CPE 322
Digital Hardware Design Fundamentals

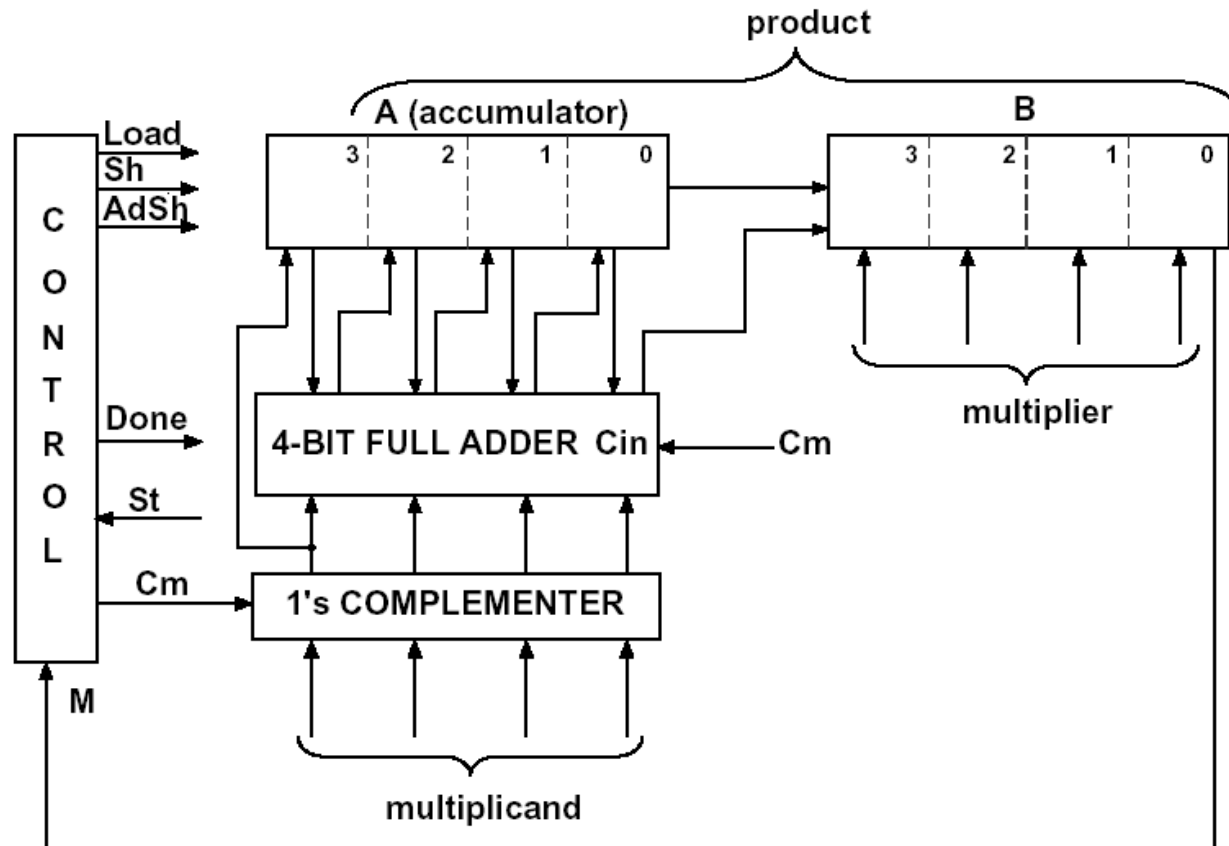Electrical and Computer Engineering
UAH

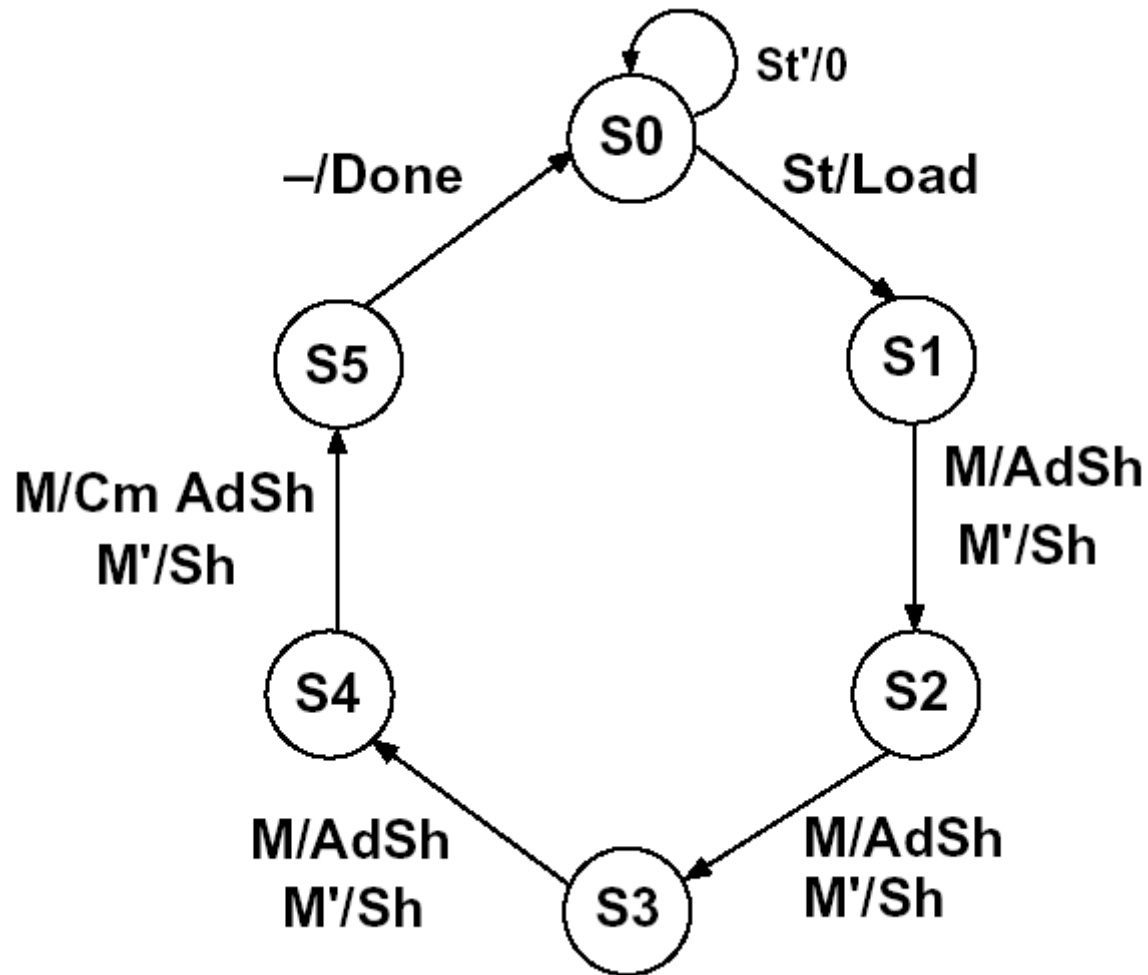## Algorithmic State Machine Notation

Example: Faster Multiplier

- Move wires from the adder outputs one position to the right => add and shift can occur at the same clock cycle

Extended State Transition Graph

- Similarities to basic State Transition Graph
  - Nodes represent states
  - Arcs (or edges) represent transition between states
  - Labelling are arcs are Inputs/Outputs
- Differences with basic State Transition Graph
  - To reduce Clutter
    - Only Inputs that impact a transition from one state to another are present.
    - Only Outputs that are TRUE for a given transition are listed.

Extended State Transition Graph for Multiplier

Digital Design with ASM Charts

- State Transition Graphs are used to describe state machines controlling a digital system
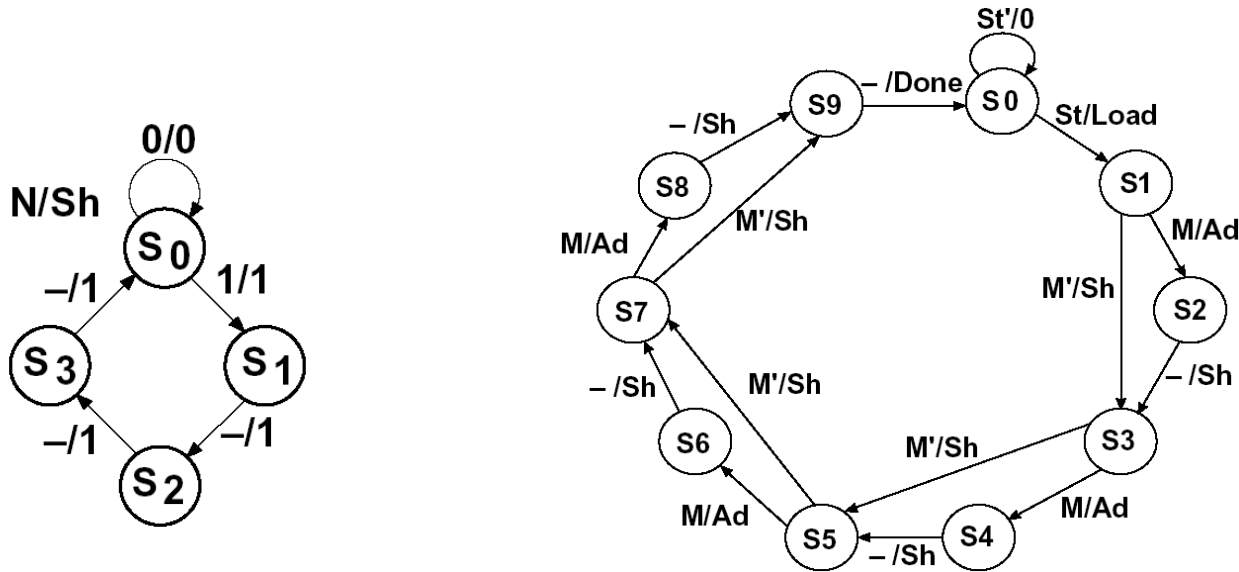
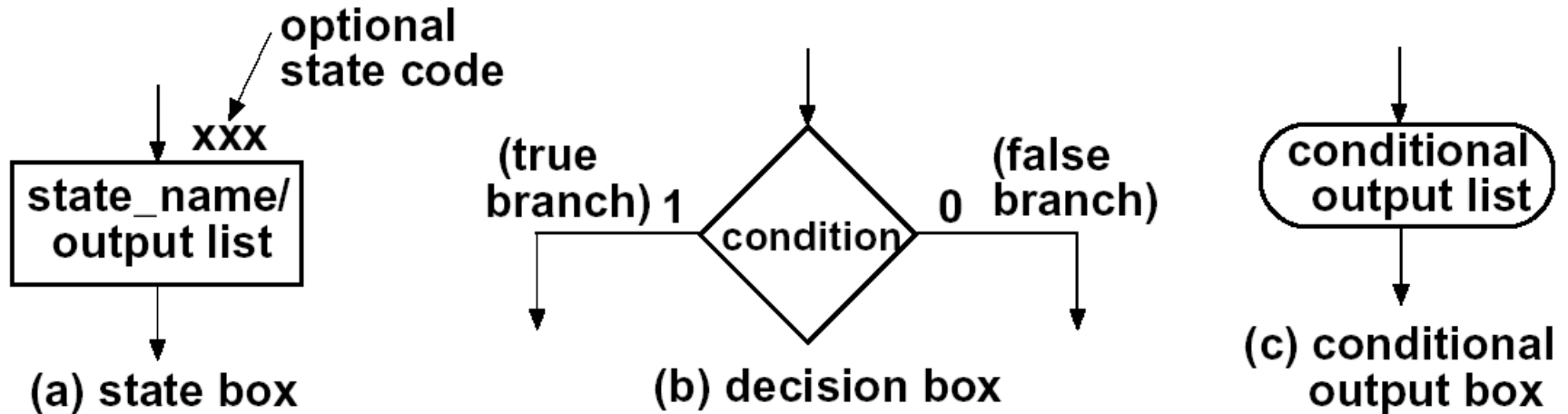- Alternative: use algorithmic state machine flowchart

State Machine Charts

- ASM (*Algorithmic State Machine*) or simply a SM chart
  - Easier to understand the operation of digital system by examining of the ASM chart instead of equivalent state transition graph
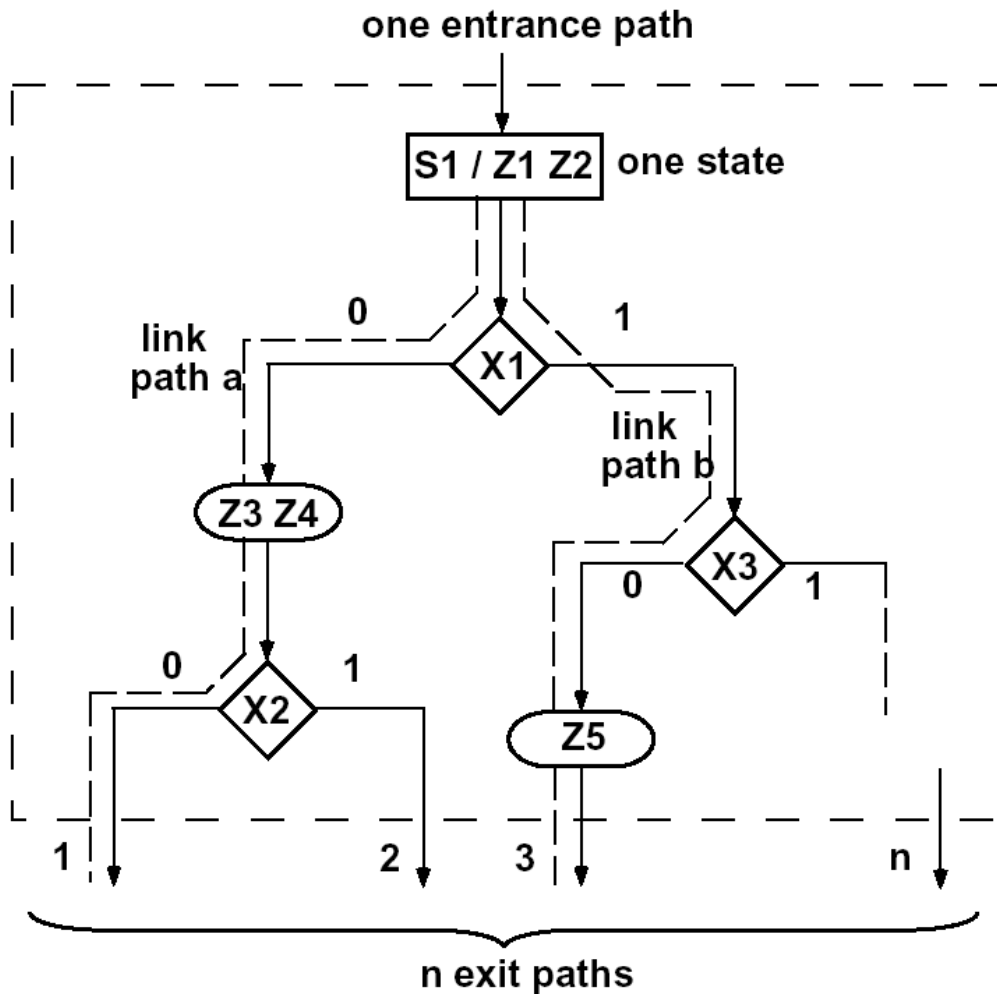 - ASM chart leads directly to hardware realization

Components of ASM charts

optional state code

xxx

state_name/ output list

(a) state box

(true branch) 1 — condition — 0 (false branch)

(b) decision box

conditional output list

(c) conditional output box

ASM Blocks

ASM chart is constructed from SM blocks

State S1 is entered =>

Z1 and Z2 become 1
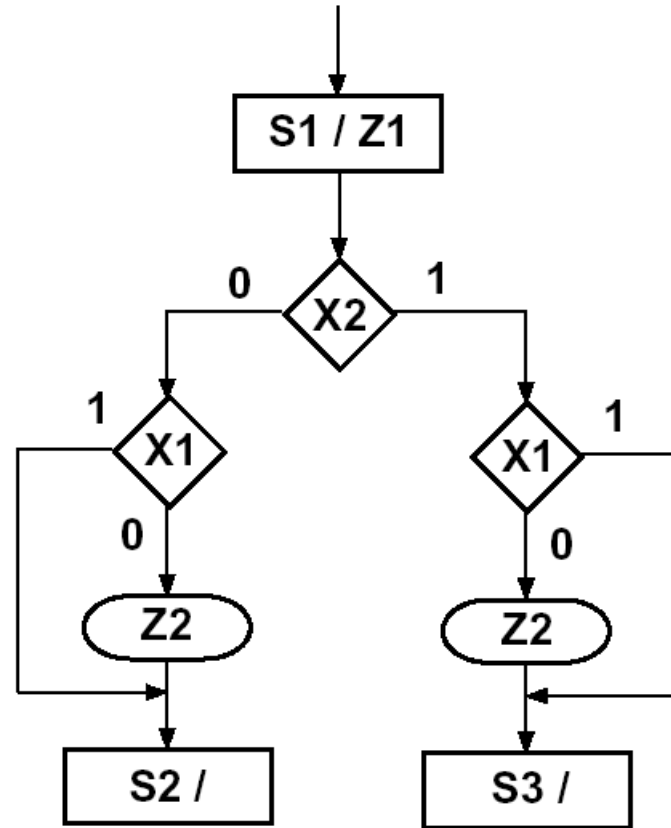
if X1=0

Z3 and Z4 become 1
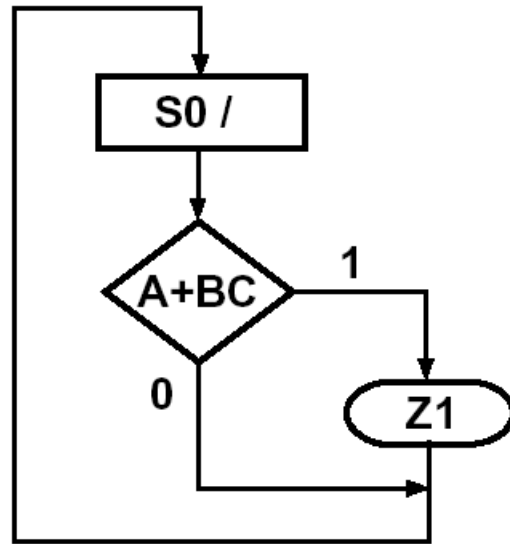
if X1=1 and X3=0

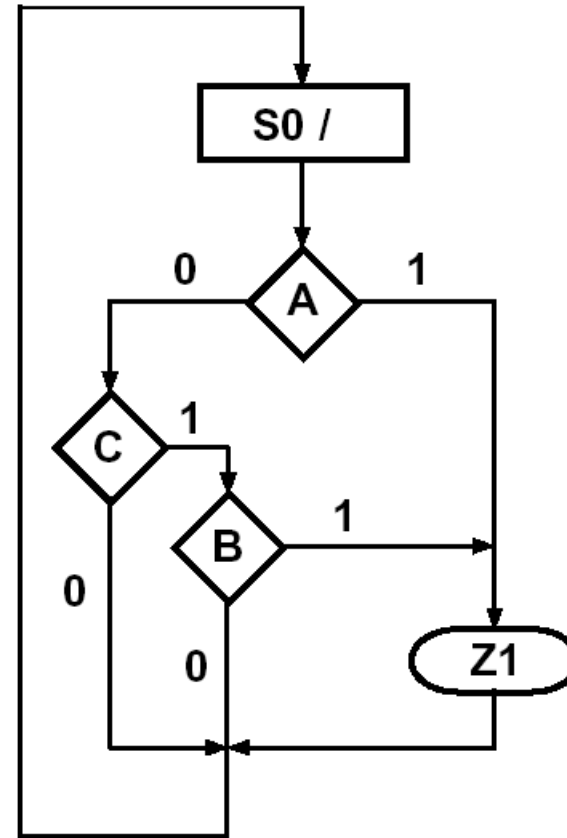Z5 become 1

Equivalent SM Blocks
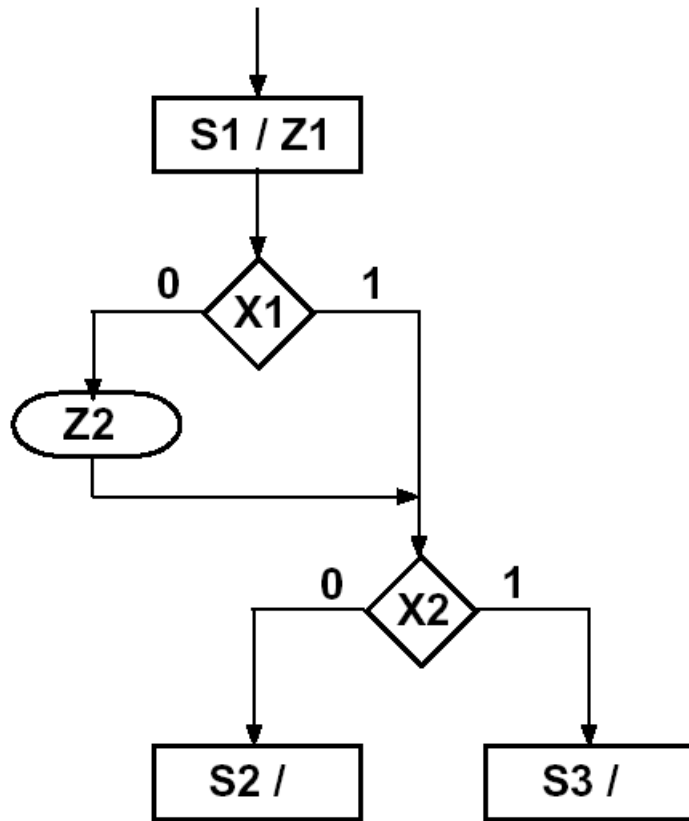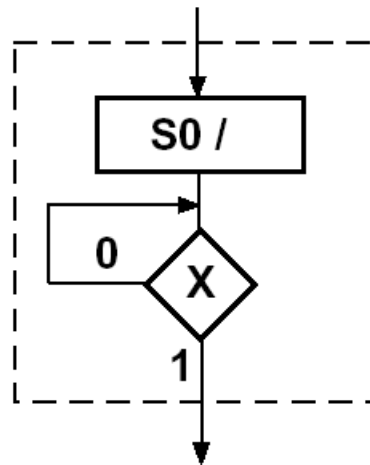

(a)

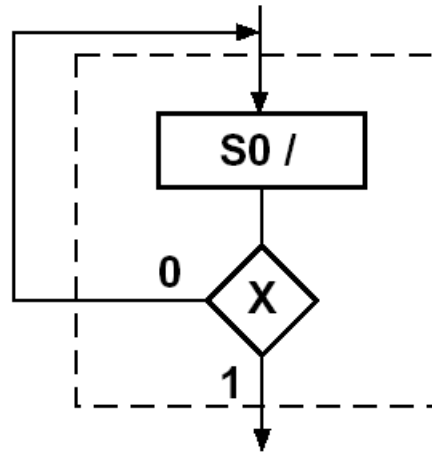(b)

Equivalent ASM Charts for Comb Networks
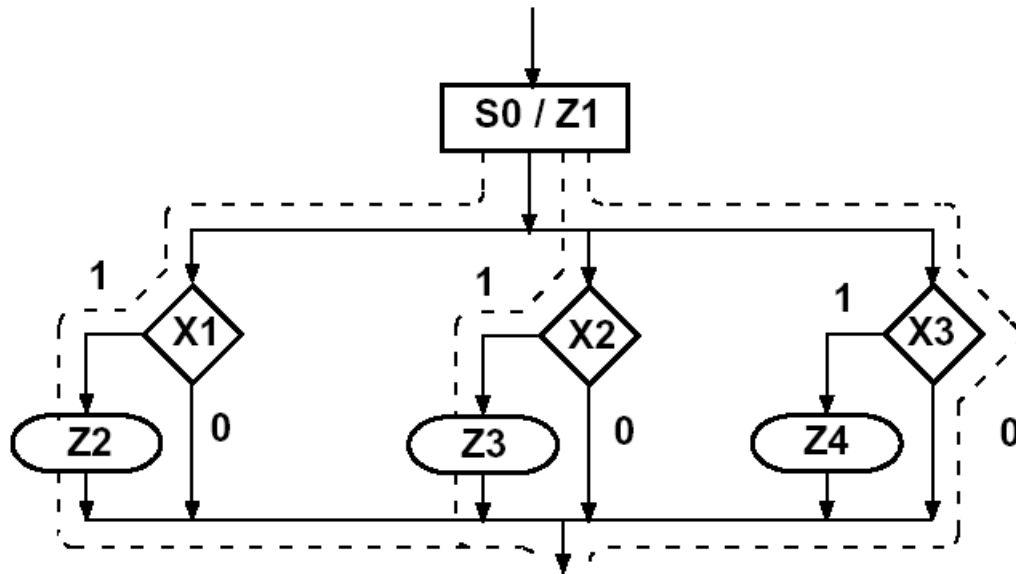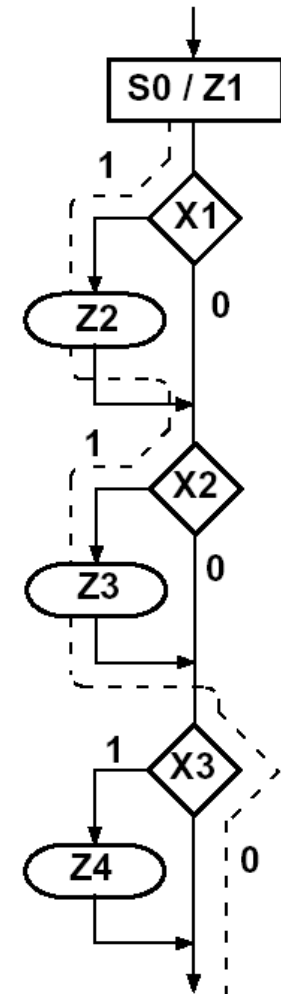

(a)

(b)

Block with Feedback

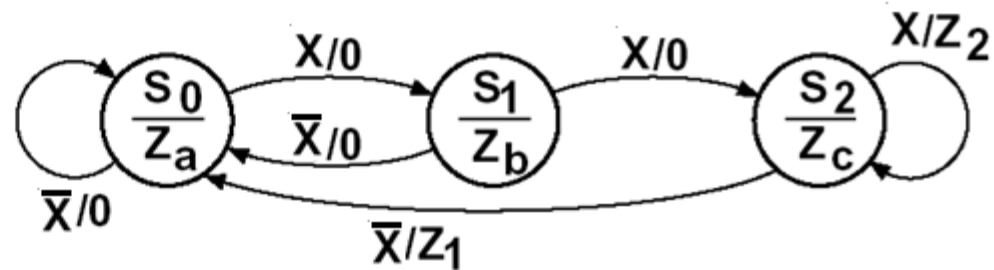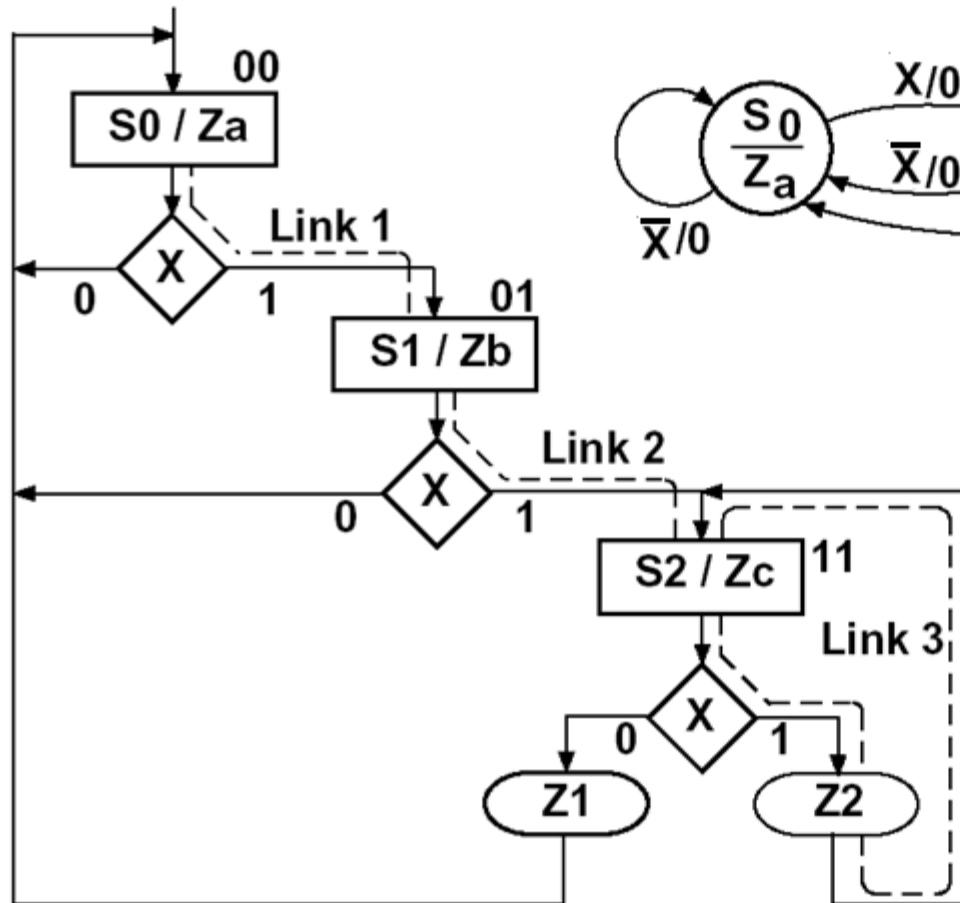(a) incorrect   (b) correct

Equivalent ASM Blocks

(a) Parallel form
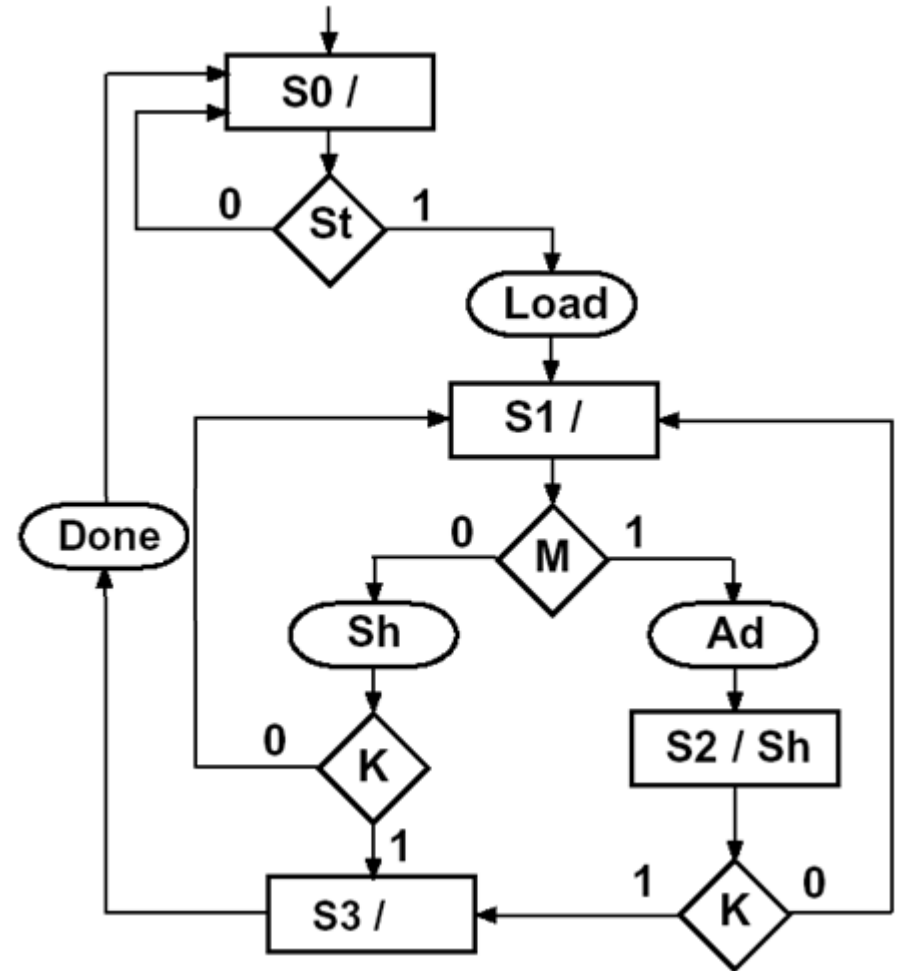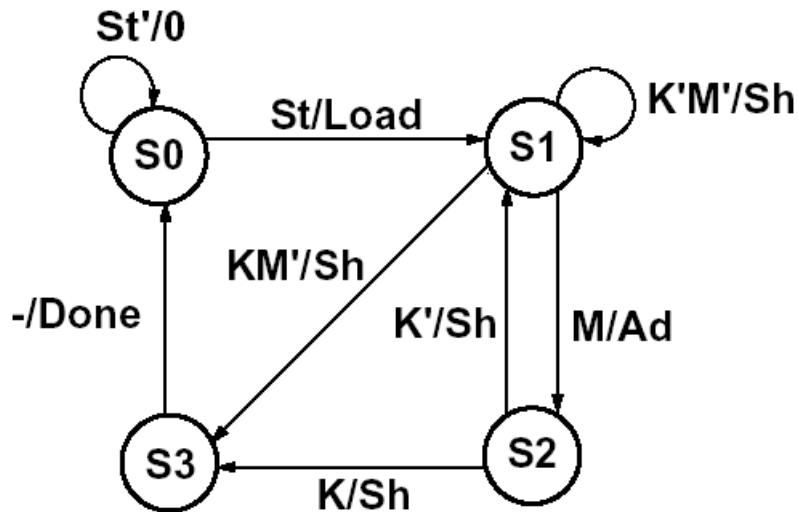
(b) Serial form

Converting an Extended STG to an ASM Chart

ASM Chart for Binary Multiplier

ASM Chart for Binary Multiplier