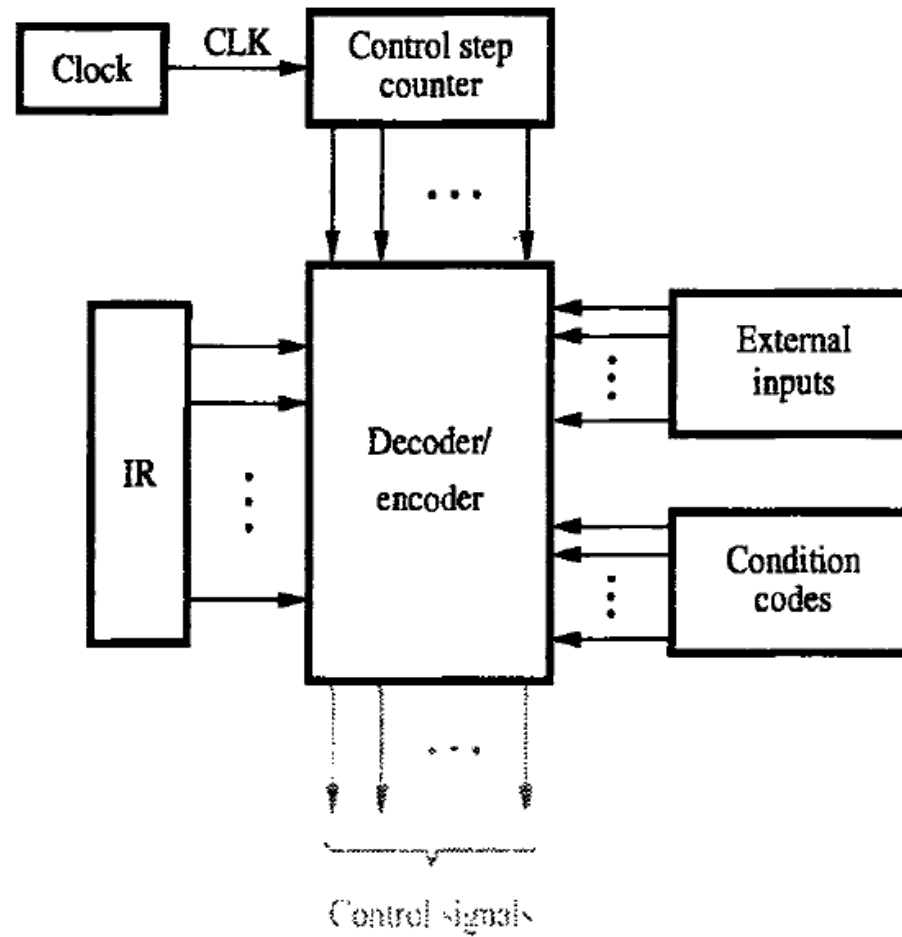


Module 4- Control Unit Design

-Neha Surti

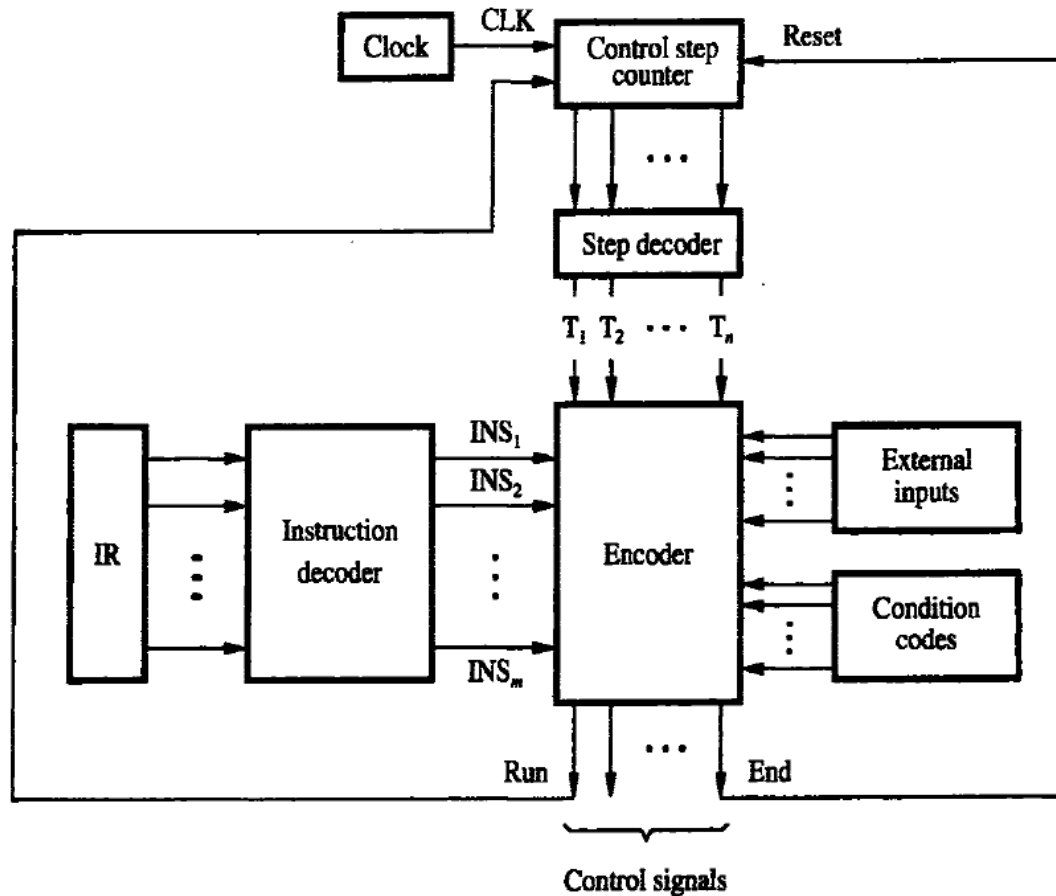
Hardwired Control Unit



Hardwired Control Unit

- The decoder/encoder is a combinational circuit that generates a set of required control signals.
- A control step counter is used to keep track of the control steps.
- Each count of this counter corresponds to one control step.
- The required control signals are determined by the following information:
 1. contents of the control step counter
 2. contents of IR register
 3. contents of the condition code flags
 4. External input signals, like MFC and interrupt request.

Hardwired Control Unit



Separation of the decoding and encoding functions.

Hardwired Control Unit

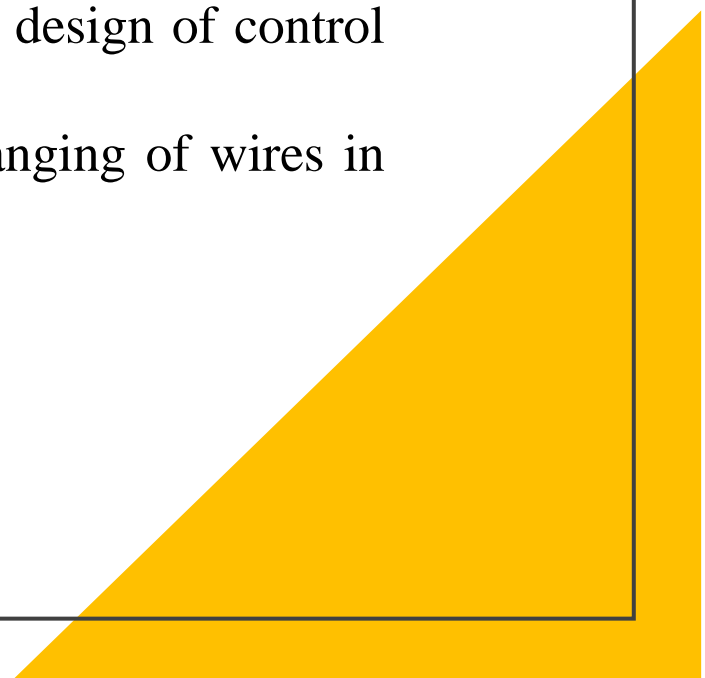
- The step decoder generate a separate signal line for each step, or time slot, in the control sequence.
- The instruction decoder decodes the instruction loaded in IR.
- The output of the instruction decoder consists of a separate line for each of the 'm' machine instruction.
- According to the code in the IR, only one line amongst all output lines of decoder is set to 1 and all other lines are set to 0.
- The input signals to encoder are combined to generate the individual control signals like add, read, etc.
- The End signal starts a new instruction fetch cycle by resetting the control step counter to its starting value.
- When run=1, the counter to be incremented by one at the end of every clock cycle.
- When run=0, the counter stops counting, and this is needed whenever the WMFC signal is activated.

Hardwired Control Unit

Advantages of Hardwired Control Unit:

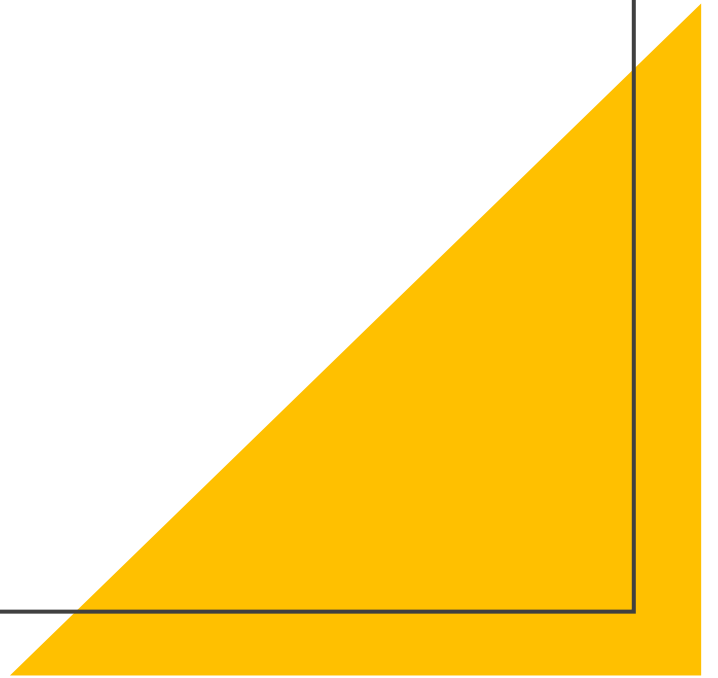
- Fast because control signals are generated by combinational circuits.
- The delay in generation of control signals depends upon the number of gates.

Disadvantages of Hardwired Control Unit:

- More the control signals required by CPU, more complex will be the design of control unit.
 - Modification in control signal are very difficult i.e., it requires rearranging of wires in the hardware circuit.
 - Difficult to add new feature in existing design of control unit.
- 
- A large yellow right-angled triangle is positioned in the bottom right corner of the slide, pointing towards the top right.

Hardwired Control Unit Design Methods

- State-table Method
- Delay-element Method
- Sequence-counter Method

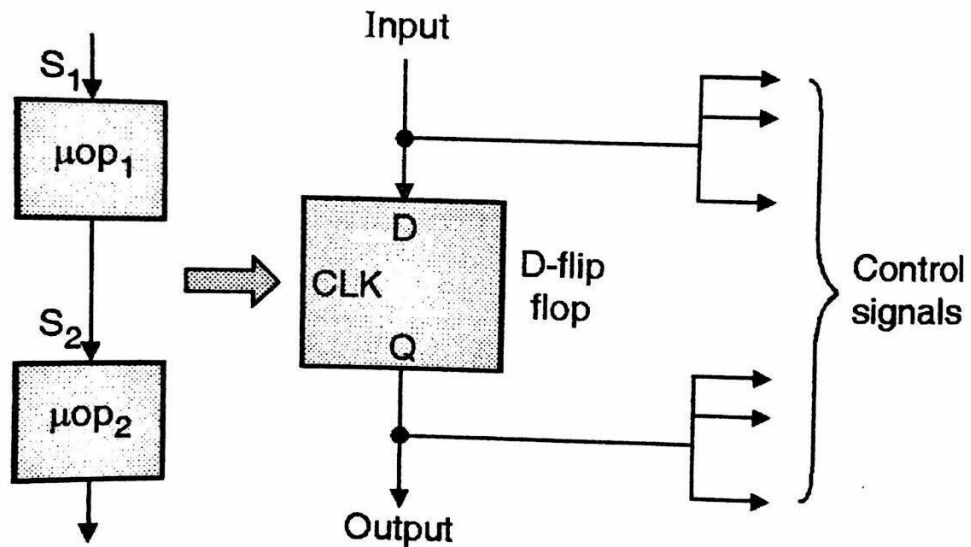


State-table Method

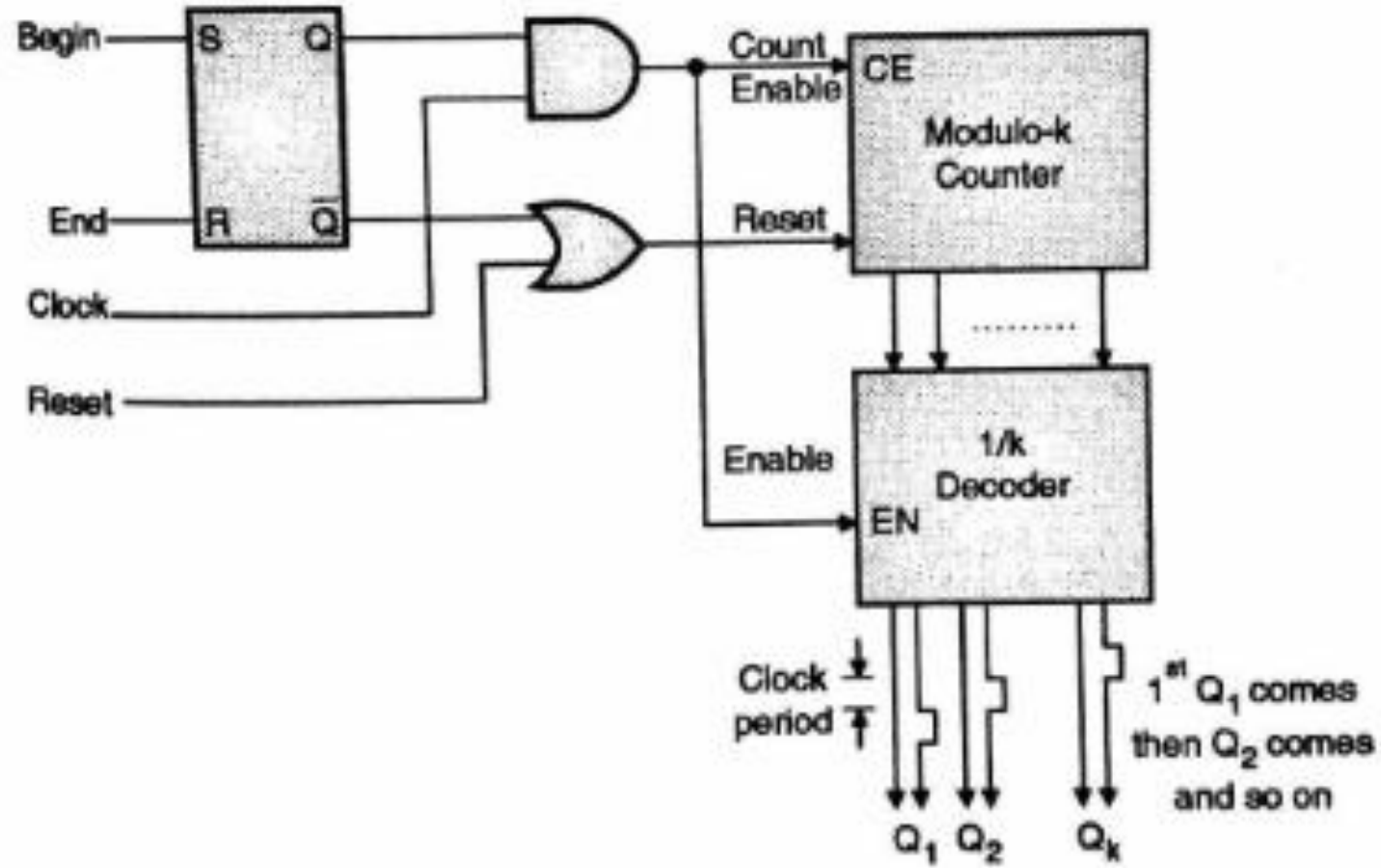
Inputs				
State	I	I ₂	I _m
S ₁	S _{1,1} , O _{1,1}	S _{1,2} , O _{1,2}	S _{1,m} , O _{1,m}
S ₂	S _{2,1} , O _{2,1}	S _{2,2} , O _{2,2}	S _{2,m} , O _{2,m}
:			
:				
S _n	S _{n,1} , O _{n,1}	S _{n,2} , O _{n,2}	S _{n,m} , O _{n,m}

Delay-element Method

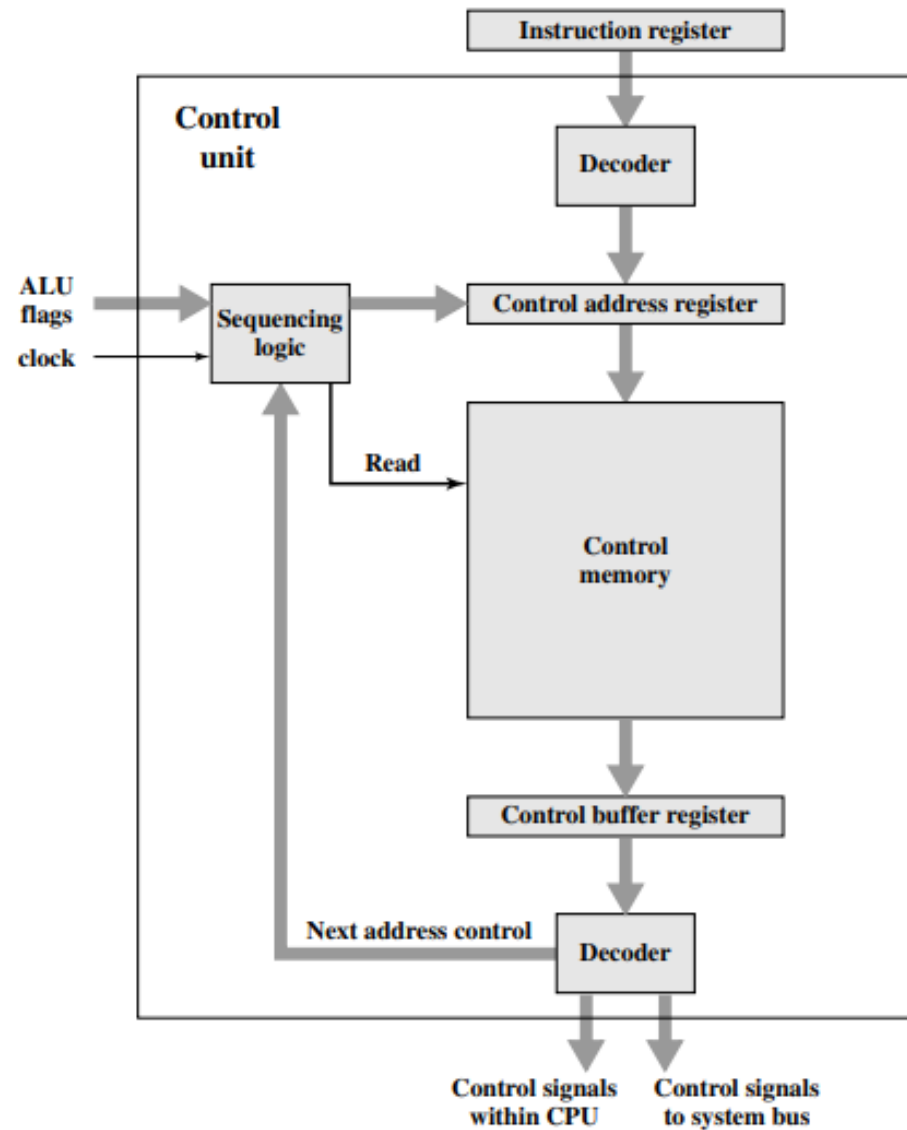
- There is a specific time delay between activation of two control signals or group of control signals.
- To ensure synchronous operation, the delay elements are implemented by D-flip flops and controlled by a common clock signal.



Sequence-counter Method

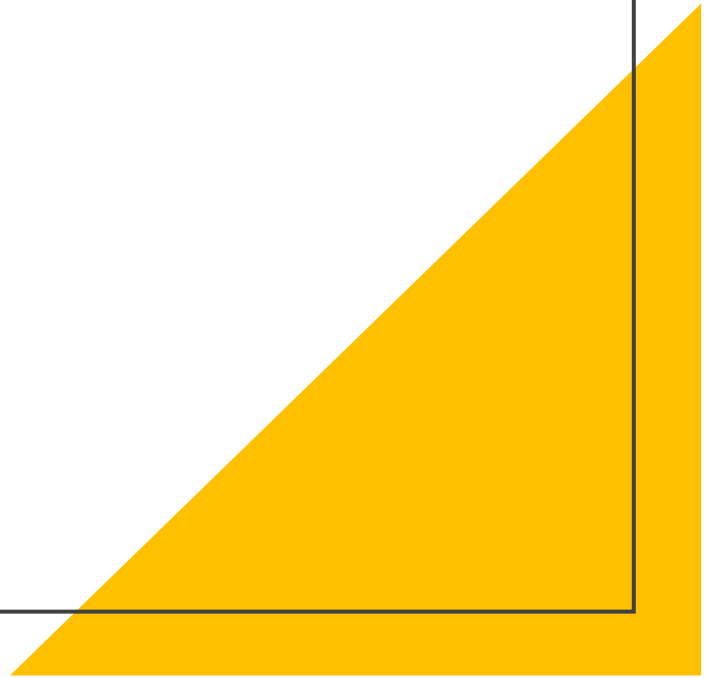


Microprogrammed Control Unit

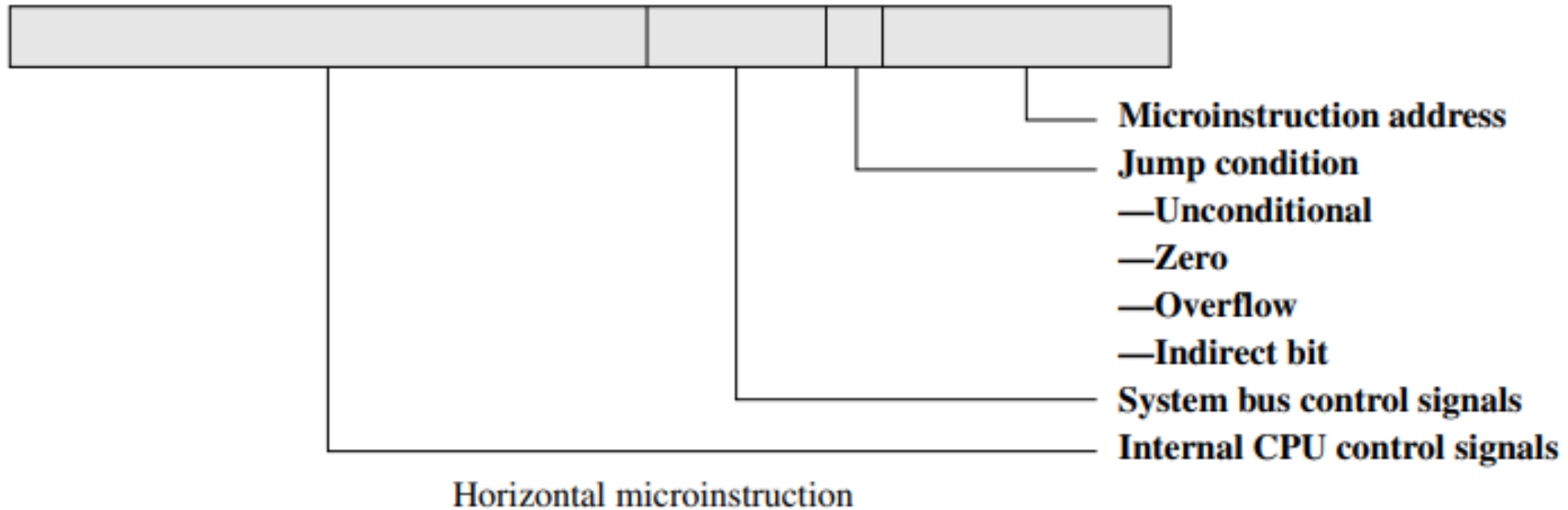


Micro Instruction-Format

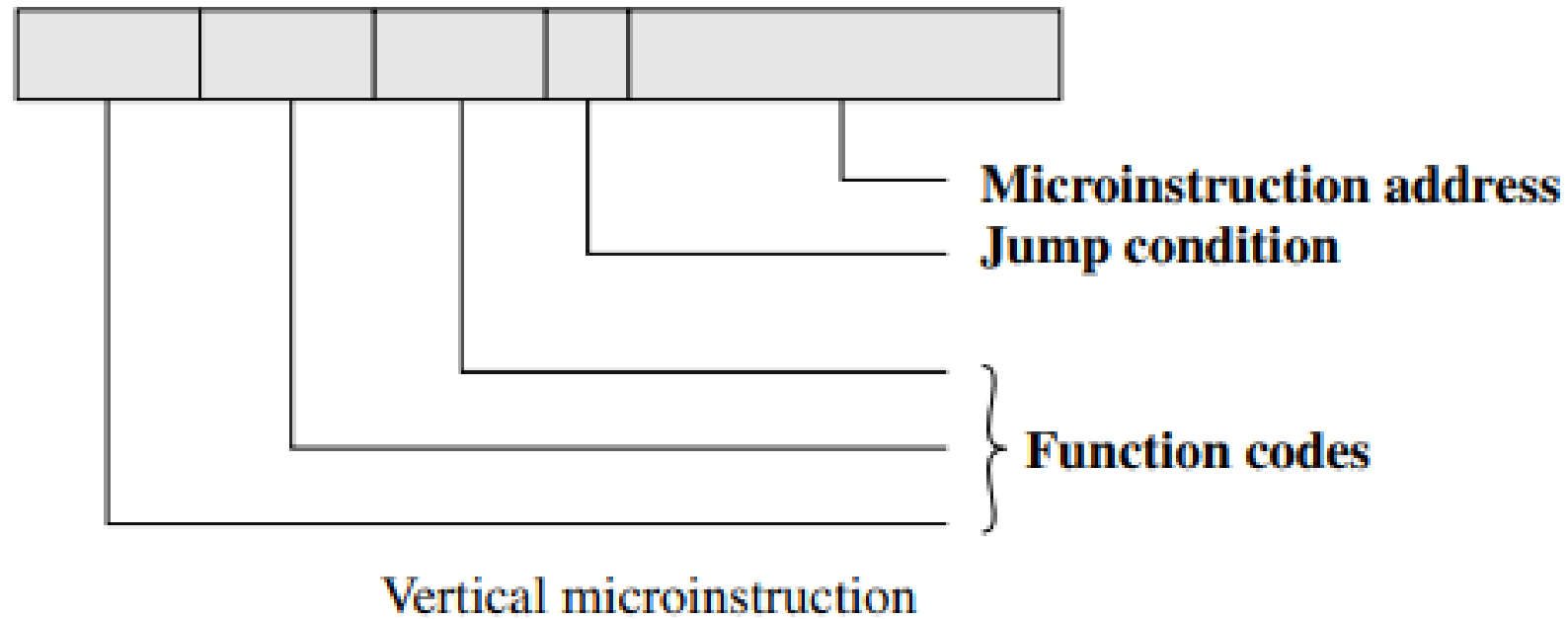
- Horizontal microinstruction
- Vertical microinstruction



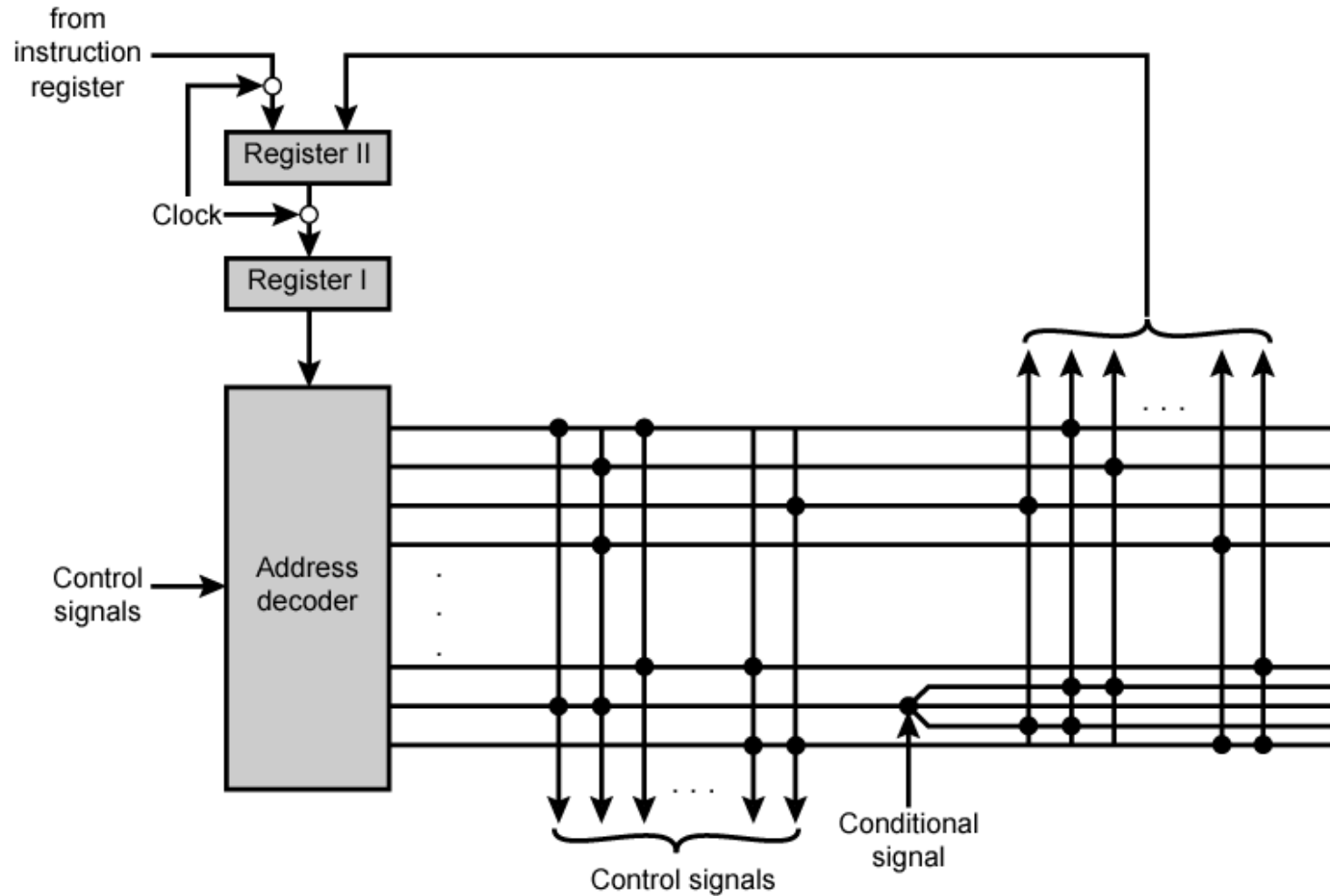
Horizontal microinstruction



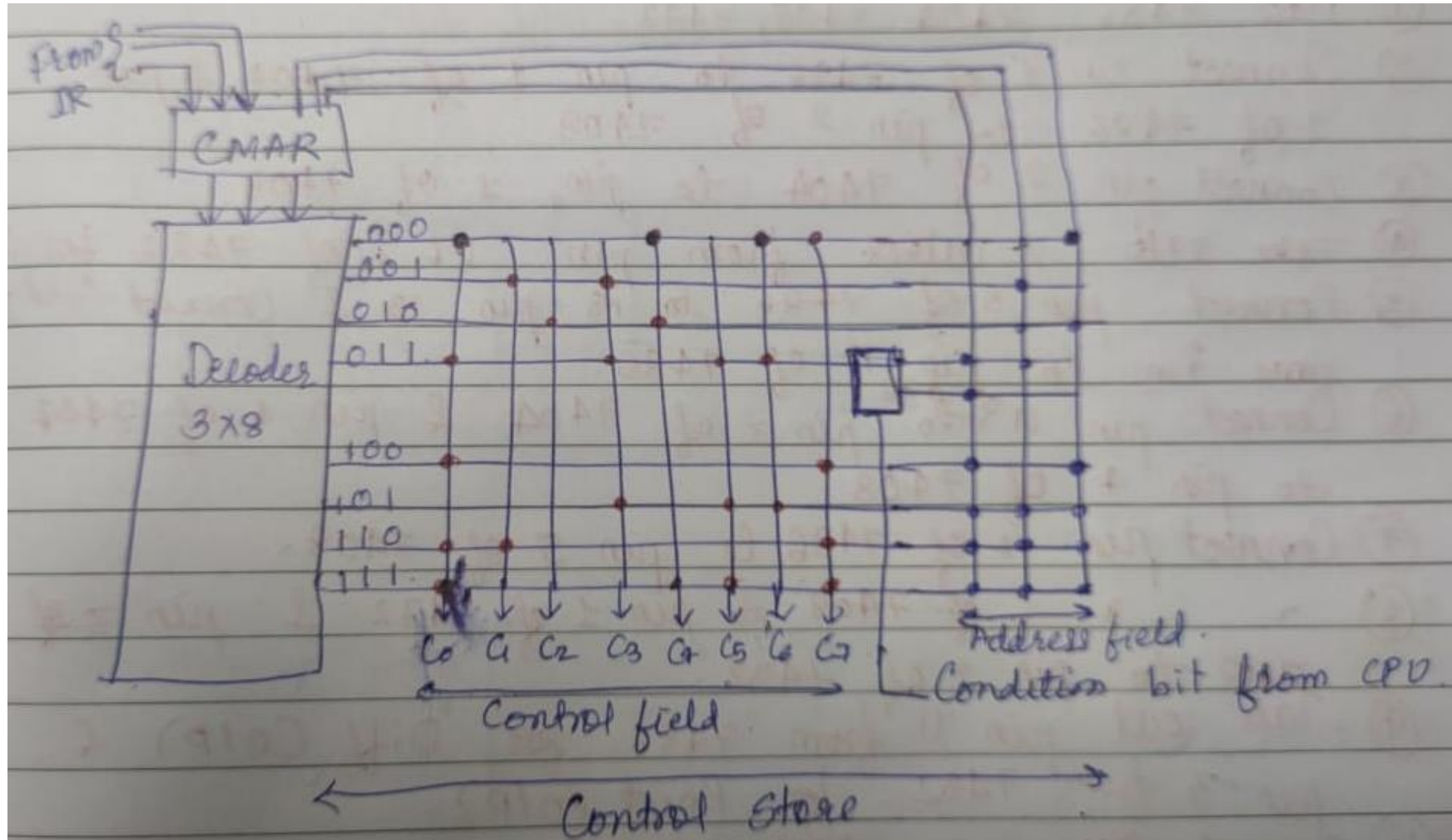
Vertical microinstruction



Wilkes's Microprogrammed Control Unit



Wilkes's Microprogrammed Control Unit



Wilkes's Microprogrammed Control Unit

Decode line activated	Control signal generated	Address of next microinstruction.
000.	C_0, C_4, C_6, C_7	001
001	C_1, C_3	010.
010	C_2, C_4	011.
011.	C_0, C_3, C_5, C_6	?
<i>Either</i>		
true {	011	C_0, C_3, C_5, C_6
	110.	C_0, C_1, C_7
	111	C_0, C_4, C_5, C_7
		If true then 110.
		111
		Load next instruct ⁿ in IR
<i>Or</i>		
false {	011	C_0, C_3, C_5, C_6
	100.	C_0, C_7
	101.	C_3, C_5, C_6
	111	C_0, C_4, C_5, C_7
		If false then address 100
		101
		111.
		Load next instruct ⁿ in IR

Hardwired Vs Micro-programmed Control Unit

Hardwired Control Unit	Microprogrammed Control Unit
Hardwired control unit generates the control signals needed for the processor using logic circuits	Microprogrammed control unit generates the control signals with the help of micro instructions stored in control memory
Hardwired control unit is faster when compared to microprogrammed control unit as the required control signals are generated with the help of hardware	This is slower than the other as micro instructions are used for generating signals here
Difficult to modify as the control signals that need to be generated are hard wired	Easy to modify as the modification need to be done only at the instruction level
Costlier as everything has to be realized in terms of logic gates	Less costly than hardwired control as only micro instructions are used for generating control signals
It cannot handle complex instructions as the circuit design for it becomes complex	It can handle complex instructions
Only limited number of instructions are used due to the hardware implementation	Control signals for many instructions can be generated
Used in computer that makes use of Reduced Instruction Set Computers(RISC)	Used in computer that makes use of Complex Instruction Set Computers(CISC)

Thank You

