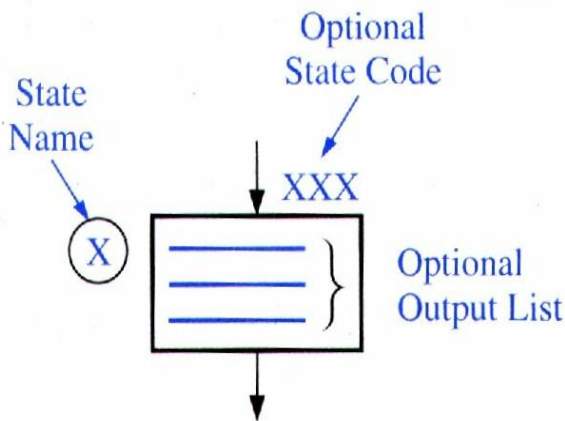
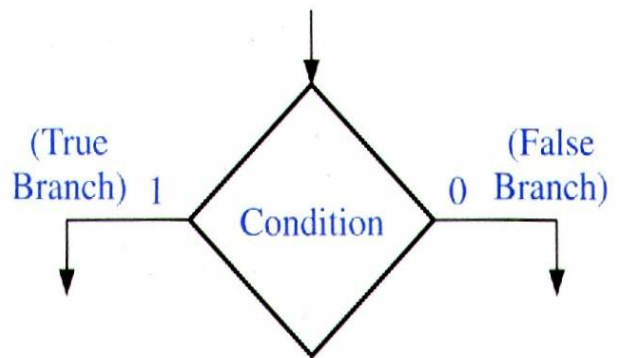


Lecture 17 State Machine Design Using SM Chart

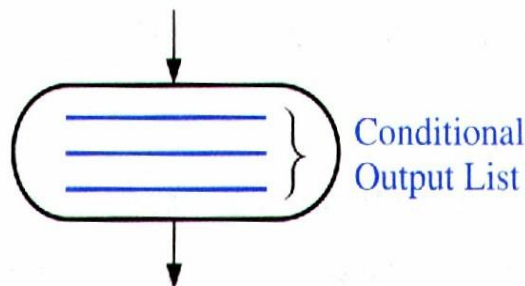
- State machine chart
 - SM chart \equiv state graph \Rightarrow hardware
 - SM chart components



(a) State box



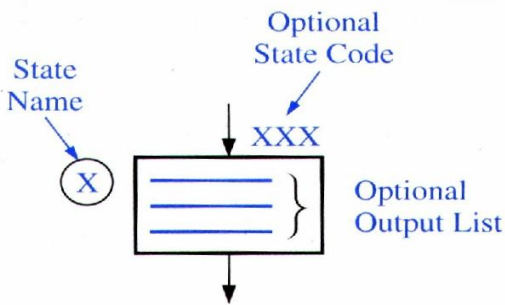
(b) Decision box



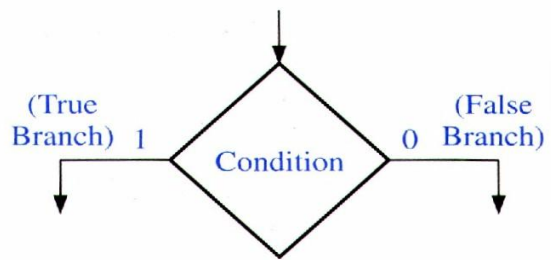
(c) Conditional output box

SM Chart Components

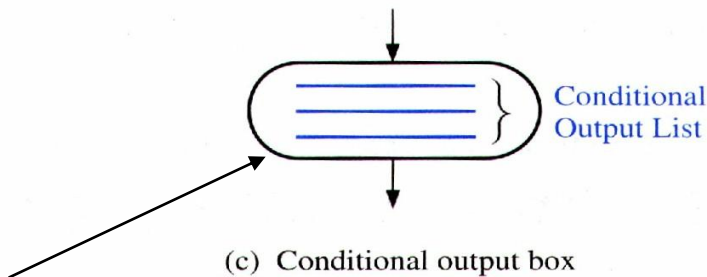
- State machine chart
 - State box: state of the system
 - Output list, state code, state name
 - Decision box
 - Conditional output box.



(a) State box



(b) Decision box



(c) Conditional output box

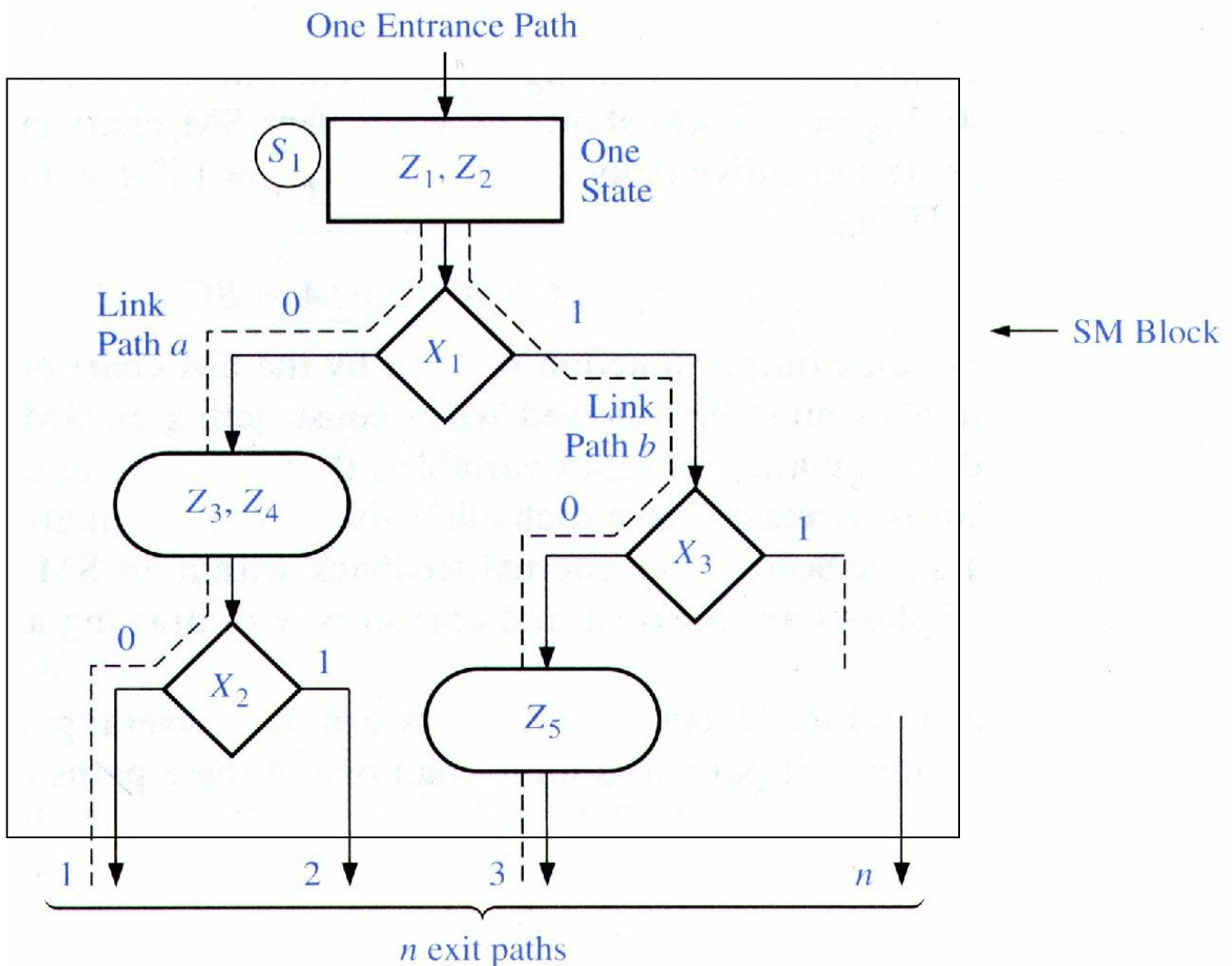
Output depends on the state of the system and inputs.

SM Blocks

- SM chart is constructed from SM blocks.
 - One state box, decision boxes, conditional output boxes.
 - Entrance(s) with several exit paths.
 - A SM block:machine operation in one state.
 - Outputs on the output lists of the state box become true.
 - Link path: path form entrance to exit

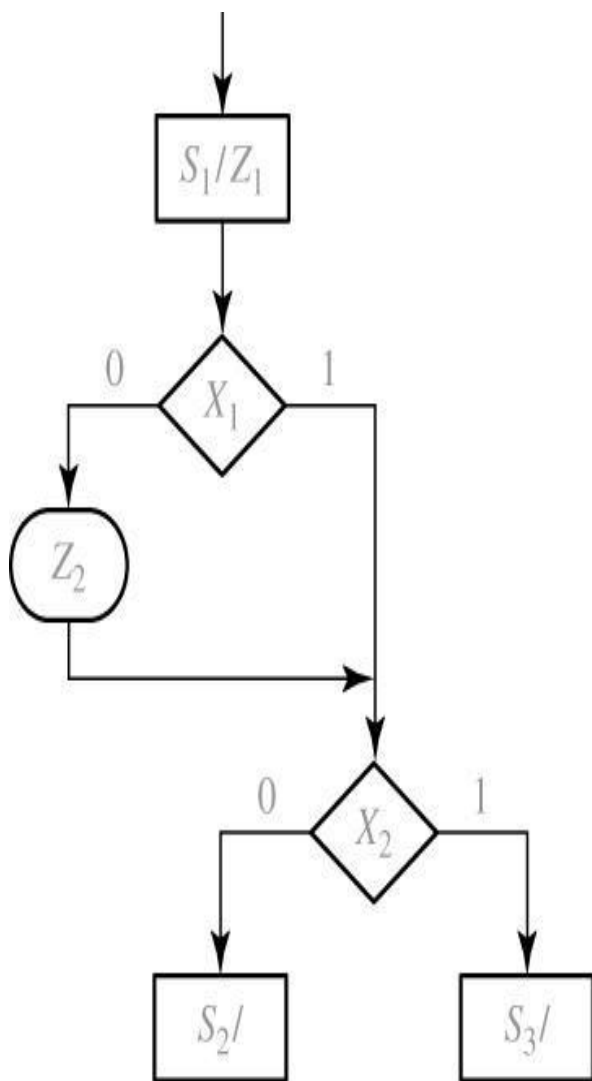
SM Blocks

- When state S_1 is entered, output Z_1 and $Z_2 = 1$
- If input $X_1=0$ and $X_2 = 0$, Z_3 , and $Z_4 = 1$.
In this case, exit path = 1 at the end of the state time.

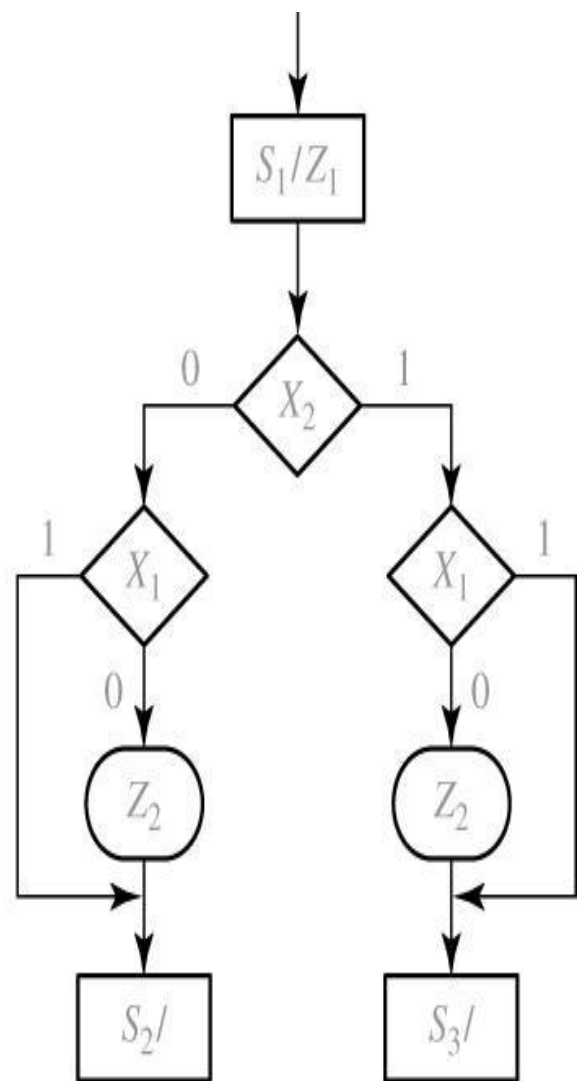


Equivalent SM Blocks

- Output $Z_2 = 1$, if $X_1 = 0$,
- Next state S_2 if $X_2 = 0$ and S_3 if $X_2 = 1$



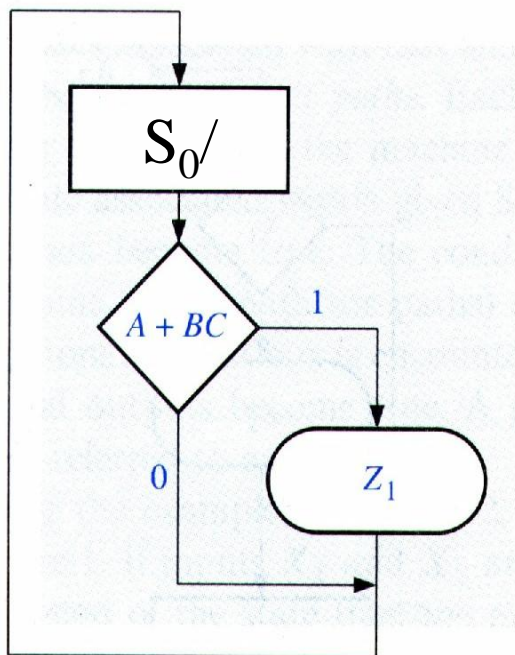
(a)



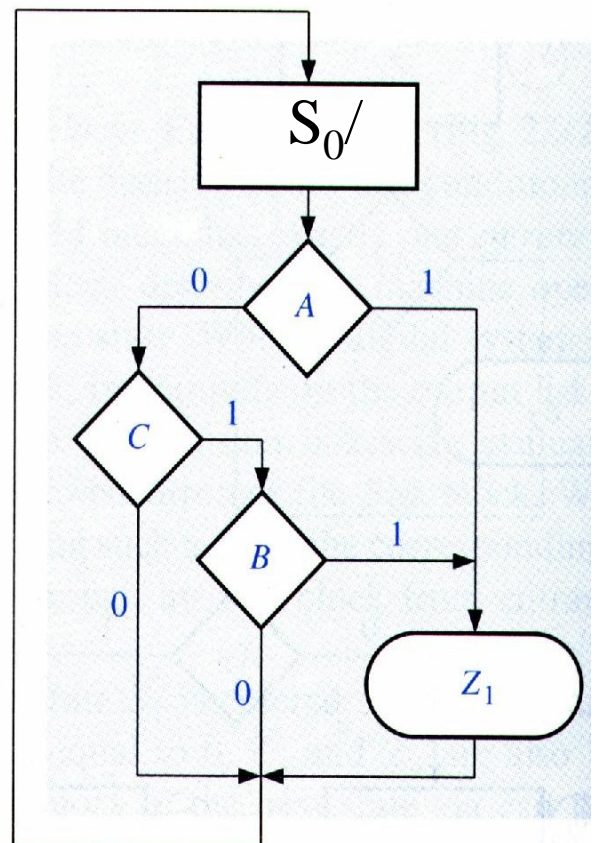
(b)

Equivalent SM Charts for a combinational ckt.

- Only one state, no state changes.
- (b) equivalent SM chart.
- $Z_1 = 1$ if $A + BC = 1$, else $Z_1 = 0$
- $Z_1 = 1$ if $A = 1$ or if $A = 0, B = 1,$ and $C = 1$
 - $Z_1 = A + A'BC = A + BC$



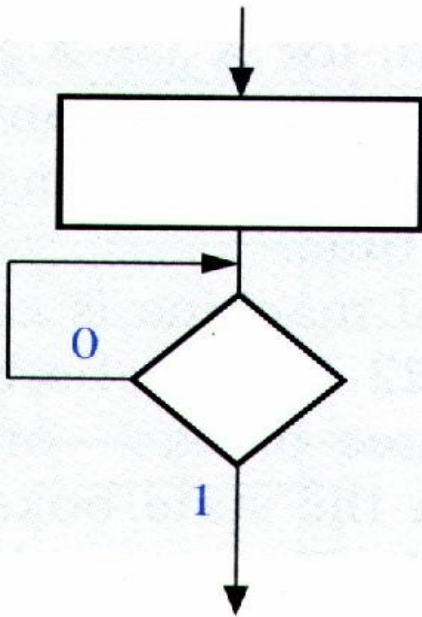
(a)



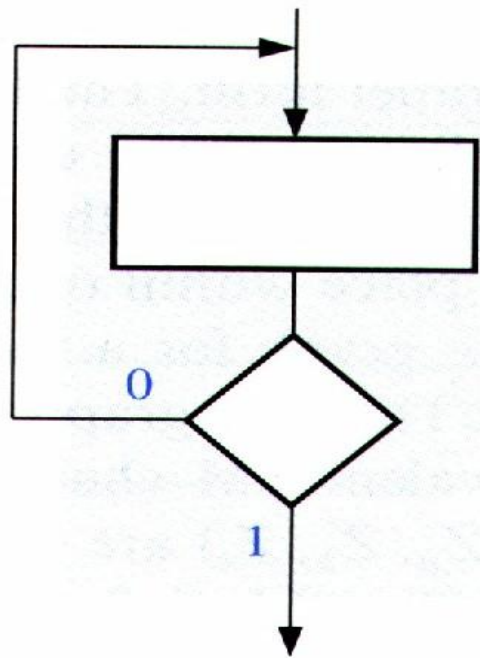
(b)

SM Chart Construction Rules

- Every valid combination of input variables must be exactly one exit path defined.
- No internal feedback within an SM block is allowed.



(a) Incorrect



(b) Correct

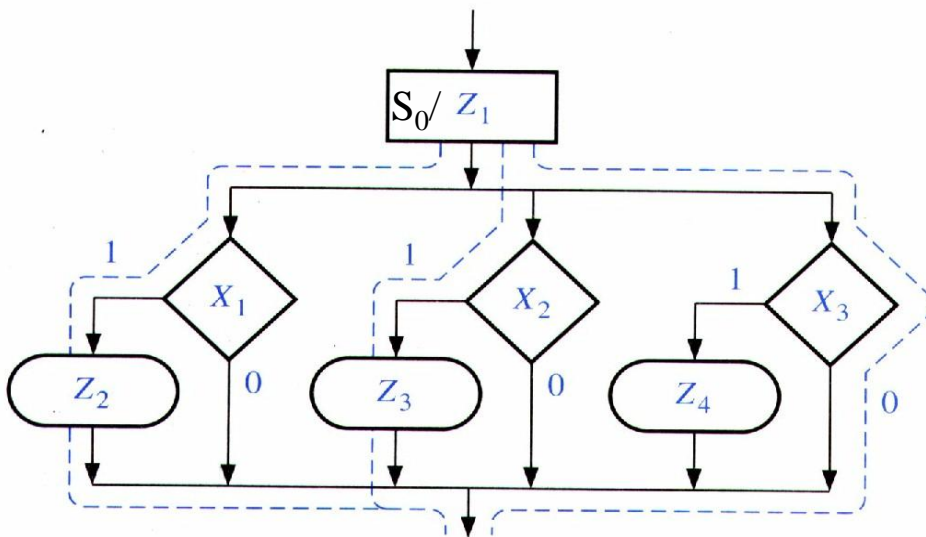
Parallel and Serial Form

– Parallel form

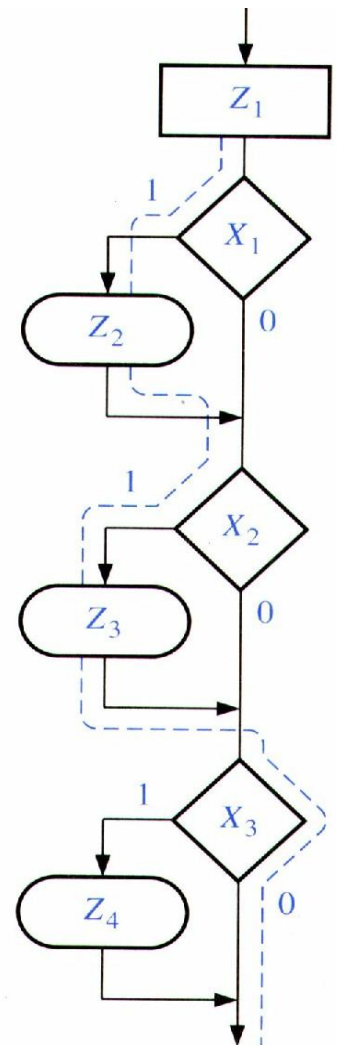
- More than one of the paths can be active. If $X_1 = X_2 = 1$ and $X_3 = 0$, output Z_1, Z_2 and $Z_3 = 1$

– Equivalent serial form.

- All of the tasks take place within one clock time.



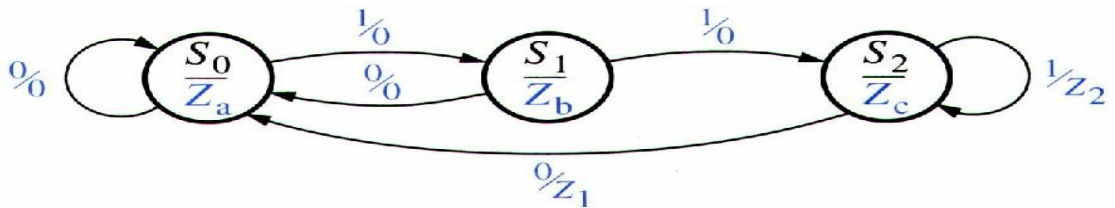
(a) Parallel form



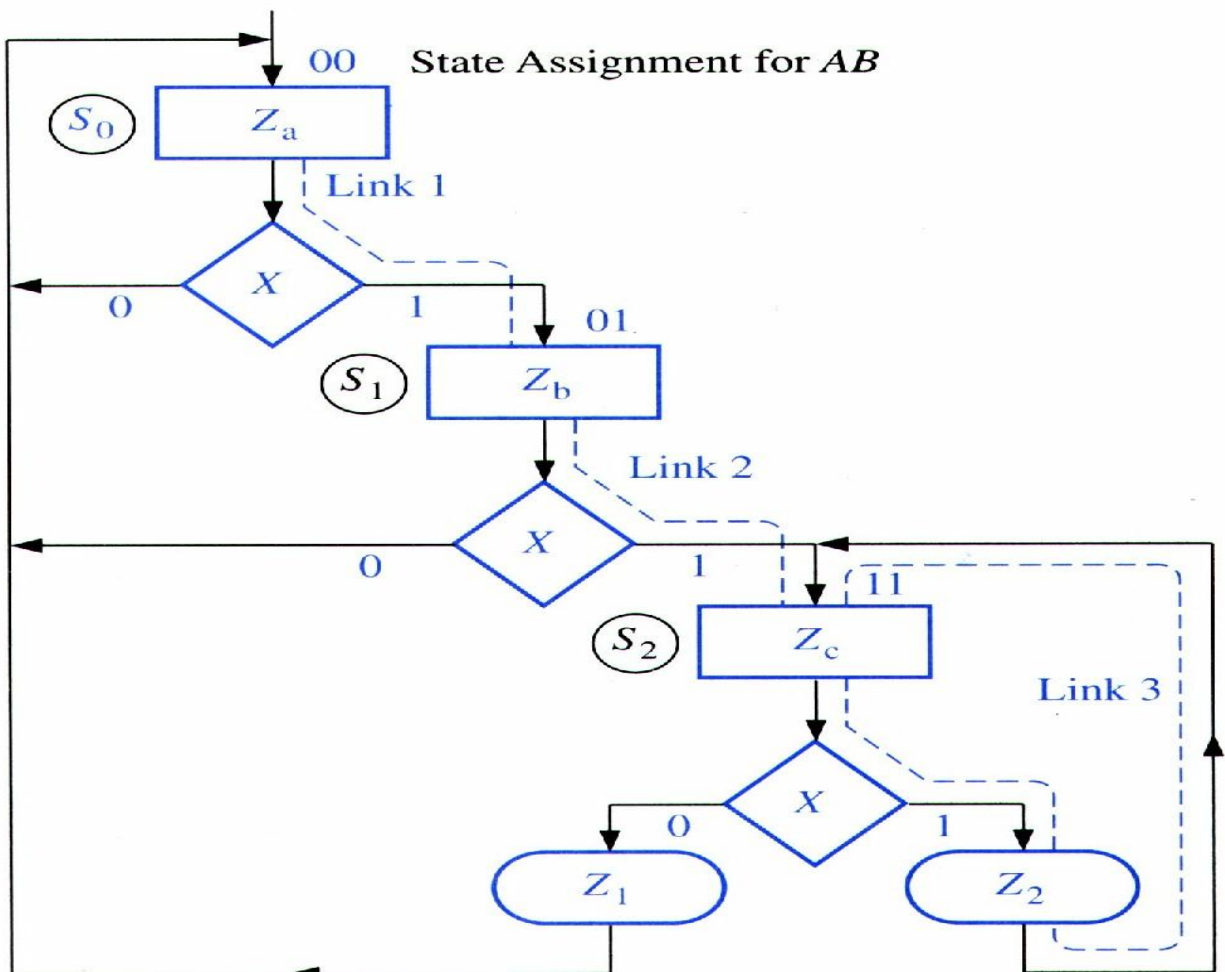
(b) Serial form

Conversion

- Moore output (Z_a, Z_b, Z_c).
- Mealy output (Z_1, Z_2)
- Input X



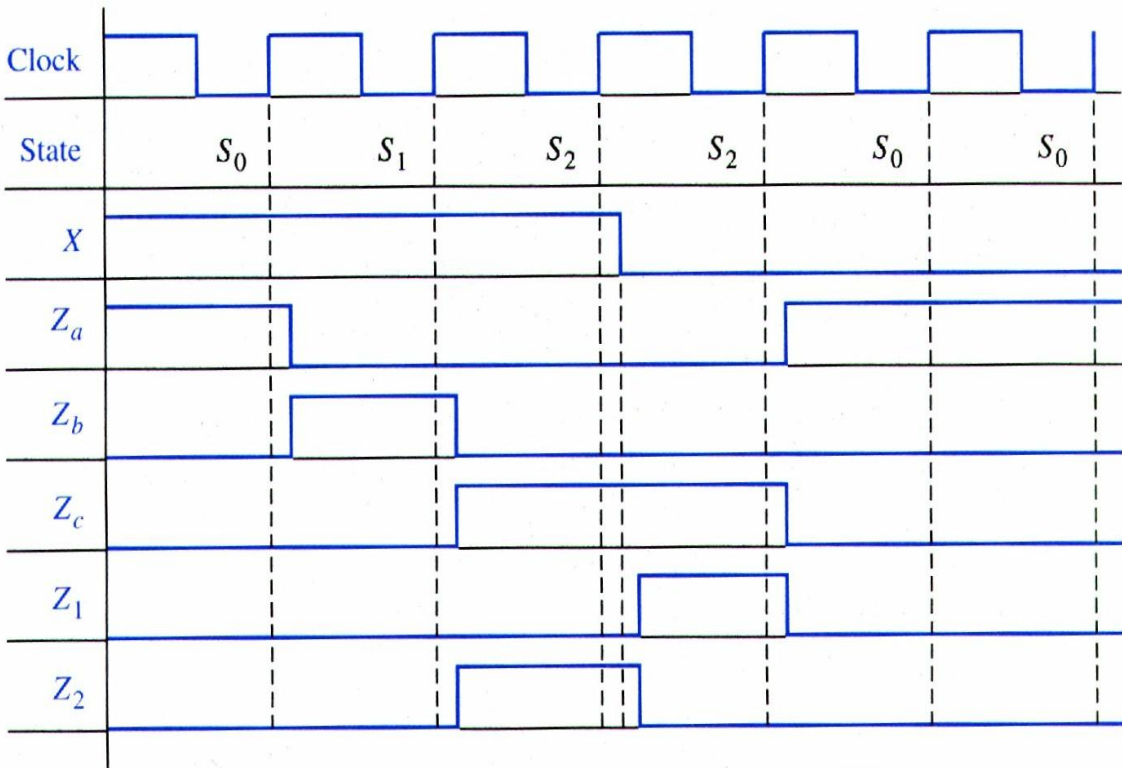
(a) State graph



(b) Equivalent SM chart

Timing

- Moore output (Z_a, Z_b, Z_c)
- Mealy output (Z_1, Z_2)
- Input X
- State change on rising edge



Realization of SM Charts

- Moore output
 - In state 00, $Z_a = A'B'$, similarly,
 $Z_b = A'B$, $Z_c = AB$
- Mealy output
 - Conditional output
 - $Z_1 = ABX'$
 - $Z_2 = ABX$
- Next state (terminated at $A = 1$, $B = 1$)
 - link 1 link 2 link 3
 - Find all the link paths that lead into the state with $Q = 1$
 - $B^+ = A'B'X + A'BX + ABX$
 - $A^+ = A'BX + ABX$ (link2 + link3)