



EE301 – Electrical Engineering Laboratory

Faculty of Engineering, Thammasat University

Lab Three – Flip-Flops and Synchronous Sequential Circuits

Name: _____ ID no. _____

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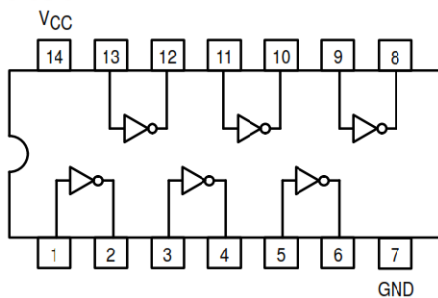
Equipment Needed

- Digital Electronics Training Board
- IC 7404 (NOT) 1 chip
- IC 7408 (AND) 1 chip
- IC 7432 (OR) 1 chip
- IC 7474 (D Flip-Flop with Preset and Clear) 1 chip
- IC 7473 (JK Flip-Flop with Clear) 1 chip

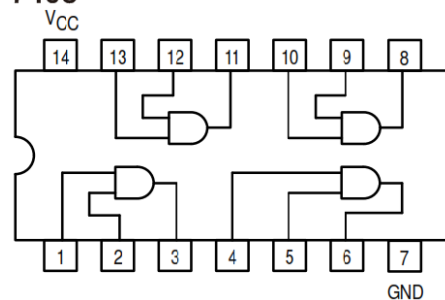
Instructions

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.

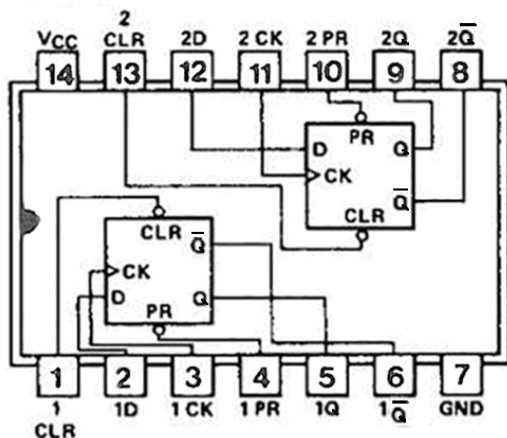
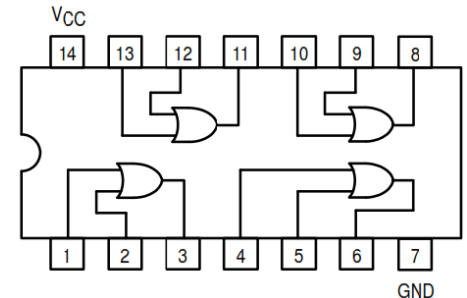
7404



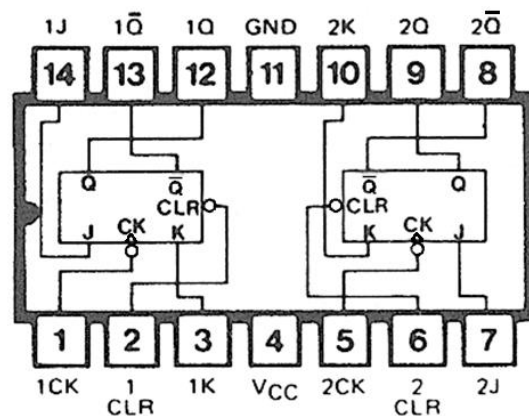
7408



7432



7474



7473

Pin assignments of the ICs

EXE 1: IC type 7474 (Dual Positive-Edge-Triggered D Flip-Flops with Preset and Clear)

Table 1 shows the function table of the IC type 7474 (D flip-flop with preset and clear). Test the IC type 7474 chip on the digital board. Connect the “pulse data” signal into the clock input. When PR (preset) signal is 0 and CLR (clear) signal is 1, the state Q of the FF is SET (1), regardless of the clock signal and D input. When PR (preset) signal is 1 and CLR (clear) signal is 0, the state Q of the FF is CLEAR (0), regardless of the clock signal and D input. When PR and CLR signals are 1, the FF changes its state Q only when there is a clock transition. Verify that your IC type 7474 chips work correctly.

Table 1. Function table of the IC type 7474 (positive-edge-triggered D flip-flops with preset and clear)

Inputs				Outputs	
PR	CLR	CLK	D	Q	\bar{Q}
0	1	X	X	1	0
1	0	X	X	0	1
0	0	X	X	Forbidden	
1	1	↑	0	0	1
1	1	↑	1	1	0

EXE 2: Analysis with D Flip-flop

Figure 1 shows a synchronous sequential circuit that has one input X, one D flip-flop A and one output Z. Do the following.

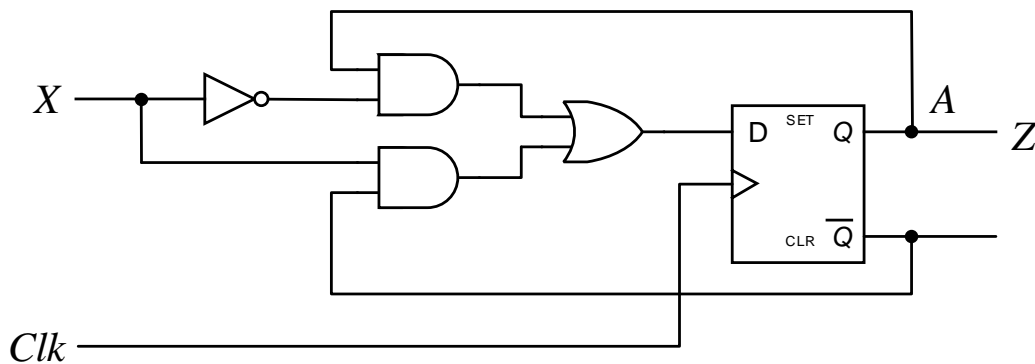


Figure 1. Logic circuit for EXE 2.

2.1 Find the flip-flop input equation and output equation of this circuit.

2.2 Derive the state table.

Present State A	Input X	Next State A	Output Z	Flip-flop Inputs D_A
0	0	.....	.....	.....
0	1	.....	.....	.....
1	0	.....	.....	.....
1	1	.....	.....	.....

2.3 Derive the state diagram.

2.4 **Simulation:** Build this circuit in Logisim. Verify that it works correctly and show it to the lab instructor. The D flip-flop 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”.

2.5 **Training Board:** Build the sequential circuit in Figure 1 on the training board using IC type 7474 and other necessary logic gates. Verify that your circuit works correctly and show it to the lab instructor.

Lab Instructor’s Signature _____

EXE 3: IC type 7473 (Dual Negative-Edge-Triggered JK Flip-Flops with Clear)

Table 2 shows the function table of the IC type 7473 (JK flip-flop with clear). Test the IC type 7473 chip on the digital board. Connect the “pulse data” signal into the clock input. When CLR signal is 0, the state Q of the FF is CLEAR (0), regardless of the clock signal and J, K inputs. When CLR signal is 1, the FF changes its state only when there is a clock transition. Verify that your IC type 7473 chips work correctly.

Table 2. Function table of the IC type 7473 (negative-edge-triggered JK flip-flops with clear)

Inputs				Outputs	
CLR	CLK	J	K	Q	\bar{Q}
0	X	X	X	0	1
1	↓	0	0	No Change	
1	↓	1	0	1	0
1	↓	0	1	0	1
1	↓	1	1	Toggle	

EXE 4: Analysis with JK Flip-flops

Figure 2 shows a synchronous sequential circuit that has one input X, two JK flip-flops A and B, and one output Z. Do the following.

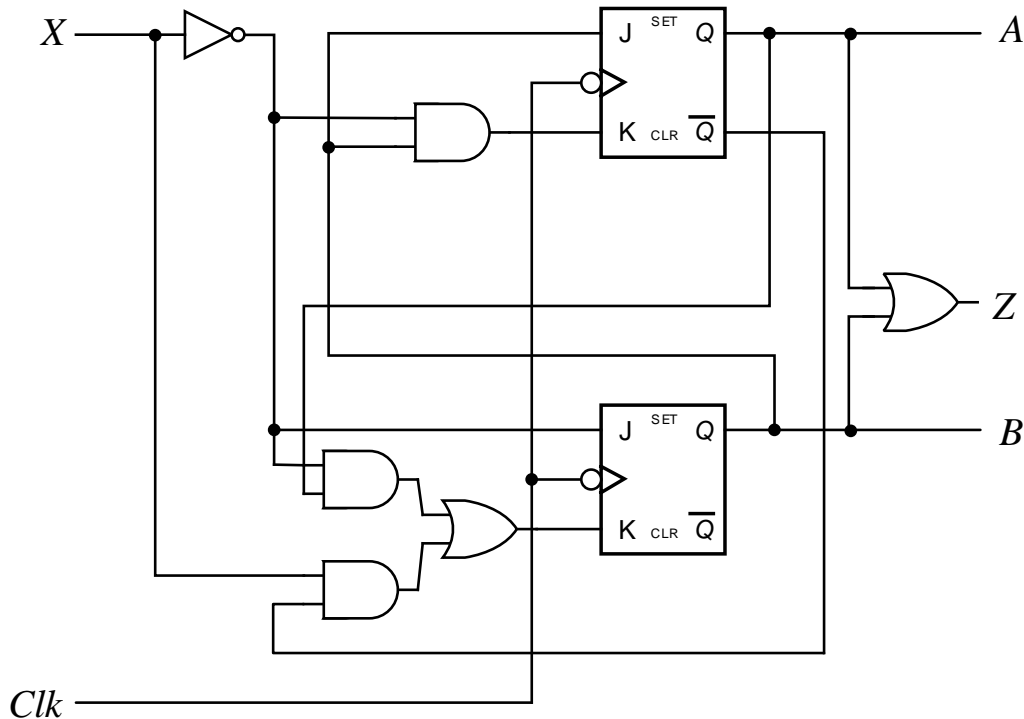


Figure 2. Logic circuit for EXE 4.

4.1 Find the flip-flop input equations and output equation of this circuit.

4.2 Derive the state table.

Present State		Input	Next State		Output	Flip-flop Inputs			
A	B	X	A	B	Z	J _A	K _A	J _B	K _B
0	0	0	.....	.....	.....	.....	.....	.....	.....
0	0	1	.....	.....	.....	.....	.....	.....	.....
0	1	0	.....	.....	.....	.....	.....	.....	.....
0	1	1	.....	.....	.....	.....	.....	.....	.....
1	0	0	.....	.....	.....	.....	.....	.....	.....
1	0	1	.....	.....	.....	.....	.....	.....	.....
1	1	0	.....	.....	.....	.....	.....	.....	.....
1	1	1	.....	.....	.....	.....	.....	.....	.....

4.3 Derive the state diagram.

4.4 **Simulation:** Build this circuit in Logisim. Verify that it works correctly and show it to the lab instructor.

4.5 **Training Board:** Build the sequential circuit in Figure 2 on the training board using IC type 7473 and other necessary logic gates. Verify that your circuit works correctly and show it to the lab instructor.

Lab Instructor's Signature _____ Time: _____