Experiment - 8

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Objective:

To design and implement a MOD-100 counter for mess occupancy.

Introduction:

Design a MOD-100 counter using push buttons so that it can be implemented as both up and down counter.

Materials Required:

- Bread Board
- IC's
- Seven segment Displays
- Push Buttons
- Connecting wires

IC's

	IC number	number of IC's
JK flipflop	7476	4
NAND gates	7410	6
NOT gates	7404	3
AND gates	7411	4
OR gates	7432	4
Decoder	7447	2

Table 1: IC's Required

Circuit Design:

The up/down counter is implemented using two cascaded mod-10 counters to form a mod-100 counter. Each counter is designed using JK flip-flops, where:

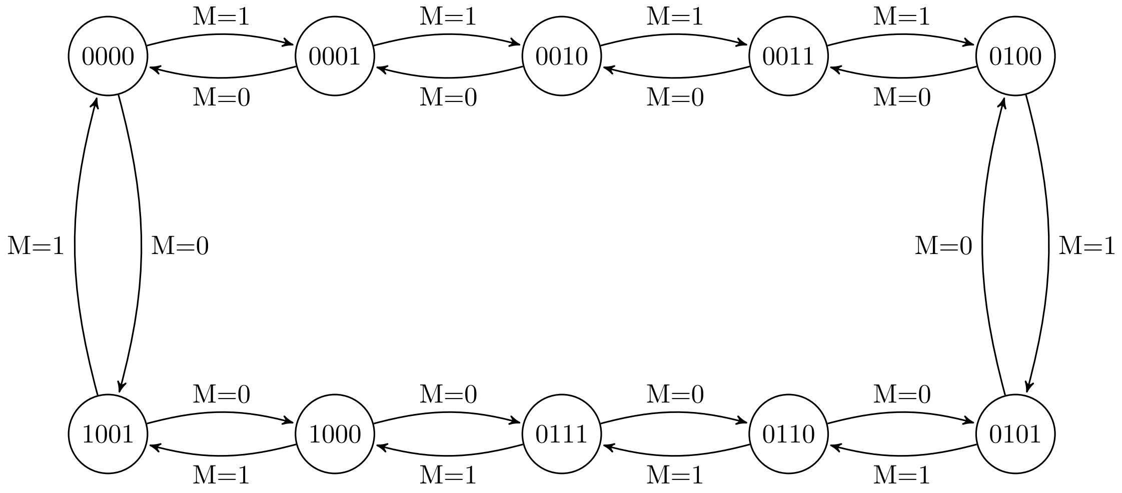
- The first counter represents the units place (0-9).
- The second counter represents the tens place (0-9).
- The counters are connected in such a way that the units counter overflows into the tens counter after reaching 9.
- Push buttons are debounced using capacitors and resistors to prevent false triggering

The following are the state transition table and state diagram of MOD-10 counter.

Present State (Q_3 Q_2 Q_1 Q_0)	Control Input (M)	Next State
0000	1 (UP)	0001
0001	1	0010
0010	1	0011
0011	1	0100
0100	1	0101
0101	1	0110
0110	1	0111
0111	1	1000
1000	1	1001
1001	1	0000
0000	0 (DOWN)	1001
1001	0	1000
1000	0	0111
0111	0	0110
0110	0	0101
0101	0	0100
0100	0	0011
0011	0	0010
0010	0	0001
0001	0	0000

Table 2: State Transition Table for Mod-10 Counter with UP/DOWN Control

MOD-10 Up/Down Counter State Diagram (Binary States)



• We have convert the JK flip flops to T flip flops to implement the circuit by using the below logic.

$$
\begin{aligned}
T_0 &= 1\\
T_1 &= Q_3\bar{Q}_0\bar{M} + Q_3Q_0M + Q_1\bar{Q}_0\bar{M} + Q_2\bar{Q}_0\bar{M}\\
T_2 &= Q_2\bar{Q}_1\bar{Q}_0\bar{M} + Q_3\bar{Q}_0M + Q_1Q_0M\\
T_3 &= \bar{Q}_2\bar{Q}_1\bar{Q}_0\bar{M} + Q_3Q_0M + Q_2Q_1Q_0M
\end{aligned}
$$

• So we have to connect the same logic T to both J and K to convert JK flip flop into T flipflop.

• This is to implement a MOD-10 UP/DOWN counter. So, we have to make two MOD-10 counters and cascade them both to make a MOD-100 counter.

• We have to cascade in such a manner that the ten's digit have to increase by 1 when the unit's digits goes from 9 to 0.

• When the units counter reaches 9 and rolls over to 0, it generates a carry-out pulse

• This pulse acts as the clock input to the tens counter, incrementing its count by 1.

• The reset logic for the mod-10 counter is $Q_3.\bar{Q}_2.Q_1\bar{Q}_0$

• The following is the pin diagram of 7476 JK flip flop

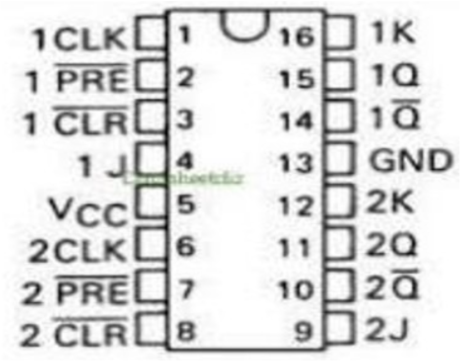


Figure 1: 7476 JK flip flop

- The count is displayed on seven segment displays by decoding the binary code into numbers.
- The connections from the decoder to seven segment display are the following

Table 3: 7447 to 7-Segment Display Connections

7447 Pin No.	Output Label	Connects to Segment	Segment Description
13	a	Segment a	Top Horizontal
12	b	Segment b	Top-Right
11	c	Segment c	Bottom-Right
10	d	Segment d	Bottom Horizontal
9	e	Segment e	Bottom-Left
15	f	Segment f	Top-Left
14	g	Segment g	Middle Horizontal

- The following is the pin diagram of 7447 decoder

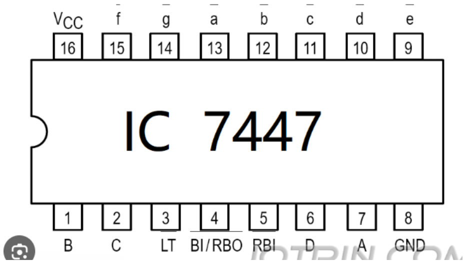


Figure 2: 7447 decoder

- The following is the pin diagram of seven segment display

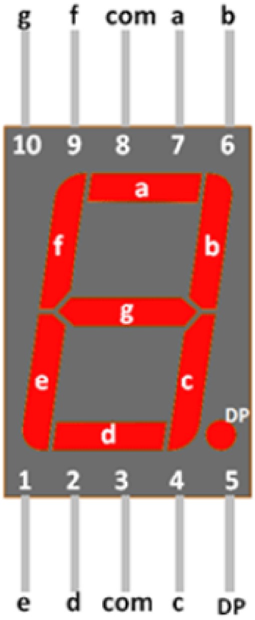


Figure 3: seven segment display

- The connections from the decoder to flipflops are the following

Table 4: JK Flip-Flop Outputs to 7447 Decoder Inputs

JK Output	**Connects to 7447 Pin**	**7447 Input Label**	**Bit Position**
Q0	7	A	LSB (2^0)
Q1	1	B	2^1
Q2	2	C	2^2
Q3	6	D	MSB (2^3)

- The following is the schematic circuit diagram that we have used for circuit setup.

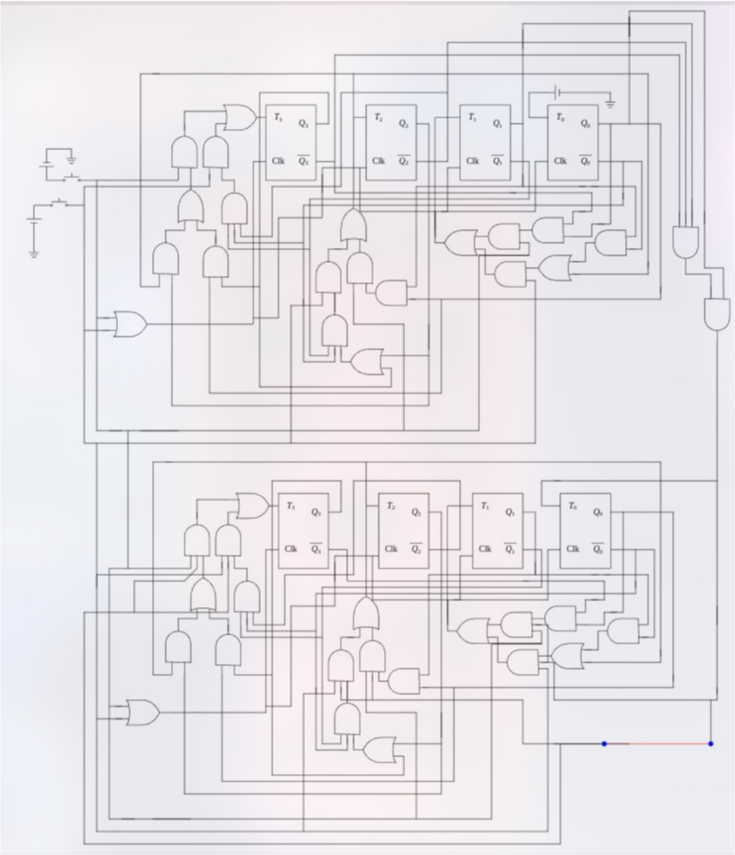


Figure 4: MOD-100 counter

Implementation details:

- The push buttons serve as manual inputs for counting people entering and exiting the mess.
- A clock signal is provided by the Arduino to trigger the JK flip-flops.
- The display is updated accordingly to reflect the current occupancy.
- When the count reaches 99, further increments are disabled.
- When the count reaches 0, further decrements are disabled to prevent negative values.

Working Mechanism:

- A student enters the mess and presses the entry button, increasing the count.
- A student exits the mess and presses the exit button, decreasing the count.
- The 7-segment display continuously updates the number of people inside the mess.
- If the count reaches 99, the entry button becomes inactive.
- If the count reaches 0, the exit button becomes inactive.

Conclusion:

The designed digital up/down counter successfully monitors the number of people in the mess during peak hours. The implementation using JK flip-flops, an Arduino-based clock, and a 7-segment display ensures accurate real-time occupancy tracking. This system helps students make informed decisions about entering the mess, optimizing crowd management during lunch hours.

Precautions:

- Ensure that for all IC's the power supply is given and properly grounded.
- For the seven segment display connect a 220 Ω resistor in between the power supply.
- For the push buttons ensure to debounce it using a RC circuit.

Future enhancements:

- Automating entry and exit detection using IR sensors instead of push buttons.
- Implementing a wireless module to display live occupancy on a mobile app.
- Integrating an LCD screen for better readability and additional information display.