North South University

Department of Electrical & Computer Engineering

LAB REPORT

Course Name: **CSE231L**

Experiment Number: 08

Experiment Name: **Synchronous Sequential Circuits**

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Section:

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Remarks:	

LAB-08: Synchronous Sequential Circuits

Objectives:

• Gain a practical understanding of State Diagrams and State Tables.
• Understand the concept of designing Sequential Circuits using Flip-Flops.
• Design and implement a Synchronous Sequential Circuit given a State Diagram.

Apparatus:

- IC 7474 (Dual D Flip-Flops)
- IC 74107 (Dual JK Flip-Flops)
- IC 7408 2-input AND gates
- IC 7404 Hex inverters (NOT gates)
- IC 7432 2-input OR gates

Theory:

Synchronous Sequential Circuits:

Sequential Circuit is made of combinational circuits and memory storage where circuits conduct the operation of present output based on present inputs and past outputs stored in memory storage. In a sequential circuit, the values of the outputs depend on the past behavior of the circuit, as well as the present values of its inputs. A sequential circuit has states, which in conjunction with the present values of inputs determine its behavior. Sequential circuits can be Synchronous where flip-flops are used to implement the states, and a clock signal is used to control the operation.

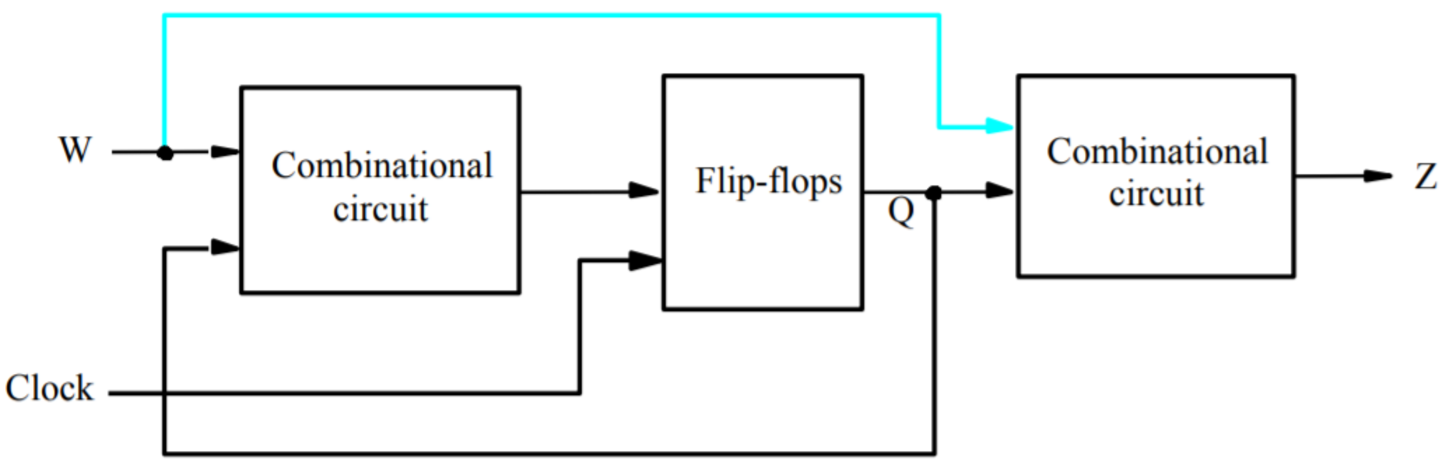


Figure: The general form of a synchronous sequential circuit.

State Table:

The state table representation of a sequential circuit consists of three sections labeled present state, next state and output. The present state designates the state of flip-flops before the occurrence of a clock pulse. The next state shows the states of flip-flops after the clock pulse, and the output section lists the value of the output variables during the present state.

State Diagram:

In addition to graphical symbols, tables or equations, flip-flops can also be represented graphically by a state diagram. In this diagram, a state is represented by a circle, and the transition between states is indicated by directed lines (or arcs) connecting the circles.

Circuit Diagram:

Experiment-1:

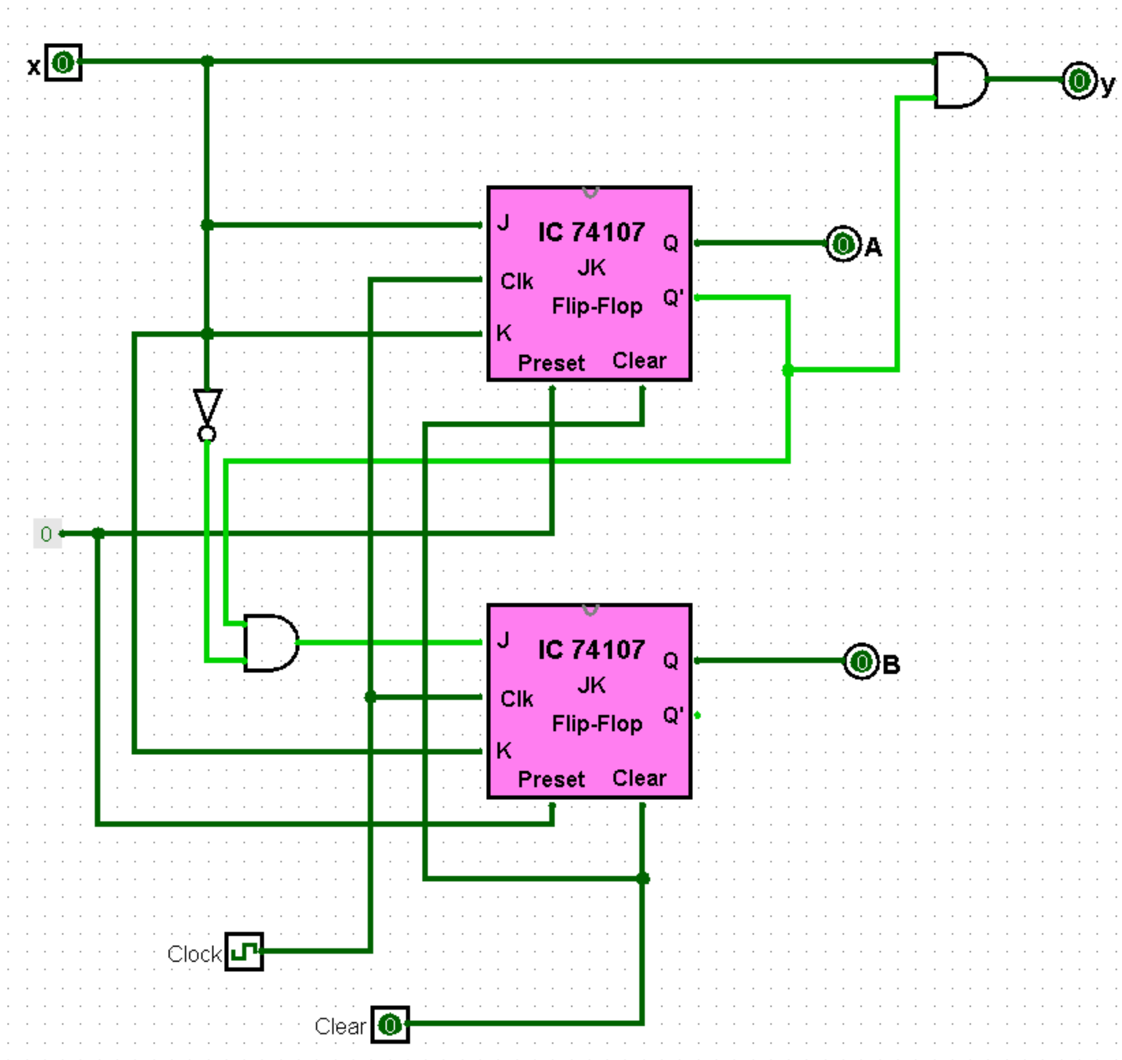


Figure F1: Constructing a Sequential Circuit using JK Flip-Flop.

Experiment-2:

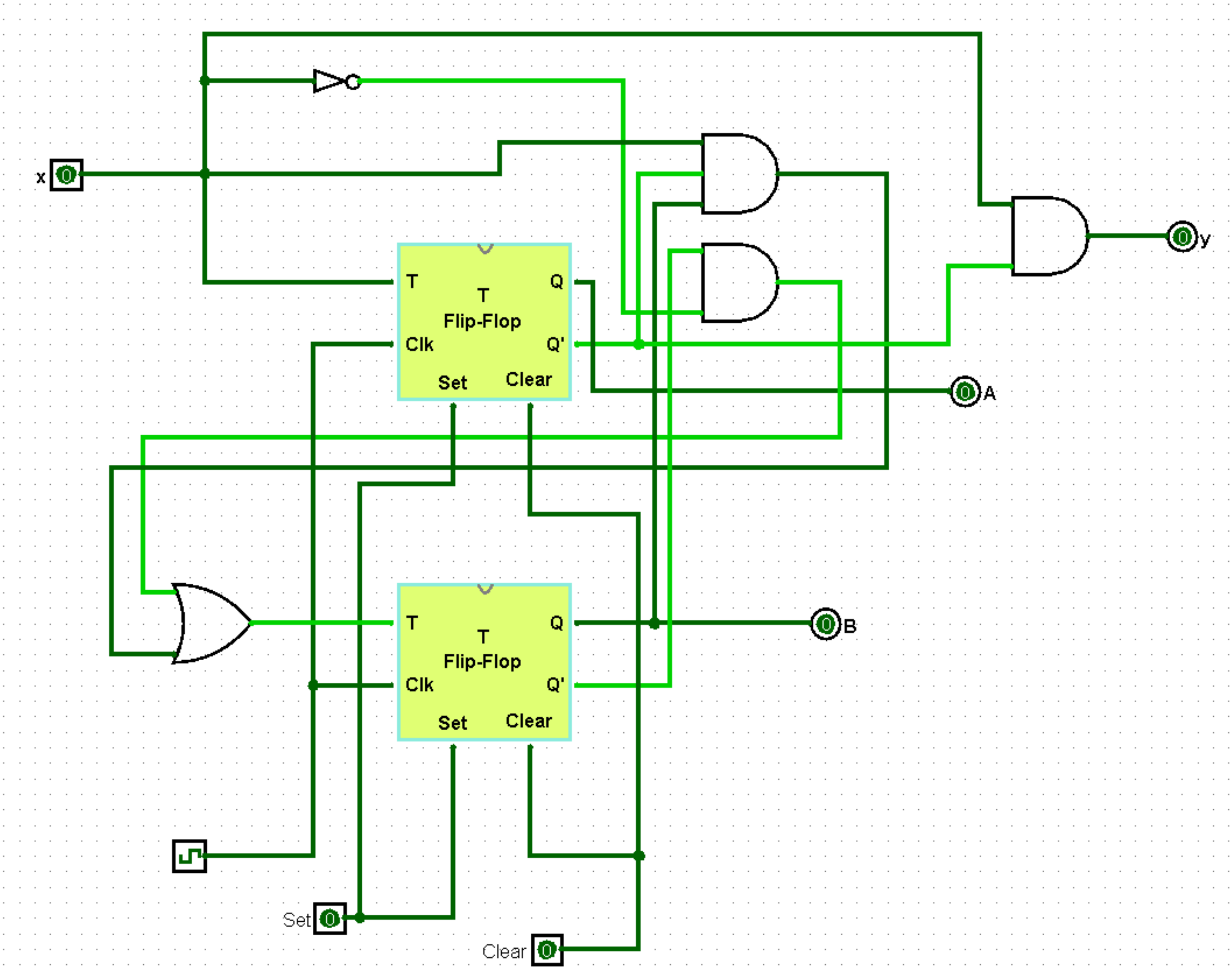


Figure F2: Constructing a Sequential Circuit using T Flip-Flop.

Experiment-3:

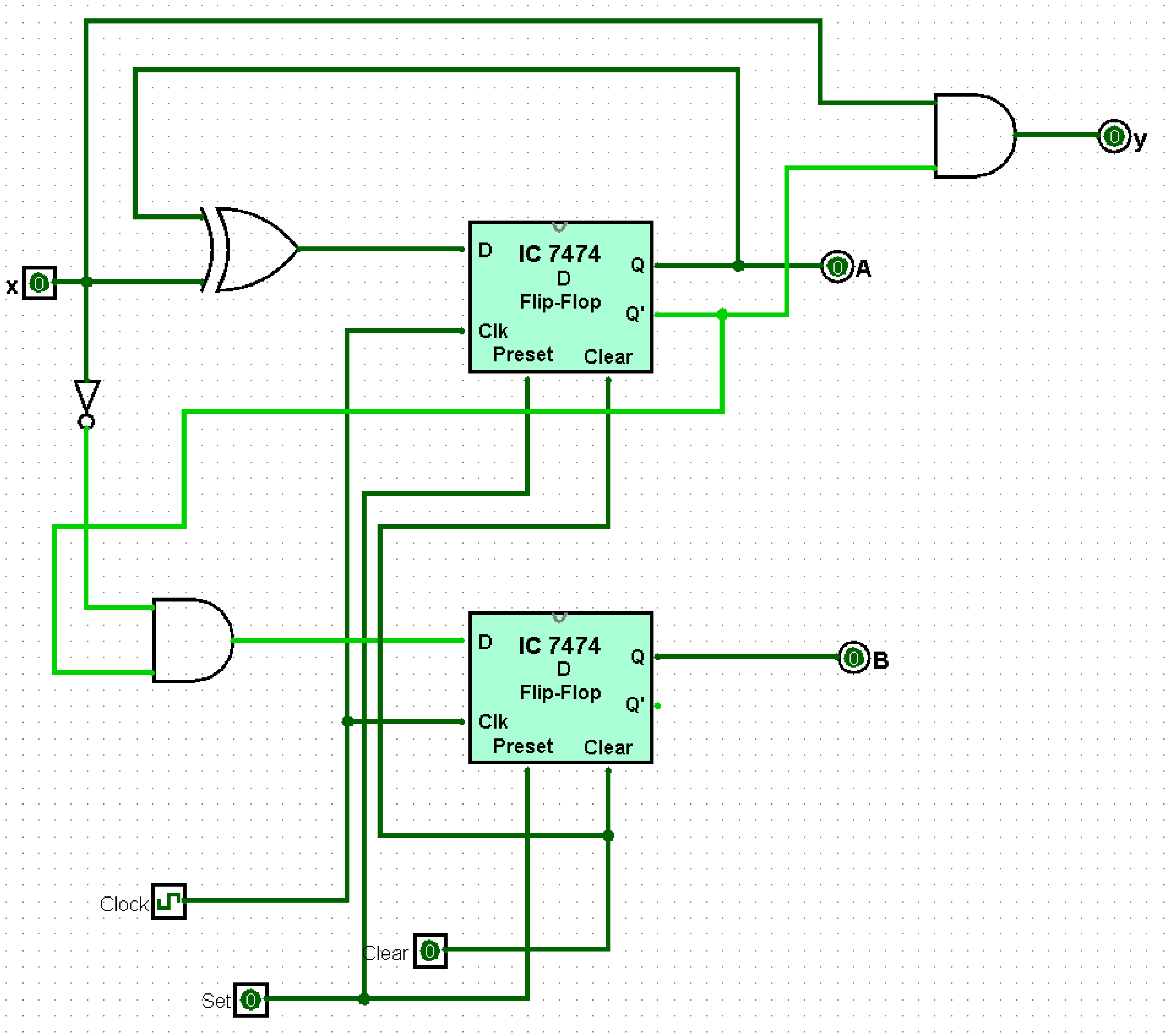


Figure F3: Constructing a Sequential Circuit using D Flip-Flop.

Data Table:

Experiment-1: Table 01: State table for circuit using JK Flip-Flop.

Present state		Input	Next state		Output	Flip-flop input functions			
A	B	X	A	B	Y	J_A	K_A	J_B	K_B
0	0	0	0	1	0	0	X	1	X
0	0	1	1	0	1	1	X	0	X
0	1	0	0	1	0	0	X	X	0
0	1	1	1	0	1	1	X	X	1
1	0	0	1	0	0	X	0	0	X
1	0	1	0	0	0	X	1	0	X
1	1	0	X	X	X	X	X	X	X
1	1	1	X	X	X	X	X	X	X

0	0	X	X
1	1	X	X

$J_A = X$

X	X	0	X
X	X	1	X

$K_A = X$

1	X	0	X
0	X	0	X

$J_B = X'A'$

X	0	X	X
X	1	X	X

$K_B = X$

0	0	0	X
1	1	0	X

$Y = XA'$

Experiment-2: Table 02: State table for circuit using T Flip-Flop.

Present state		Input	Next state		Output	Flip-flop input functions	
A	B	X	A	B	Y	T_A	T_B
0	0	0	0	1	0	0	1
0	0	1	1	0	1	1	0
0	1	0	0	1	0	0	0
0	1	1	1	0	1	1	1
1	0	0	1	0	0	0	0
1	0	1	0	0	0	1	0
1	1	0	X	X	X	X	X
1	1	1	X	X	X	X	X

0	0	0	X
1	1	1	X

T_A = X

1	0	0	X
0	1	0	X

T_B = XA'B+X'B'

0	0	0	X
1	1	0	X

Y = XA'

Experiment-3: Table 03: State table for circuit using D Flip-Flop.

Present state		Input	Next state		Output	Flip-flop input functions	
A	**B**	**X**	**A**	**B**	**Y**	**D_A**	**D_B**
0	**0**	**0**	0	1	0	0	1
0	**0**	**1**	1	0	1	1	0
0	**1**	**0**	0	1	0	0	1
0	**1**	**1**	1	0	1	1	0
1	**0**	**0**	1	0	0	1	0
1	**0**	**1**	0	0	0	0	0
1	**1**	**0**	X	X	X	X	X
1	**1**	**1**	X	X	X	X	X

0	0	1	X
1	1	0	X

D_A = XA'+X'A

1	1	0	X
0	0	0	X

D_B = X'A'

0	0	0	X
1	1	0	X

Y = XA'

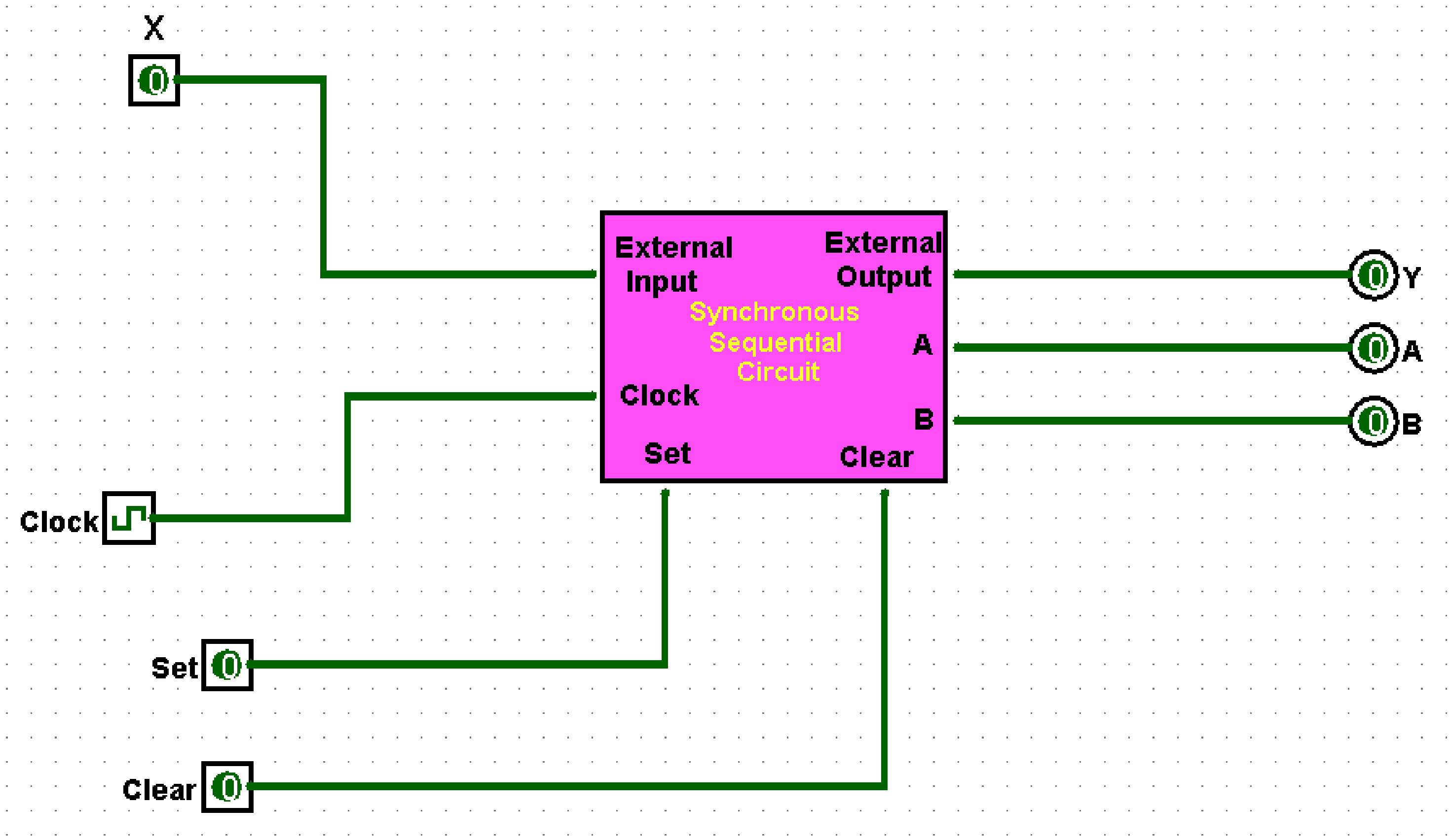
<u>Question and Answer:</u>

Experiment-2:

Ques-01: Reason behind the output y equation of JK and T be the same

ANS: from given state diagram, the obtained output values of y depend on the flip-flop output and external input for both JK flip-flop and T flip-flop. As the values of external output y is same for JK flip-flop and T flip-flop, the output equation obtained from k-map will also be same.

Experiment-3: IC Diagram for the logic circuit in T Flip-Flop



Discussion:

The overall lab experiment was about the implementation of synchronous sequential circuit using different types of flip-flops.

At the beginning of the experiment, I implemented the synchronous sequential circuit using JK flip-flop. At first, from given state diagram, I had to complete the state table with next state values and external output values. Then using Karnaugh map built from state table, I got required state equations. Using these state equations, I constructed the sequential circuit.

Then I constructed synchronous sequential circuit using D flip-flop and T flip-flop as same as did for JK flip-flop.

Additionally, I did the implementation with basic logic gate ICs and T flip-flop.

During experiment, Logisim worked properly.

Above all, from the experiment, I learned how to implement the synchronous sequential circuit using JK, D, T flip-flops.