INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
HYDERABAD

DIGITAL SYSTEMS AND MICROCONTROLLERS

Experiment - 5 **Latches , Flip-flops and Counters** **Monsoon 2018**

In this experiment, the two basic modules required for the design of sequential circuits – LATCH for asynchronous circuits, and for synchronous circuits – FLIP-FLOP will be studied. RS latch using NOR gates will be separately assembled and tested. The basic operation of master-slave J-K flip-flop will then be studied by combining two latches to make a flip-flop. All IC's used in this experiment belong to the CMOS CD40xx family.

A. RS Latch

Assemble a NOR latch using two gates from the CD4001 chip, with the R and S inputs connected to two Input Switches and the Q and Q' outputs displayed on two LED Displays. Observe and tabulate the sequence of Q and Q' in response to the following input sequence:

S R = 01, 00, 10, 00, 01, 10, 01, 00, 11, 00, 10, 11, 00, 01, 11, 00.

Interpret the observed result and verify the latch operation.

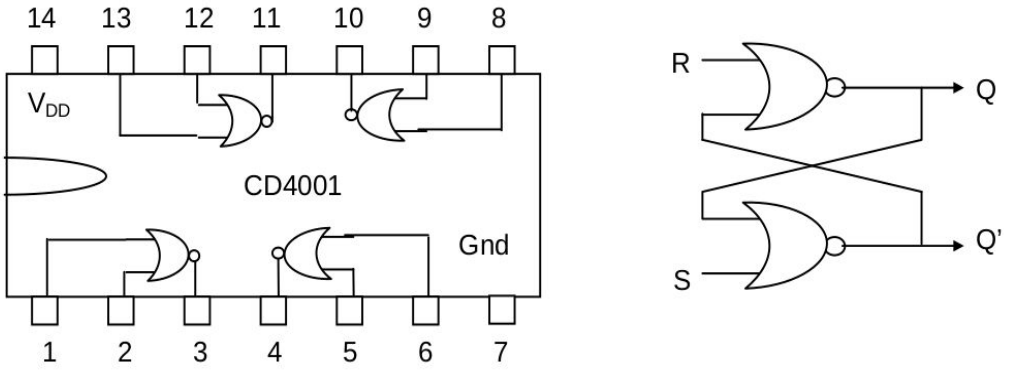

Fig 5.1 NOR Latch using CD4001 Quad 2 - input NOR gate

B. JK Master-Slave Flip-Flop

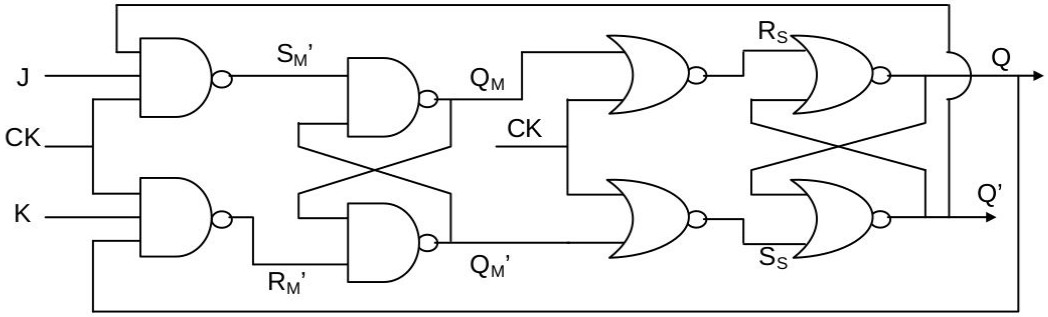

FIg 5.2 J-K Master-Slave Flip-Flop Circuit

Assemble the circuit as shown in Fig. 5.2 by using two 4-input NAND gates from a CD4012 chip as 3-input gates. Connect the unused inputs of the 4-input NAND gates to the HIGH (VCC) level. Verify theoretically that the circuit does realise the required logic

for the R-S inputs of the Master and Slave latches constituting a J-K Master-Slave flip-flop: TODO

$$R_M = K \cdot Q \cdot CK,\ S_M = J \cdot Q' \cdot CK,\ S_S = Q_M \cdot CK' \text{ and } R_S = Q_M' \cdot CK'$$

J-K FLIP-FLOP TRUTH TABLE			
J	K	ACTION	Q_{n+1}
0	0	HOLD	Q
0	1	CLEAR	0
1	0	SET	1
1	1	TOGGLE	Q'

Table 5.1

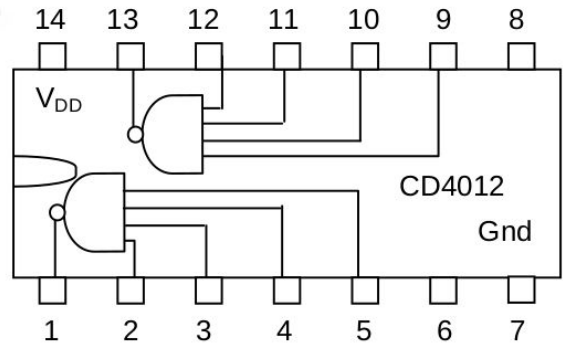

Fig 5.3

C. 4-bit Up-Down Counter

1) In the second part of the experiment , We will use an arduino to implement a 4 bit ripple counter. The bits will be represented by LEDS .

2) Connect arduino pins to the LEDs in breadboard and set the pins to OUTPUT .

```
void setup()
{
  pinMode(ledPin, OUTPUT);
}
```

3) First initialize a Timer t and use t.oscillate function in arduino to toggle the pin value after a particular period.

Int oscillate(int pin, long period, int startingValue): Toggle the state of the digital output 'pin' every 'period' milliseconds. Eg. t.oscillate(13,500,LOW), wll toggle the output pin 13, which will toggle every 500 ms and will start from LOW (0) .
Hint : Make a function which will initialize t.oscillate for the four pins.

4) Write a code which will behave as a 4 bit counter and change the Value of the output pins accordingly which should be seen on the LEDs.

5) Down counter : Add if condition in the code to switch code to a down counter once the count reaches 16(1111 in binary) . Hint : when switching , first stop the timer and then initialize it again for down counter.

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