 1$

$= \bar{Z}$ = R.H.S.

2. Simplify equation

$[A\bar{B}(C + BD) + \bar{A}\bar{B}]C$

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

$(A\bar{B}C + 0 + \bar{A}\bar{B})C$

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

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

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

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

$\bar{B}C \cdot 1$

$\bar{B}C$

Q.5. b) BCD Adder using 4bit binary adder.