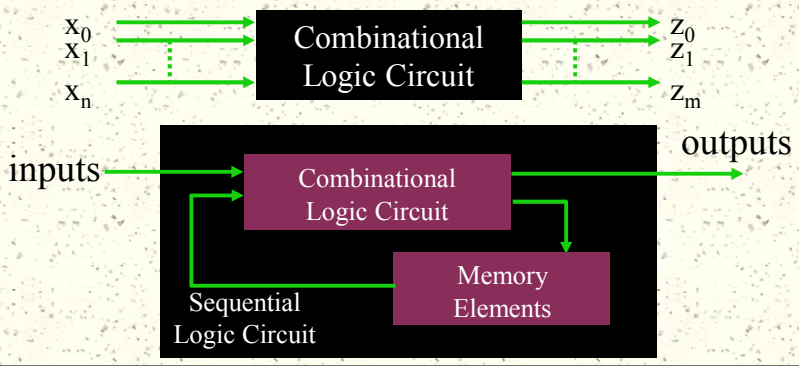
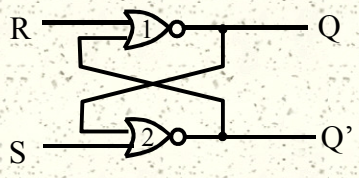
Digital Systems

- Digital vs. analog
- Synchronous vs. asynchronous
- Combinational vs. sequential



Latch: Basic Memory Unit

- Two outputs (Q and Q')
- Various ways to feed latches
- NOR Gate latch

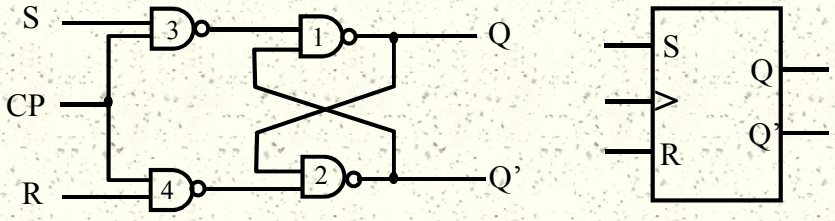


S	R	Q	Q'
1	0	1	0
0	0	1	0
0	1	0	1
0	0	0	1

- Outputs of latches may change at any time when input changes (asynchronous system)

Flip-Flop: Basic Memory Unit

- Flip-Flops are similar to latches, but have a signal to control when output will change.



- Three inputs: S, R, CP (RS = 0)
- One bit information: Q(t)
  - Q(t+1) = S + R'Q(t)

Flip-Flop Excitation Tables

- How to feed the FF input line(s) to make its memory change as required.

Q(t)	Q(t+1)	S	R
0	0	0	x
0	1	1	0
1	0	0	1
1	1	x	0

Q(t)	Q(t+1)	D
0	0	0
0	1	1
1	0	0
1	1	1

Q(t)	Q(t+1)	J	K
0	0	0	x
0	1	1	x
1	0	x	1
1	1	x	0

Q(t)	Q(t+1)	T
0	0	0
0	1	1
1	0	1
1	1	0

Example: System Specification

Design a circuit with one input x and three outputs A,B,C. An external source feeds x one bit per clock cycle, when x=0, the outputs remain no change; otherwise, they repeat the binary sequence: 0,1,3,7,6,4, one at a time.

current state			next state x=0			x=1		
A	B	C	A	B	C	A	B	C
0	0	0	0	0	0	0	0	1
0	0	1	0	0	1	0	1	1
0	1	1	0	1	1	1	1	1
1	1	1	1	1	1	1	1	0
1	1	0	1	1	0	1	0	0
1	0	0	1	0	0	0	0	0

state transition table/graph