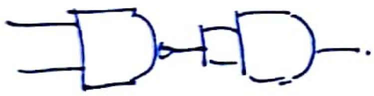
Solutions.

Q-2 a) Prove that NAND and NOR Gates are universal Gates.

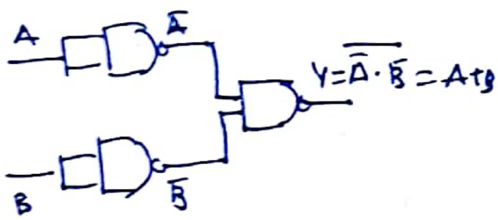
1) NAND

i) NOT Gate.

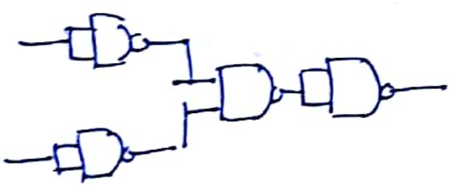
ii) AND Gate.



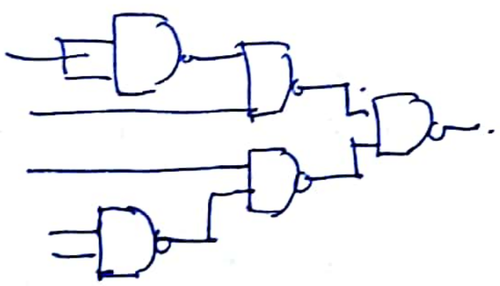
iii) OR Gate



iv) NOR Gate.



v) EX OR.

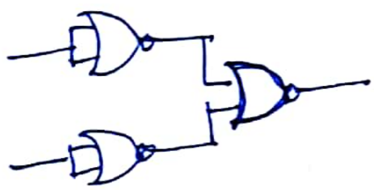


2) NOR

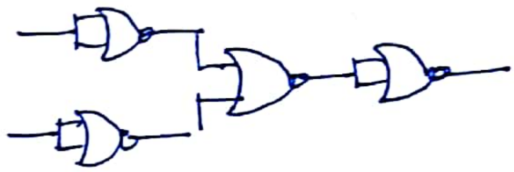
i) NOT Gate

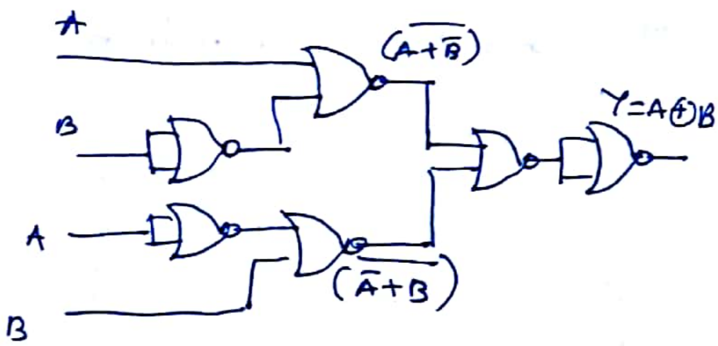
ii) OR Gate

iii) AND Gate.



iv)





Q. 2 b)

Design a full subtractor.

A full subtractor will have three inputs A_n (minuend) B_n (subtrahend) and C_{n-1} (borrow from previous stage) and the two outputs D_n (Difference) and C_n (borrow)

Truth table.

Inputs			Outputs	
A_n	B_n	C_{n-1}	D_n	C_n
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

K - map for Difference.

C_{n-1} \ A_nB_n	00	01	11	10
0		1		1
1	1		1	

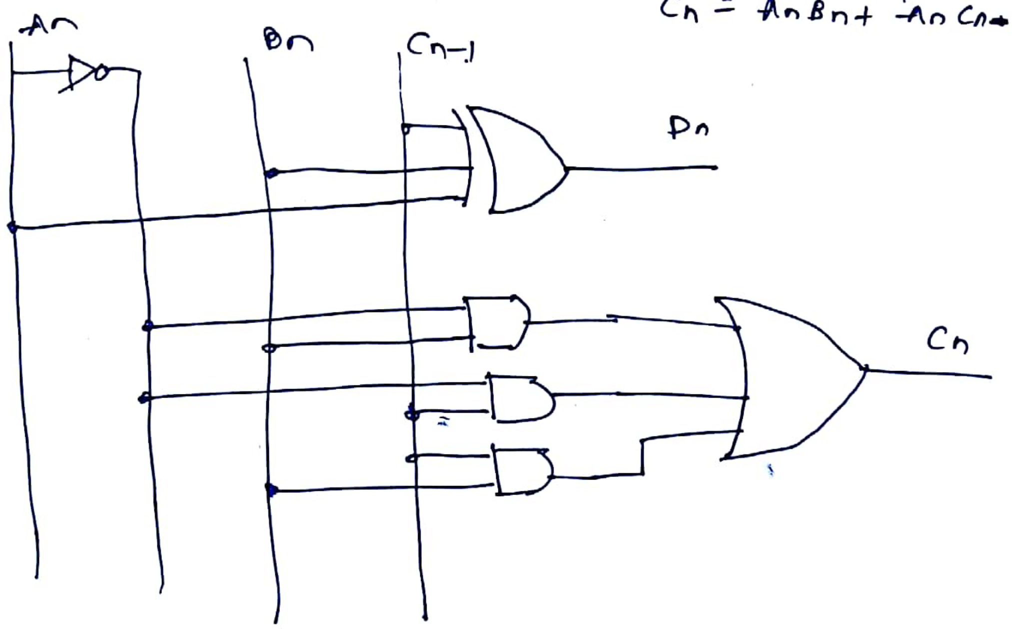
$$D = \bar{A}_n \bar{B}_n C_{n-1} + \bar{A}_n B_n \bar{C}_{n-1} + A_n B_n C_{n-1} + A_n \bar{B}_n \bar{C}_{n-1}$$

$$= A_n \oplus B_n \oplus C_{n-1}$$

K- map for Borrow

C_{n-1} \ A_nB_n				
		1		
	1	1	1	

$$C_n = \bar{A}_n B_n + \bar{A}_n C_{n-1} + B_n C_{n-1}$$



Q.3 (a) Design a Binary to Gray code converter

S.N.	Binary B_3	B_2	B_1	B_0	Gray G_3	G_2	G_1	G_0
0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	1
2	0	0	1	0	0	0	1	1
3	0	0	1	1	0	0	1	0
4	0	1	0	0	0	1	1	0
5	0	1	0	1	0	1	1	1
6	0	1	1	0	0	1	0	1
7	0	1	1	1	0	1	0	0
8	1	0	0	0	1	1	0	0
9	1	0	0	1	1	1	0	1
10	1	0	1	0	1	1	1	1
11	1	0	1	1	1	1	1	0
12	1	1	0	0	1	0	1	0
13	1	1	0	1	1	0	1	1
14	1	1	1	0	1	0	0	1
15	1	1	1	1	1	0	0	0

B_1B_0 \ B_3B_2	00	01	11	10
00				
01	1	1	1	1
11				
10	1	1	1	1

$G_0 = B_0 \oplus B_1$

B_1B_0 \ B_3B_2	00	01	11	10
00		1	1	
01			1	
11	1			1
10	1			1

$G_1 = B_2 \oplus B_1$

B_1B_0 \ B_3B_2	00	01	11	10
00		1		1
01		1		1
11		1		1
10		1		1

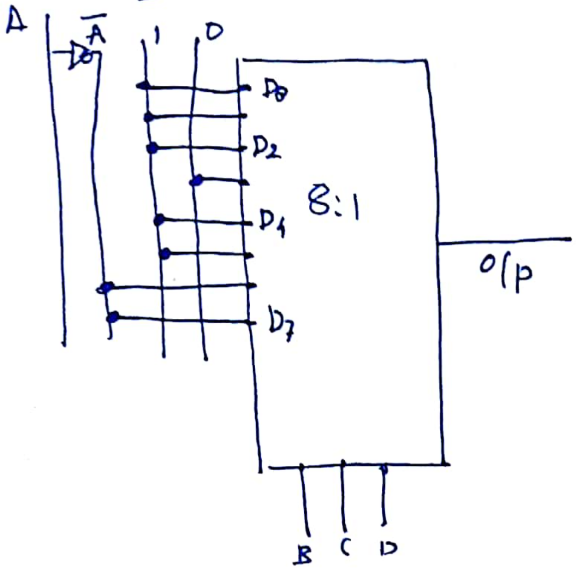
$G_2 = B_3 \oplus B_2$

B_1B_0 \ B_3B_2	00	01	11	10
00			1	1
01			1	1
11			1	1
10			1	1

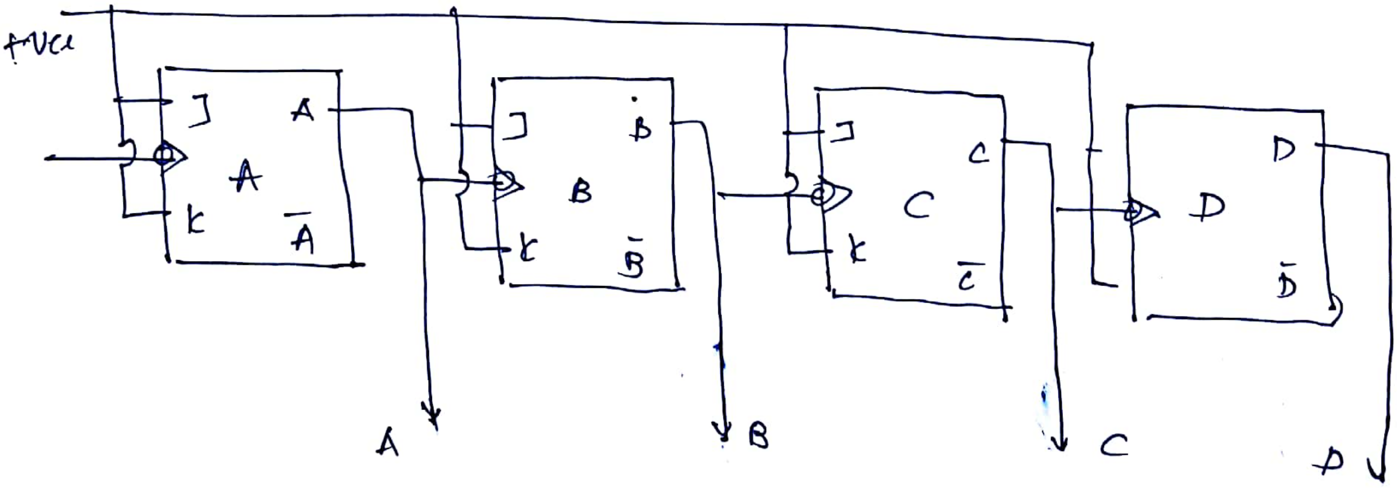
$G_3 = B_3$

Q.3(b)

	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	Row 1
A	8	9	10	11	12	13	14	15	Row 2
	1	1	1	0	1	1	$\bar{A}$	$\bar{A}$	



Q. 4 a)



Q.5 (a) Minimize the following expression using Queine McClusky Technique.

$$F(A,B,C,D) = \sum m\,(0,1,2,3,5,7,9,11,15)$$

soln.

Table 1.

Group	minterms	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
	15	1	1	1	1

Table-2.

Group	minterms	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	—
2	3, 7	0	—	1	1
	3, 11	—	0	1	1
	5, 7	0	1	—	1
	9, 11	1	0	—	1
3	7, 15	—	1	1	1
	11, 15	1	—	1	1

Table 3.

Group	minterms	A	B	C	D	
0	0, 1, 2, 3	0	0	–	–	$\bar{A}\bar{B}$
1	1, 9, 3, 11	–	0	–	1	$\bar{B}D$
	3, 7, 11, 15	–	–	1	1	CD
	1, 3, 5, 7	0	–	–	1	$\bar{A}D$

Table of prime Implicants.

Term	Decimal	minterms 0	1	2	3	5	7	9	11	15
$\bar{A}\bar{B}$	0, 1, 2, 3	X	X	X	X					
$\bar{B}D$	1, 3, 9, 11		X		X			X	X	
CD	3, 7, 11, 15				X		X		X	X
$\bar{A}D$	1, 3, 5, 7		X		X	X	X			

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

Q.5 b) Convert JK FF to T FF & SR to D-FF.

Truth table.

Present state Q_n	Next state Q_{n+1}	T_n	Outputs J_n	K_n
0	0	0	0	x
0	1	1	1	x
1	0	1	x	1
1	1	0	x	0

K Map for J.

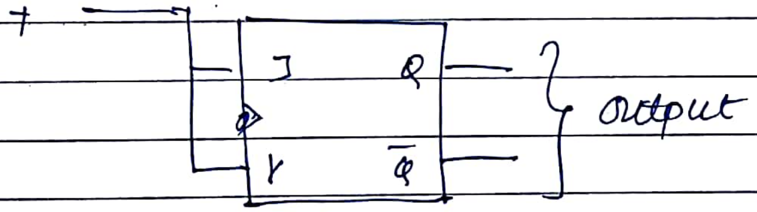
T \ Q_n	0	1
0	0	x
1	1	x

$J = T.$

K - Map for K.

T_n \ Q_n	0	1
0	x	0
1	x	1

$K = T.$



Truth Table.

Q_n Present Q_n	Next Q_{n+1}	D_n	Outputs S_n	R_n
0	0	0	0	x
0	1	1	1	0
1	0	0	0	1
1	1	1	x	0

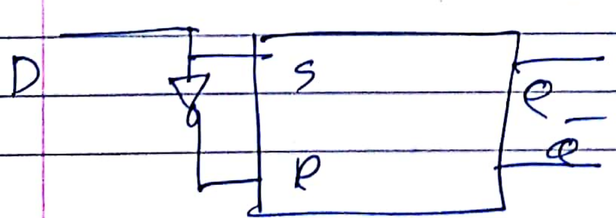
K - Map for S_n

D_n \ Q_n	0	1
0		
1	1	x

$S_n = D_n.$

D_n \ Q_n	0	1
0	x	1
1		

$R_n = \overline{D_n}$



Q.6 A mod-5 counter using T ff.

Excitation Table for T-ff.

Q_n	Q_{n+1}	T_n
0	0	0
0	1	1
1	0	1
1	1	0

CLK	Present state			Next State			FF control.		
	Q_A	Q_B	Q_C	Q_A^+	Q_B^+	Q_C^+	T_A	T_B	T_C
	0	0	0	0	0	1	0	0	1
	0	0	1	0	1	0	0	1	1
	0	1	0	0	1	1	0	0	1
	0	1	1	1	0	0	1	1	1
	1	0	0	0	0	0	1	0	0
	1	0	1	0	0	0	1	0	1
	1	1	0	0	0	0	1	1	0
	1	1	1	0	0	0	1	1	1

K-Map for T_A

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

$T_A = A + BC$

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

$T_B = \bar{A}C + AB$

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

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