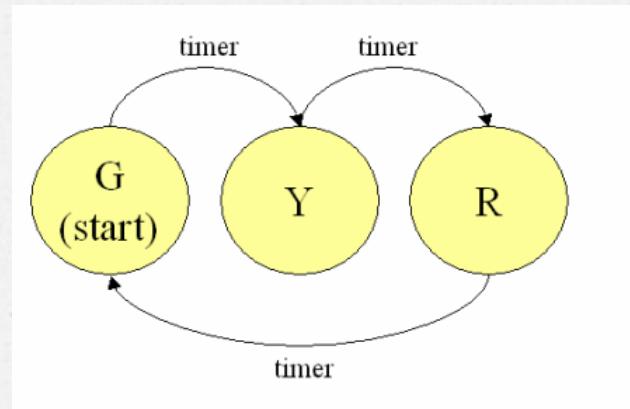


# COMP1003 Computer Organization

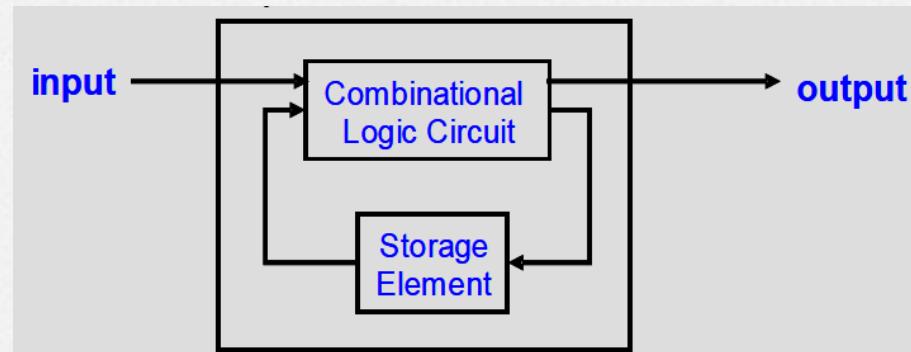
## Lecture 7 Finite State Machine



United International College

# The Concept of State

- The output of a sequential circuit is a function of the current input and the previous state
- **The state is stored in the storage element**
- The new state is also a function of the previous state and the current input

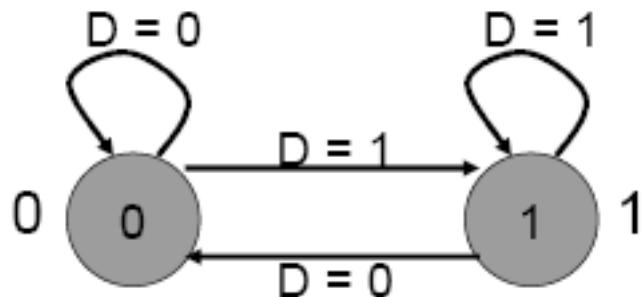


# Finite State Machine

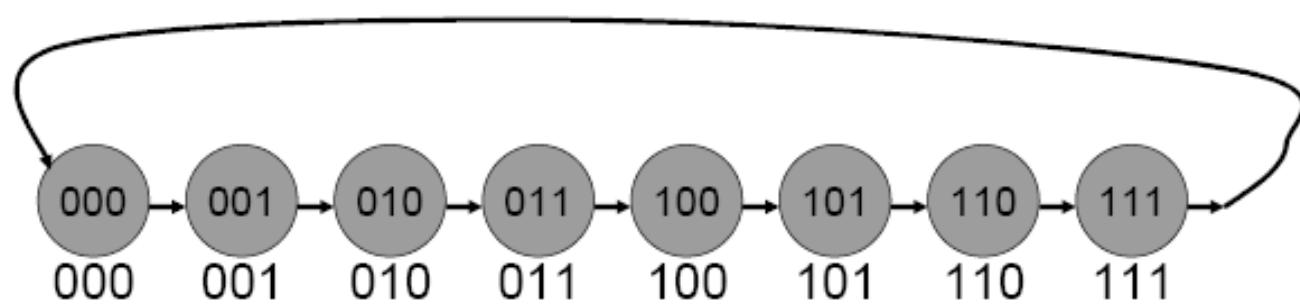
- o A system is a finite state machine if it has the following five properties:
  - A finite number of states
  - A finite number of external inputs
  - A finite number of external outputs
  - An explicit specification of all allowed **state transitions**
  - An explicit specification of the rules for each external output value

# State Diagram

- Each state is shown with a circle, labeled with the state value – the contents of the circle are the outputs
- An arc represents a transition to a different state, with the inputs indicated on the label
- What does this state diagram describe?

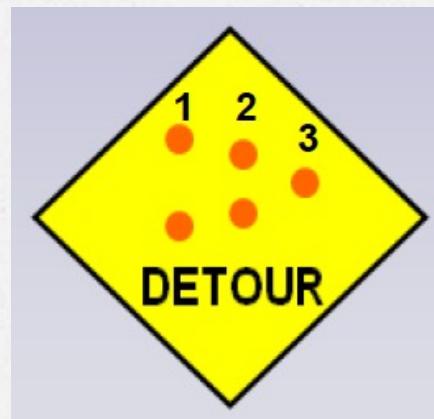


# 3-bit Counter

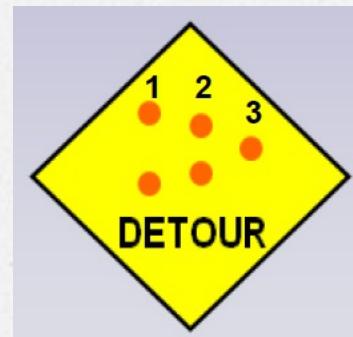
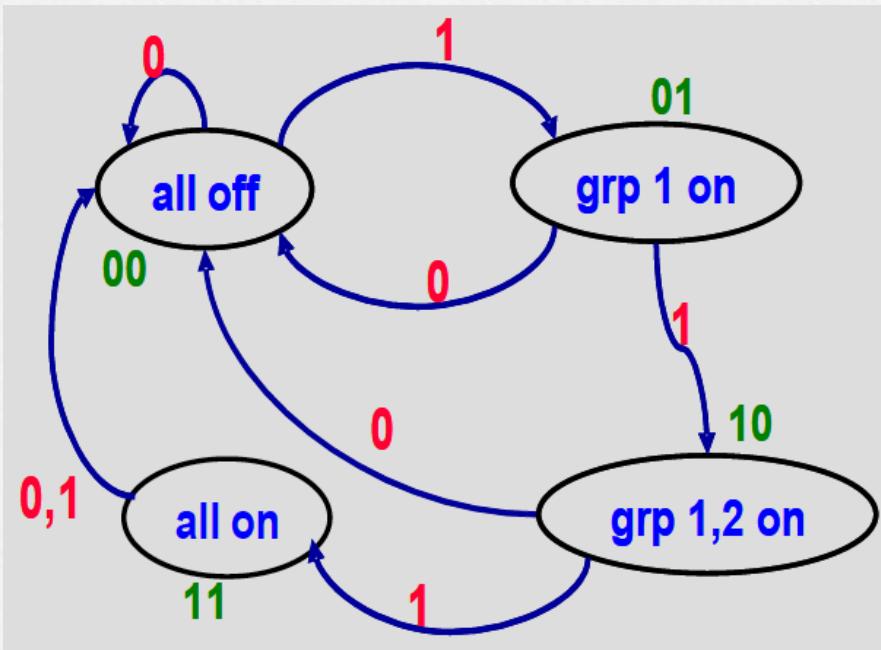


# FSM Example

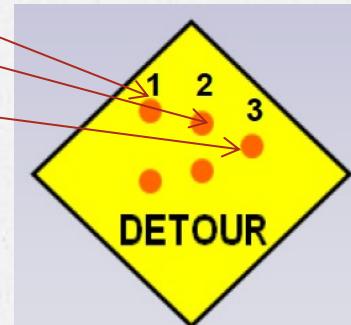
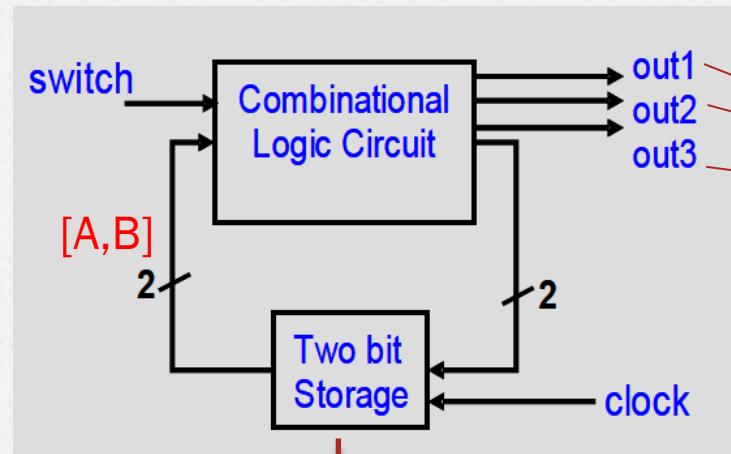
- o Three groups of lights to be lit in a sequence:  
group 1 on, groups 1 & 2 on, all groups on, all off.
- o The lights are on only if the main switch is on.
- o How many states are there in this system? What does the state diagram look like?



# State Diagram



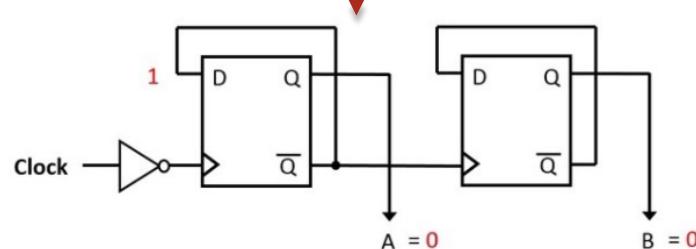
# The Circuit



$$G1 = A + B$$

$$G2 = B$$

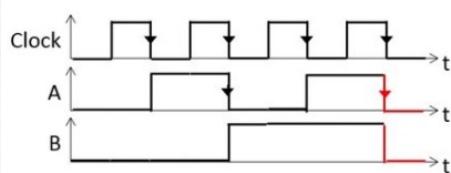
$$G3 = AB$$



Clock pulse number	B	A
0	0	0
1	0	1
2	1	0
3	1	1
4	0	0

G1	G2	G3
0	0	0
1	0	0
1	1	0
1	1	1

All off  
G1 on  
G1 & G2 on  
All on

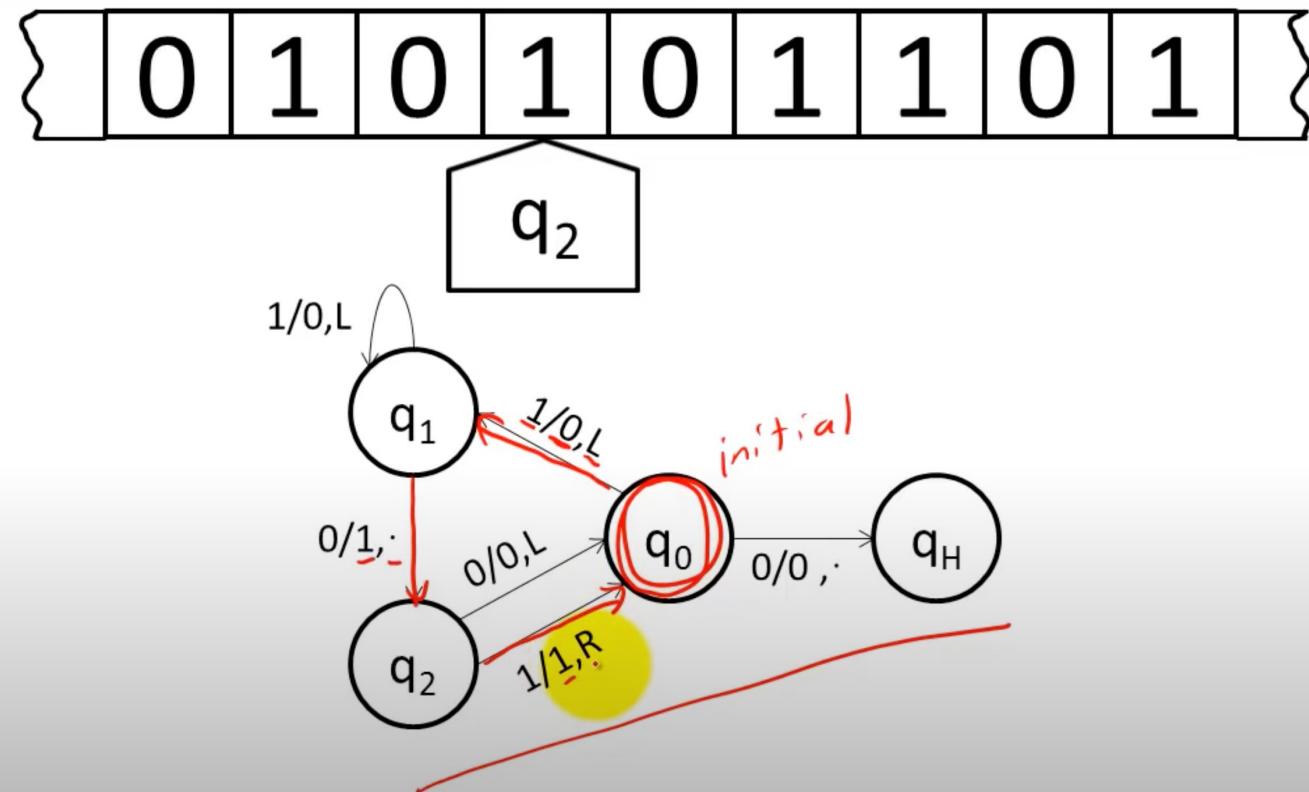


# Circuit Implementation of FSM

In electronic implementation of a finite Turing machine, the transition from one state to another occurs at the start of each clock cycle.

# Think

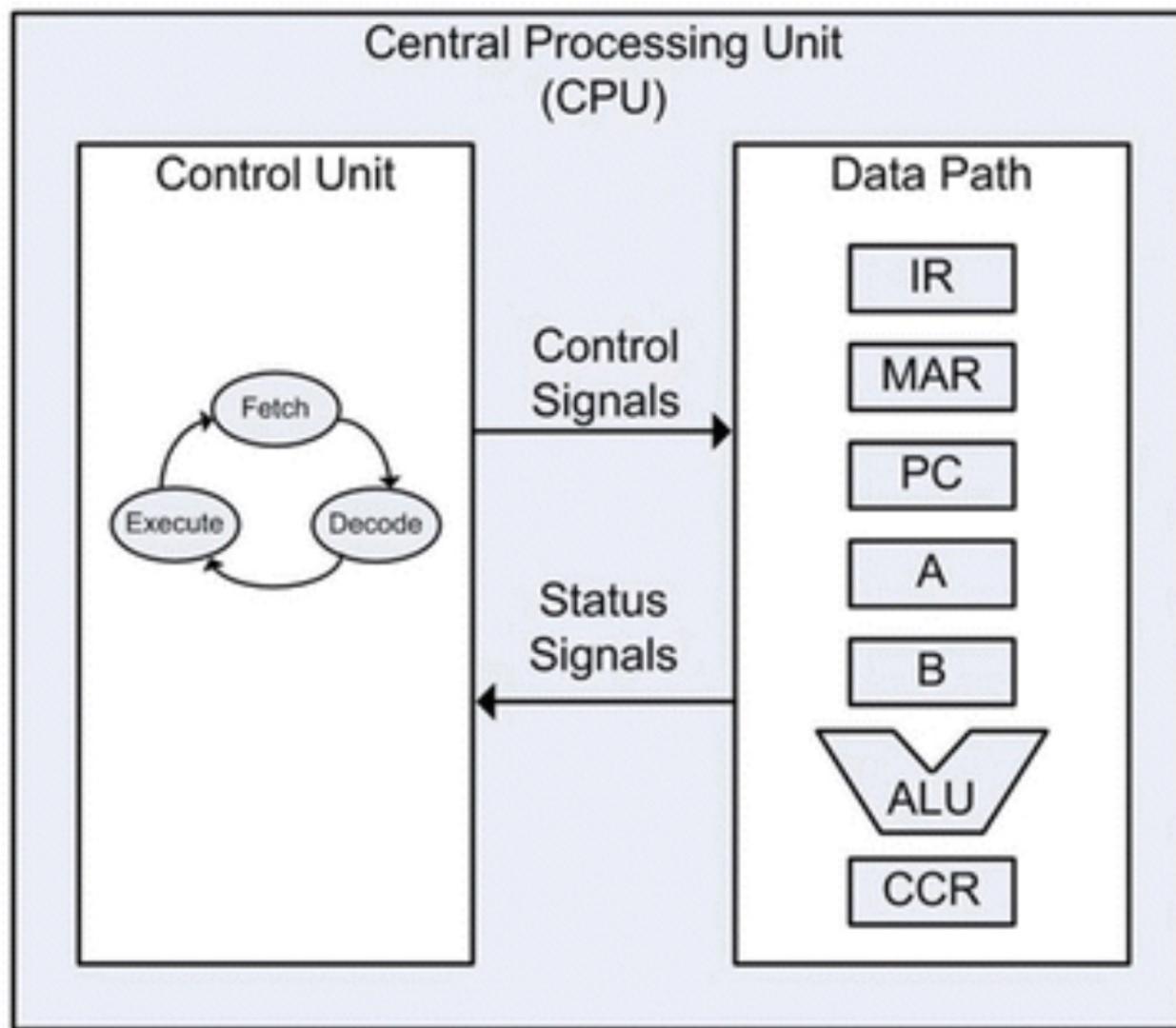
- o How is the FSM related to Turing Machine?

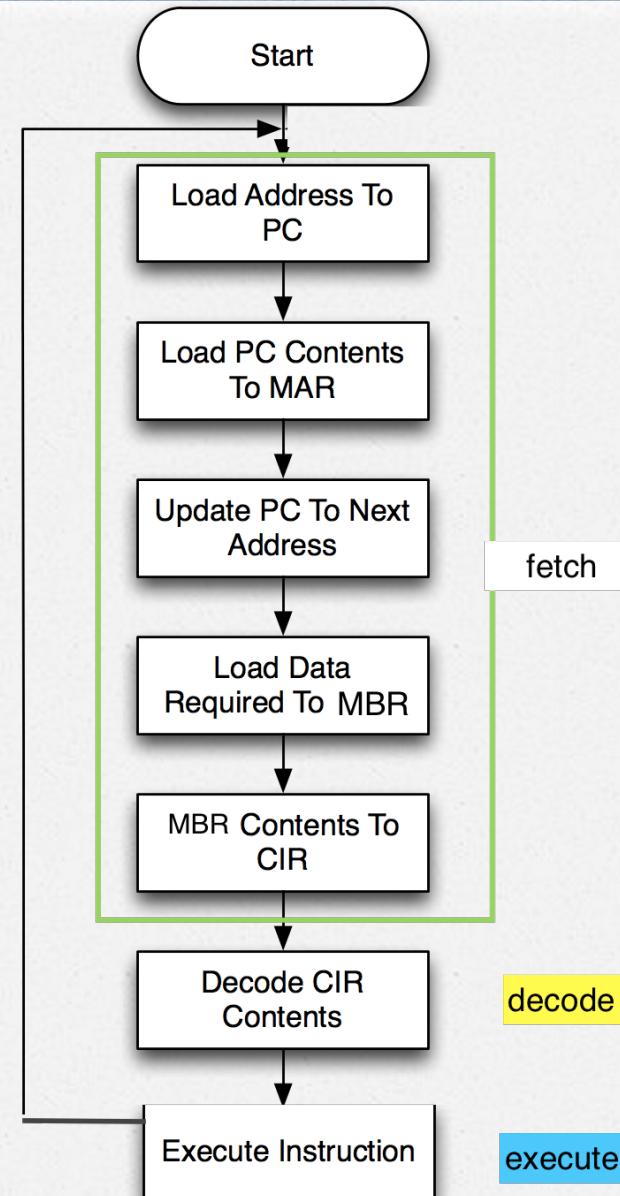
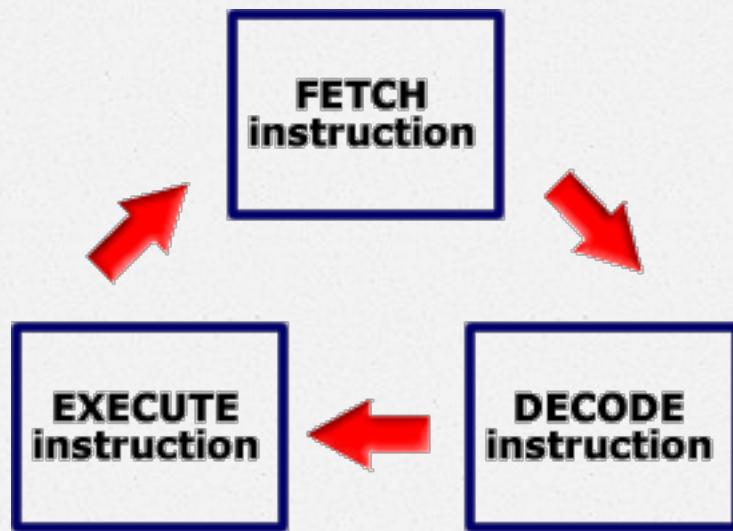


# Turing Machine vs FSM

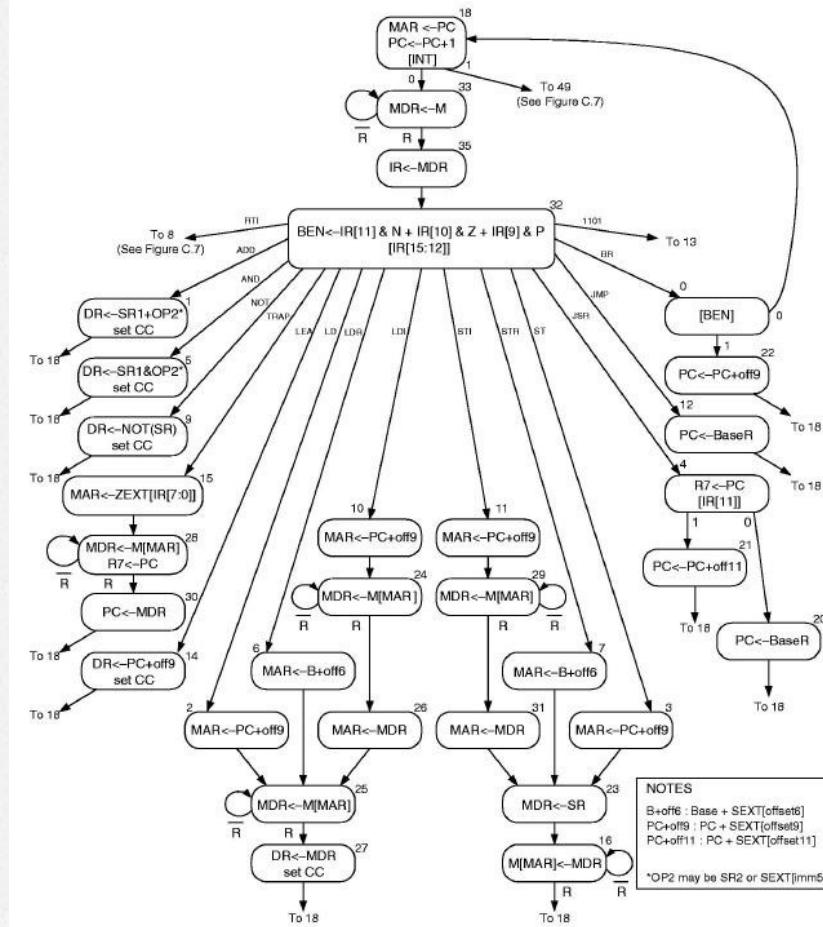
- o A Turing machine is a finite state machine plus a tape memory.
- o Each transition may be accompanied by an operation on the tape (move, read, write).
- o Its total possible configurations are arbitrarily large, regardless of the size of the program; it expands towards infinity.
- o Turing machines have more computational power than FSM.

A CPU is functionally organized into a control unit and a data path. The control unit contains the FSM to orchestrate the fetch-decode-execute process. The registers and ALU are grouped into a unit called the data path. The control unit sends control signals to the data path to move and manipulate data. The control unit uses status signals from the data path to decide which states to traverse in its FSM.





# FSM of the LC<sub>3</sub> (little computer 3)



# What's Next

- o How to construct the **microarchitecture** using circuits to implement the ISA

