ME 311: Microprocessors and Automatic Control

Basics of digital logic design
Sequential logic

This set of slides is very important to establish Fundamentals notions so do not ignore

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Life skill

How to know if you have understood?

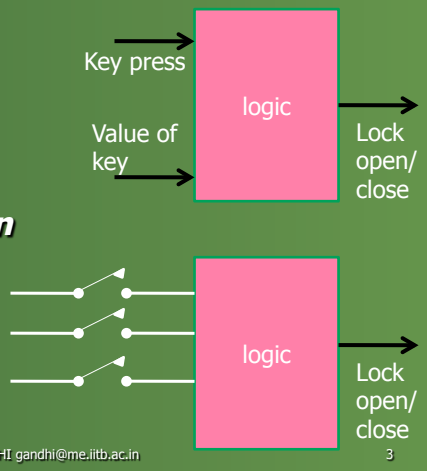
- Catch hold of some friend who does not know about topic and teach her/ him
- Solve text book problems on topic

Sequential logic design: Example

- Combination lock
- Problem statement

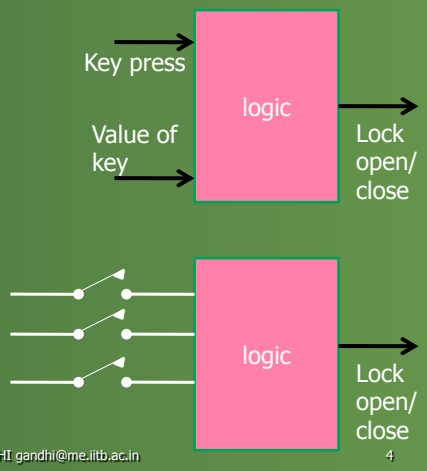
*Door combination lock: should open only when 3 distinct keys are pressed **in a sequence** on a small keyboard with only 3 keys*

Q: how many sequences are possible for 3 keys?



Sequential logic design: Example

- Combination lock
- As a first cut can we try the problem using combination logic?
- Say we just use AND of 3 key presses what is the problem?
- ➔ we do NOT get the notion of sequence isnt it?
- How do we achieve this?



Sequential logic design: digital lock

- Need the following notions in place

  Q: How to know if we are looking for the first key press or second or the third? We need to know what was previously pressed key or some such thing!!

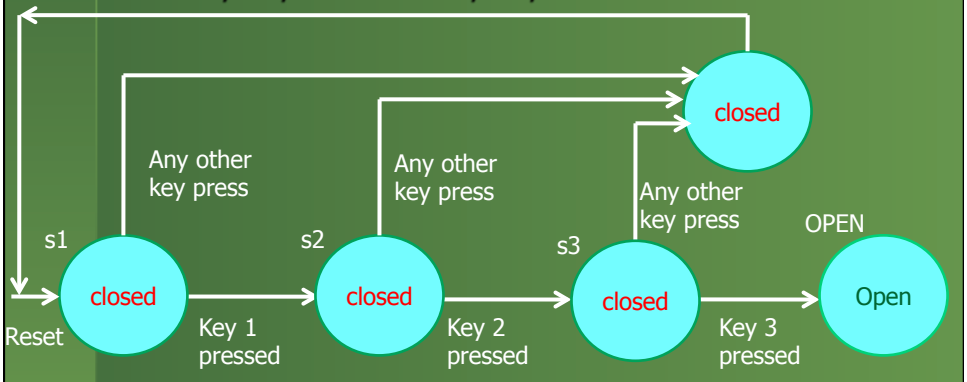
  – Need to "REMEMBER" something ➔ notion of memory!!
  – Say we have some way to 'remember' ; is it sufficient?
  – What is needed in addition? Sense of time.

Sequential logic design: digital lock

- LOGIC DEVELOPMENT
  – Use of *clock* for establishing notion of sequence in digital circuits
  – Add concept/ notion of "*state*" of the system and moving from one state to other under certain conditions
  – Can you define states and develop state diagram for this problem?

Sequential logic design: digital lock

- LOGIC DEVELOPMENT: Lock open sequence is key1 followed by key2 followed by key3



Sequential logic design: digital lock

- Assume that memory is available. What do we remember?
- Remember the current state so that it can be used to make decisions based on key presses and decide future state for next clock cycle
- Assume all keys are like buttons once pressed it will remain in the pressed position ok. Simple.
- There can be more complications. Say you can have a 'press and pop' button like a key board logic need to be different. Think how??

Sequential logic design: digital lock

Key1	Key2	Key3	STATE	Next STATE		LOCK
0	-	-	S1	S1		Closed
1	0	0	S1	S2		Closed
1	1	0	S2	S3		Closed
1	1	1	S3	OPEN		Open

- For all other combinations of keys and whatever be the state the next state should be s1 then lock will remain closed
- Memory block will make previous state available for given clock cycle to decide the next state AND change the state to the next state every clock cycle
- Now states (4) can be represented further as binary number to get the logic circuit with a memory block

Questions?

- Ok fine this solution may work.
- Main question is how do we realize in practice the memory block which will in some sense remember values and we will have control over updating these values at will
- For this we need to study and develop ability to analyze digital logic circuits with feedback : ➔ next topic of discussion namely FlipFlops (EE 101)
- We will come back to completion of problem after developing understanding of FlipFlops


THANK YOU
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