



EE301 – Electrical Engineering Laboratory

Faculty of Engineering, Thammasat University

Lab Four – Counter

Name: _____ ID no. _____

_____ ID no. _____

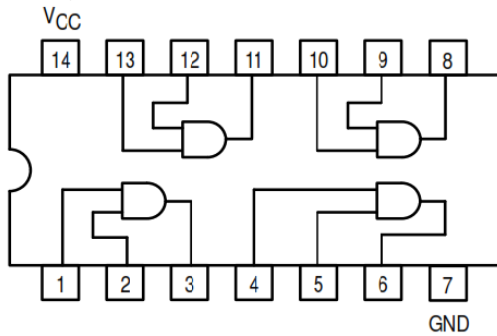
Equipment Needed

- Digital Electronics Training Board
- IC 7408 (AND) 1 chip
- IC 7432 (OR) 1 chip
- IC 7473 (JK Flip-Flop with Clear) 2 chips

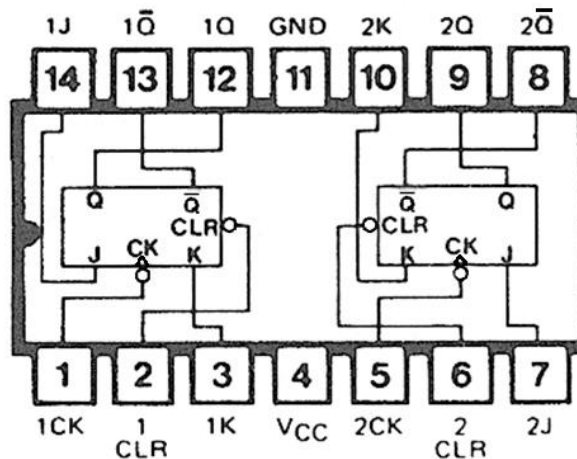
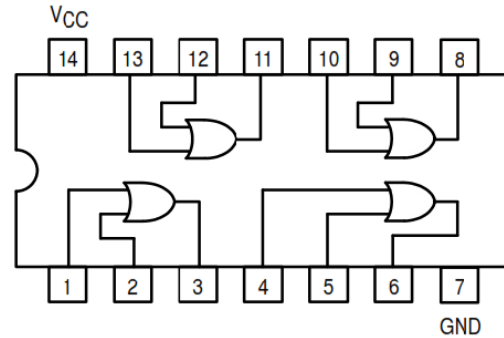
Instructions

1. For your safety, unplug the power supply while you are building your logic circuits.
2. If you find the digital board operate incorrectly (i.e., LED lights are not turned on as they are supposed to be, etc), unplug the power supply. You may accidentally build a short circuit.

7408



7432



7473

Pin assignments of the ICs

EXE 1: User-defined Counter Using JK Flip-Flops

You are asked to design a synchronous counter using JK flip-flops with the following repeated binary sequence: 0, 2, 3, 5, 8, 10, 12, 13, 0 and so on.

1.1 Draw the state diagram of this counter.

1.2 Fill out the state table of this counter.

Present state				Next state				JK flip-flop inputs							
Q ₃	Q ₂	Q ₁	Q ₀	Q ₃	Q ₂	Q ₁	Q ₀	J _{Q3}	K _{Q3}	J _{Q2}	K _{Q2}	J _{Q1}	K _{Q1}	J _{Q0}	K _{Q0}
0	0	0	0	—	—	—	—	—	—	—	—	—	—	—	—
0	0	0	1	—	—	—	—	—	—	—	—	—	—	—	—
0	0	1	0	—	—	—	—	—	—	—	—	—	—	—	—
0	0	1	1	—	—	—	—	—	—	—	—	—	—	—	—
0	1	0	0	—	—	—	—	—	—	—	—	—	—	—	—
0	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—
0	1	1	0	—	—	—	—	—	—	—	—	—	—	—	—
0	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
1	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	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—

1.3 Simplify the JK flip-flop inputs by means of K-maps.

		Q_1Q_0			
		00	01	11	10
Q_3Q_2	00				
	01				
	11				
	10				

$J_{Q0} =$ _____

		Q_1Q_0			
		00	01	11	10
Q_3Q_2	00				
	01				
	11				
	10				

$K_{Q0} =$ _____

		Q_1Q_0			
		00	01	11	10
Q_3Q_2	00				
	01				
	11				
	10				

$J_{Q1} =$ _____

		Q_1Q_0			
		00	01	11	10
Q_3Q_2	00				
	01				
	11				
	10				

$K_{Q1} =$ _____

		Q_1Q_0			
		00	01	11	10
Q_3Q_2	00				
	01				
	11				
	10				

$J_{Q2} =$ _____

		Q_1Q_0			
		00	01	11	10
Q_3Q_2	00				
	01				
	11				
	10				

$K_{Q2} =$ _____

		Q_1Q_0			
		00	01	11	10
Q_3Q_2	00				
	01				
	11				
	10				

$J_{Q3} =$ _____

		Q_1Q_0			
		00	01	11	10
Q_3Q_2	00				
	01				
	11				
	10				

$K_{Q3} =$ _____

- 1.4 **Simulation:** Build this counter in Logisim. The JK flip-flops can be found under “Memory” in the explorer pane, and the clock signal is located in “Wiring”. You can simulate your clock signal by selecting Simulate → Ticks Enabled or press “Ctrl + K”. Verify that your circuit works correctly and show it to the lab instructor.
- 1.5 **Training Board:** Build the circuit obtained from 1.4 on the digital board. Verify that your circuit works correctly and show it to the lab instructor.

Lab Instructor’s Signature _____ Time: _____