

# Patrician College of Arts and Science

Department of Computer  
Science

Digital Electronics and Microprocessor

SAE2B

Even Semester

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# What is a JK Flip-flop?

- A flip-flop is a circuit that has two stable states and can be used to store state information.
- The flip-flop can be made to change state by signals applied to one or more control inputs and will have one or two outputs.

# JK Terminology/Structure

Has 5 inputs named:

J(set),K(reset), PR, CLR, and CLK

Has 2 outputs: Q and Q'

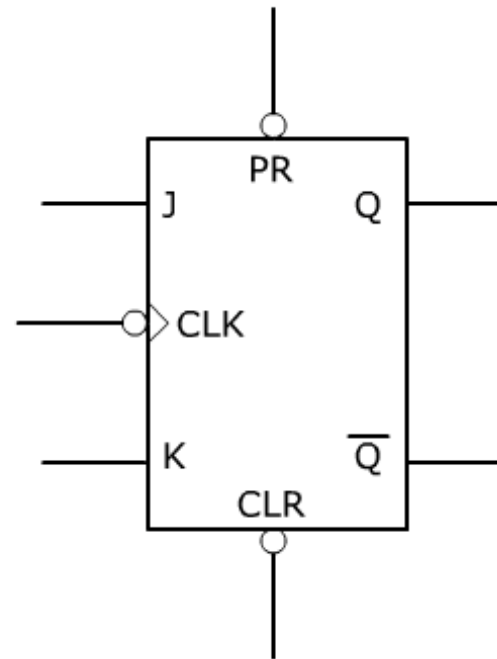
PR = Preset

CLR = Clear

CLK = Clock

**Set:** when it stores a binary 1

**Cleared (reset):** when it stores a binary 0

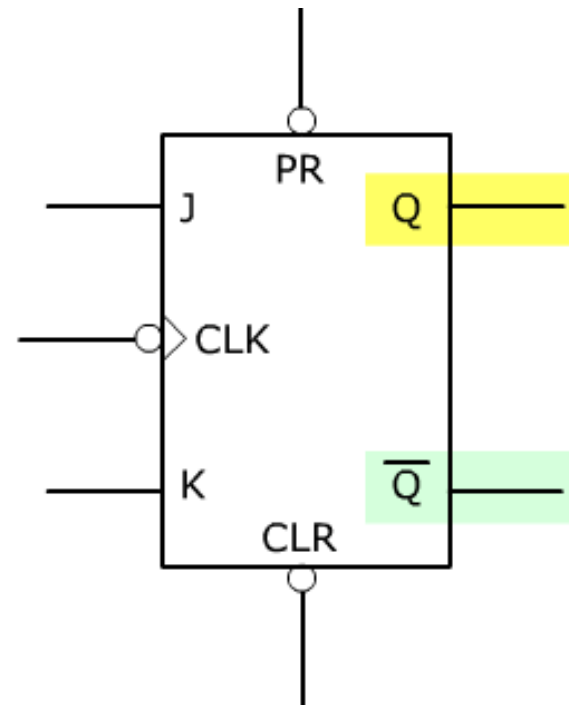


# Outputs

The Q output is the primary output. This means that the binary bit stored **in the flip-flop**, 1 or 0, is the **same as Q**.

The Q' output is the **opposite** binary bit value that is stored in Q.

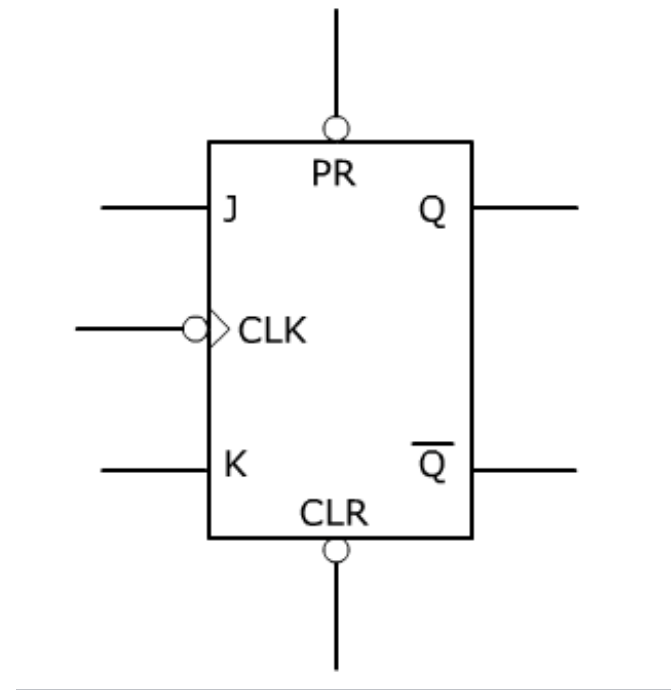
The PR and CLR inputs always **override** the J,K inputs.



# Inputs: PR and CLR

A low at the PR input sets  $Q = 1$

A low at the CLR input sets  $Q = 0$

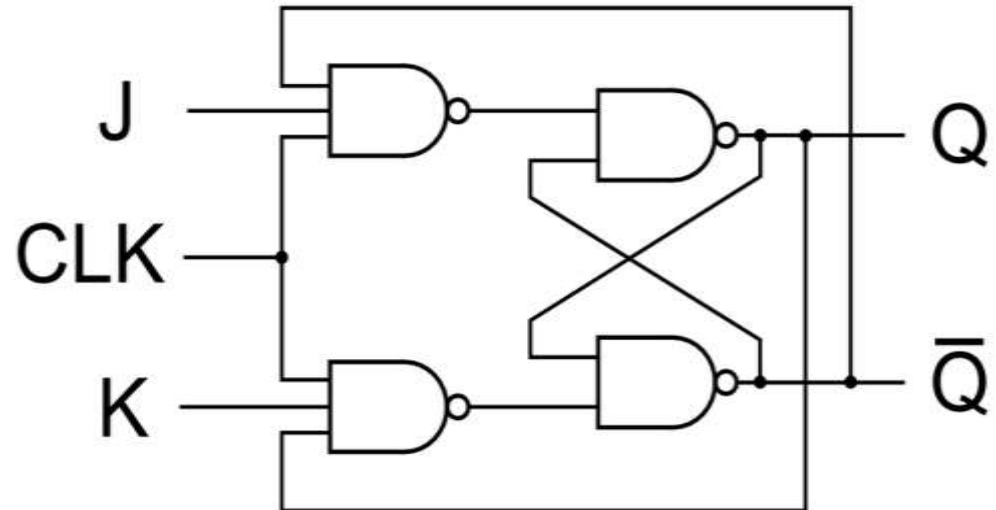


# Inputs: J and K

- The logic states applied to the J and K inputs cause the flip-flop to operate 4 different ways.
- The way the logic state is applied to J and K is called **Mode of Operation**.
- The mode of operation refers to the condition of the flip-flop as it prepares for the positive clock pulse.

# Four Modes Of Operation

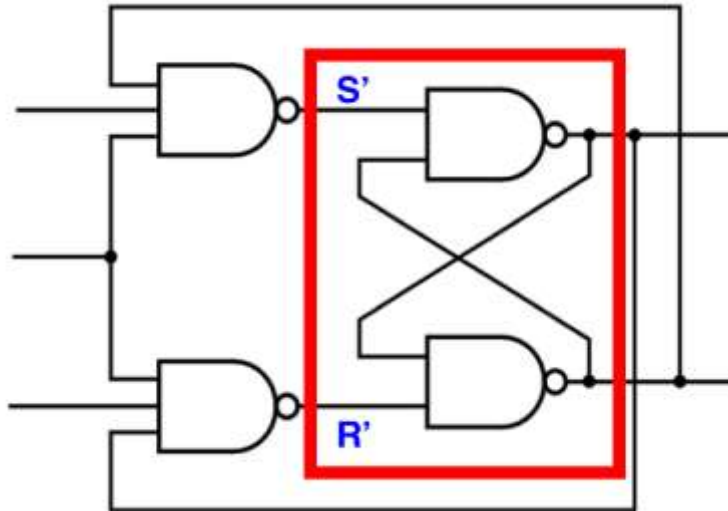
The 4 modes of operation are:  
**hold, set, reset, toggle**



J	K	Q	Q'	Mode
0	0	Q	Q'	Hold
1	0	1	0	Sets
0	1	0	1	Resets
1	1	Q'	Q	Toggle

JK contains an internal  
**Active Low SR latch.**

# Active Low SR Latch



## Point to remember:

A '0' at the set or the reset will either set or reset the value of Q.

S' – “set”	R' – “reset”	Q	Q'
0	0	Invalid	Invalid
0	1	1	0
1	0	0	1
1	1	Q	Q'



# Review: Truth Table for NAND

2 Inputs:

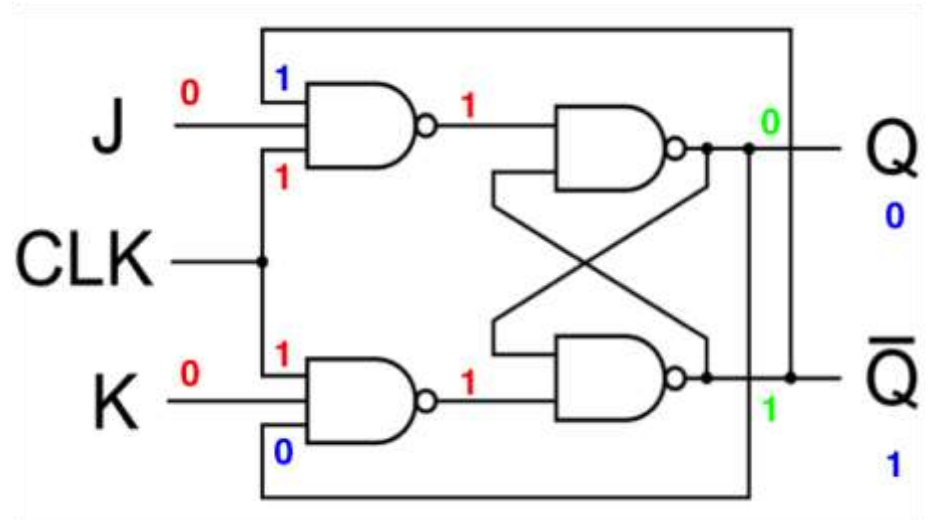
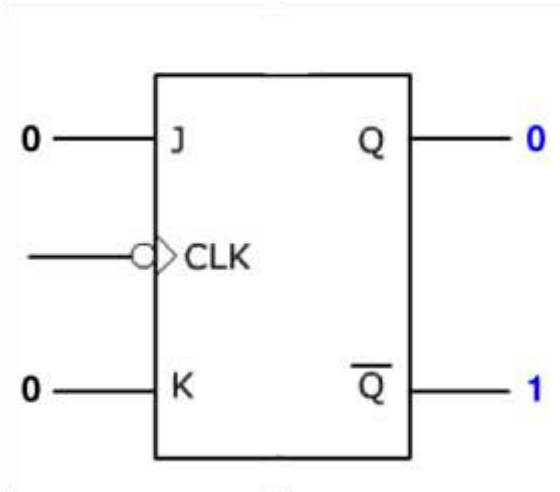
A	B	X
0	0	1
0	1	1
1	0	1
<b>1</b>	<b>1</b>	<b>0</b>

3 Inputs:

A	B	C	X
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>

# Mode of Operation: Hold

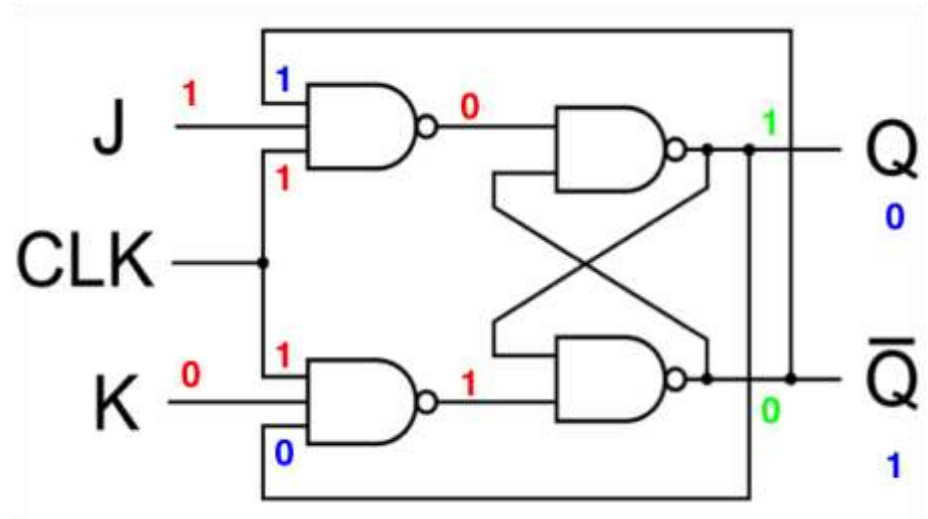
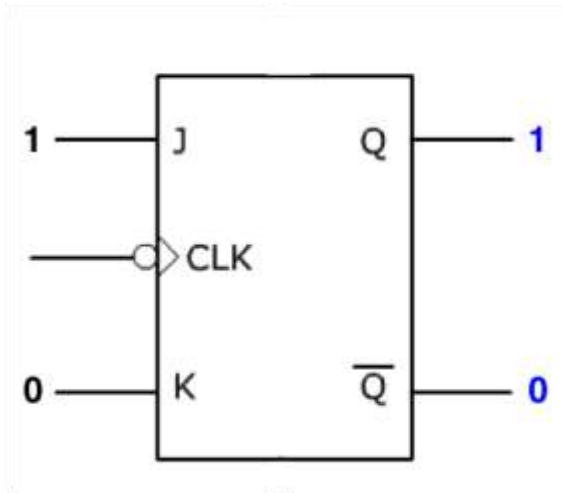
**Hold:** no change in Q.



J	K	Q	Q'	Orig. Q	Orig. Q'
0	0	0	1	0	1

# Mode of Operation: Set

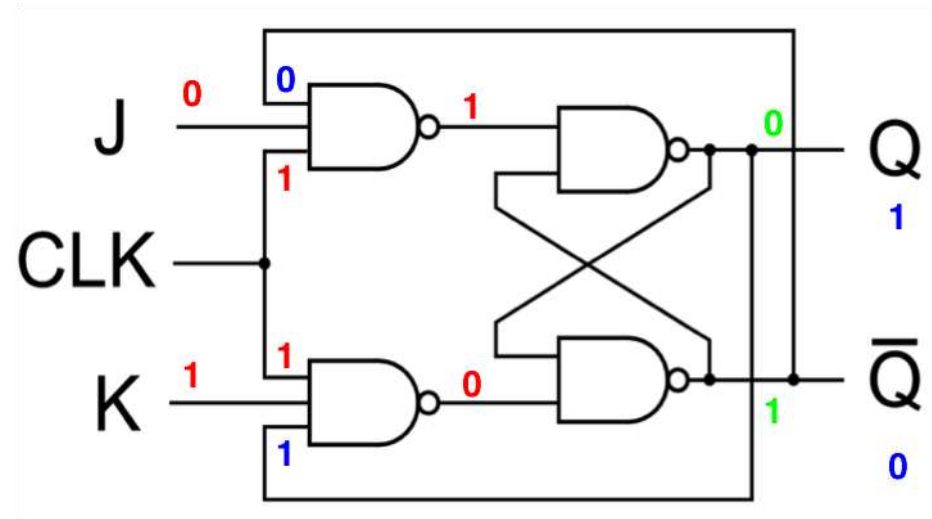
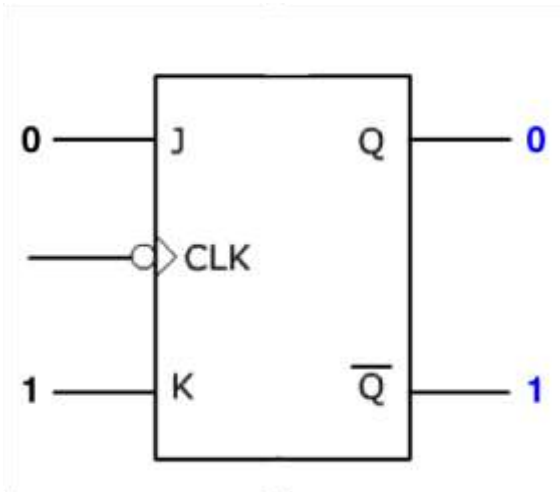
**Set:**  $Q = 1$ .



J	K	Q	Q'	Orig. Q	Orig. Q'
1	0	1	0	0	1

# Mode of Operation: Reset

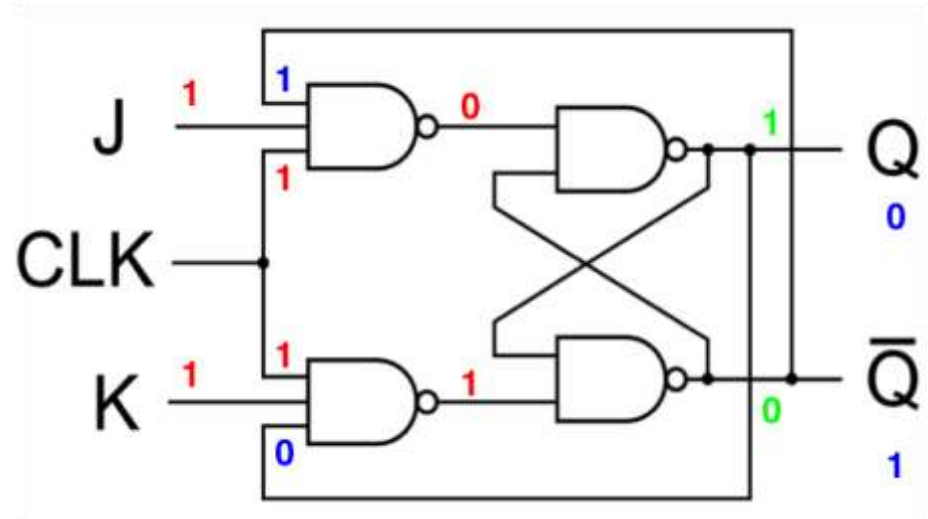
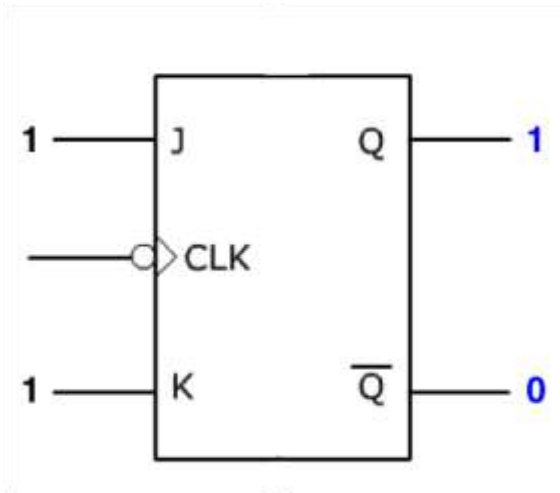
**Reset:**  $Q = 0$ .



J	K	Q	Q'	Orig. Q	Orig. Q'
0	1	0	1	1	0

# Mode of Operation: Toggle

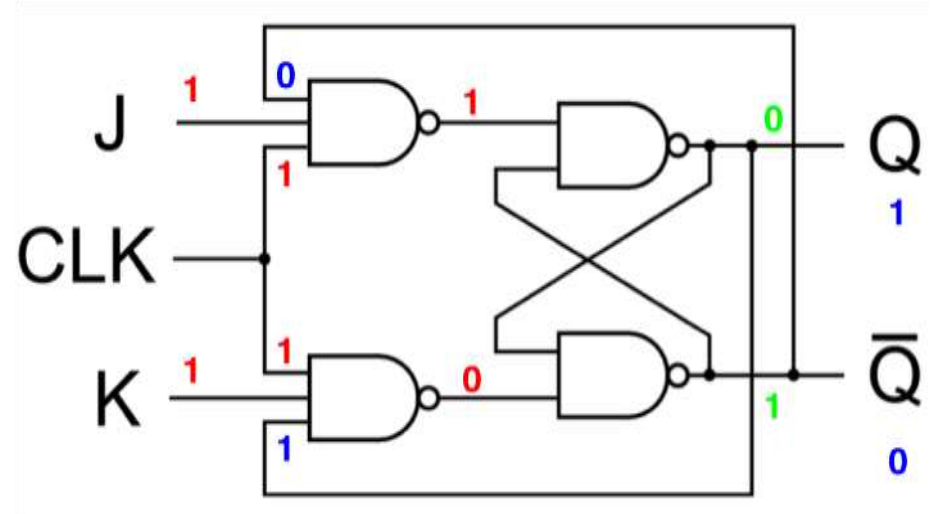
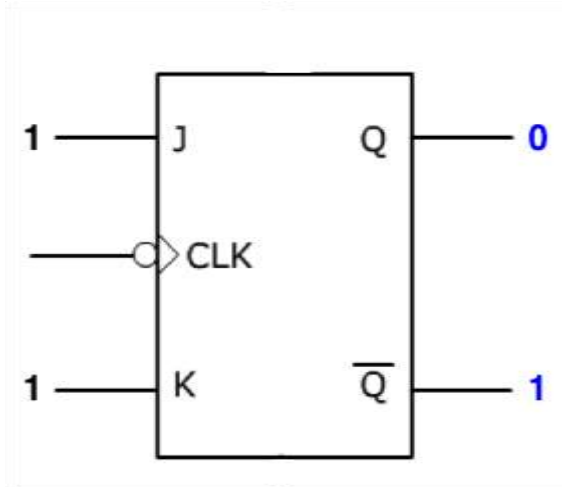
**Toggle:**  $Q = Q'$ .



J	K	Q	Q'	Orig. Q	Orig. Q'
1	1	1	0	0	1

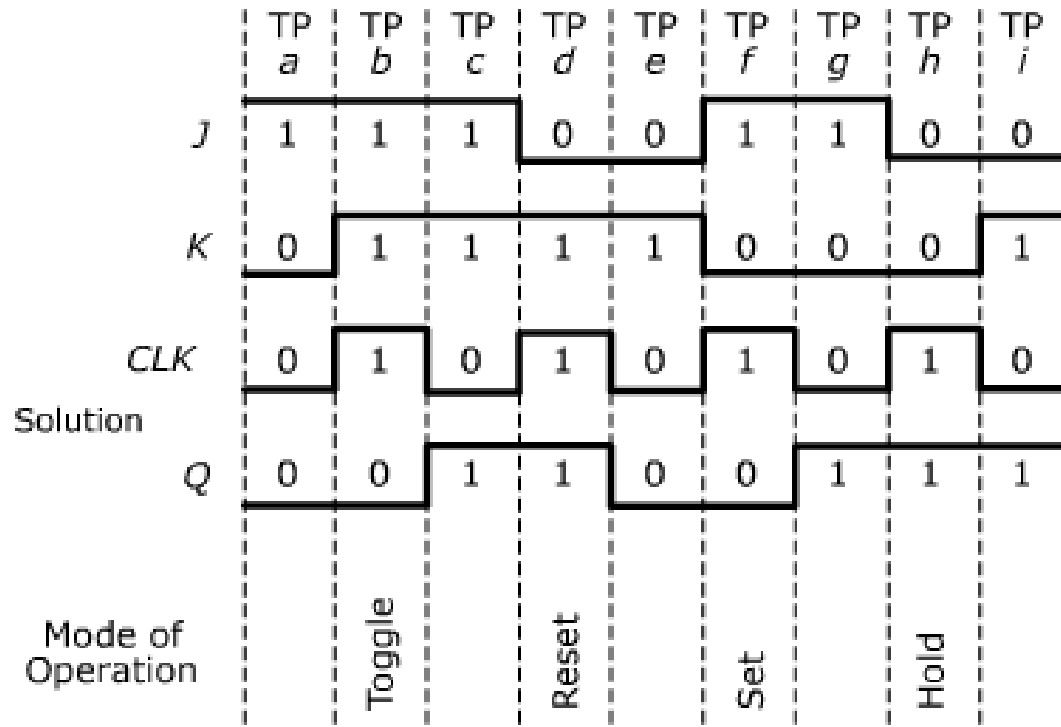
# Mode of Operation: Toggle again

**Toggle:**  $Q = Q'$ .



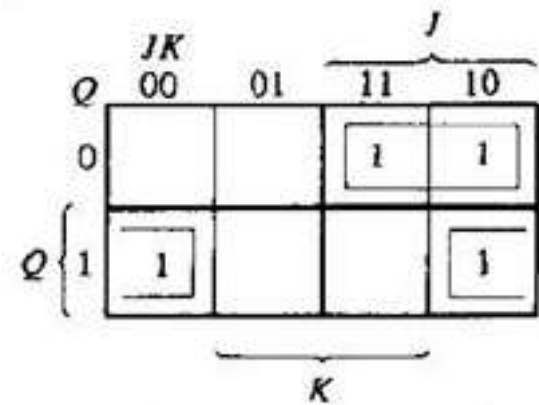
J	K	Q	Q'	Orig. Q	Orig. Q'
1	1	0	1	1	0

# Overview: During a time period



# Characteristic Equation

Q	J	K	Q(t + 1)
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0



Characteristic Equation:

$$Q(t+1) = J \cdot Q' + K' \cdot Q$$



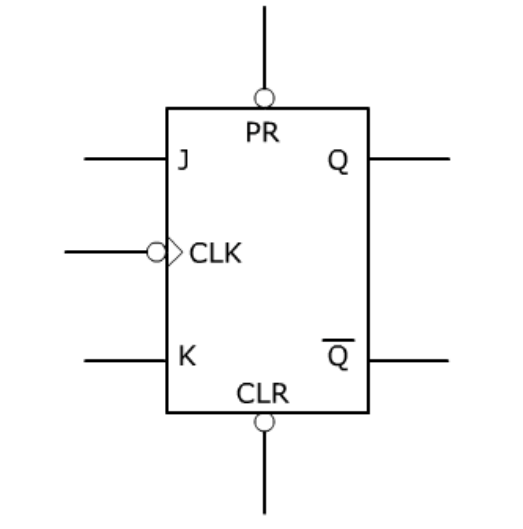
# If only one slide to remember...

## Characteristic Equation:

$$Q(t+1) = J \cdot Q' + K' \cdot Q$$

**Q** is the primary output.

<b>J</b>	<b>K</b>	<b>Q</b>	<b>Q'</b>	<b>Mode</b>
0	0	Q	Q'	Hold
1	0	1	0	Sets
0	1	0	1	Resets
1	1	Q'	Q	Toggle



## SR Latch:

A '0' at the set or the reset will either set or reset the value of Q.



# Thank you

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