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GATE 2009, ECE Question Number 39

Abstract

This project implements the GATE 2009 Q39 JK Flip-Flop counter using a Pico 2W, buttons, and LEDs. The system simulates a 3-state counter with the sequence `01` → `10` → `00` → `01`.... Button presses act as clock signals, and LEDs represent the outputs Q1 and Q2.

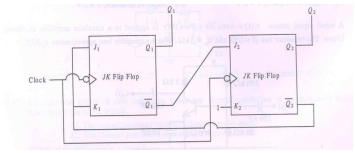

Figure: JK Flip-Flop logic diagram used in simulation

1. Components

Component	Qty
Pico 2W	1
Push Button (clock input)	1
LEDs (Q1, Q2)	2
220Ω Resistors	2
Breadboard	1
Jumper Wires	8
Micro-USB Cable	1

Table 1: List of components used

2. Setup and Connections

- **Button (Clock)** → GPIO 15 with a pull-down resistor.
- **LED Q1** → GPIO 16 via 220Ω resistor.
- **LED Q2** → GPIO 17 via 220Ω resistor.
- GND connections from Pico to breadboard.
- Button press triggers state change.

3. State Table for Q39

Press	Q2	Q1
Initial	0	0
1st	0	1
2nd	1	0
3rd	0	0
4th	0	1

Table 2: State transition sequence for 3-state counter

4. MicroPython Code for Raspberry Pi Pico W

```
from machine import Pin
import time

# Assign GPIO pins
button = Pin(15, Pin.IN, Pin.PULL_DOWN)
q1_led = Pin(16, Pin.OUT)
q2_led = Pin(17, Pin.OUT)

q1 = 0
q2 = 0
prev = 0

def update_leds():
    q1_led.value(q1)
    q2_led.value(q2)

while True:
    clk = button.value()
    if clk == 1 and prev == 0:
        # JK FF behavior
        next_q1 = 1 - q1
        next_q2 = (not q2 and q1) or (q2 and not q1)

        # update states
        q1 = int(next_q1)
        q2 = int(next_q2)

        update_leds()
        time.sleep(0.3)  # debounce

    prev = clk
```

5. Analysis

- Flip-Flop 1 toggles on every clock (J=Q2, K=1)
- Flip-Flop 2 toggles based on Q1 (J=Q1, K=1)
- Implemented logic replicates JK Flip-Flop transitions
- LED outputs match state sequence: 01 $\rightarrow$ 10 $\rightarrow$ 00 $\rightarrow$ ...

6. Circuit Image

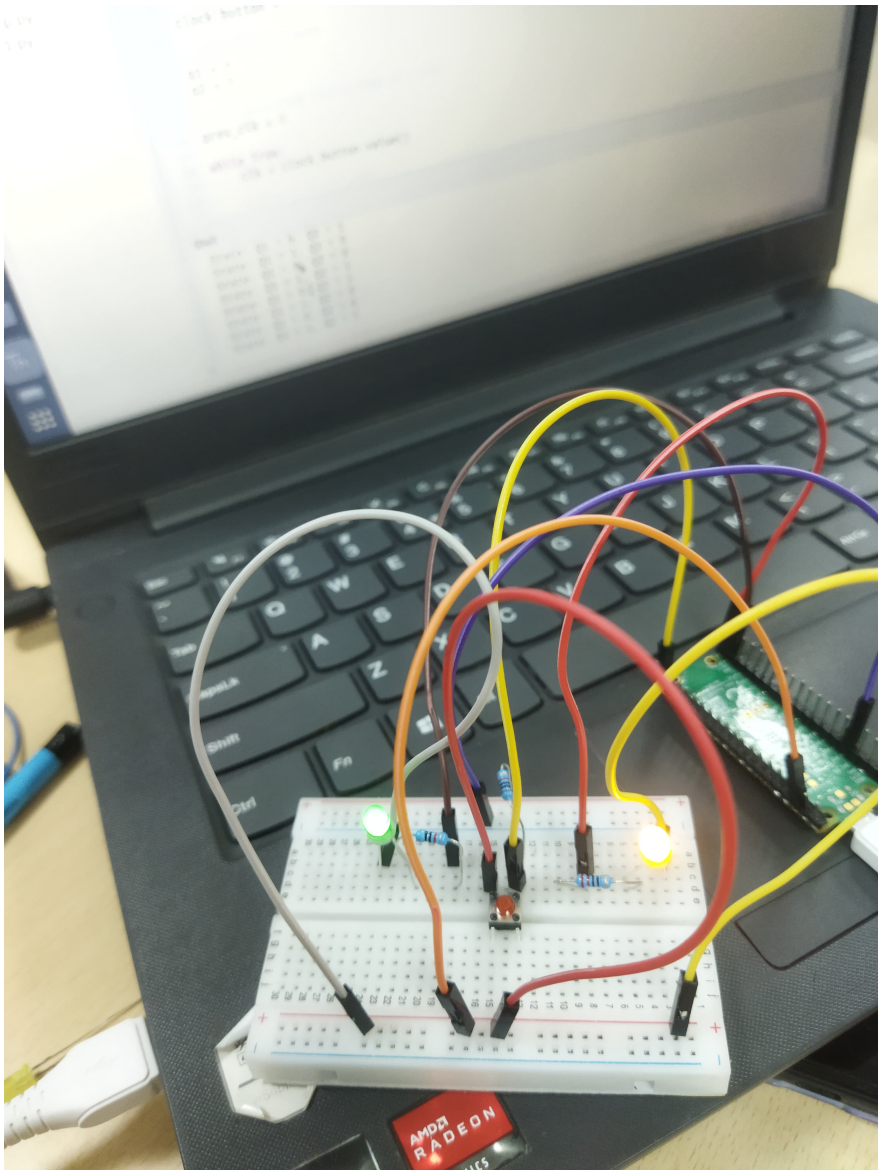

Figure: Real hardware setup using Pico2 W

7. Conclusion

This hardware implementation using Pico2W accurately simulates the JK flip-flop logic defined in GATE ECE 2009 Q39. The LED outputs reflect the correct 3-state sequence, and button input effectively acts as a manual clock pulse generator.