Digital Logic Circuits
'Sequential Logic Analysis'
ELEC2200

David J. Broderick
brodedj@auburn.edu
http://www.auburn.edu/~brodedj
Office: Broun 360

Sequential Analysis

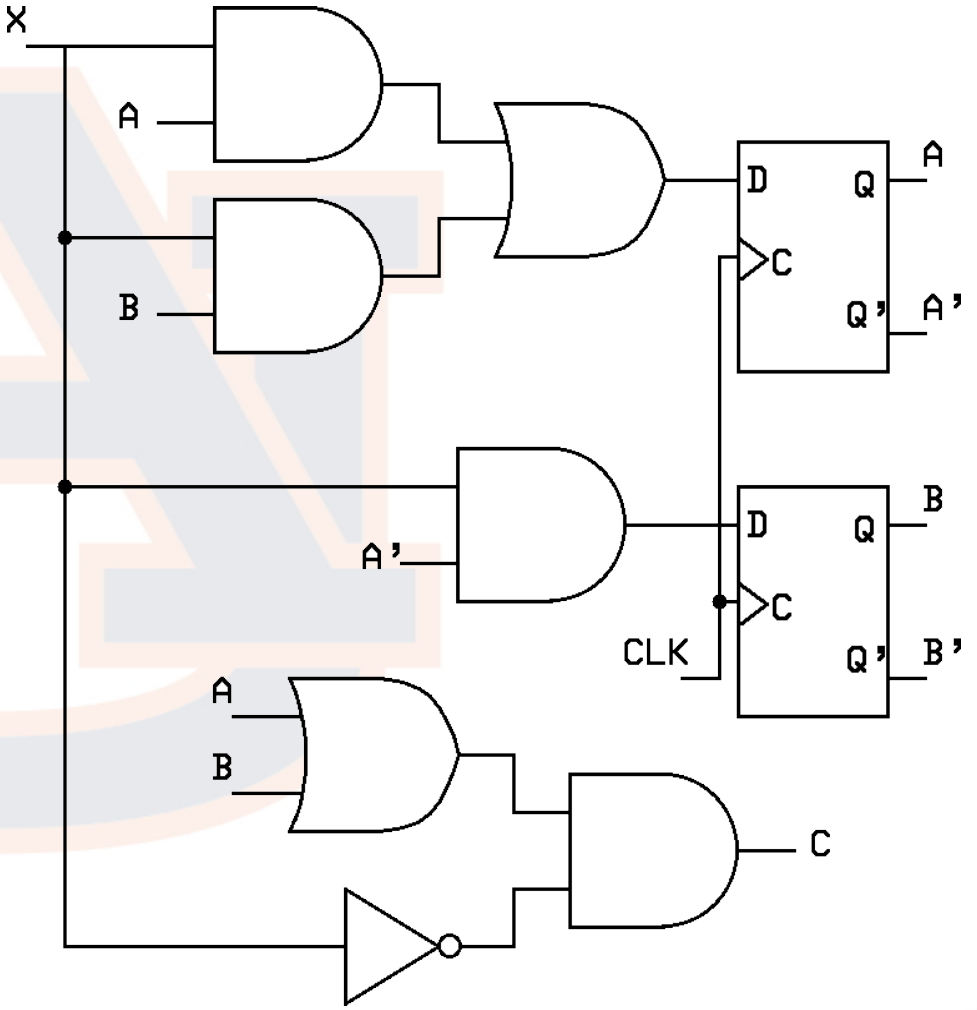
- Divides into two categories
    - Given a circuit, find the state table and diagram
    - Given a state and an input sequence, what will the output sequence be?
- We'll perform both today and through the rest of the semester

Sequential Analysis

- Use combinational analysis to write the expressions for each flip-flop input and each output.
- Use characteristics of flip-flops to construct state table
- Draw state diagram based on state table
- Use state diagram to find state/output sequence

Analysis Example

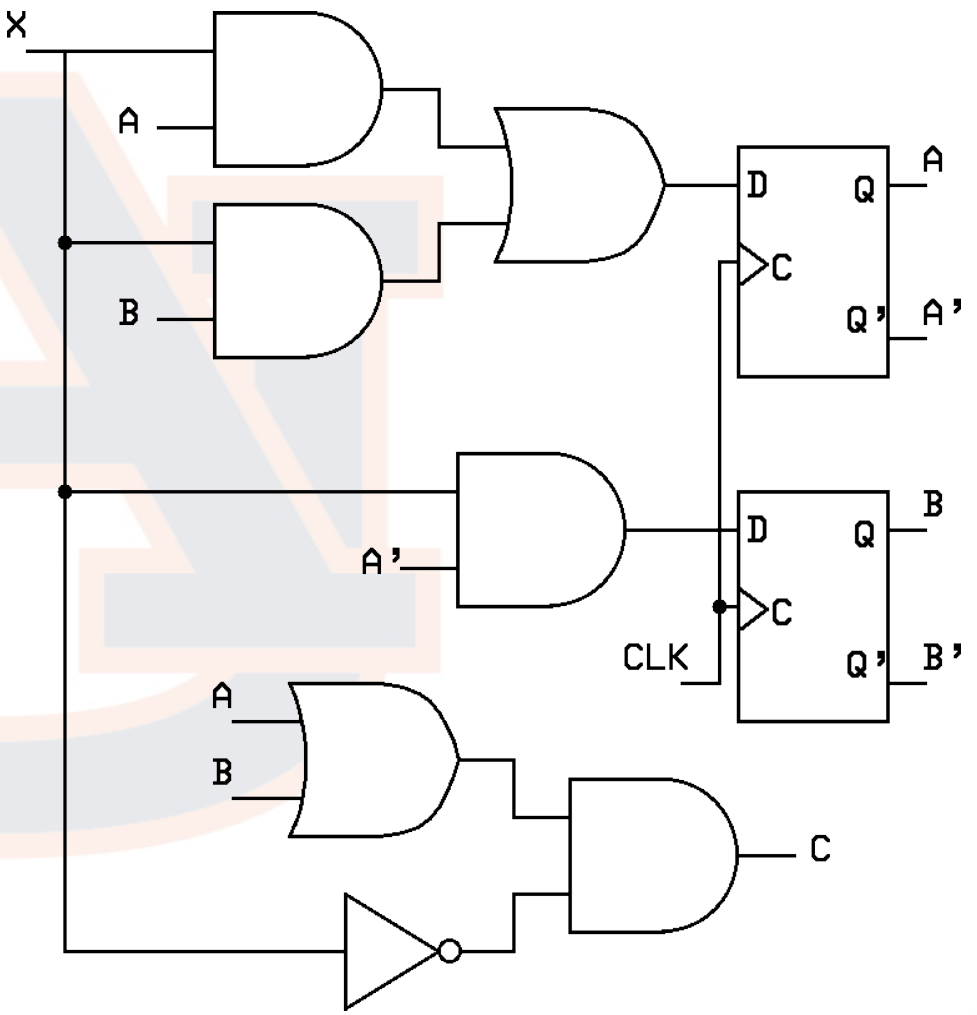
- Given this sequential logic circuit and:
  - An initial state of A=0,B=1
  - An input sequence of X=010011
- What will the final state be?
- What will the output sequence be?



Analysis Example

Use combinational analysis to write the expressions for each flip-flop input and each output

- Flip-flop inputs
  - $D_A = X \cdot A + X \cdot B$
  - $D_B = X \cdot A'$
- Output
  - $C = X' \cdot (A + B)$



Analysis Example

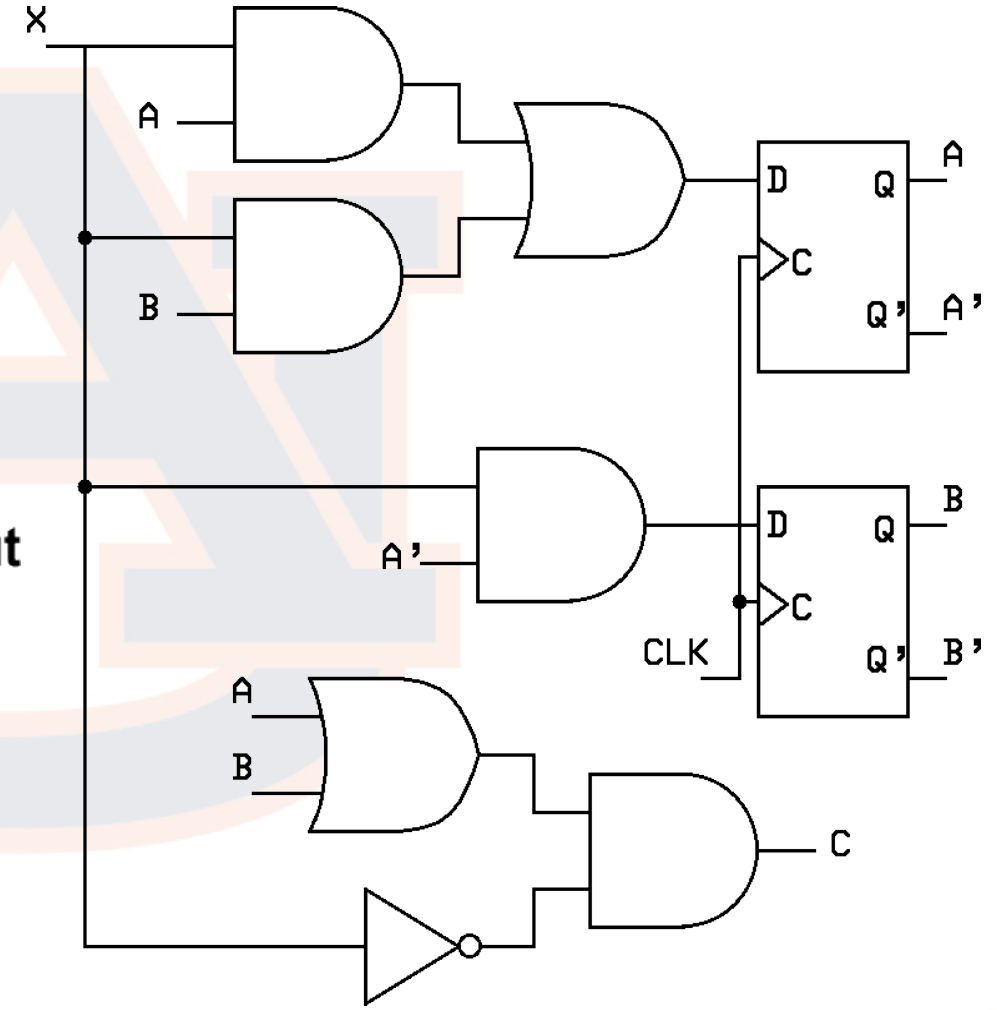
Use characteristics of flip-flops to construct state table

$$D_A = X \cdot A + X \cdot B$$

$$D_B = X \cdot A'$$

$$C = X' \cdot (A + B)$$

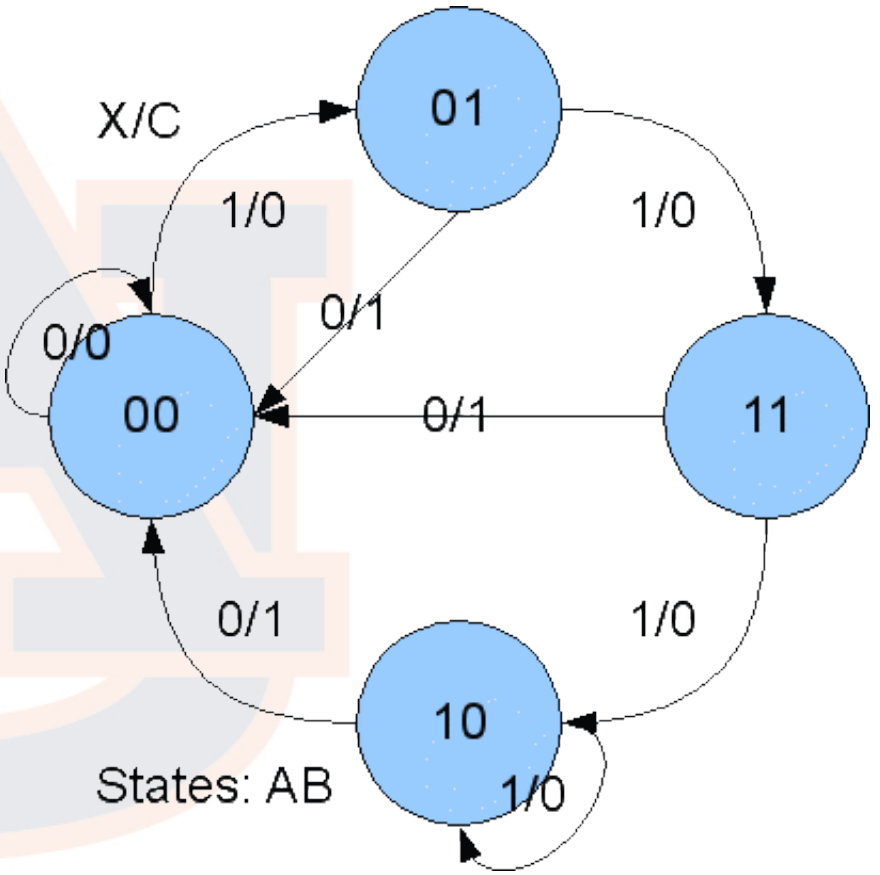
Input	Curr. State		Next State		Output
X	A	B	A	B	C
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	0	0	1
0	1	1	0	0	1
1	0	0	0	1	0
1	0	1	1	1	0
1	1	0	1	0	0
1	1	1	1	0	0



Analysis Example

Draw state diagram based on state table

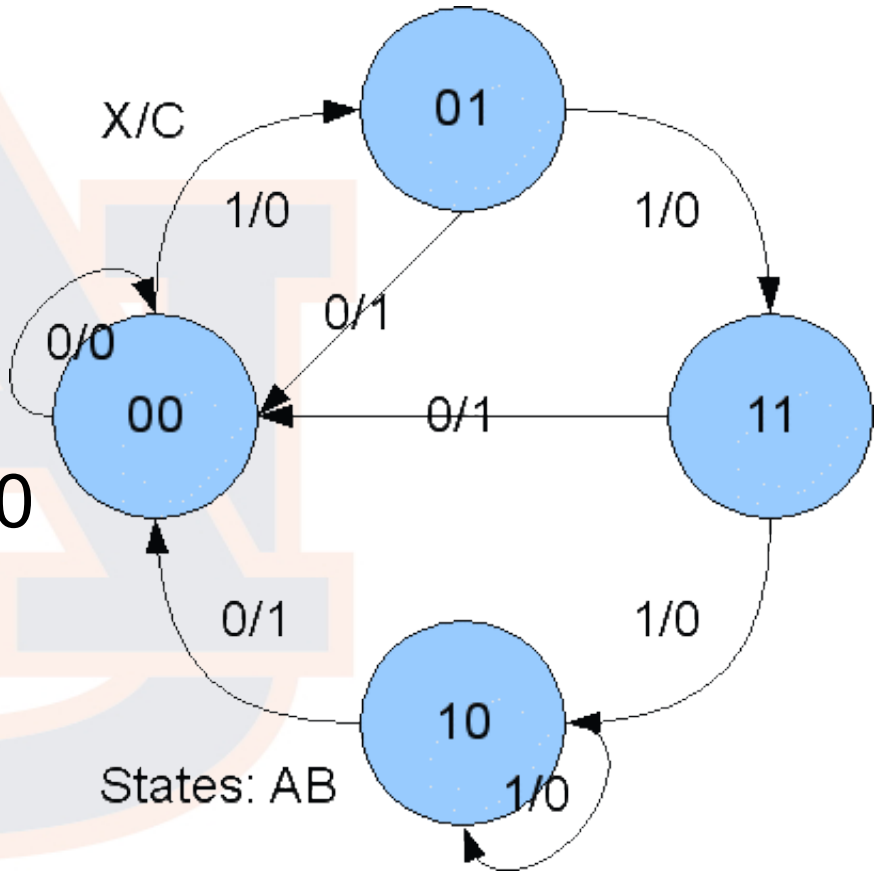
Input	Curr. State		Next State		Output
X	A	B	A	B	C
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	0	0	1
0	1	1	0	0	1
1	0	0	0	1	0
1	0	1	1	1	0
1	1	0	1	0	0
1	1	1	1	0	0



Analysis Example

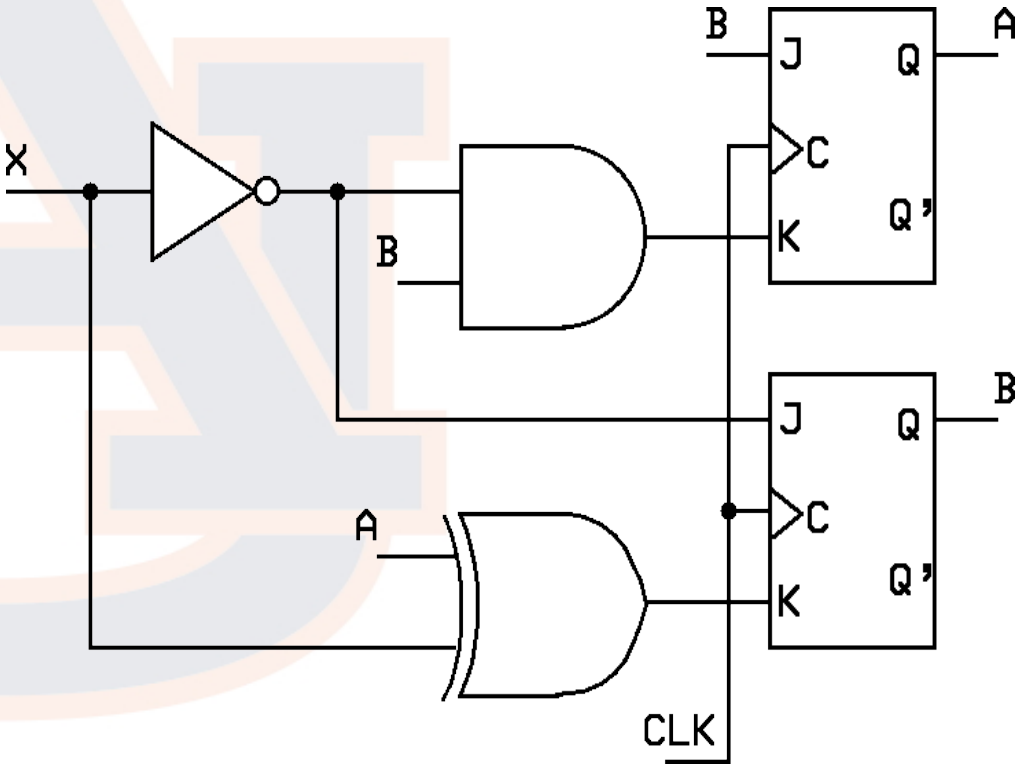
Use state diagram to find state/output sequence

- X=010011
- initial state of A=0,B=1
- State order
  AB=01,00,01,00,00,01,11
- Output
  C=1,0,1,0,0,0



JK Circuit Analysis

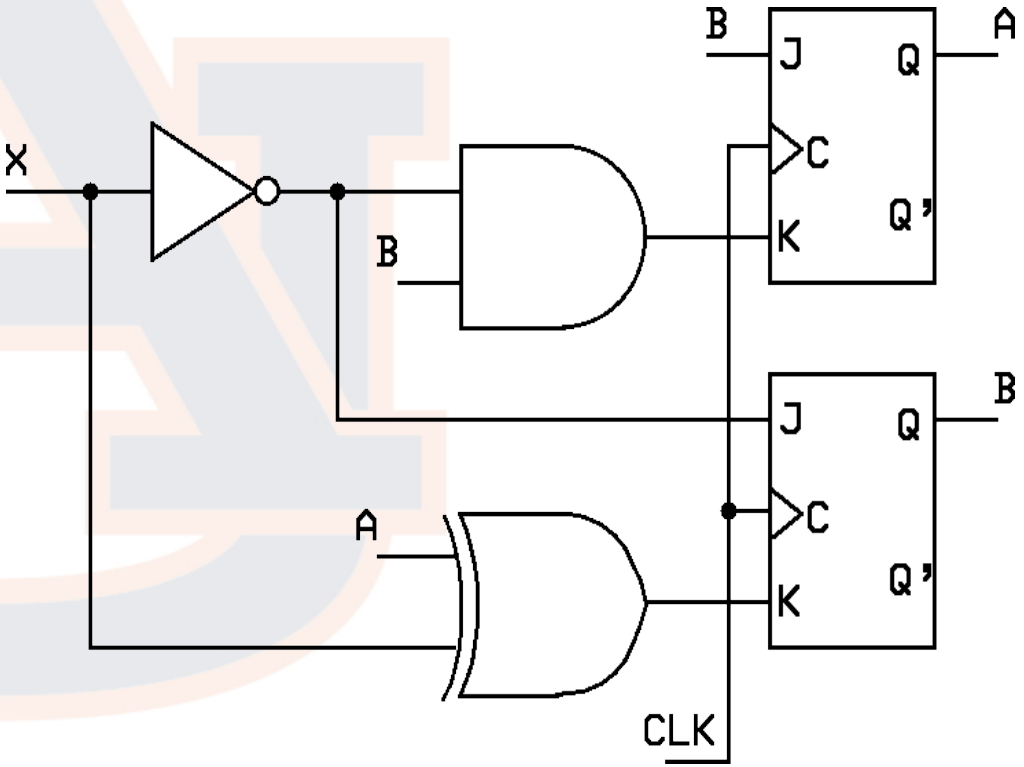
- Assuming A and B are the circuit outputs draw the state diagram for this circuit



JK Circuit Analysis

Use combinational analysis to write the expressions for each flip-flop input and each output

- Flip-flop inputs
  - $J_A = B$
  - $K_A = X' \cdot B$
  - $J_B = X'$
  - $K_B = A(+)X$



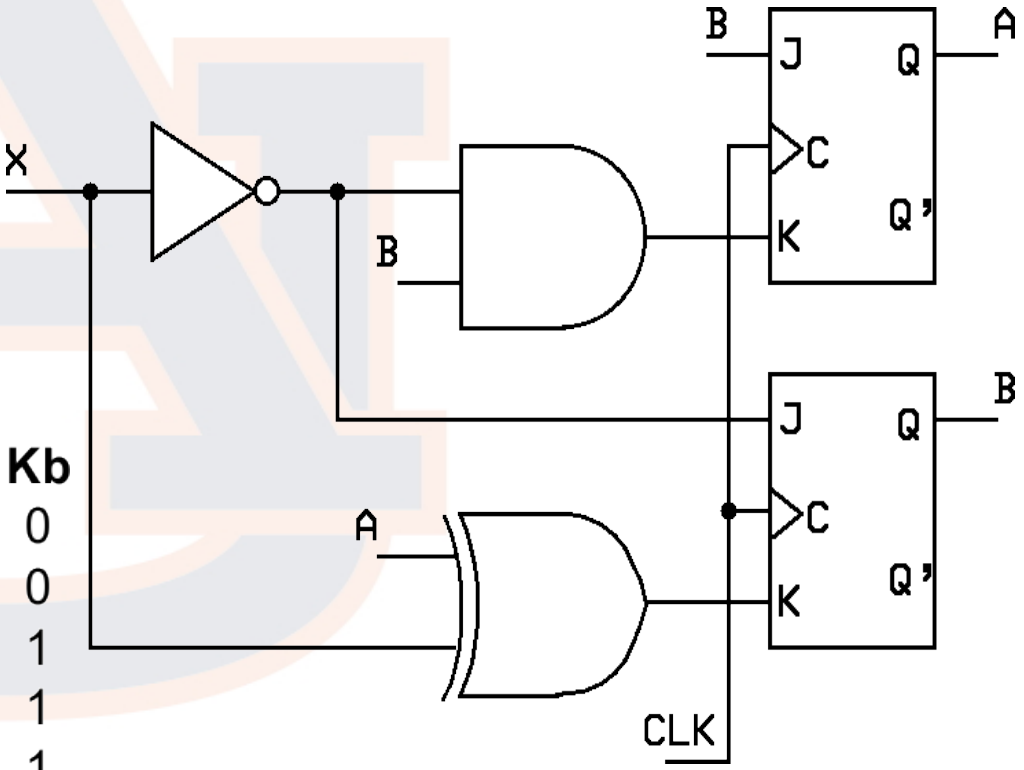
JK Circuit Analysis

Use characteristics of flip-flops to construct state table

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

$J_B = X' \qquad K_B = A(+)X$

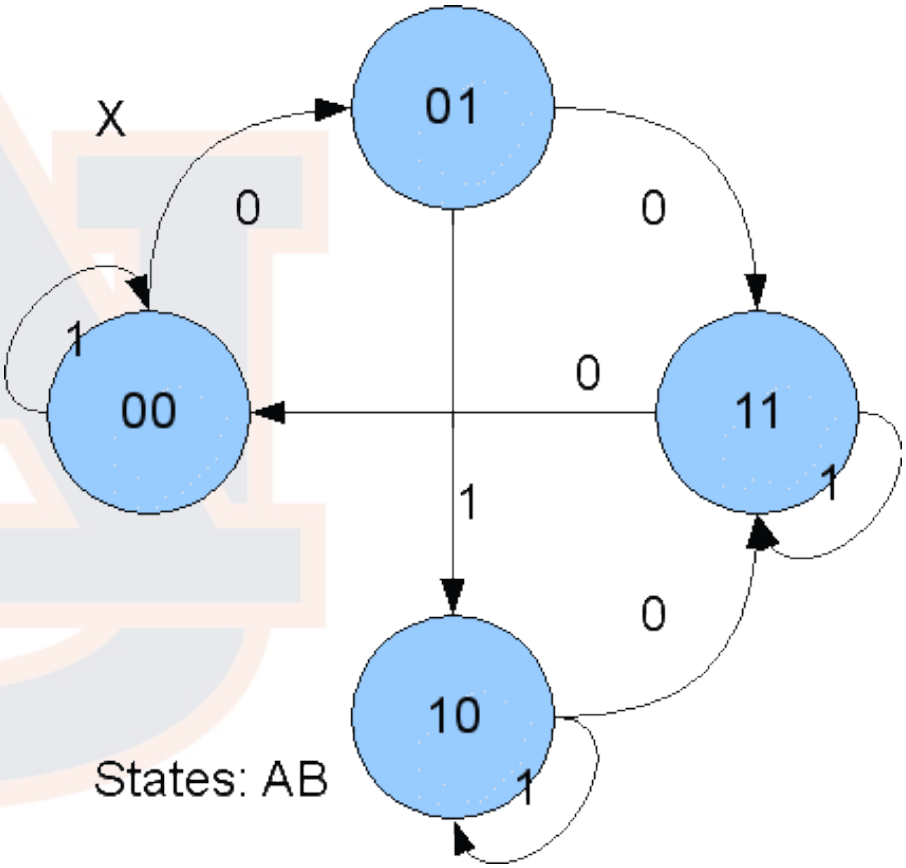
Input	Curr. State		Next State		Excitation			
X	A	B	A	B	Ja	Ka	Jb	Kb
0	0	0	0	1	0	0	1	0
0	0	1	1	1	1	1	1	0
0	1	0	1	1	0	0	1	1
0	1	1	0	0	1	1	1	1
1	0	0	0	0	0	0	0	1
1	0	1	1	0	1	0	0	1
1	1	0	1	0	0	0	0	0
1	1	1	1	1	1	0	0	0



JK Circuit Analysis

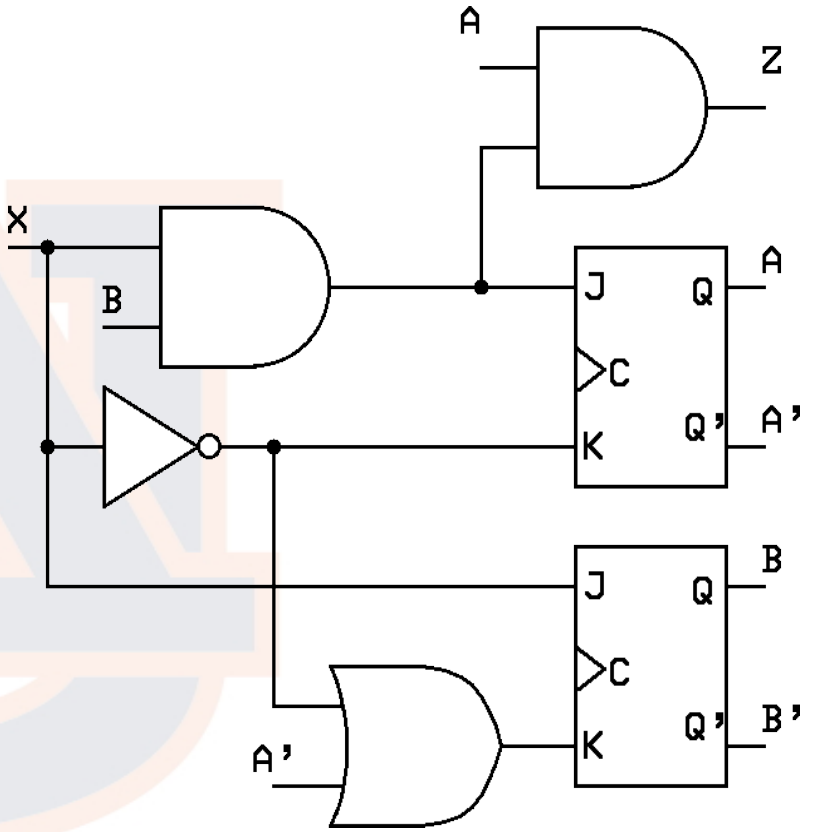
Draw state diagram based on state table

Input	Curr. State		Next State		Excitation			
X	A	B	A	B	Ja	Ka	Jb	Kb
0	0	0	0	1	0	0	1	0
0	0	1	1	1	1	1	1	0
0	1	0	1	1	0	0	1	1
0	1	1	0	0	1	1	1	1
1	0	0	0	0	0	0	0	1
1	0	1	1	0	1	0	0	1
1	1	0	1	0	0	0	0	0
1	1	1	1	1	1	0	0	0



JK Exercise

- Draw the state diagram
- Given the initial state A=1 and B=0 and the input X=1001111, find the output sequence



D Exercise

- Draw the state diagram
- Given the initial state C=0 and input A=0011, B=0101 Find the sequence of states and output