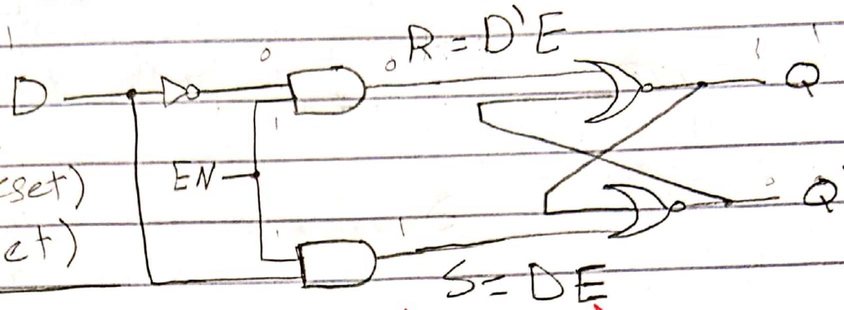
Exercise Six

1- The following D latch is constructed with NOR gates for the SR Latch part and two AND gates for the Control Select and an inverter.

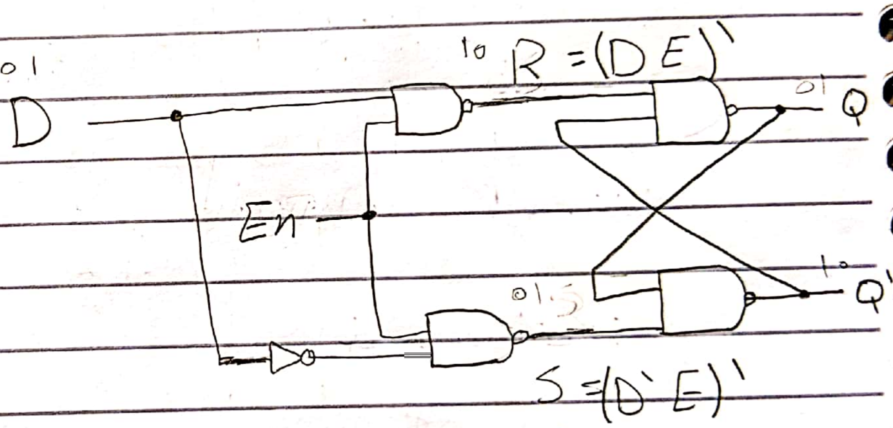
En	D	Q
0	X	no change
1	0	Q = 0 (reset)
1	1	Q = 1 (set)



Obtain a D latch, draw the logic diagram and verify the circuit operation.

(a) Use four NAND gates and an inverter.

En	D	Q
0	X	no chage
1	0	Q = 0 (reset)
1	1	Q = 1 (set)

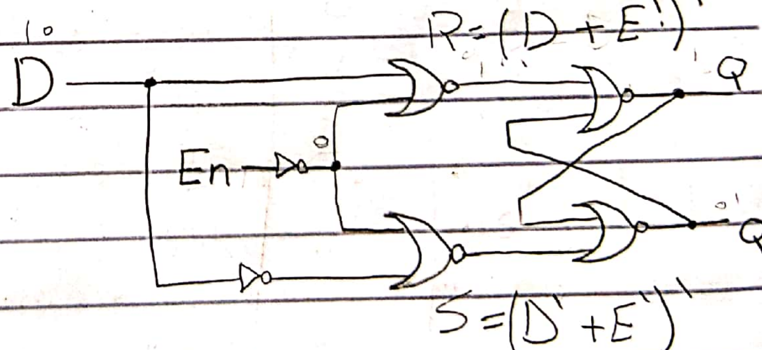


$R = (DE)' = D' + E'$

$S = (D'E)' = D + E$

(b) Use four NOR gates. Inverters may be needed.

En	D	Q
0	X	no change
1	0	Q = 0 (reset)
1	1	Q = 1 (set)

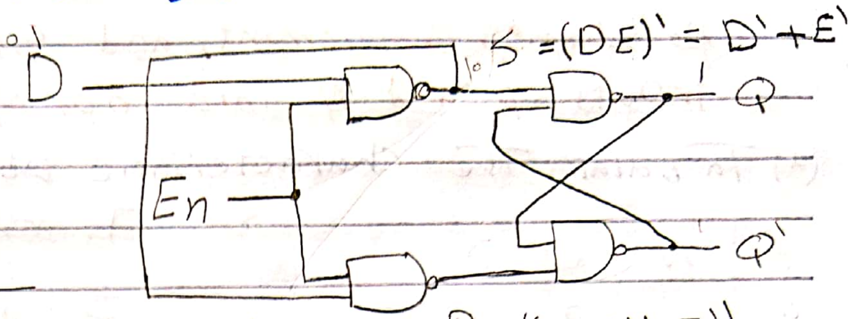


$R = (D + E')' = D'E$

$S = (D' + E')' = DE$

(C) Use four NAND gates only (without an inverter).

En	D	Next State of Q
0	X	no change
1	0	Q = 0 (reset)
1	1	Q = 1 (set)

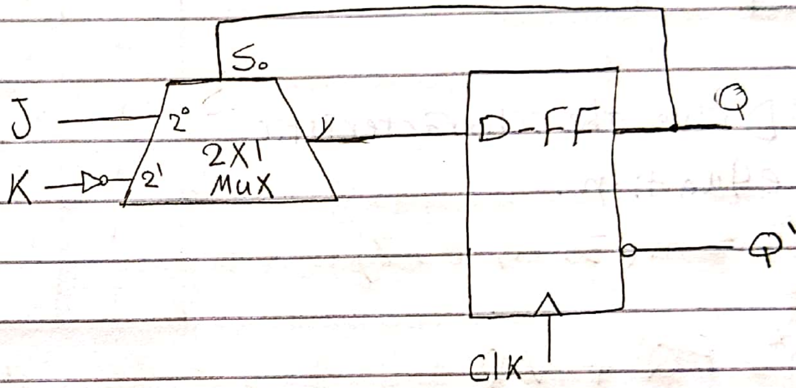


$R = DE + E' = (E' + D)(E + E') = (E' + D)$ $\qquad R = ((DE)' \cdot E)'$

2- Construct ~~...~~ a JK Flip-Flop using a D-ff, two-to-one multiplexer, and an inverter.

1) Input equation

S	y
0	J
1	K'



$y = S'J + SK'$

$D = JQ' + K'Q$

2) Charcteristic equation

$Q(t+1) = D$

$= JQ' + K'Q$

3- Show that the characteristic equation for the complement output of a JK flip-flop is

Transition Table $\quad Q'^{*} = J'Q' + KQ$

J	K	Q	Q*
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

$Q^{*} = \Sigma m(1, 4, 5, 6)$

J \ KQ	00	01	11	10
0		1	0	0
1	1	1	0	1

$Q'^{*} = J'Q' + KQ$ ✓

4. A PN flip-flop has four operations: clear to 0, no chang, complement, and set to 1, when inputs P and N are 00, 01, 10, and 11, respectively.

(a) Tabulate The characteristic table.

P	N	Q^*
0	0	0 (clear)
0	1	Q (no change)
1	0	Q` (Complement)
1	1	1 (Set)

Transition Table

P	N	Q	Q^*	
0	0	0	0	Clear
0	0	1	0	
0	1	0	0	no chang
0	1	1	1	
1	0	0	1	Complement
1	0	1	0	
1	1	0	1	se
1	1	1	1	

(b) Drive the characteristic equation.

$Q^* = \Sigma m(3, 4, 6, 7)$

$Q^* = PQ' + NQ$

P \ NQ	00	01	11	10
0			1	
1	1		1	1

(C) Tabulate ecitation table

Q	Q^*	P	N
0	0	0	X
0	1	1	X
1	0	X	0
1	1	X	1

(d) Show how ~~to~~ The PN flip flop Can be converted to a D flip-flop.

Conect P and N together $P = D$ & $N = D$

then: $Q^* = DQ' + DQ = D(Q' + Q) = D$ ≠

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5- Explain the differences among

- Truth Table: Discribes The Combinational circuits.
- State table: Discribes The Sequential circuits.
- Characteristic table: Discribe the Flip-Flop operations.
- Excitation table: Predict the input of a flip flop.
- Boolean equation: It's a boolean function the output is a function of the inputs only
- State equation: It's a boolean function but the output is a function of the inputs and the previous state of the function.
- Characteristic equation: Boolean function discribes the flip-flop operation.
- ~~Input~~ Flip-Flop input equation: Boolean function discribes the Present (Previous) State of a flip-flop

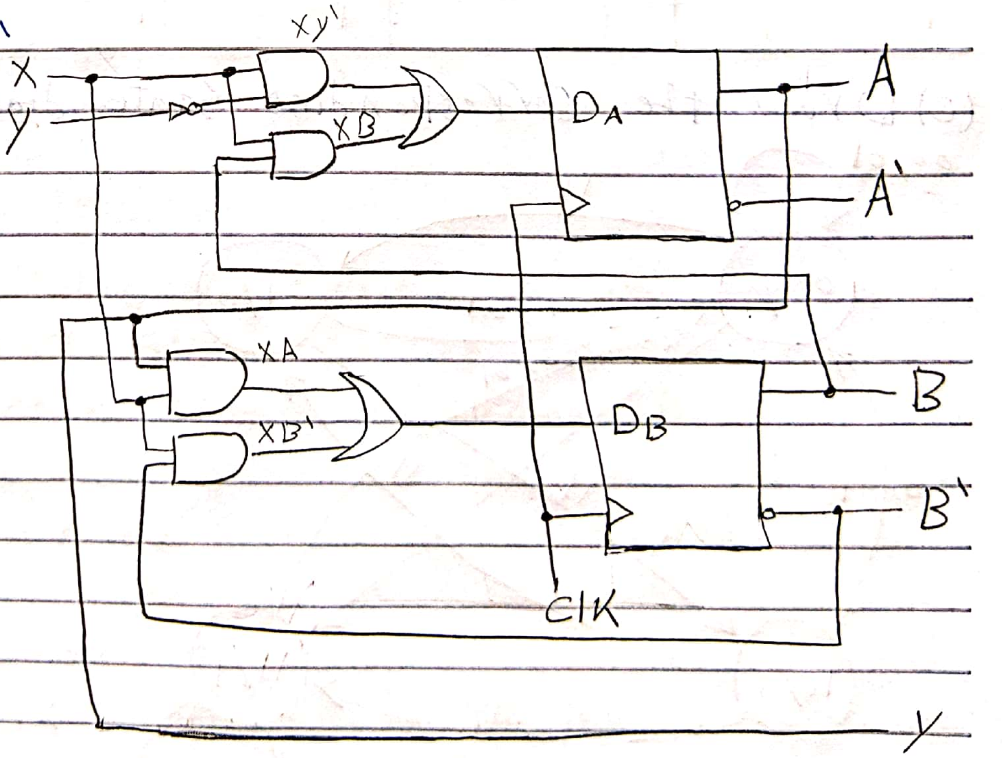
6- A Sequential Circuit with two D flip-flops A and B, two inputs X and y; one output Z.

$A^* = xy' + XB$

$B^* = XA + XB'$

$Z = A$

(a) Draw logic diagram



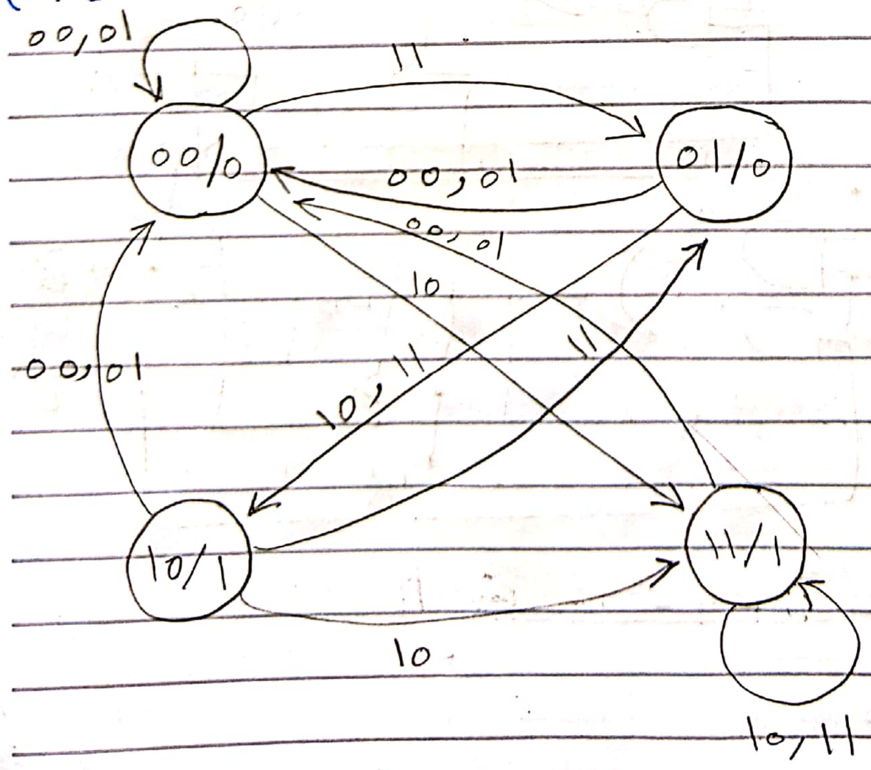
$A^* = X(Y' + B)$

$B^* = X(A + B')$

(b) list the State Table:-

Present State		inputs		Next State		output
A	B	X	Y	A^*	B^*	Z
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	0	1	0	1	1	0
0	0	1	1	0	1	0
0	1	0	0	0	0	0
0	1	0	1	0	0	0
0	1	1	0	1	0	0
0	1	1	1	1	0	0
1	0	0	0	0	0	1
1	0	0	1	0	0	1
1	0	1	0	1	1	1
1	0	1	1	0	1	1
1	1	0	0	0	0	1
1	1	0	1	0	0	1
1	1	1	0	1	1	1
1	1	1	1	1	1	1

(c) Draw the corresponding State diagram

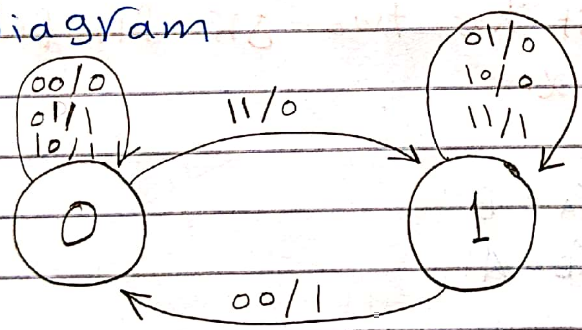


7- A Sequential Circuit has one flip-flop Q, two inputs X and Y, and one output S. It Consists of a full-adder circuit Connected to a D flip-flop. Drive

State table

Present State Q	inputs X	inputs Y	Next State Q(t+1)	output S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

State diagram



8- Drive the state table and State diagram of the Sequential Circuit Shown in fig. P5.8. EXplain the function that the circuit Perform.

1- Input equation

$T_A = A + B$ $\qquad$ $T_B = A' + B$

2- Characteristic equation

$A_{(t+1)} = T_A \oplus A$ $\qquad$ $B_{(t+1)} = T_B \oplus B$

3- Next State equation

$A_{(t+1)} = (A + B) \oplus A$ $\qquad$ $B_{(t+1)} = (A' + B) \oplus B$

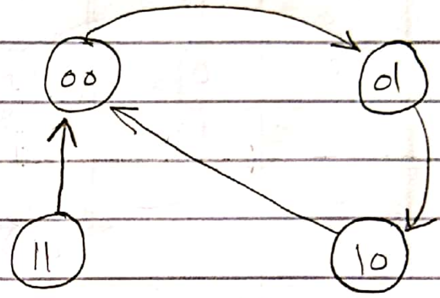
$A_{(t+1)} = (A+B) \oplus A$
$= (A+B)A' + (A+B)'A$
$= AA' + A'B + (A'B')A$
$= 0 + A'B + 0$
$= A'B$

$B_{(t+1)} = (A'+B) \oplus B$
$= (A'+B)B' + (A'+B)'B$
$= A'B' + BB' + AB'B$
$= A'B' + 0 + 0$
$= A'B'$

4- State table

Present state		Next state		
A	B	$A_{(t+1)}$	$B_{(t+1)}$	
0	0	0	1	1
0	1	1	0	2
1	0	0	0	0
1	1	0	0	0

5- State diagram



The circuit performs as a counter from zero to two.

9- A sequential circuit has two JK flip-flops A and B and one ~~output~~ input x.

Input equations:

$J_A = X$ $\qquad$ $K_A = B$

$J_B = X$ $\qquad$ $K_B = A'$

(a) Drive State equations:

1- JK Characteristic equations:

$A_{(t+1)} = J_A A' + K_A' A$ $\qquad$ $B_{(t+1)} = J_B B' + K_B' B$

2- State equations:

$A_{(t+1)} = XA' + B'A$
$= A'X + AB'$

$B_{(t+1)} = XB' + (A')'A$
$= XB' + AA$
$= XB' + A$
$= A + B'X$

(B) Draw State diagram:-

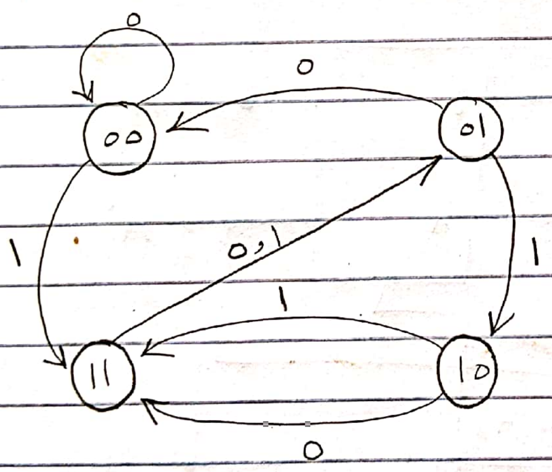
$A^* = A'x + AB'$

1- State Table

$B^* = A + B'x$

Present state		input	Next State	
A	B	X	$A_{(t+1)}$	$B_{(t+1)}$
0	0	0	0	0
0	0	1	1	1
0	1	0	0	0
0	1	1	1	0
1	0	0	1	1
1	0	1	1	1
1	1	0	0	1
1	1	1	0	1

2- State diagram



1- A Sequential Circuit has two JK flip-flop A and B, two inputs x and y, and one output Z.

1- Input equations:-

$J_A = Bx + B'y'$ $K_A = B'xy'$

$J_B = A'x$ $K_B = A + xy'$

2- JK-FF Characteristic ~~table~~ equations:-

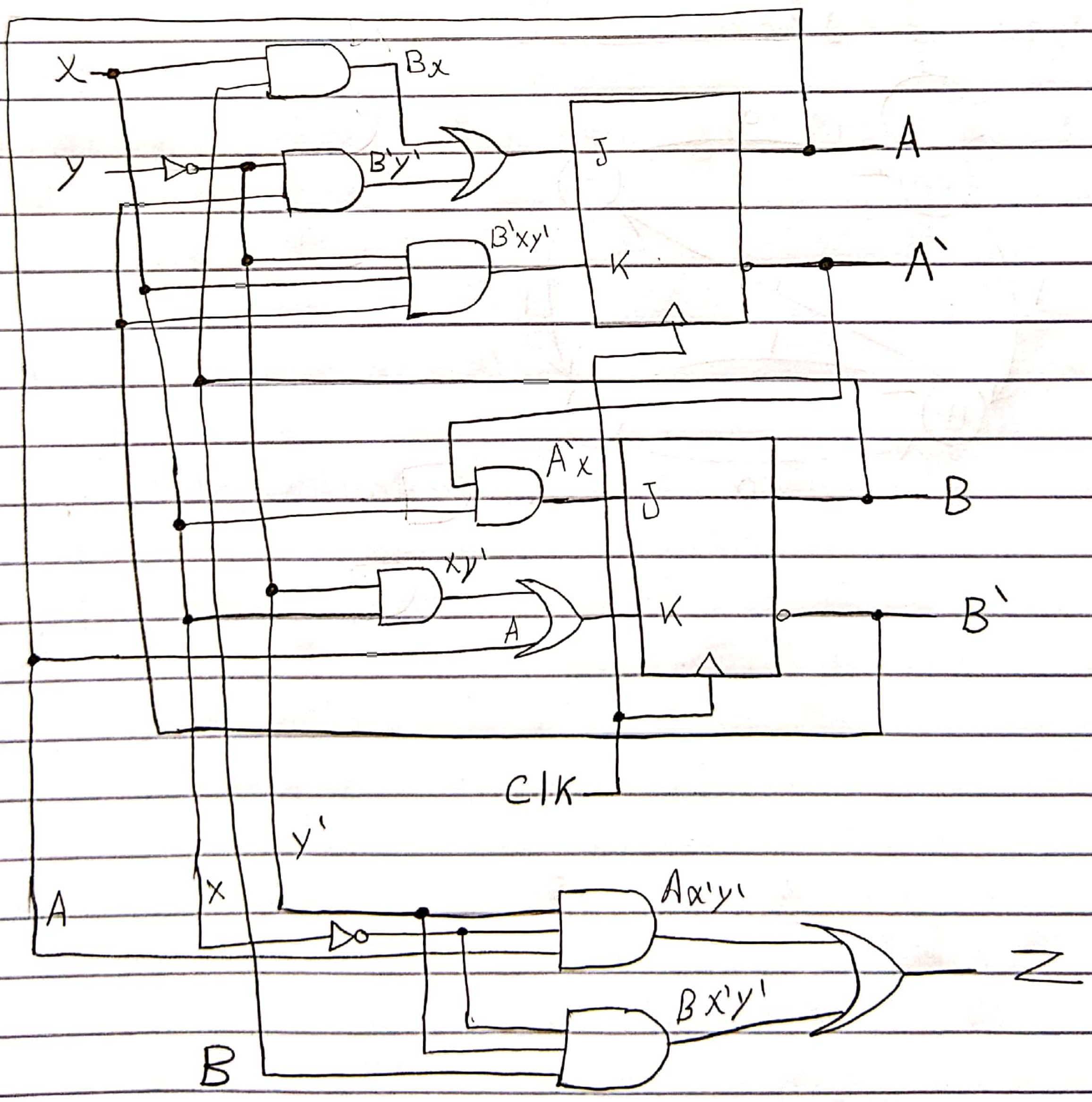
$A(t+1) = J_A A' + K_A' A$ $B(t+1) = J_B B' + K_B' B$

3- Output and Next State equations:-

$A(t+1) = (Bx + B'y')A' + (B'xy')'A$ $B(t+1) = (A'x)B' + (A+xy')'B$

$Z = Ax'y' + Bx'y'$

(a) Draw the logic diagram



(b) Tabulate the state table:-

Present A	Present B	inputs x	inputs y	Next A	Next B	output Z
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	0	1	0	0	1	0
0	0	1	1	1	1	0
0	1	0	0	0	1	1
0	1	0	1	1	1	0
0	1	1	0	1	0	0
0	1	1	1	1	1	0
1	0	0	0	1	0	1
1	0	0	1	1	0	0
1	0	1	0	0	0	0
1	0	1	1	1	0	0
1	1	0	0	1	0	1
1	1	0	1	1	0	0
1	1	1	0	1	0	0
1	1	1	1	1	0	0

$A = Ax' + Ay + Bx + B'y$

$B = A'B'x + A'Bx' + A'By$
$= A'(B'x + Bx' + By)$

$Z = Ax'y' + Bx'y'$
$= x'y'(A+B)$

(C) State equations for A and B

$A = (Bx + B'y')A' + (B'xy')'A$
$= A'Bx + A'B'y' + (B + x' + y)A$
$= A'Bx + A'B'y' + AB + Ax' + Ay$
$= B(A'x + A) + A'B'y' + Ax' + Ay$
$= B(A + x) + A'B'y + Ax' + Ay$
$= AB + Bx + A'B'y + Ax' + Ay$
$= Bx + A'B'y + Ax' + Ay$
$= Bx + y(A'B' + A) + Ax'$
$= Bx + y(B' + A) + Ax'$
$= Bx + yB' + Ay + Ax'$

$= \boxed{Ax' + Ay + Bx + B'y}$

$B = (A'x)B' + (A + xy')'B$
$= A'B'x + (A'(x' + y))B$
$= A'B'x + (A'x' + A'y)B$
$= A'B'x + A'Bx' + A'By$

$= \boxed{A'B'x + A'Bx' + A'By}$

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15- List a State table for the JK flip-flop using Q as P.S and N.S and J and K as inputs. Design the sequential circuit specified by the State table.

1- State table

	Inputs		P.S	N.S
	J	K	Q	(Q+1)
H	0	0	0	0
	0	0	1	1
R	0	1	0	0
	0	1	1	0
S	1	0	0	1
	1	0	1	1
Com	1	1	0	1
	1	1	1	0

$Q^* = \sum m(1, 4, 5, 6)$

J \ KQ	00	01	11	10
0		1		
1	1	1		1

$Q^* = JQ' + K'Q$

Design the Sequential Circuit :-