

Practice sheet 3 solutions

Q1.

Full adder, $Q(n+1) = C$, $S = Q(n) + x + y$

st. table:

$Q(n)$	x	y	$Q(n+1) = C$	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

st. diagram:

```

graph LR
    0((0)) -- "00/0" --> 0
    0 -- "01/1" --> 1((1))
    0 -- "10/1" --> 1
    0 -- "11/0" --> 1
    1 -- "00/0" --> 0
    1 -- "01/1" --> 1
    1 -- "10/1" --> 1
    1 -- "11/1" --> 1
  
```

Q2.

$A \rightarrow T_1: A+B$

$B \rightarrow T_2: \bar{A}+B$

st. table:

	$A(n)$	$B(n)$	$T_1(n)$	$T_2(n)$	$A(n+1)$	$B(n+1)$
	0	0	0	1	0	1
	0	1	1	1	1	0
	1	0	1	0	0	0
	1	1	1	1	0	0

st. diagram:

```

graph LR
    00((00)) -- "00/0" --> 00
    00 -- "01/1" --> 01((01))
    00 -- "10/1" --> 01
    00 -- "11/1" --> 01
    01 -- "00/0" --> 00
    01 -- "01/1" --> 01
    01 -- "10/1" --> 10((10))
    01 -- "11/1" --> 10
    10 -- "00/0" --> 00
    10 -- "01/1" --> 01
    10 -- "10/1" --> 01
    10 -- "11/1" --> 01
  
```

Binary Counter: $0 \rightarrow 1 \rightarrow 2$

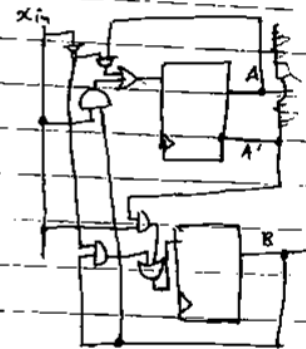
Q3.

Q 3a)

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graph LR; S0((00)) -- "0/0" --> S1((01)); S1 -- "0/1" --> S2((10)); S2 -- "1/0" --> S3((11)); S3 -- "1/1" --> S4((00)); S4 -- "0/0" --> S5((01)); S5 -- "0/1" --> S6((10)); S6 -- "1/0" --> S7((11)); S7 -- "1/1" --> S8((00)); S8 -- "0/0" --> S9((01)); S9 -- "0/1" --> S10((10)); S10 -- "1/0" --> S11((11)); S11 -- "1/1" --> S12((00));
```

Q/p - 00 00 00 01 00 00 01

b_j	A	B	x_{in}	$A(m_{in})$	$B(m_{in})$
0	0	0	0	0	0
0	0	1	1	0	1
0	1	0	0	0	1
0	1	1	1	1	1
1	0	0	0	1	0
1	0	1	1	0	0
1	1	0	0	1	1
1	1	1	1	1	0



K_{max} :

A : $\begin{array}{c|cccc} & B_A & 00 & 01 & 11 & 10 \\ \hline 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 1 \end{array}$

\overleftarrow{Bx}

	00	01	11	10
0	0	1	1	1
1	0	0	0	1

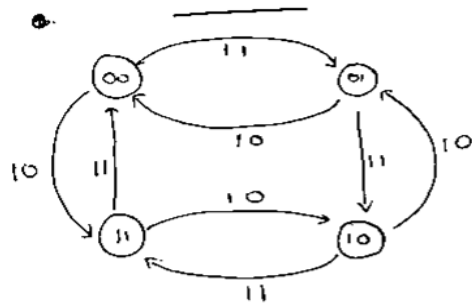
 \overrightarrow{B}

$$A(n+1) = Bx + Ax'$$

$$\underline{B(n+1)} = \underline{A'x} + \underline{Bx'}$$

4.

4) State diagram



State table

Present state		Input		Next stage		FlipFlop Inputs			
A	B	E	X	A	B	J _A	K _A	J _B	K _B
0	0	0	0	0	0	0	X	0	X
0	0	0	1	0	0	0	X	0	X
0	0	1	0	1	1	1	X	1	X
0	0	1	1	0	1	0	X	1	X
0	1	0	0	0	0	0	X	X	0
0	1	0	1	0	0	0	X	X	0
0	1	1	0	1	0	1	X	X	1
0	1	1	1	1	0	X	0	0	X
1	0	0	0	1	0	X	0	0	X
1	0	0	1	1	0	X	0	0	X
1	0	1	0	0	1	X	1	1	X
1	0	1	1	1	1	X	0	1	X
1	1	0	0	1	1	X	0	X	0
1	1	0	1	1	1	X	0	X	0
1	1	1	0	0	0	X	0	X	1
1	1	1	1	0	0	X	1	X	1

1/1

AB \ EX	00	01	11	10
00	0	0	0	1
01	0	0	1	0
11	X	X	X	X
10	X	X	X	X

$$J_A = BEX + E\bar{B}$$

AB \ EX	00	01	11	10
00	0	0	1	1
01	X	X	X	X
11	X	X	X	X
10	0	0	1	1

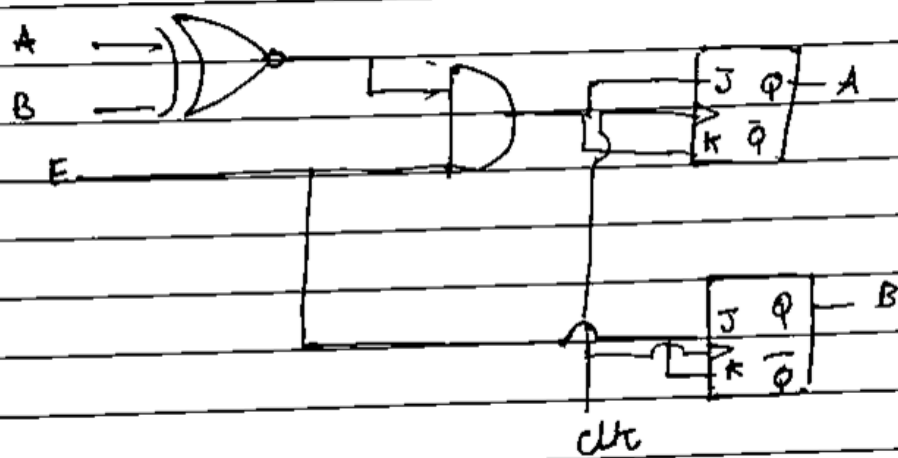
$$J_B = \bar{E}$$

AB \ EX	00	01	11	10
00	X	X	X	X
01	X	X	X	X
11	0	0	1	0
10	0	0	0	1

$$K_A = BEX + B\bar{E}X$$

AB \ EX	00	01	11	10
00	X	X	X	X
01	0	0	1	1
11	0	0	1	1
10	X	X	X	X

$$K_B = \bar{E}$$



5.

Present state			input x	Next State			output y
A	B	C		$A^{*}(next)$	$B^{*}(next)$	$C^{*}(next)$	
0	0	0	0	0	1	1	0
0	0	0	1	1	0	0	1
0	0	1	0	0	0	1	0
0	0	1	1	1	0	0	1
0	1	0	0	0	1	0	0
0	1	0	1	0	0	0	1
0	1	1	0	0	0	1	0
0	1	1	1	0	1	0	1
1	0	0	0	0	1	0	0
1	0	0	1	0	1	1	0

we use don't care condition, i.e. $d(A, B, C, x) = \Sigma(10, 11, 12, 13, 15)$

$$A^* = A'B'x$$

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

$$B^* = A + C'x' + BCx$$

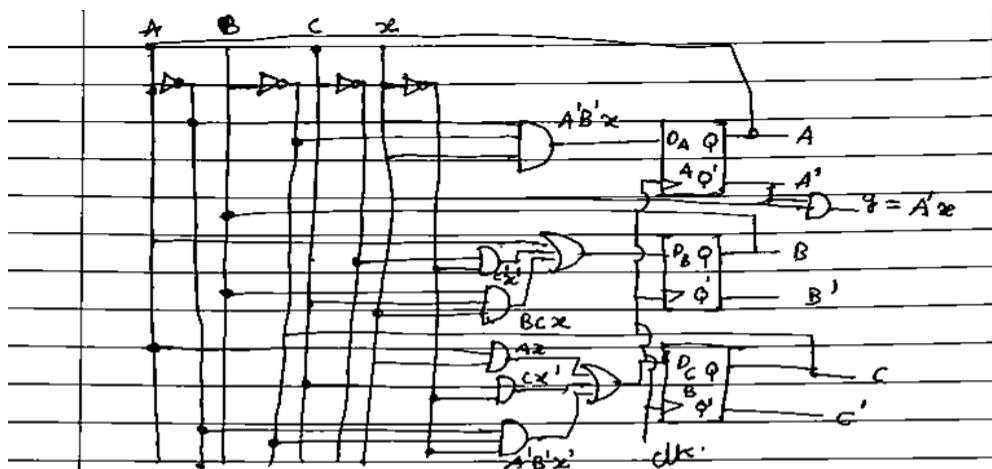
AB \ C	x			
	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	x	x	1	x
10	1	1	x	x

$$C^* = Ax + Cx' + A'B'x'$$

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

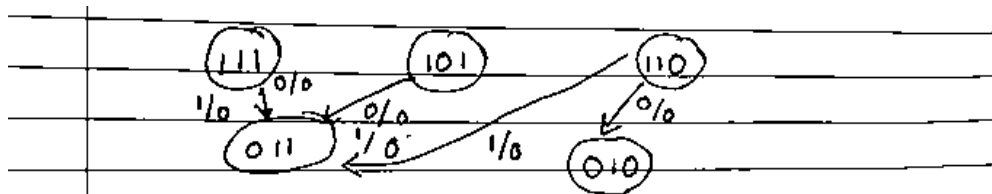
$$y = A'x$$

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



For don't care for unused state

Present State			input	Next State			output
A	B	C	x	A*	B*	C*	y
1	0	1	0	0	1	1	0
1	0	1	1	0	1	1	0
1	1	0	0	0	1	0	0
1	1	0	1	0	1	1	0
1	1	1	0	0	1	1	0
1	1	1	1	0	1	1	0



The machine is transitioning from unused states to known states.