4.5 State Graphs for Control Circuits

1 Notations and Conditions Used on Control State Graphs

- Label control state graphs using variable names instead of 0's and 1's.
- Label of arc on a Mealy state graph

  $X_i X_j / Z_p Z_q$

  - inputs X_i, X_j : 1

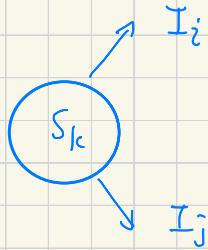
    other inputs : don't care's

  - outputs Z_p, Z_q : 1

    other outputs : 0

  - Then traverse the arc to go to the next state.

- completely specified proper state graph :
  - the next state is uniquely defined for every input combination.



- constraints on the input labels for every state S_k:

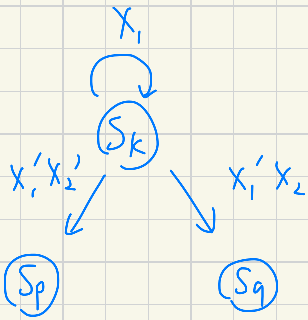
  Each I_x is a boolean condition formed from from the machine's input variables, e.g. $I_i = A'B$ or AB'

1. If I_i and I_j are any pair of input labels on arcs exiting state S_k, then $I_i I_j = 0$ if $i \neq j$.
   $\Rightarrow$ At most one input label can be 1 at any given time.

2. If n arcs exit state S_k and the n arcs have labels $I_1, I_2, \ldots, I_n$, respectively, then, $I_1 + I_2 + \ldots + I_n = 1$

⇒ At least one input label will be 1 at any given time.

Ex. A Partial State Graph



- For S_k:

$$\begin{cases} I_1 = x_1 \\ I_2 = x_1' x_2' \\ I_3 = x_1' x_2 \end{cases}$$

- Condition 1:

$$I_1 I_2 = (x_1)(x_1' x_2') = 0$$

$$I_1 I_3 = (x_1)(x_1' x_2) = 0$$

$$I_2 I_3 = (x_1' x_2')(x_1' x_2) = 0$$

- Condition 2:

$$I_1 + I_2 + I_3$$

$$= x_1 + x_1' x_2' + x_1' x_2 = 1$$

⇒ conditions 1 & 2 are satisfied, this graph is a completely specified state graph

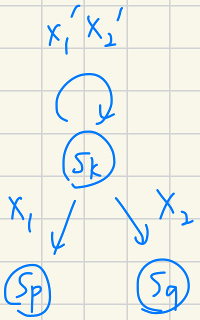
- incompletely specified state graph
  - It must always satisfy condition 2.

$$I_1 + I_2 + \dots + I_n = 1$$

- It must condition 1 for all combinations of values of input variables that can occur for each state S_k.

$$I_i I_j = 0 \quad \text{if} \quad i \neq j$$

Ex. A partial state graph



- For S_k:

$$\begin{cases} I_1 = x_1'x_2' \\ I_2 = x_1 \\ I_3 = x_2 \end{cases}$$

- Condition 2:

$$I_1 + I_2 + I_3$$
$$= x_1'x_2' + x_1 + x_2$$
$$= 1$$

- Condition 2:

$$I_1 I_2 = (x_1'x_2')x_1 = 0$$
$$I_2 I_3 = (x_1'x_2)x_2 = 0$$
$$I_2 I_3 = (x_1)(x_2) = ?$$

$\Rightarrow$ $x_1 = x_2 = 1$ cannot occur in state S_k.