COM 204 – Digital Logic Systems

Week – 7

Sample Review Problems

Problem 1

- A *PN* flip -flop 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.
  - Tabulate the characteristic table
  - Derive the characteristic equation
  - Tabulate the excitation table

P	N	Q(t+1)
0	0	0
0	1	Q(t)
1	0	Q’(t)
1	1	1

Problem 1..

- Characteristic table:

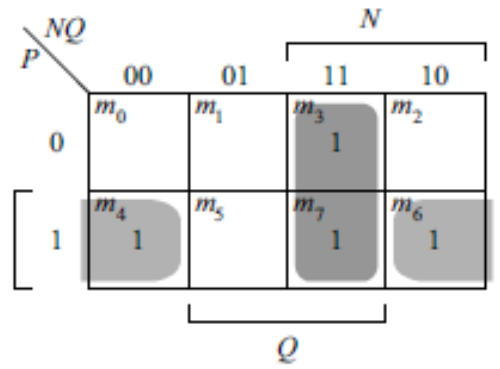
P	N	Q(t + 1)
0	0	0
0	1	Q(t)
1	0	Q'(t)
1	1	1

- Excitation Table

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

Characteristic Equation

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



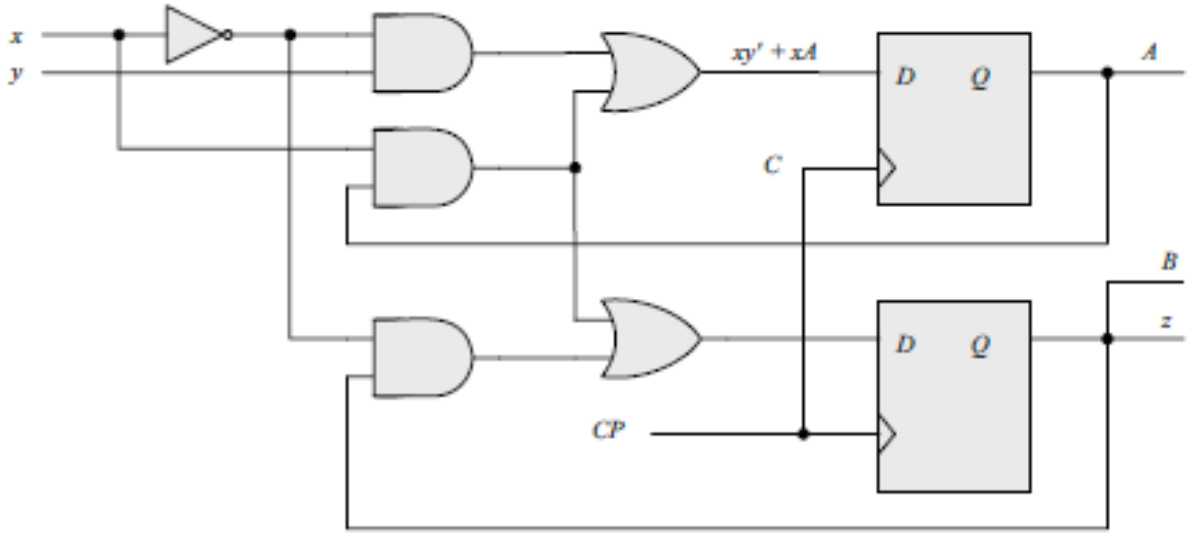
$Q(t+1) = PQ' + NQ$

Problem 2

- A sequential circuit with two *D* flip-flops *A* and *B,* two inputs *x* and y, and one output z is specified by the following next-state and output equations.
  - A(t+1)=x'y+xB
  - B(t+1)=x'A+xB
  - z=A

  - Draw the logic diagram of the circuit
  - List the state table for the sequential circuit
  - Draw the corresponding state diagram

Problem 2..



- A(t+1)=x’y+xA
- B(t+1)=x’B+xA
- z=B

- State Table

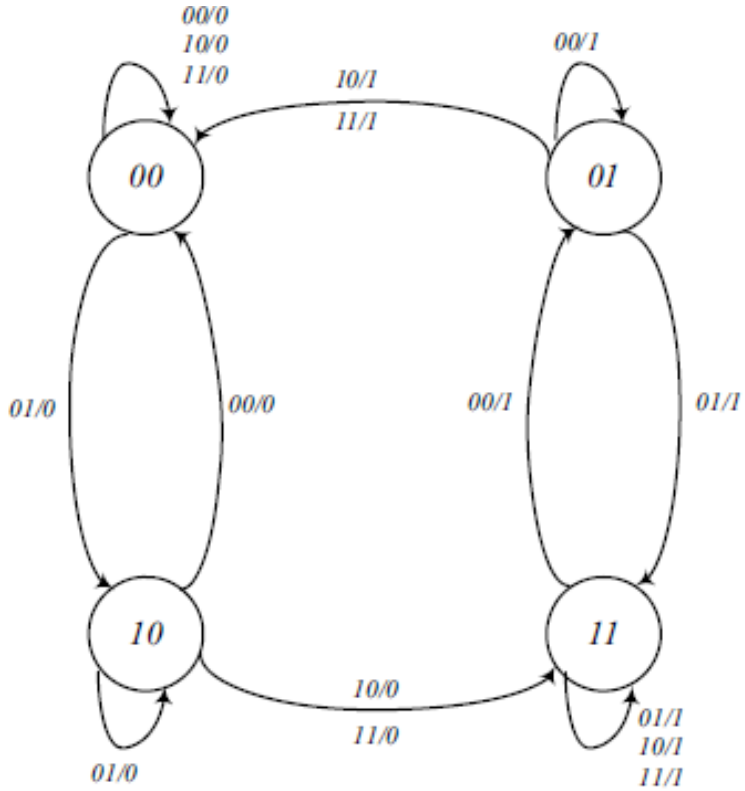
Problem 2

- A(t+1)=x'y+xA
- B(t+1)=x'B+xA
- z=B

- 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	1	0	0
0	0	1	0	0	0	0
0	0	1	1	0	0	0
0	1	0	0	0	1	1
0	1	0	1	1	1	1
0	1	1	0	0	0	1
0	1	1	1	0	0	1
1	0	0	0	0	0	0
1	0	0	1	1	0	0
1	0	1	0	1	1	0
1	0	1	1	1	1	0
1	1	0	0	0	1	1
1	1	0	1	1	1	1
1	1	1	0	1	1	1
1	1	1	1	1	1	1

State Diagram

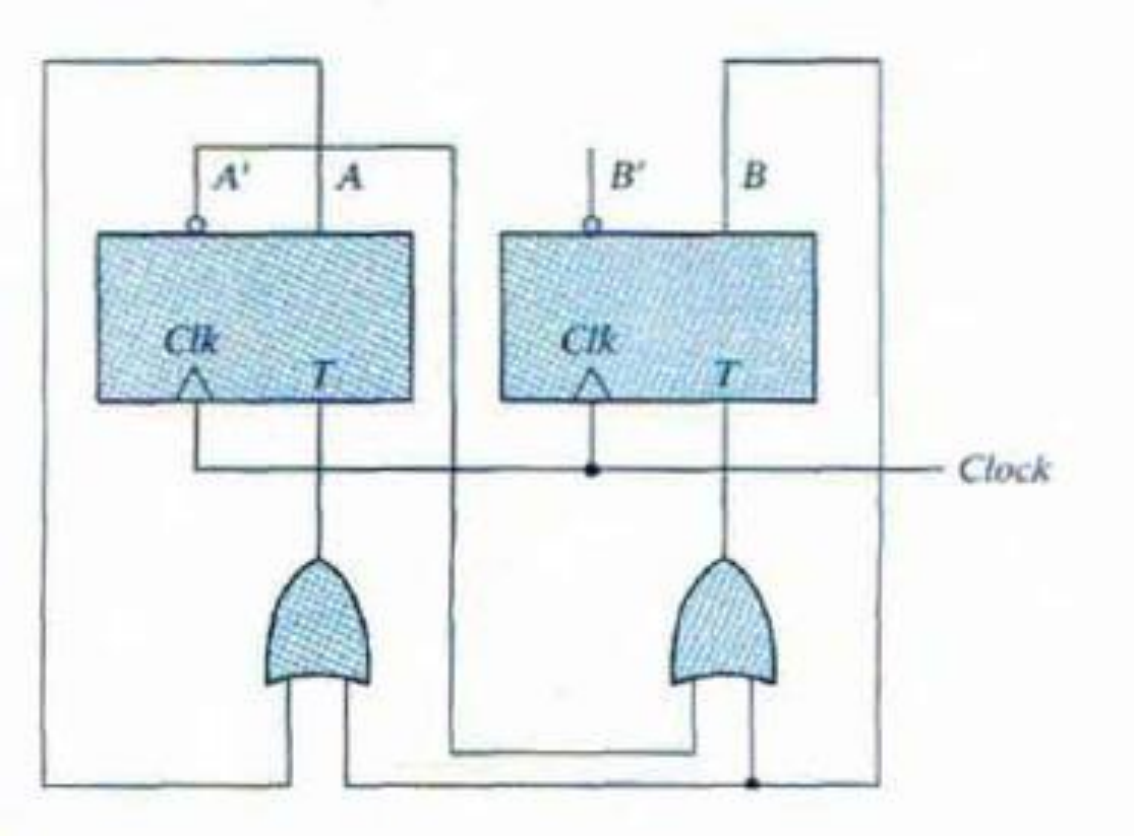


Problem 3

- Derive the state table and the state diagram of the sequential circuit shown in the figure, explain the function that the circuit performs.

  - FF input equations:

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



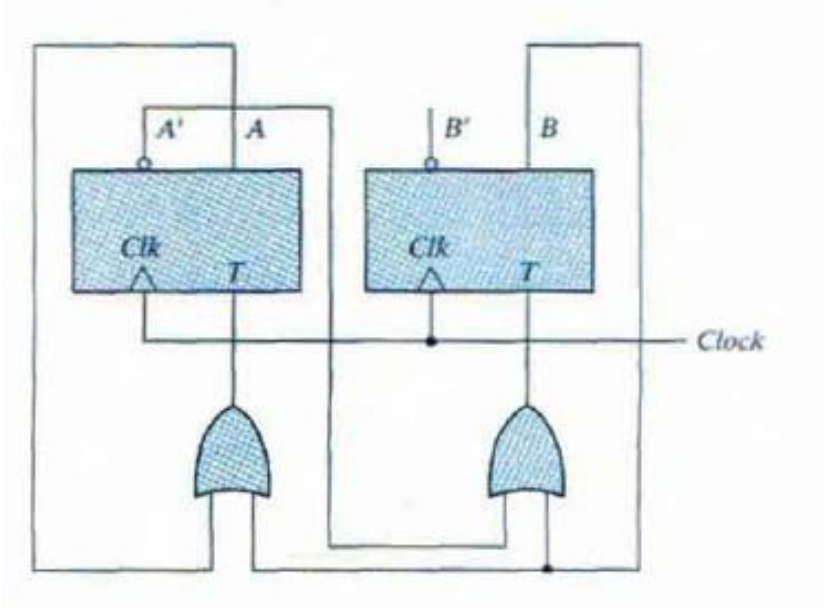
Problem 3..

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

- State table:

T	Q(t+1)
0	Q(t)
1	Q'(t)

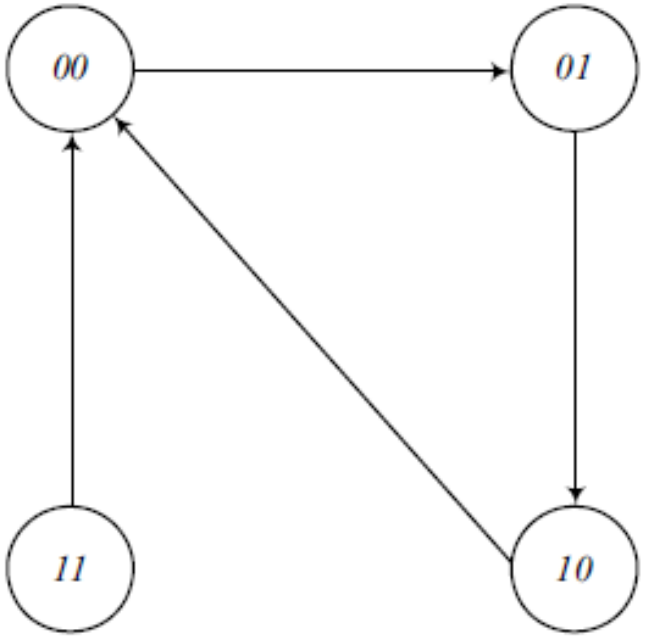
Present State		Next State		FF-inputs	
A	B	A	B	T_A	T_B
0	0	0	1	0	1
0	1	1	0	1	1
1	0	0	0	1	0
1	1	0	0	1	1



Problem 3..

Present State		Next State		FF-inputs	
A	B	A	B	T_A	T_B
0	0	0	1	0	1
0	1	1	0	1	1
1	0	0	0	1	0
1	1	0	0	1	1

- State diagram:

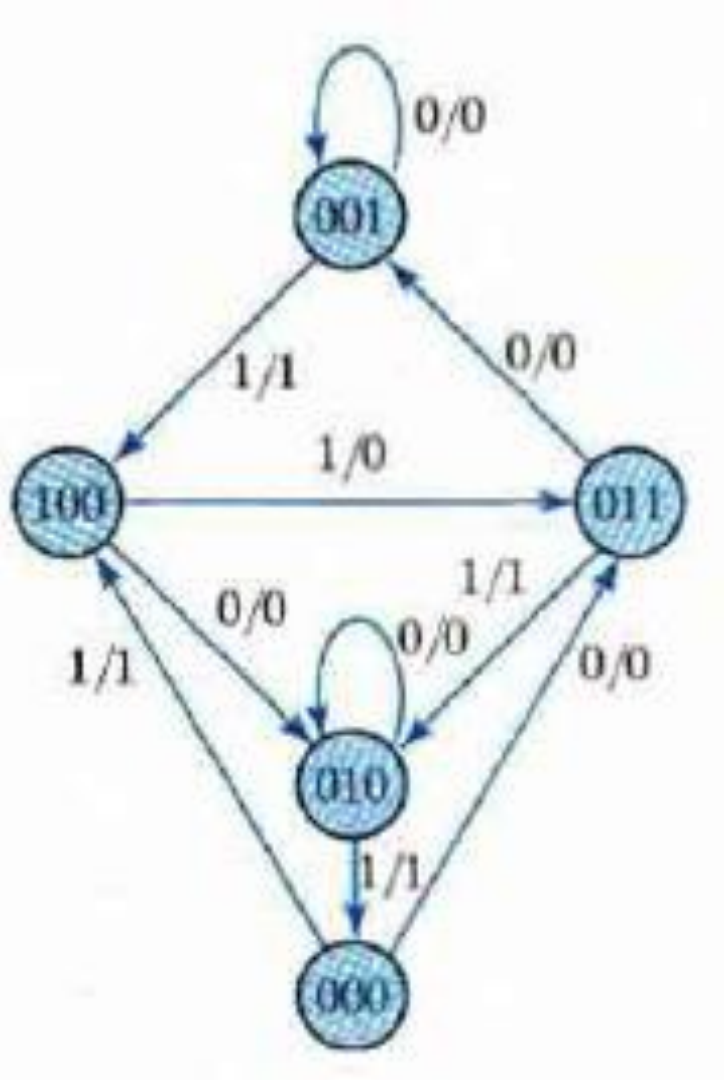


- Explain?

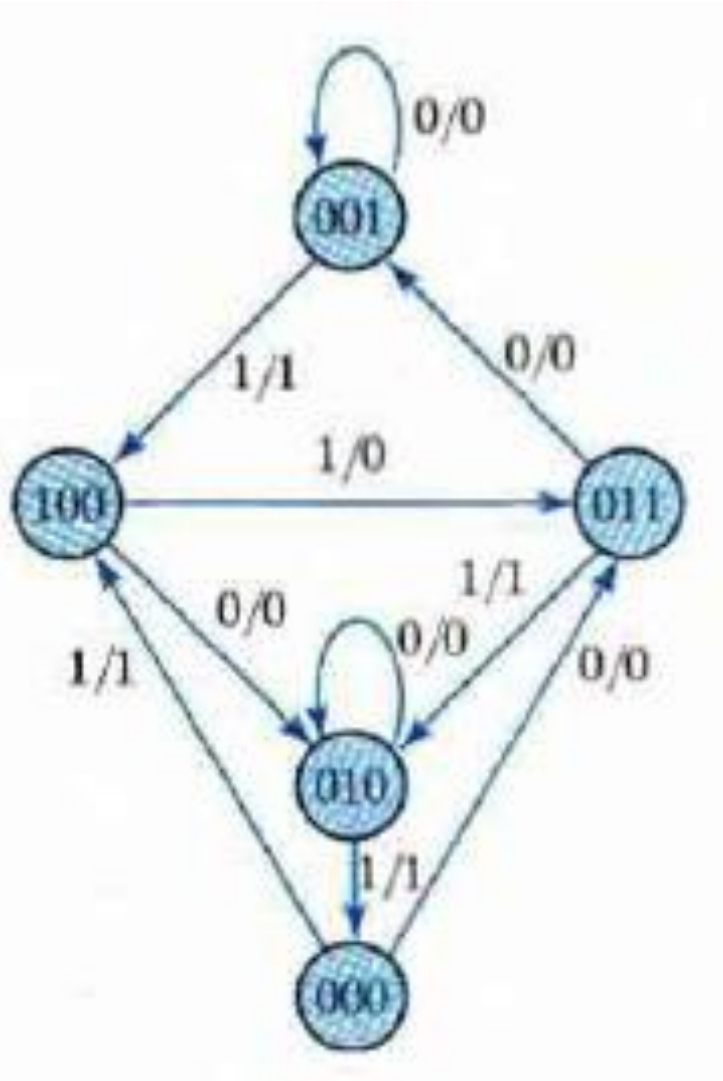
  A Counter with a repeated sequence of 00-01-10

Problem 4

- A sequential circuit has three flipflops A, B and C; and one input x_in and one output y_out. The state diagram is given as follows. The circuit is to be designed by treating unused states as don't care conditions. Analyze the circuit obtained from the design to determine the effect of the unused states.
  - A) Use D flip-flops in the design.
  - B) Use JK flip-flops in the design.



Problem 4..



Present State			input	Next State			Output
A	B	C	x	A	B	C	y
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
1	0	1	0	X	X	X	X
1	0	1	1	X	X	X	X
1	1	0	0	X	X	X	X
1	1	0	1	X	X	X	X
1	1	1	0	X	X	X	X
1	1	1	1	X	X	X	X

Unused states?

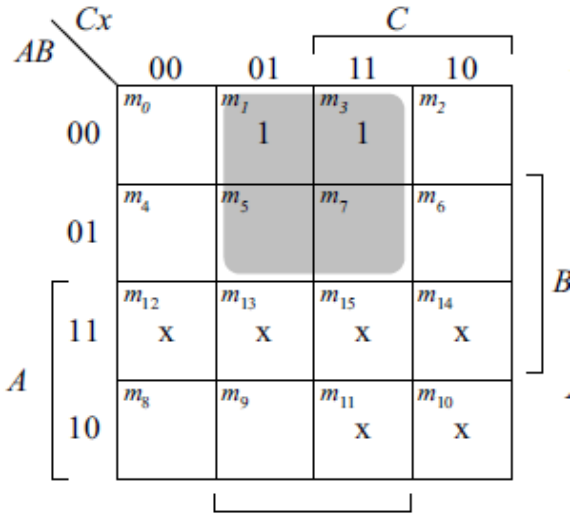
101,110,111

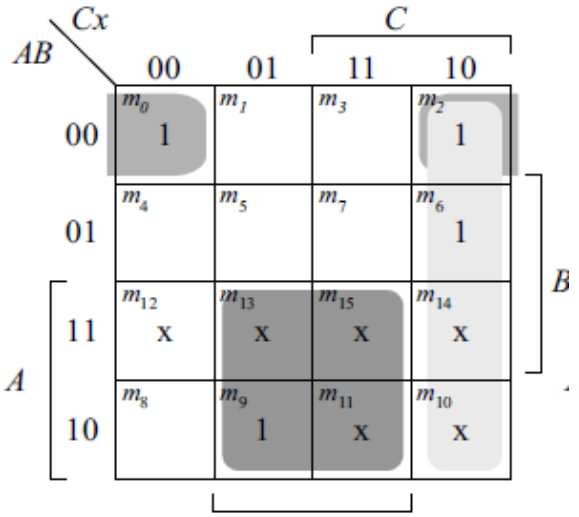
Problem 4..

Present state ABC	Input x	Next state ABC	Output y
000	0	011	0
000	1	100	1
001	0	001	0
001	1	100	1
010	0	010	0
010	1	000	1
011	0	001	0
011	1	010	1
100	0	010	0
100	1	011	1

- d(A,B,C,x)=∑(?)
  - 10,11,12,13,14,15

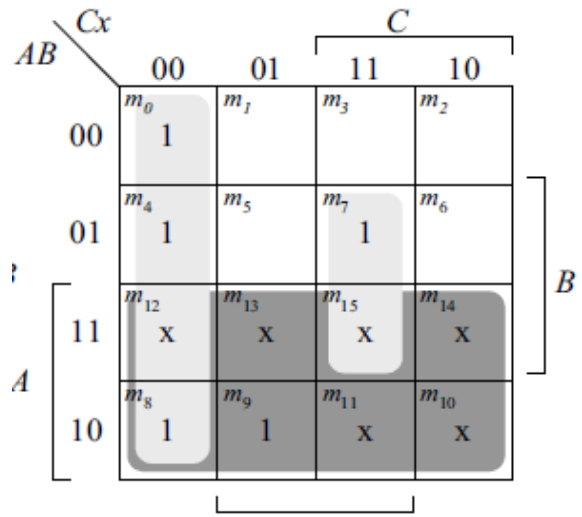
D_A = ? $D_A = A'B'x$

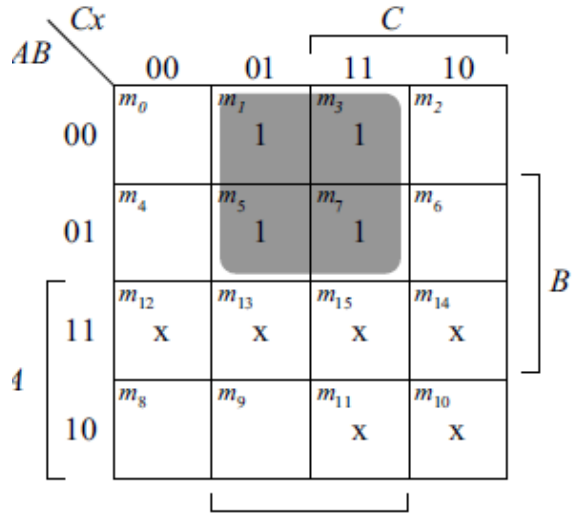




$D_C = Cx' + Ax + A'B'x'$

D_B = ? $D_B = A + Cx' + BCx$





$y = A'x$

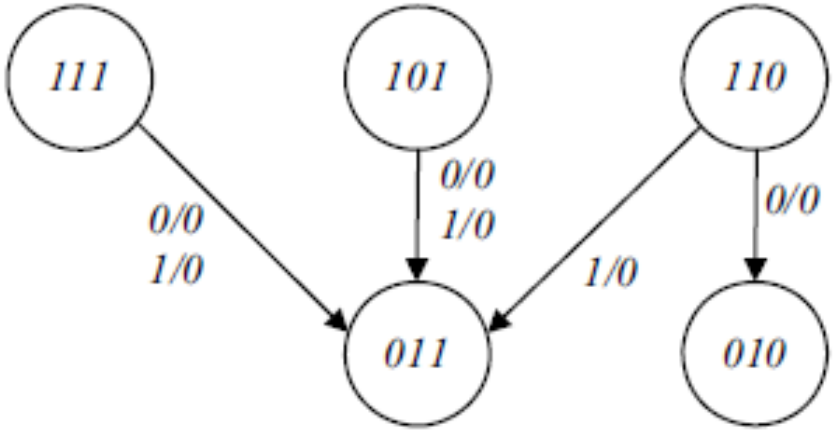
Problem 4..

$$D_A = A'B'x \qquad D_B = A + C'x' + BCx$$

$$D_C = Cx' + Ax + A'B'x'$$

- What happens at unused states?
  - 101?
    - →011
  - 110?
    - x=0 →010
    - x=1 →011
  - 111?
    - →011

The machine is self-correcting, i.e., the unused states transition to known states.



Problem 4..

- With JK Flipflops

J	K	Q(t+1)
0	0	Q(t)
0	1	0
1	0	1
1	1	Q'(t)

Q(t)	Q(t+1)	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

Present State			input	Next State			Output	FF inputs					
A	B	C	x	A	B	C	y	JA	KA	JB	KB	JC	KC
0	0	0	0	0	1	1	0	0	X				
0	0	0	1	1	0	0	1	1	X				
0	0	1	0	0	0	1	0	0	X				
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						
1	0	1	0	X	X	X		X	X	X	X	X	X
1	0	1	1	X	X	X		X	X	X	X	X	X
1	1	0	0	X	X	X		X	X	X	X	X	X
1	1	0	1	X	X	X		X	X	X	X	X	X
1	1	1	0	X	X	X		X	X	X	X	X	X

Problem 4..

- State table is the same

Flip-flop inputs					
J_A	K_A	J_B	K_B	J_C	K_C
0	x	1	x	1	x
1	x	0	x	0	x
0	x	0	x	x	0
1	x	0	x	x	1
0	x	x	0	0	x
0	x	x	1	0	x
0	x	x	1	x	0
0	x	x	0	x	1
x	1	1	x	0	x
x	1	1	x	1	x

$J_A = B'x$ $\quad K_A = 1$

$J_B = A + C'x'$ $\quad K_B = C'x + Cx'$

$J_C = Ax + A'B'x'$ $\quad K_C = x$

$y = A'x$

The machine is self-correcting because $K_A = 1$.

101 → 0__

JA= KA=1

110 → 0__

111 → 0__

Good Luck in the exams.