Hardwired Control

Micro Operations of Instruction in C

- Basics of Micro-operations
  - There can be multiple Micro Operations in single instruction execution.
  - Micro Operations are executed on values stored in registers.
  - To describe Micro Operations we use "Register Transfer Language - RTL"

Instruction cycle [MOV R_1, R_2]

T_0 : $AR \leftarrow PC$ } Fetch

T_1 : $IR \leftarrow M[AR]$, $PC \leftarrow PC + 1$ }

T_2 : $D_0 \ldots D_7 \leftarrow IR(14\text{-}12)$ decode, $AR \leftarrow IR(11\text{-}0)$, $I \leftarrow IR(15)$ } decode

(Opcode) (Operand) (mode)

T_3 : $R_1 \leftarrow R_2$ } Execute.

Micro Operations / Microinstructions.

Hardwired Control Unit in CO

- Basics of Hardwired Control Unit
  - Control Unit generates control signals to perform microoperations in CPU.
  - Hardwired Control Unit provides control signals by Hardware.
  - In general three types of hardwired control units are available.

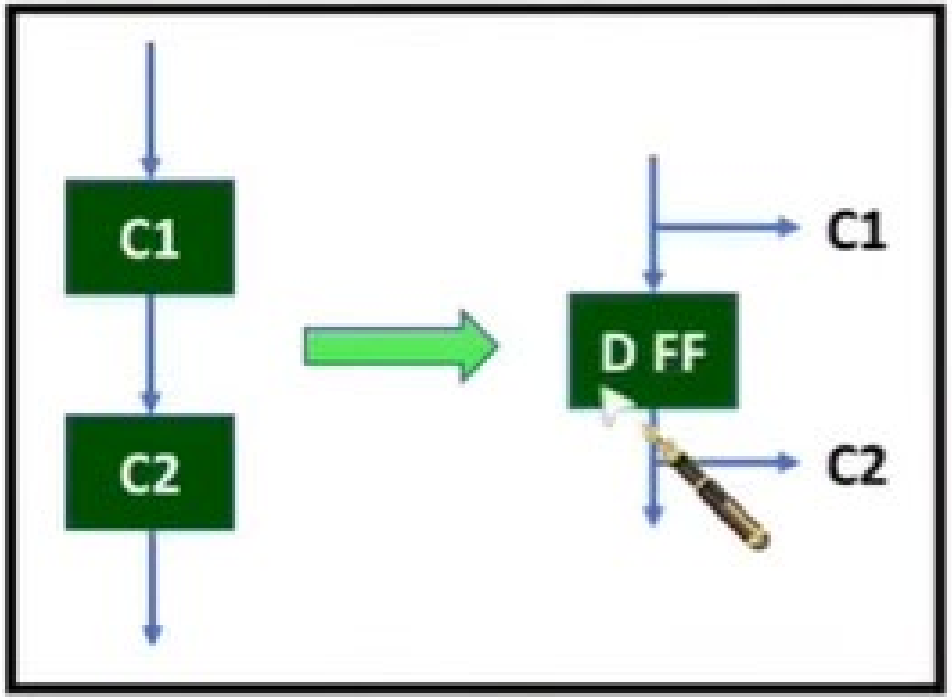
1. State Table Method of Hardwired Control Unit
   - It is the most basic method of hardwired control unit.
   - Here behavior of control unit is represented in the form of a table called state table.
   - The rows represents T states and columns represents instructions.

T States	Instructions			
	I1	I2	- - - - -	In
T1	C(1, 1)	C(1, 2)	- - - - -	C(1, n)
T2	C(2, 1)	C(2, 2)	- - - - -	C(2, n)
⋮	⋮	⋮		⋮
Tm	C(m, 1)	C(m, 2)	- - - - -	C(m, n)

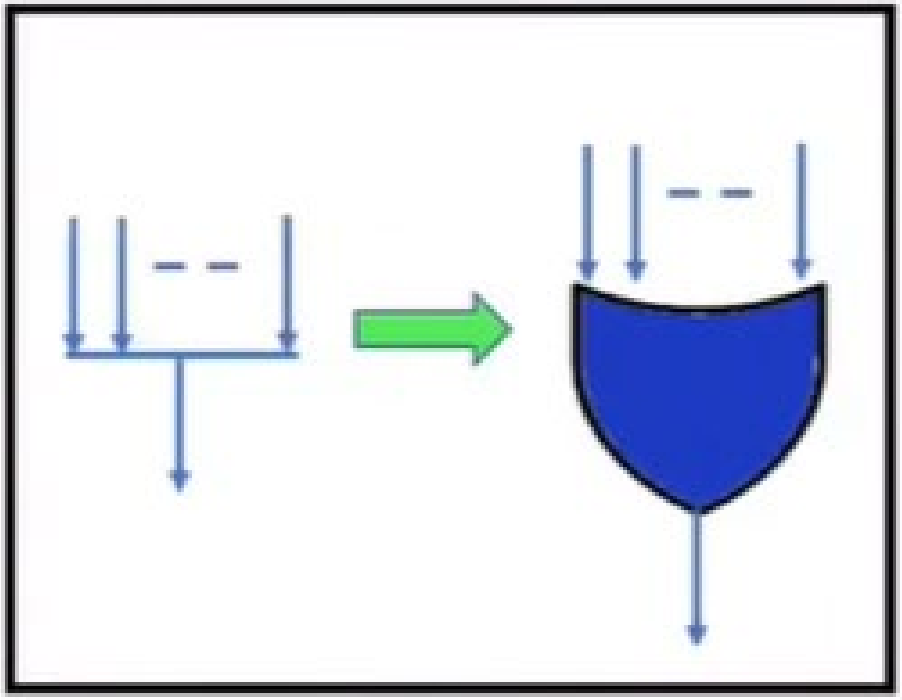
- Advantage
  - It is simple Method.
  - It is ideal for very small instruction set.
- Disadvantage
  - For Large instruction set, hardwired circuit will be very complicated and costly.

2. Delay Element Method of Hardwired Control Unit

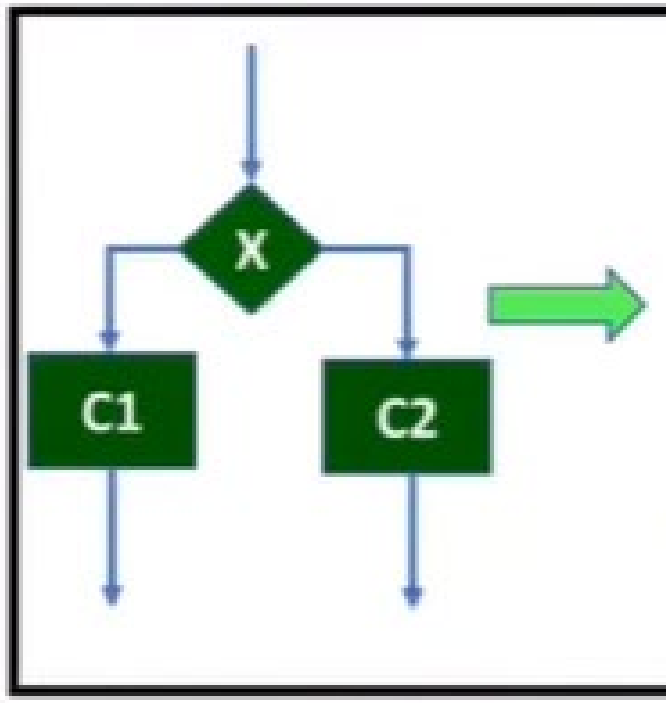
- Here, Out of all the D Flip Flops only one will be active. So this methos is also called "One Hot Method"
- We need to apply simple three rules to convert flowchart into hardwire control signals.



Rule 1



Rule 2



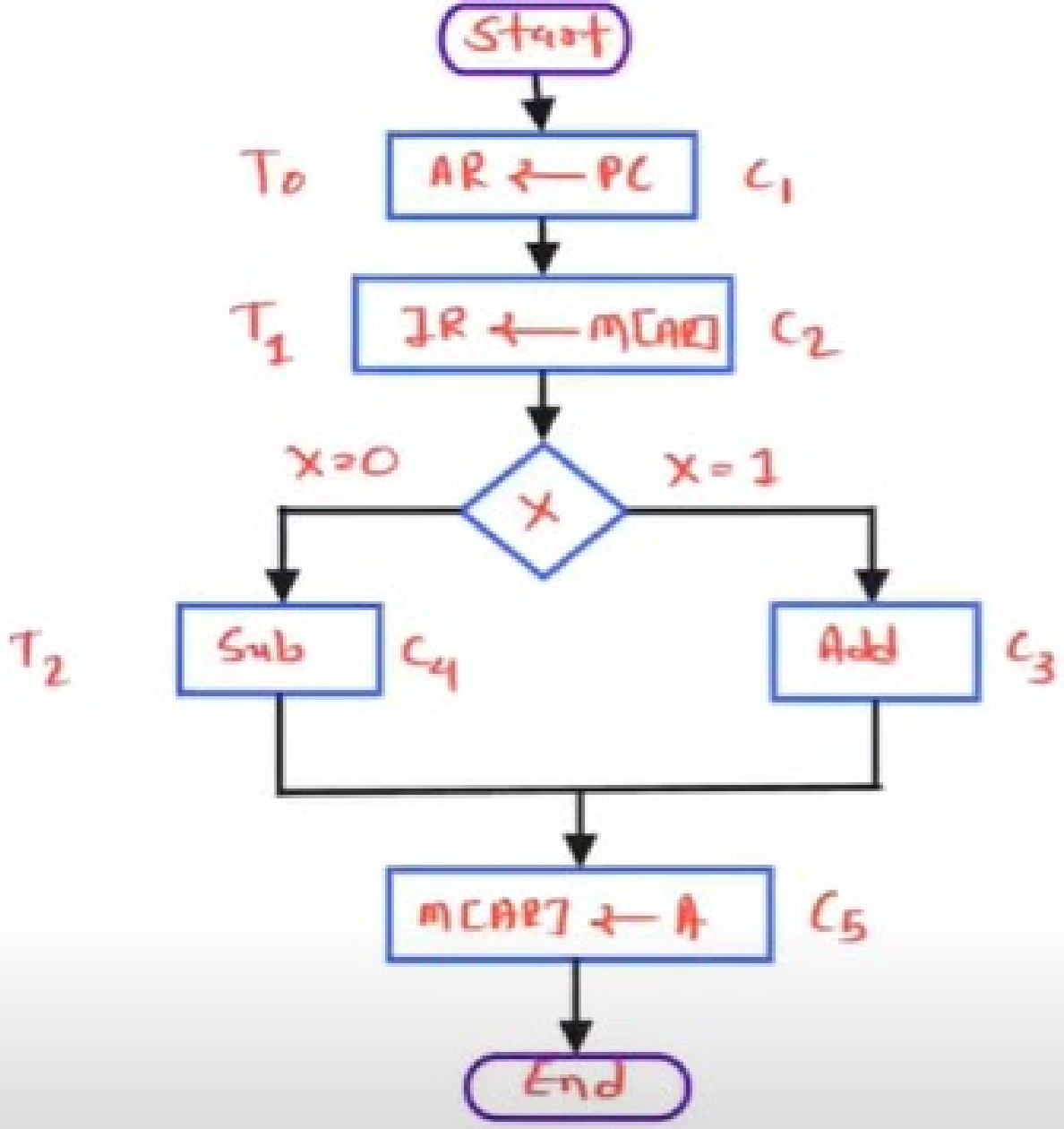
Rule 3

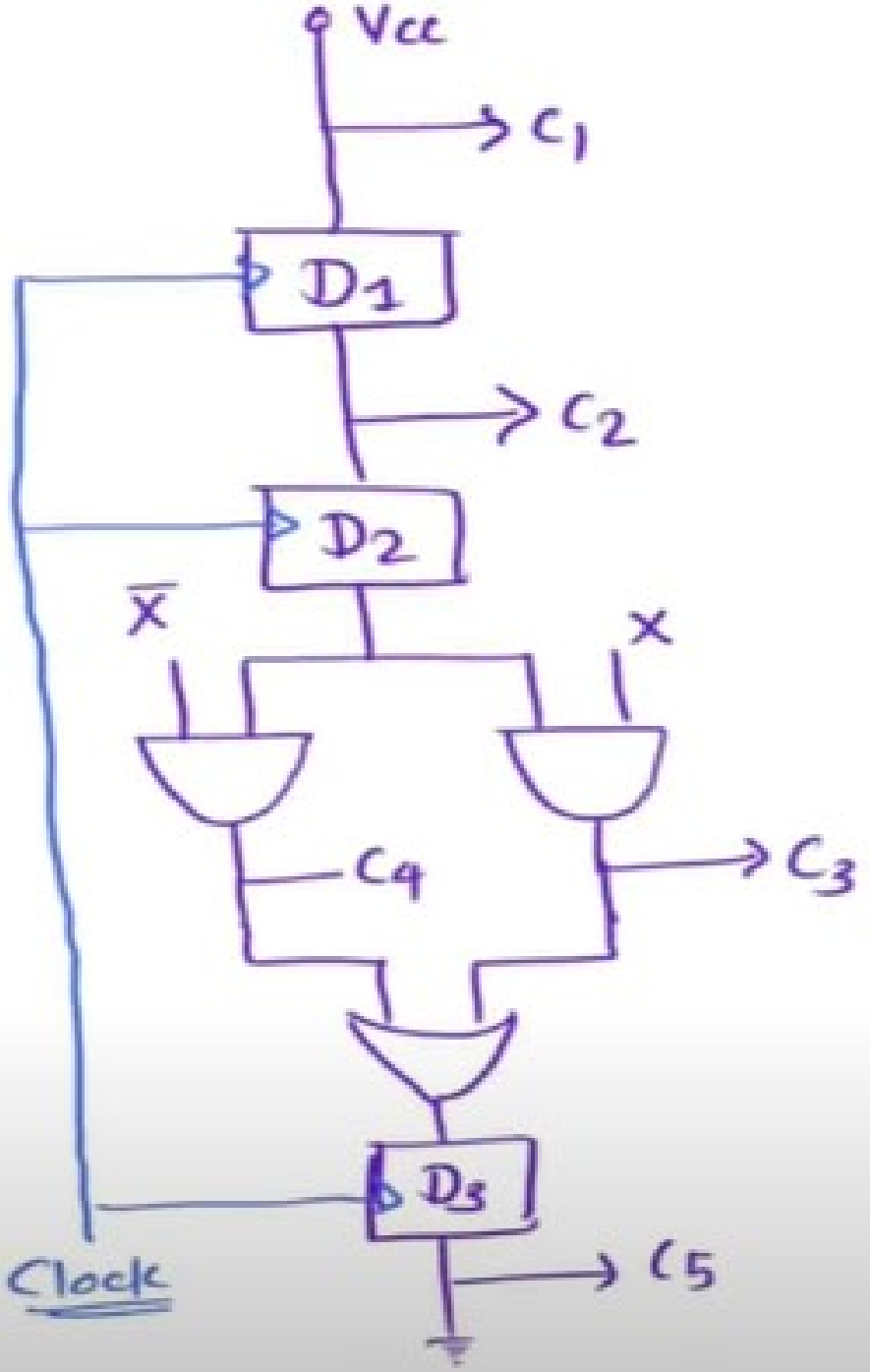
Advantage

- It deceases the complexity of circuit for control unit.
- For Common controls, we don't need separate control signals.

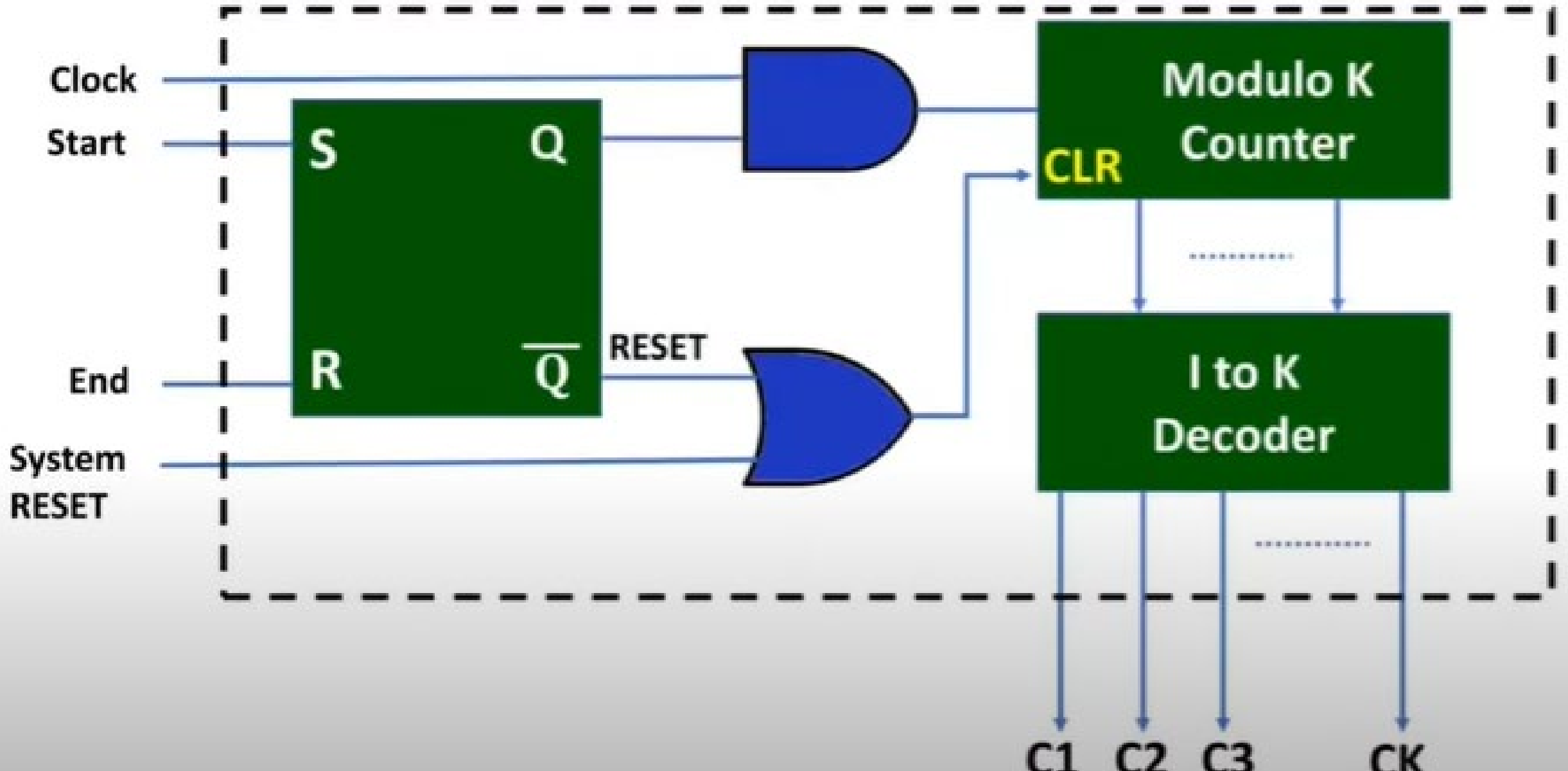
Disadvantage

- For Large instruction set number of D Flip Flops will be more, which will increase the cost and size of circuit.


Start
T_0
AR ← PC
C_1
T_1
IR ← M[AR]
C_2
X=0
X
X=1
T_2
Sub
C_4
Add
C_3
M[AR] ← A
C_5
End


Vcc
C_1
D_1
C_2
D_2
$\bar{X}$
X
C_4
C_3
D_3
Clock
C_5

- This is most popular method of hardwire control unit.
- Approach of Delay method and this method is same, but it doesn't requires many D Flip Flops for control signals.



Wilkes Design For Micro Programmed C