Course Name:	**Digital Design Laboratory**	**Semester:**	**III**
Date of Performance:	**2/ 9 /2024**	**Batch No:**	**A2**
Faculty Name:	**Shivani Deosthale**	**Roll No:**	**16010123032**
Faculty Sign & Date:		**Grade/Marks:**	**___/25**

Experiment No: 5
Title: Flip Flops

Aim and Objective of the Experiment:

To Verify truth table of JK Flip flop using IC 7476 and study conversion of JK FF to D FF and T FF

COs to be achieved:

CO3: Design synchronous and asynchronous sequential circuits.

Tools used:

Trainer kits

Theory:

Flip-flop is the common name given to two-state devices which offer basic memory for sequential logic operations. Flip-flops are heavily used for digital data storage and transfer and are commonly used in banks called "registers" for the storage of binary numerical data.

JK-flip flop: has two inputs, traditionally labeled J and K. IC 7476 is a dual JK master slave flip flop with preset and clear inputs. If J and K are different then the output Q takes the value of J at the next clock edge. If J and K are both low then no change occurs. If J and K are both high at the clock edge, then the output will toggle from one state to the other. It can perform the functions of the set/reset flip-flop and has the advantage that there are no ambiguous states.

D Flip Flop: tracks the input, making transitions with match those of the input D. The D stands for "data"; this flip-flop stores the value that is on the data line. It can be thought of as a basic memory cell. D flip-flop can be made from J-K flip-flop by connecting both inputs through a not gate.

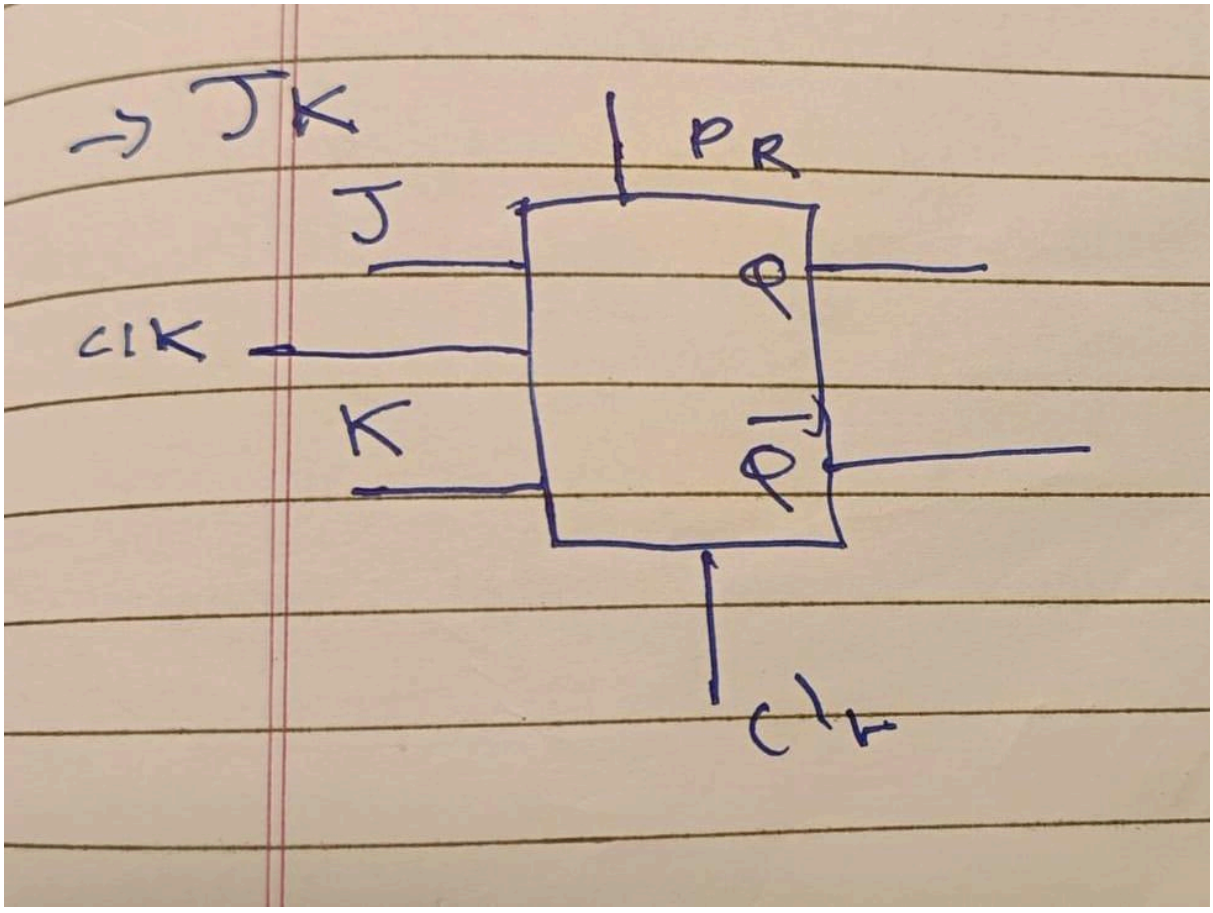
T Flip Flop: T or "toggle" flip-flop changes its output on each clock edge, giving an output which is half the frequency of the signal to the T input. It is useful for constructing binary counters, frequency dividers, and general binary addition devices. It can be made from a J-K flip-flop by tying both of its inputs high.

Implementation Details:

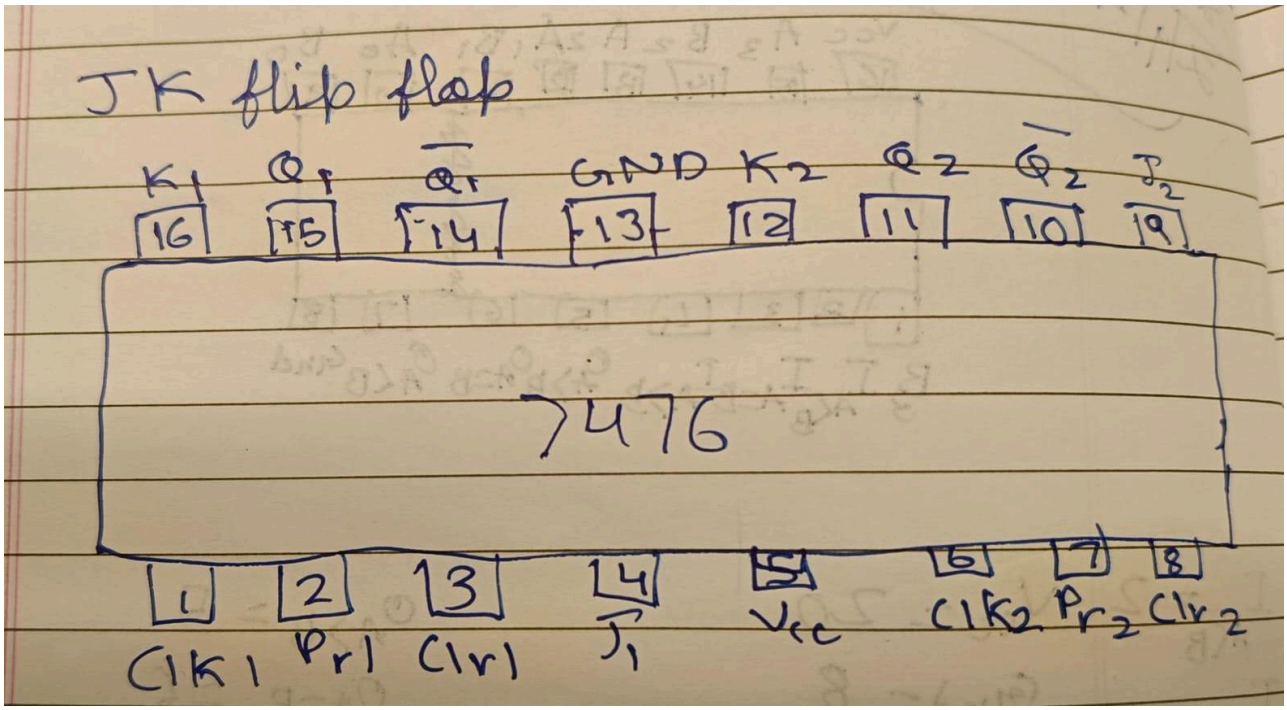
Procedure

1) Locate IC 7476 on Digital trainer kit
2) Apply various inputs to J & K pins by means of the output on logic output indicator.
3) Connect a pulsar switch to the clock input.
4) Connect the J&K as D and T flip flop as shown in diagrams and verify the respective truth tables.

Logic Symbol

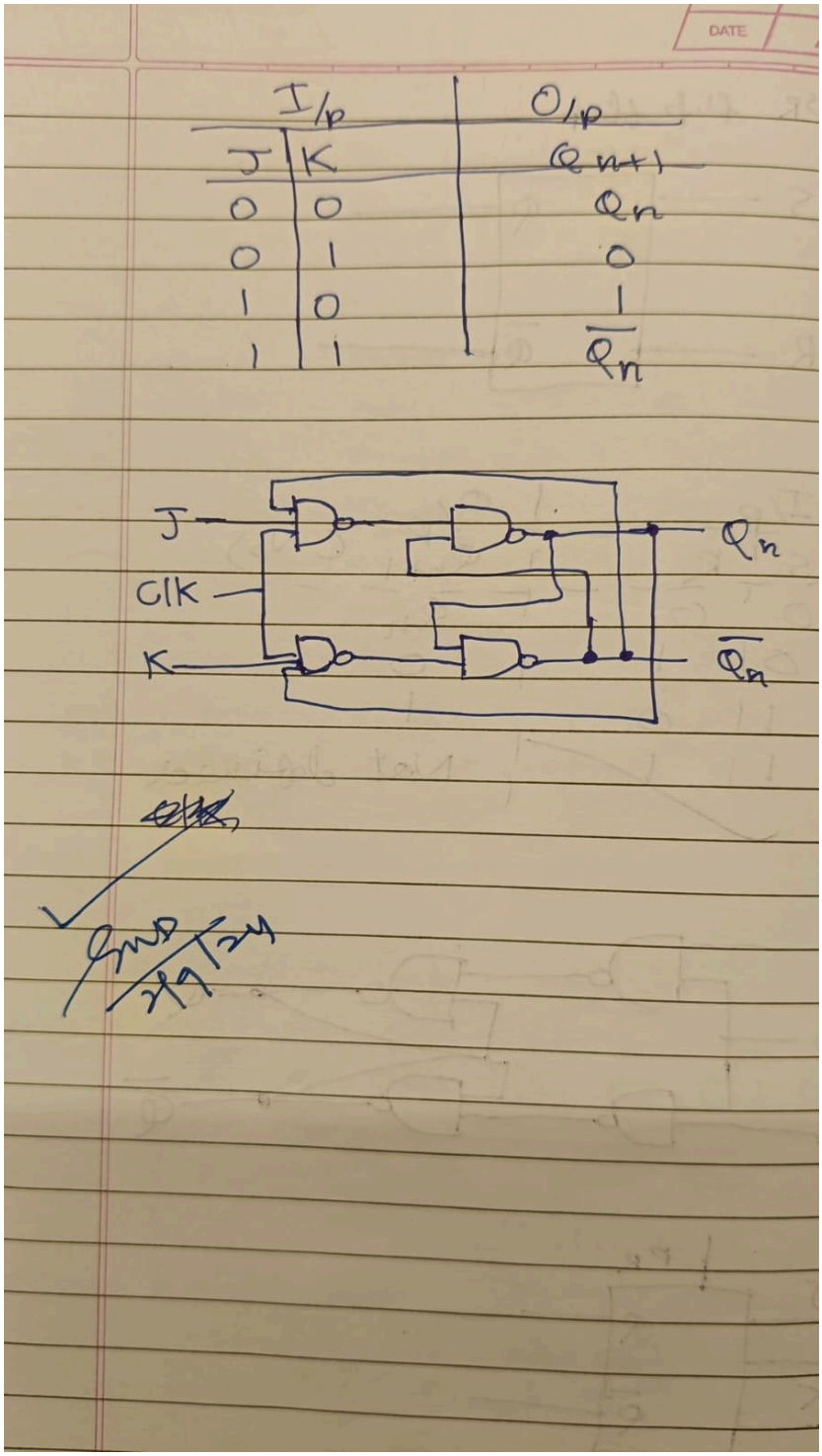


Pin Diagram of IC 7476



Truth Table of JK FF

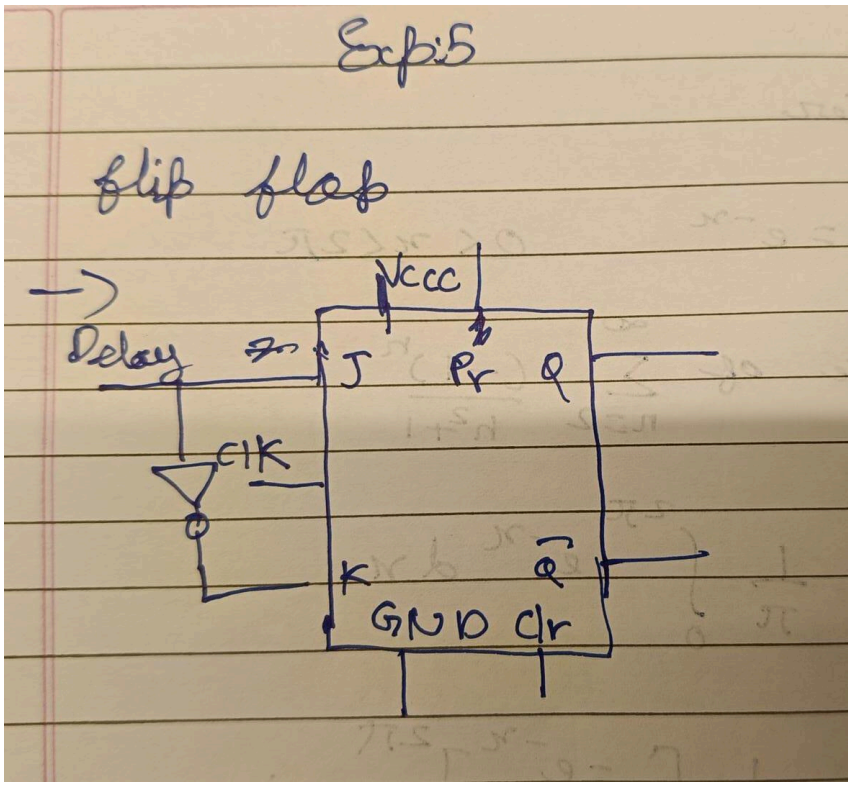
CLK	J	K	Pr	Clr	Q	$\overline{Q}$
0	x	x	x	x	x	x
0	x	x	x	x	x	x
0	x	x	x	x	x	x
0	x	x	x	x	x	x
1	0	0	1	1	Qn	$\overline{Q}_n$
1	0	1	1	1	0	1
1	1	0	1	1	1	0
1	1	1	1	1	$\overline{Q}_n$	Qn


DATE
I/p
J
K
O/p
Q n+1
0 0 Qn
0 1 0
1 0 1
1 1 $\overline{Q_n}$
J
Clk
K
Qn
$\overline{Q_n}$

Conversion of FFs

1) JK to D FF

Conversion Diagram

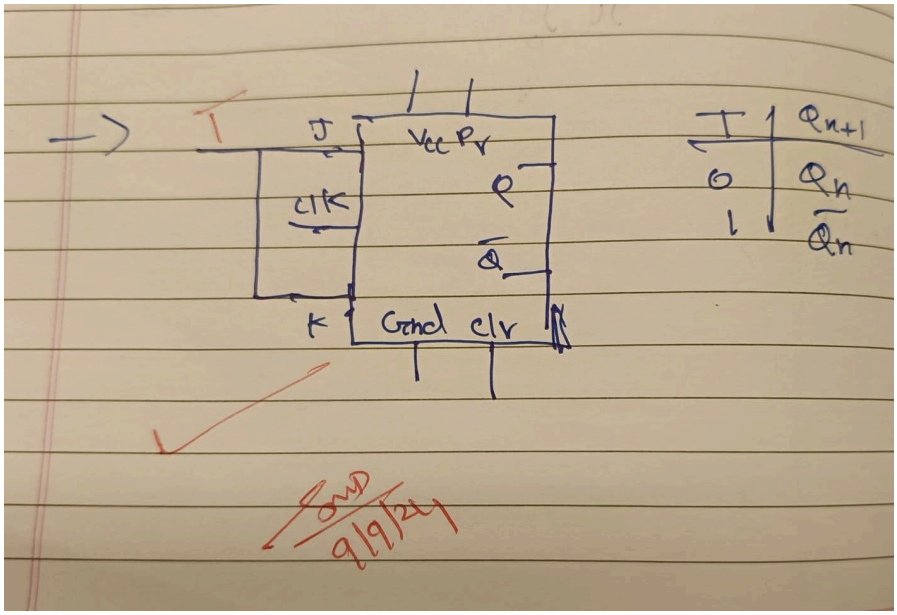


Truth Table of D FF

CLK	D	Q	$\overline{Q}$
0	x	x	x
1	0	0	1
1	1	1	0

1) JK to T FF

Conversion Diagram



Truth Table of T FF

CLK	T	Q	$\overline{Q}$
0	x	x	x
1	0	0	Q’
1	1	Q	0

Implementation Details

Procedure:

1) Locate the IC 7476 and place the IC on trainer kit.
2) Connect VCC and ground to respective pins of IC trainer kit.
3) Implement the circuit as shown in the circuit diagram.
4) Connect the inputs to the input switches provided in the trainer kit.
5) Connect the outputs to the switches of O/P LEDs
6) Apply various combinations of inputs according to the truth table and observe the condition of LEDs.
7) Note down the corresponding output readings for various combinations of inputs.

Post Lab Subjective/Objective type Questions:

1. How does a JK flip-flop differ from an SR flip-flop in its basic operation?
   Ans:

Key Differences Between JK and SR Flip-Flops

1. **Undefined Input Combination:** The JK flip-flop has a defined behavior when both inputs are high (toggle), while the SR flip-flop's behavior is undefined in this state.
2. **Input Functionality:** In a JK flip-flop, both inputs can be used to set or reset the output, while in an SR flip-flop, the S input is used to set and the R input is used to reset.
3. **Versatility:** The JK flip-flop's ability to toggle the output state makes it more versatile and widely used in digital circuits.
4. **Applications:** Both flip-flops are used in various digital circuits, but the JK flip-flop is often preferred due to its flexibility and ease of use.
5. **Design and Analysis:** Characteristic and excitation tables are essential tools for understanding the behavior and designing circuits using both JK and SR flip-flops.

2. What is the use of characteristic and excitation tables?
   Ans:

Uses of Characteristic and Excitation Tables

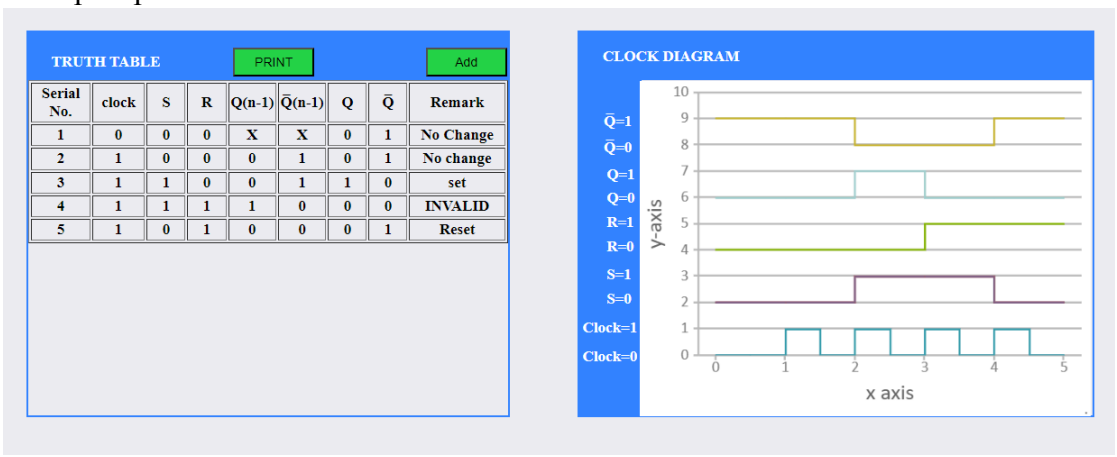
- **Flip-Flop Design:** These tables help in designing sequential circuits by providing a clear understanding of the flip-flop's behavior and the required input conditions.
- **Circuit Analysis:** When analyzing existing circuits, these tables can be used to determine the functionality and operation of flip-flops within the circuit.
- **State Machine Design:** In designing state machines, characteristic and excitation tables are crucial for defining the state transitions and the corresponding input requirements.
- **Fault Diagnosis:** If a circuit is not functioning as expected, these tables can be used to identify potential faults or errors in the flip-flop's operation.
- **Educational Tool:** They serve as a valuable educational aid for understanding the principles and operation of sequential logic circuits.

3. How many flip flops do you require storing the data 1101?
   Ans:

   To store the 4-bit data "1101", you would need 4 flip-flops. Each flip-flop can store a single bit of data. Since "1101" has 4 bits, you need 4 flip-flops to store the entire value.

4. Virtual Lab for Flipflop. Perform Simulation give feedback.
   https://de-iitr.vlabs.ac.in/exp/truth-tables-flip-flops/simulation.html

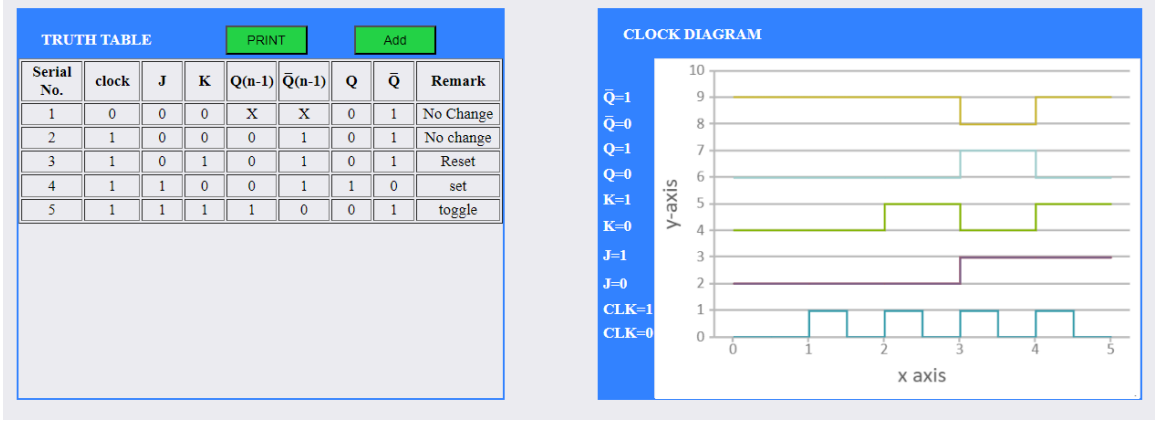
SR flip flop



TRUTH TABLE PRINT Add

Serial No.	clock	S	R	Q(n-1)	$\bar{Q}$(n-1)	Q	$\bar{Q}$	Remark
1	0	0	0	X	X	0	1	No Change
2	1	0	0	0	1	0	1	No change
3	1	1	0	0	1	1	0	set
4	1	1	1	1	0	0	0	INVALID
5	1	0	1	0	0	0	1	Reset

JK flip flop



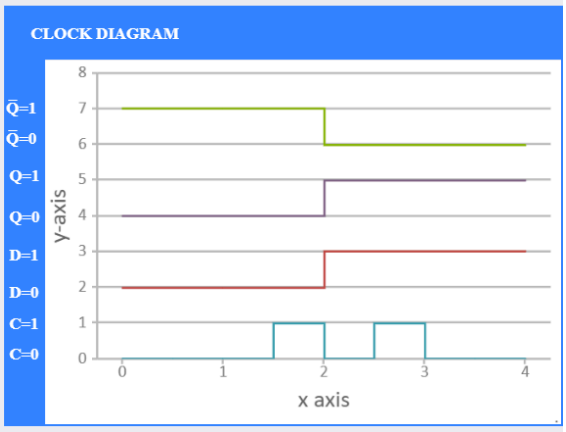
TRUTH TABLE PRINT Add

Serial No.	clock	J	K	Q(n-1)	$\bar{Q}$(n-1)	Q	$\bar{Q}$	Remark
1	0	0	0	X	X	0	1	No Change
2	1	0	0	0	1	0	1	No change
3	1	0	1	0	1	0	1	Reset
4	1	1	0	0	1	1	0	set
5	1	1	1	1	0	0	1	toggle

D flip flop

TRUTH TABLE PRINT Add

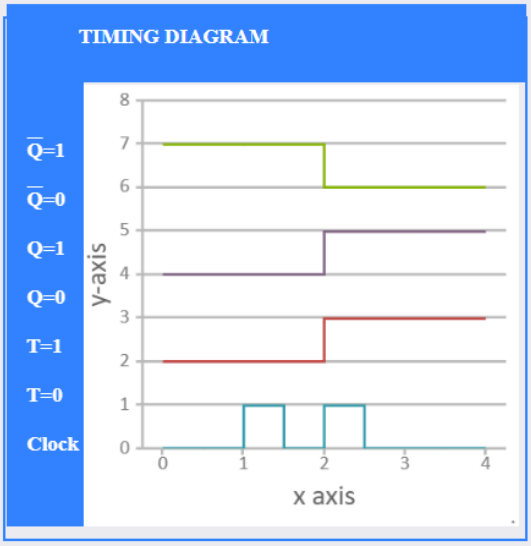
Serial No.	clock	D	Q(n-1)	Q'(n-1)	Q	Q'	Remark
1	0	0	X	X	0	1	No Change
2	1	0	0	1	0	1	Reset
3	1	1	0	1	1	0	set
4	0	1	1	0	1	0	No change



T flip flop

TRUTH TABLE Add Print

Serial No.	Clock	T	Q_{n-1}	$\bar{Q}_{n-1}$	Q	$\bar{Q}$	Remarks
1	0	0	X	X	0	1	No Change
2	1	0	0	1	0	1	No change
3	1	1	0	1	1	0	Toggle
4	0	1	1	0	1	0	No Change



Conclusion:

We successfully verified the truth table of JK Flip flop using IC 7476 and study conversion of JK FF to D FF and T FF

Signature of faculty in-charge with Date: