DIGITAL DESIGN

ASSIGNMENT REPORT

ASSIGNMENT ID : 1

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PART 1: DIGITAL DESIGN THEORY

Provide your answers here:

- (20 points) A PN flipflop has four operations: clear to 0, no change, complement, and set to 1, when inputs P and N are 00, 01, 10, and 11, respectively.
  1. Tabulate the characteristic table.
  2. Derive the characteristic equation.
  3. Tabulate the excitation table.
  4. Show how the PN flipflop can be converted to a D flipflop.

① present → next

P	N	Q(t)	Q(t+1)
0	0	0	0
0	0	1	0
0	1	0	Q(t)
0	1	1	Q(t)
1	0	0	$\overline{Q(t)}$
1	0	1	$\overline{Q(t)}$
1	1	0	1
1	1	1	1

② use K-map

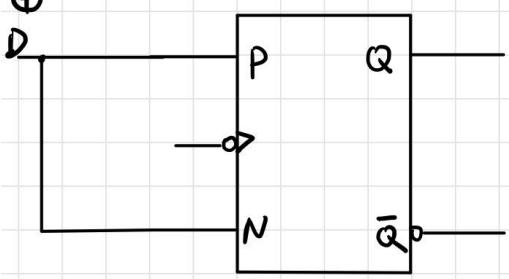
Q(t) \ PN	00	01	11	10
0	0	0	1	1
1	0	1	1	0

$Q(t+1) = PQ' + NQ$

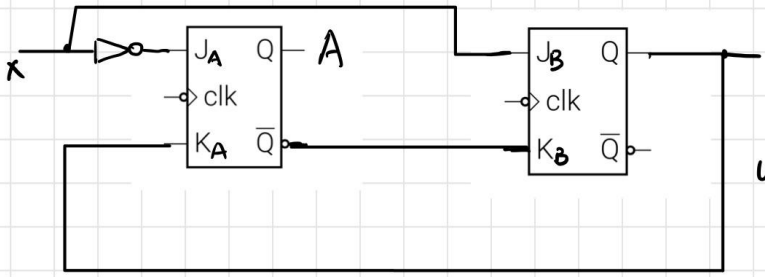
③

Q(t)	Q(t+1)	P	N
0	0	0	X
0	1	1	X
1	0	X	0
1	1	X	1

④



- (20 points) A sequential circuit has two JK flip-flops A and B and one input x. The circuit is described by the following flip-flop input equations: $J_A = x'$, $K_A = B$, $J_B = x$, $K_B = A'$.
  1. Derive the state equations $A(t+1)$ and $B(t+1)$ by substituting the input equations for the J and K variables. raw the state diagram of the circuit.



$Q_A(t+1) = J_A Q_A' + K_A' Q_A$

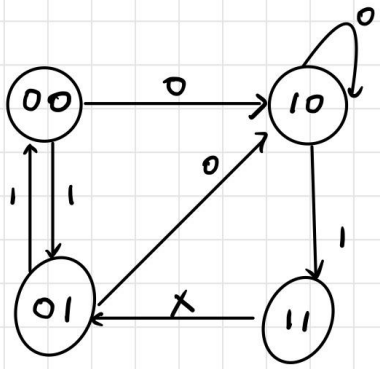
$Q_B(t+1) = J_B Q_B' + K_B' Q_B$

we use $J_A = x'$, $K_A = B$, $J_B = x$, $K_B = A'$

$Q_A(t+1) = x' A' + B' A$

$Q_B(t+1) = x B' + A B$

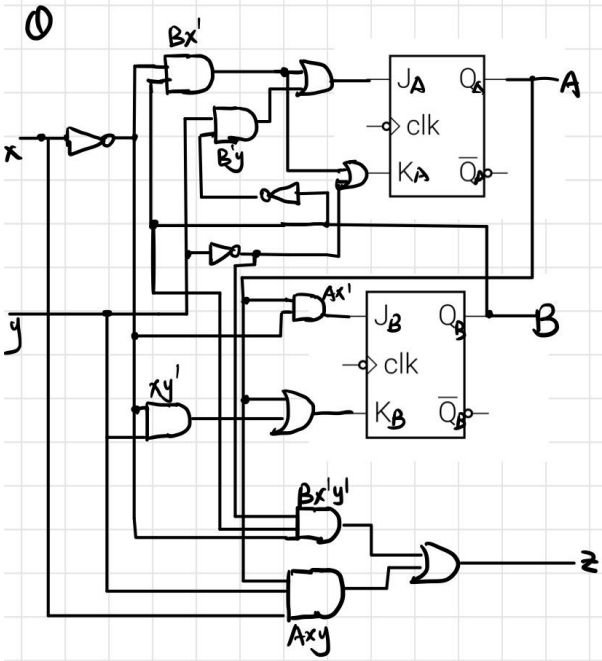
Present		Input	Next	
A	B	x	A	B
0	0	0	1	0
0	0	1	0	1
0	1	0	1	0
0	1	1	0	0
1	0	0	1	0
1	0	1	1	1
1	1	0	0	1
1	1	1	0	1



(20 points) A sequential circuit has two JK flipflops A and B, two inputs x and y, and one output z. The flipflop input equations and circuit output equation are $J_A = Bx' + B'y$, $K_A = Bx' + y'$, $J_B = Ax'$, $K_B = A + xy'$, $z = Axy + Bx'y'$.

1. Draw the logic diagram of the circuit.
2. Tabulate the state table.
3. Derive the state equations for A and B.

①



③

$A(t+1) = J_A A_t' + K_A' A_t$

$= (Bx' + B'y)A' + (Bx' + y')'A$

$= A'Bx' + A'B'y + Axy + AB'y$

$= B'y + A'Bx' + Axy$

$B(t+1) = J_B B_t' + K_B' B_t$

$= Ax'B' + (A + xy')'B$

$= Ax'B' + A'x'B + A'yB$

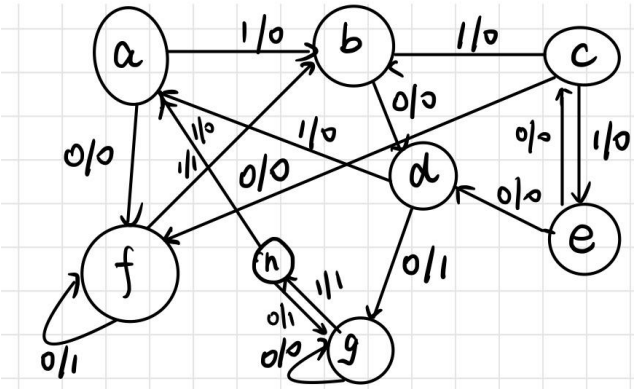
J	K	Q_{t+1}	
0	0	Q_t	No change
0	1	0	Reset
1	0	1	Set
1	1	Q_t'	Complement

present		Inputs		next		output	FF inputs			
A	B	x	y	A	B	z	J_A	K_A	J_B	K_B
0	0	0	0	0	0	0	0	1	0	0
0	0	0	1	1	0	0	1	0	0	0
0	0	1	0	0	0	0	0	1	0	1
0	0	1	1	1	0	0	1	0	0	0
0	1	0	0	1	1	1	1	1	0	0
0	1	0	1	1	1	0	1	0	0	0
0	1	1	0	0	0	0	0	1	0	1
0	1	1	1	0	1	0	0	0	0	0
1	0	0	0	0	1	0	0	1	1	1
1	0	0	1	1	1	0	1	0	1	1
1	0	1	0	0	0	0	0	1	0	1
1	0	1	1	1	0	1	1	0	0	1
1	1	0	0	0	0	1	1	1	1	1
1	1	0	1	0	0	0	1	1	1	1
1	1	1	0	0	0	0	0	1	0	1
1	1	1	1	1	0	1	0	0	0	1

(20 points) For the following state table

Present State	Next State $x=0$	Next State $x=1$	Output $x=0$	Output $x=1$
a	f	b	0	0
b	d	c	0	0
c	f	e	0	0
d	g	a	1	0
e	d	c	0	0
f	f	b	1	1
g	g	h	0	1
h	g	a	1	0

1. Draw the corresponding state diagram.
2. Tabulate the reduced state table.
3. Draw the state diagram corresponding to the reduced state table.
4. Determine the output sequence for input sequence 01010101111 (from left to right) with the original state table and the reduced state table, starting from a.

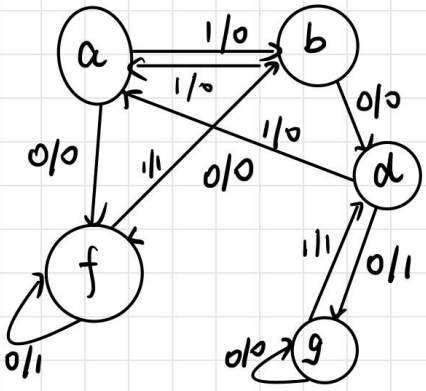


a 0→ f 1→ b 0→ d 1→ a 0→ f
0 1 0 0 0

0→ f 1→ b 0→ d 1→ a 1→ b 1→ c
1 1 0 0 0 0

01000 11000

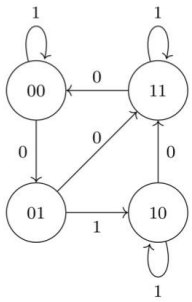
Present State	Next State $x=0$	Next State $x=1$	Output $x=0$	Output $x=1$
a	f	b	0	0
b	d	a	0	0
d	g	a	1	0
f	f	b	1	1
g	g	d	0	1



01010010111

a 0→ f 1→ b 0→ d 1→ a 0→ f 0→ f 1→ b 0→ d 1→ a 1→ b 1→ a
0 1 0 0 0 1 1 0 0 0 0

- (20 points) Obtain the simplified input equations for a sequential circuit that uses T flip-flops and is specified by the state diagram below.



Present A	Present B	Input x	next A	next B	TFF T_A	TFF T_B
0	0	0	0	1	0	1
0	0	1	0	0	0	0
0	1	0	1	1	1	0
0	1	1	1	0	1	1
1	0	0	1	1	0	1
1	0	1	1	0	0	0
1	1	0	0	0	1	1
1	1	1	1	1	0	0

T_A k-map

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

$T_A = x'B + A'B$

A_{t+1} k-map

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

$A_{t+1} = A'B + AB' + xB$

T_B k-map

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

$T_B = x'B' + x'A + xA'B$

B_{t+1} k-map

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

$B_{t+1} = x'A' + x'B' + xAB$