ELECTRONIC PRINCIPLES AND DEVICES

Prof.

Department of Electronics and Communication Engineering

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Digital Electronics

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Department of Electronics and Communication Engineering

Points addressed in this lecture

Recap

- D Flip-Flop: Working, Function Table
- JK Flip-Flop: Working, Function Table
- T Flip-Flop: Working, Function Table
- Conclusion Remarks

Recap:

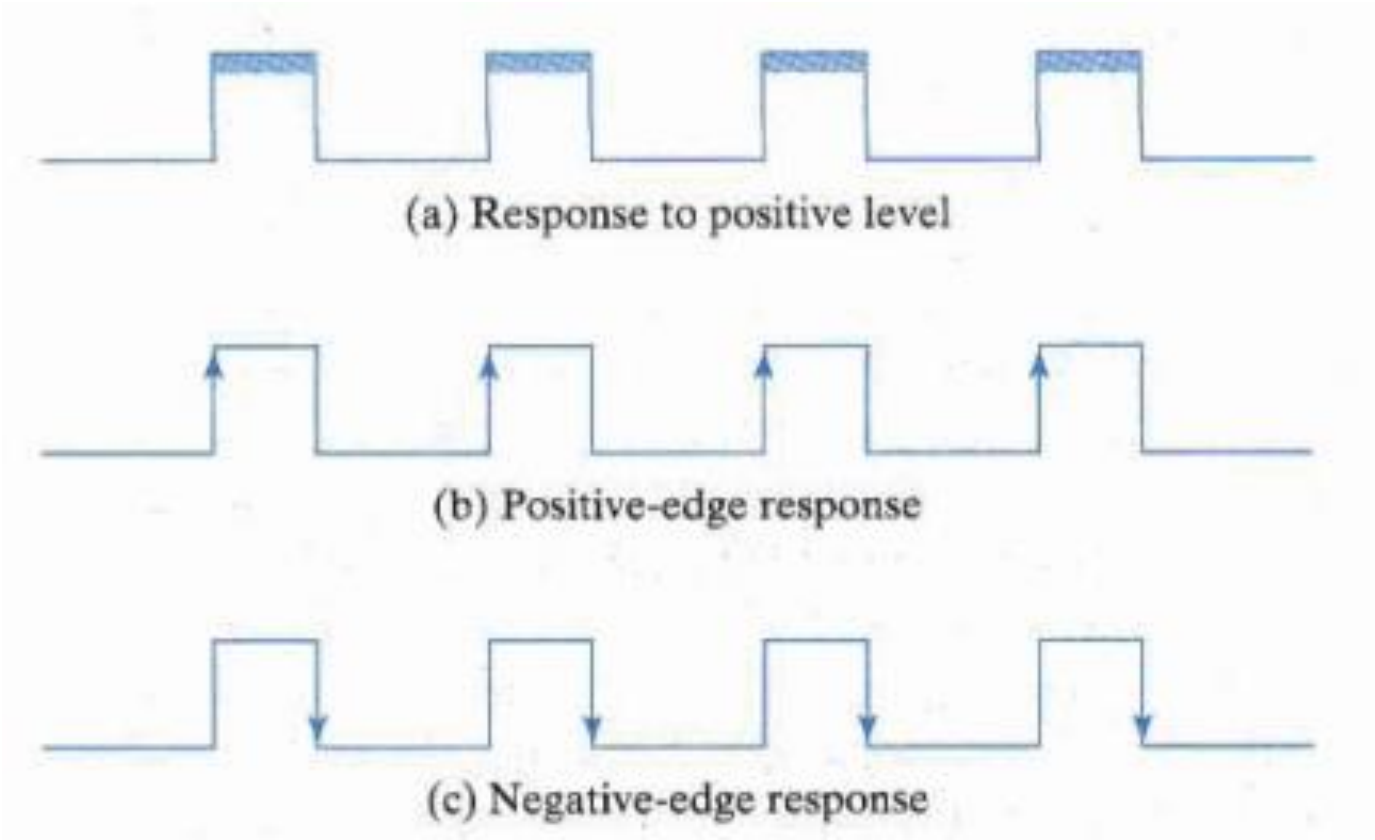
1. Flip – flops are the **building blocks** of sequential circuits.
   But these are built from **latches**.

2. Flip- flops **continuously checks** its inputs and changes its outputs correspondingly only at time instant determined by the **clock signal**.

3. Flip – flops is **sensitive** to signal change. They transfer data only at single time instance and data can't be changed till next signal change.
   - Therefore they are used as **registers**.

4. It is an edge triggered circuit, means that the output and the next state input changes, when there's a change in the clock pulse whether it can may be **POSITIVE (+ve)** or **NEGATIVE (-ve) clock pulse.**

Clock Response in Flip – Flop:

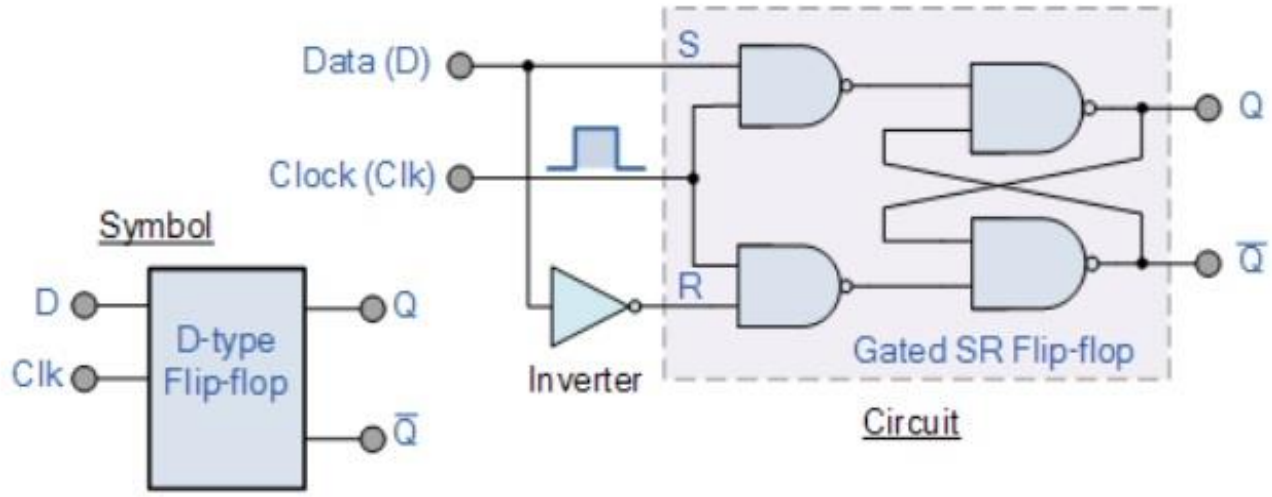


Flip-Flops will change the Output when the clock remains as logic 1 as shown in figure (a)

Flip-Flops will change the Output when the clock changes from logic 0 to Logic 1 as shown in figure (b)

Flip-Flops will change the Output when the clock changes from logic 1 to Logic 0 as shown in figure (c)

The Data (D) Flip – Flop:



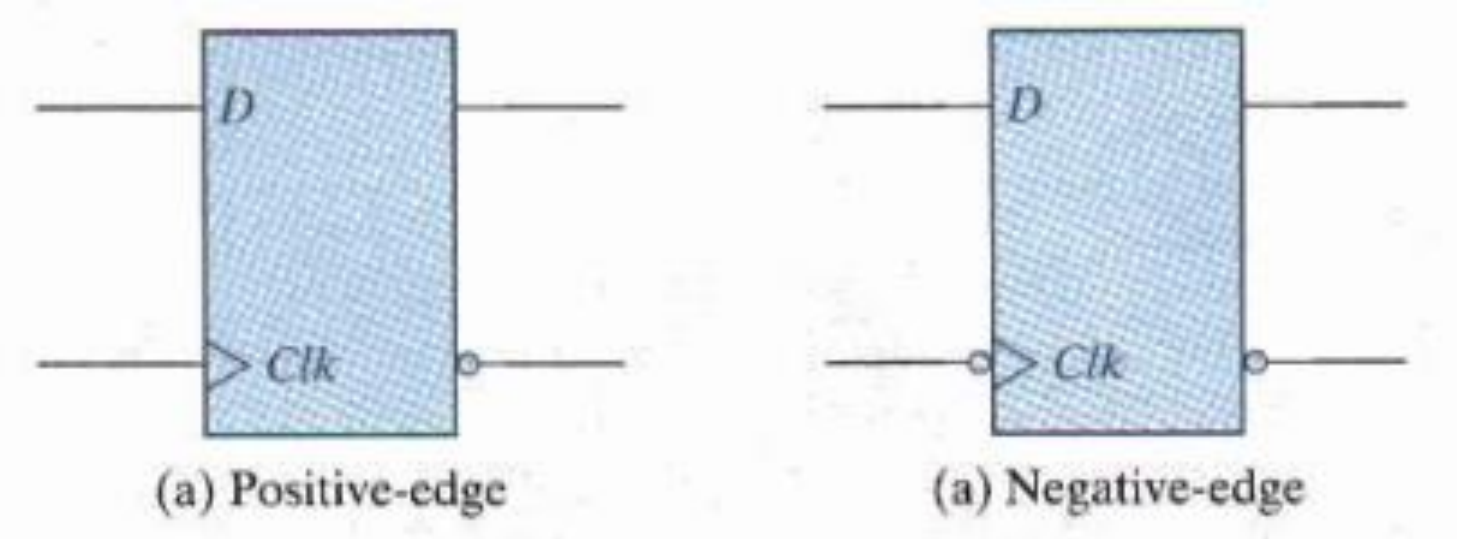
- The **D Flip Flop** is by far the most important of the clocked flip-flops as it ensures that ensures that inputs **S** and **R** are **never equal** to one at the same time.
- The **D Flip Flop** are constructed from a SR flip-flop with an **inverter** added between the **S** and the **R** inputs to allow for a single D (Data) input.

D Flip – Flop Function Table

INPUTS		OUTPUTS		Status of D Flip-Flop
CLK	D	Q	Q’	
0	X	Q_{-1}	Q'_{-1}	PREVIOUS STATE
1	0	0	1	RESET
1	1	1	0	SET

- The D Flip-flop will store and output whatever logic level is applied to its **DATA** input.
- Once the clock input goes LOW the “set” and “reset” inputs of the flip-flop are both held at logic level “1”, so it will not change its state.
- ↓ and ↑ indicates direction of clock pulse as it is assumed D-type flip flops are edge triggered.

Positive & Negative Edge Triggered 'D' Flip – Flop:



In D Flip-Flops, Absence of the bubble in front of the Clk indicates Positive edge triggered as shown in figure (a)

In D Flip-Flops, Presence of the bubble in front of the Clk indicates Positive edge triggered as shown in figure (b)

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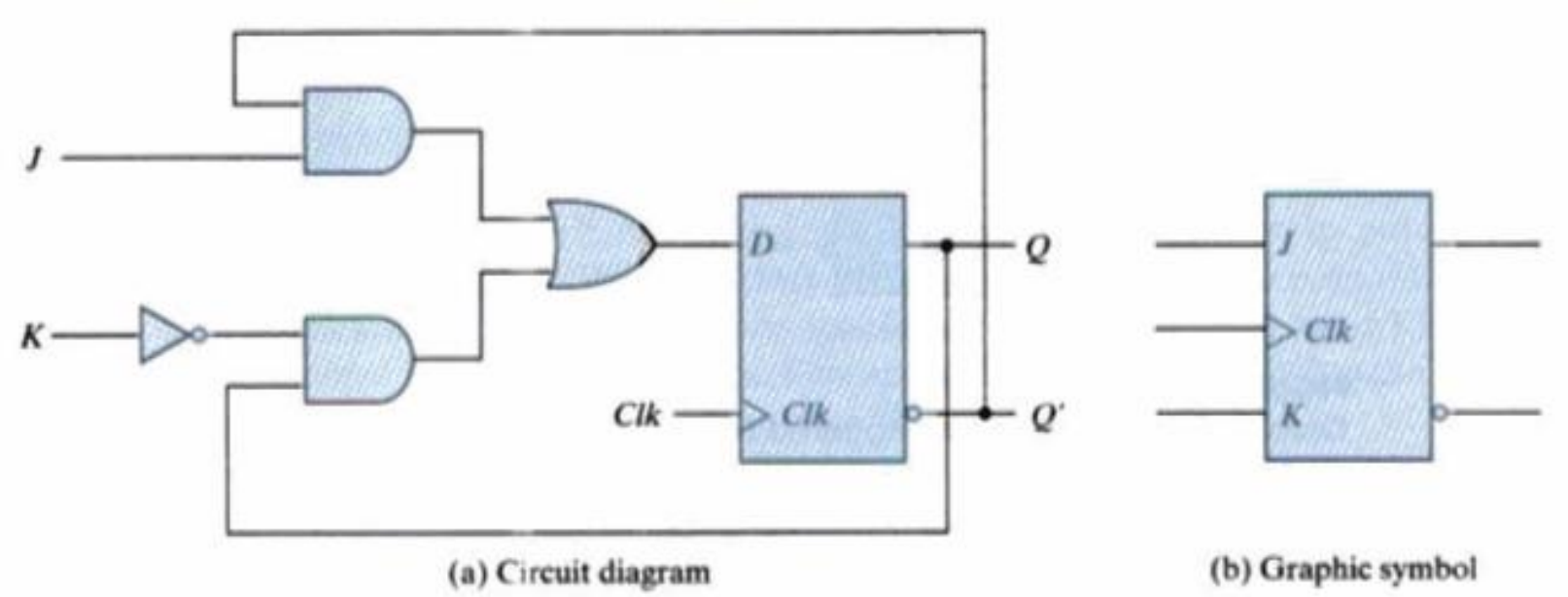
JK Flip – Flop:



(a) Circuit diagram (b) Graphic symbol

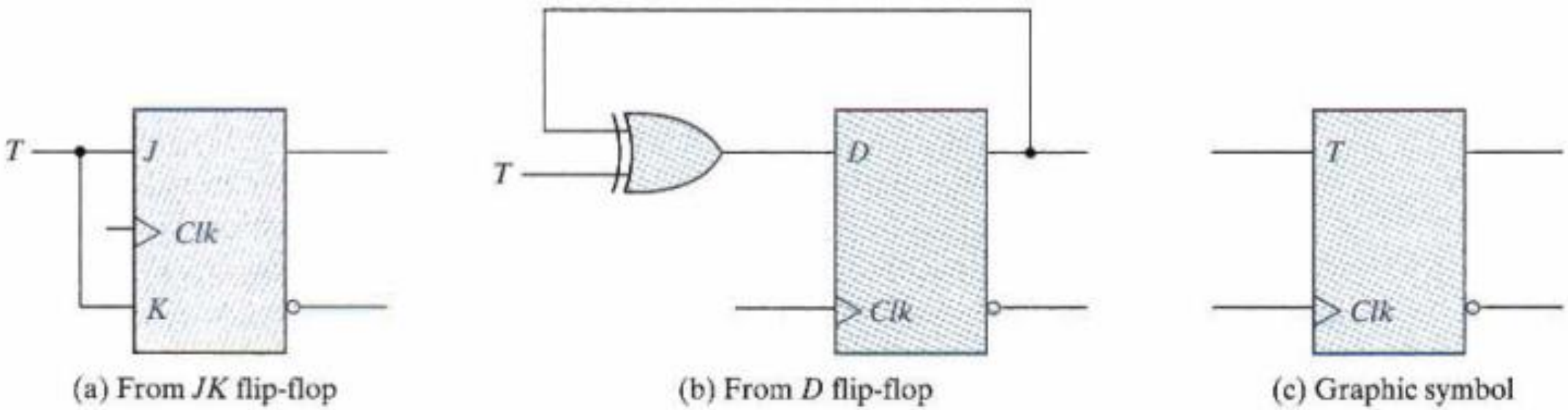
- The Inputs are **J-K** along with the Clk
  - J-K inputs comes after its inventors **Jack Kilby**.

JK Flip – Flop:

Function Table

INPUTS			OUTPUTS		Status of JK Flip-Flop
CLK	J	K	Q	Q’	
0	X	X	Q_{-1}	Q'_{-1}	PREVIOUS STATE
1	0	0	Q_{-1}	Q'_{-1}	PREVIOUS STATE
1	0	1	0	1	RESET
1	1	0	1	0	SET
1	1	1	Q'_{-1}	Q_{-1}	TOGGLE

T Flip – Flop:



(a) From *JK* flip-flop (b) From *D* flip-flop (c) Graphic symbol

T Flip-Flop using JK Flip-Flop & D Flip-Flop

- T Flip-Flop is a **synchronous** device, where high to low or low to high transitions is passed through **clock signal** which **changes** the output state of Flip-Flop.

T Flip – Flop: - Function Table

INPUTS		OUTPUTS		Status of T Flip-Flop
CLK	T	Q	Q’	
0	X	Q_{-1}	Q'_{-1}	PREVIOUS STATE
1	0	Q_{-1}	Q'_{-1}	PREVIOUS STATE
1	1	Q'_{-1}	Q_{-1}	TOGGLE

Advantages of T flip-flop:

- These Flip-Flops has a **toggle input** and a **clock**.
  When a clock is triggered it **inverts** the value of Flip-Flops.

- They are used for designing the **counters**.

Conclusion Remarks :

- **JK flip-flop** is a sequential circuit, whose state transitions are **synchronized** with the **clock pulse** (+ve / -ve) edge triggered.

- In **JK flip-flop** all the rows are a valid state in the characteristic table, also when J=K=1, the output toggles, **Toggle state**.

- **D flip-flop** is a sequential circuit, whose output is same as the input and hence also called as **transparent flip-flop**.

- **T flip-flop** is a synchronous sequential circuit, whose state transitions are **synchronized** with the **clock pulse**.

- **T flip-flop** finds its application in counters, **Toggle state** is used.

THANK YOU

Prof.

Department of Electronics and Communication Engineering

@pes.edu