S J P N TRUST
HIRASUGAR INSTITUTE OF TECHNOLOGY

SUB: ANALOG AND DIGITAL ELECTRONICS

CODE:18CS33

Module 5

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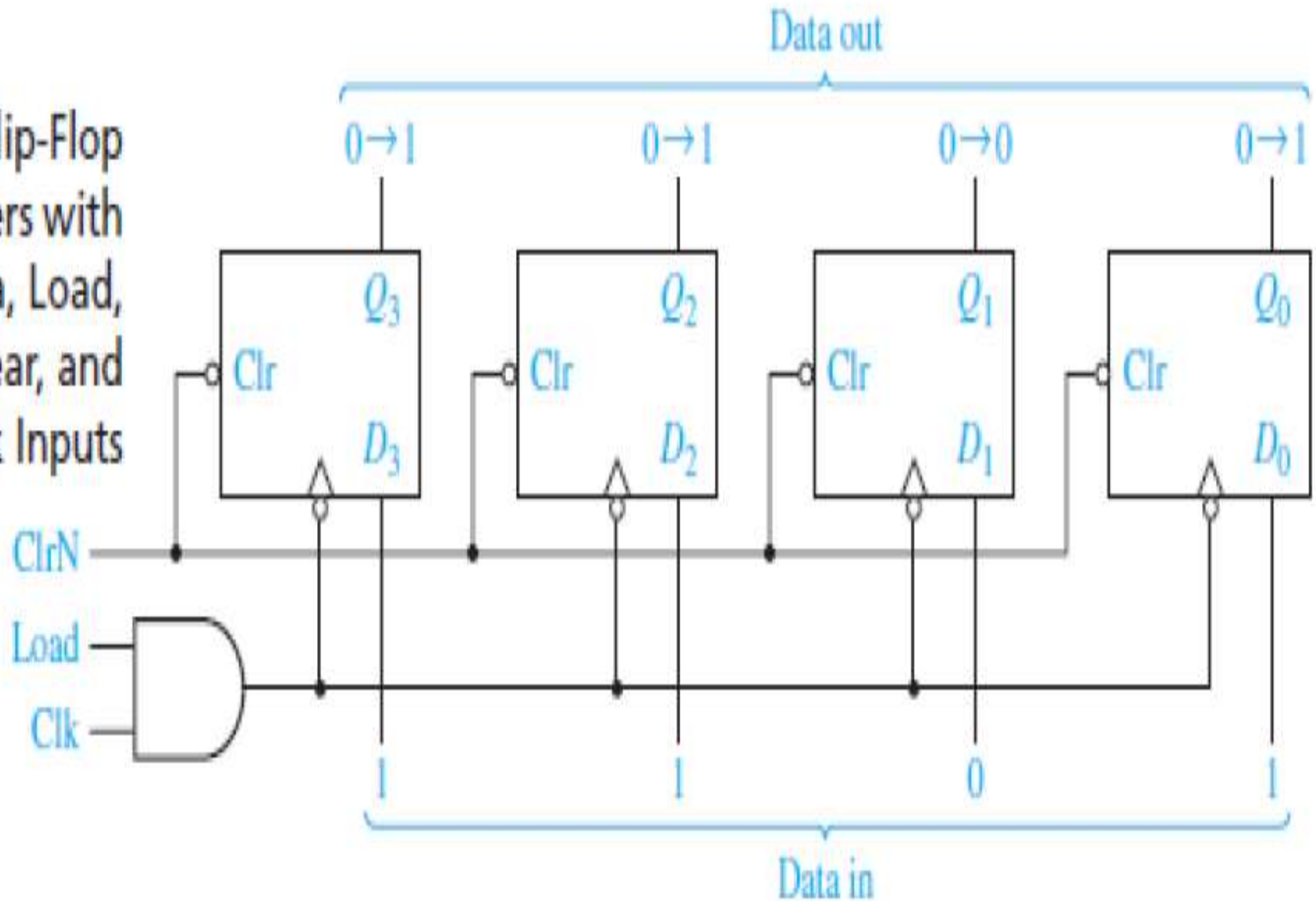
REGISTERS AND COUNTERS

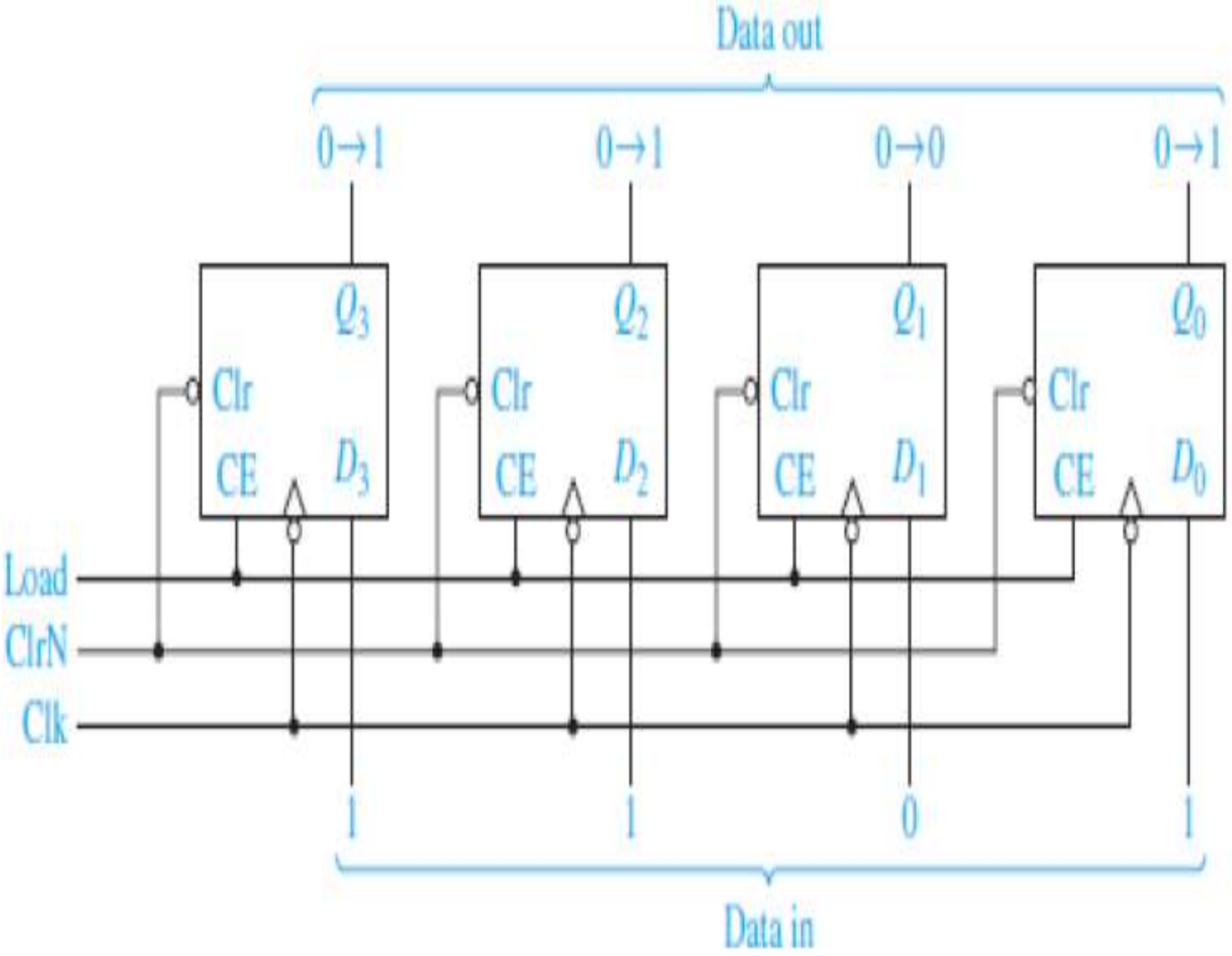
A *register* consists of a group of flip-flops with a common clock input. Registers are commonly used to store and shift binary data.

Counters are another simple type of sequential circuits. A counter is usually constructed from two or more flip-flops which change states in a prescribed sequence when input pulses are received.

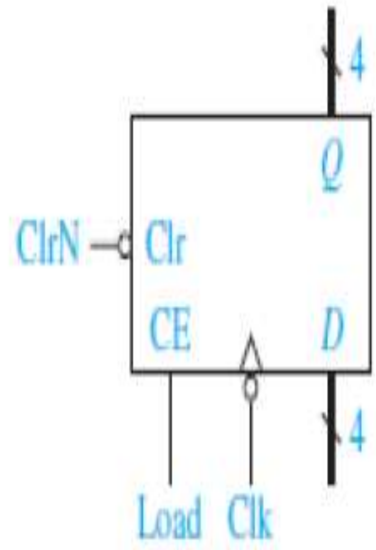
4-Bit D Flip-Flop Registers with Data, Load, Clear, and Clock Inputs



(a) Using gated clock



(b) With clock enable



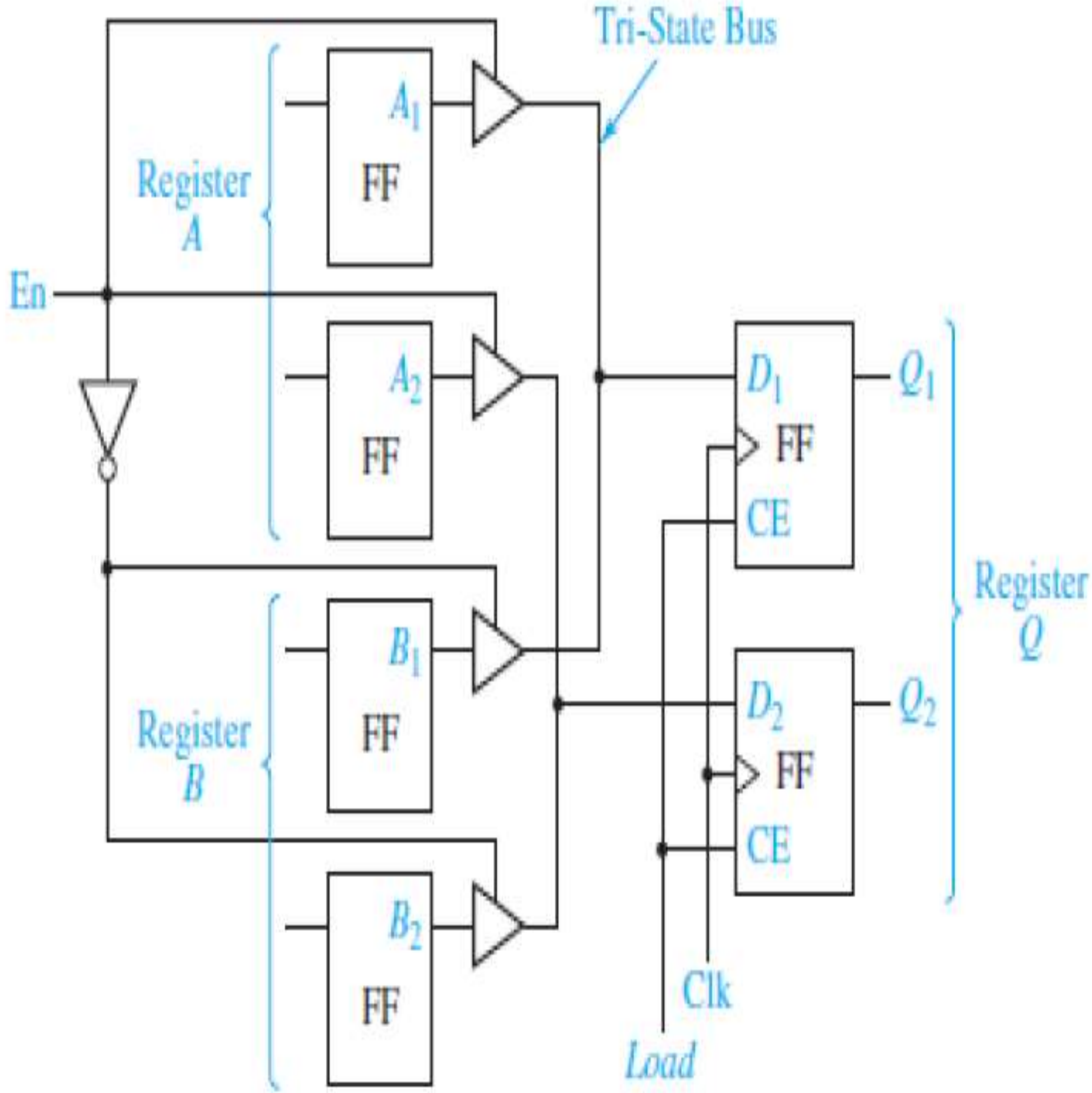
(c) Symbol

Data Transfer Between Registers

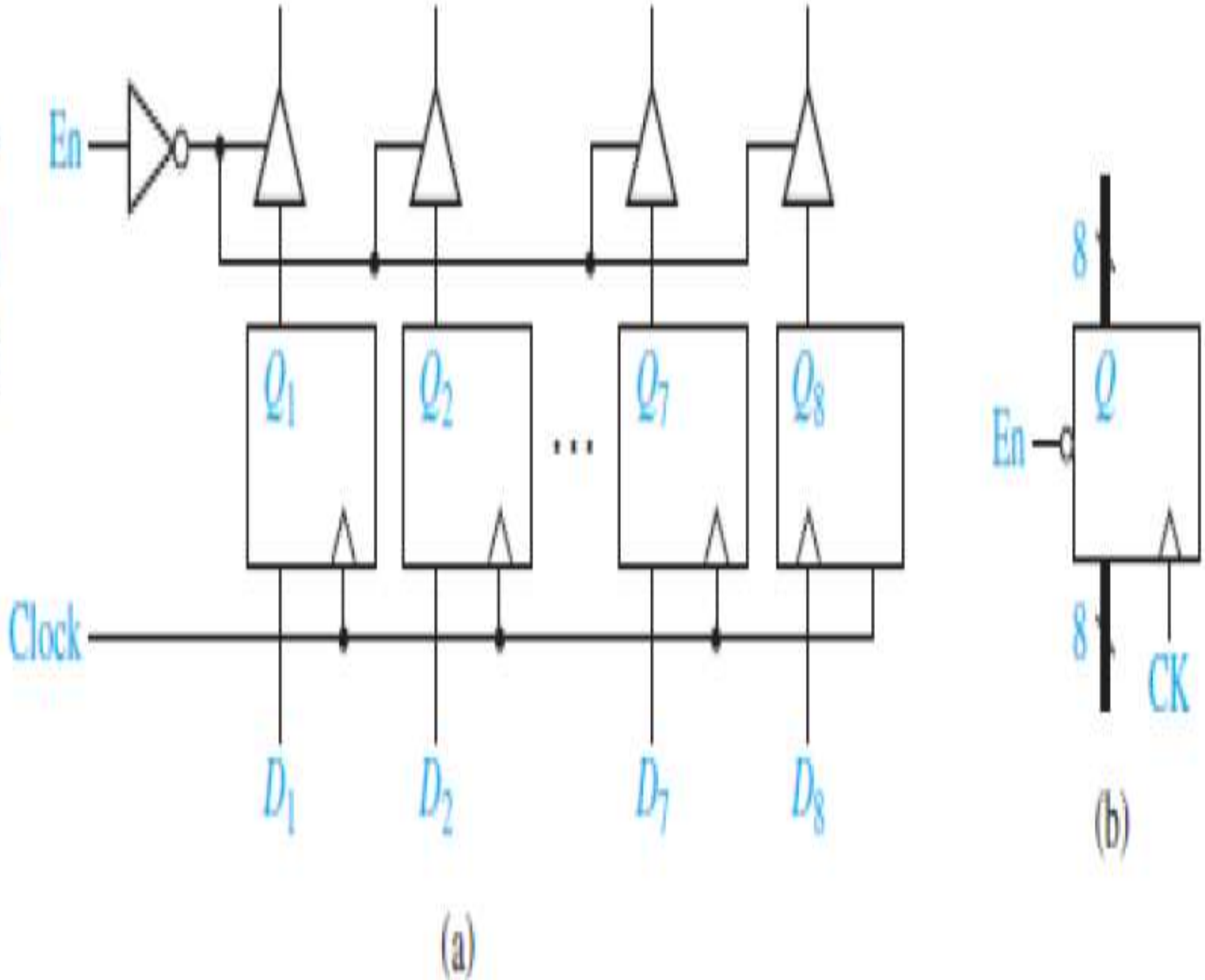
Register A = Flip-flops A_1 and A_2

Register B = Flip-flops B_1 and B_2

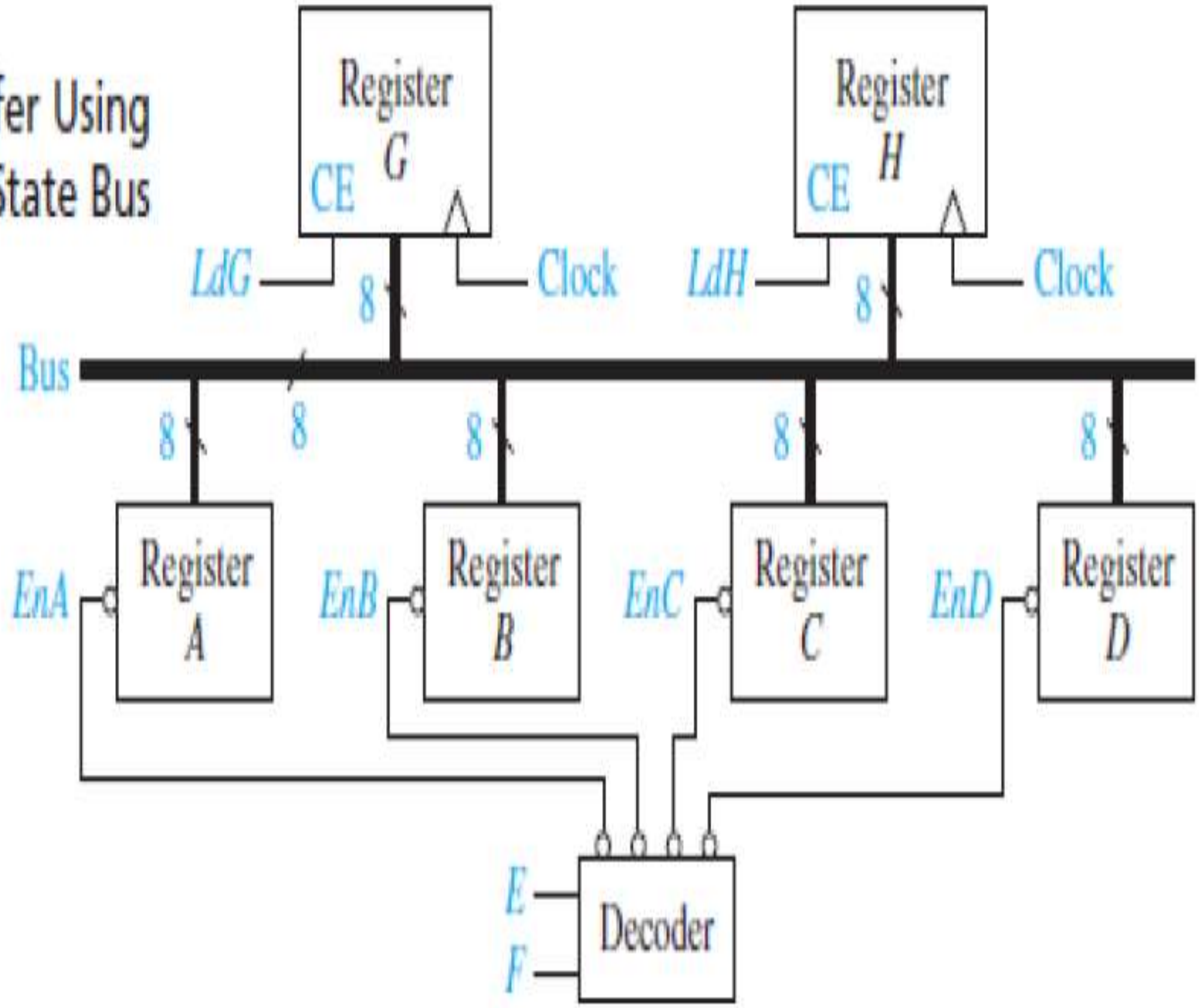
Register Q = Flip-flops Q_1 and Q_2



Logic Diagram for 8-Bit Register with Tri-State Output



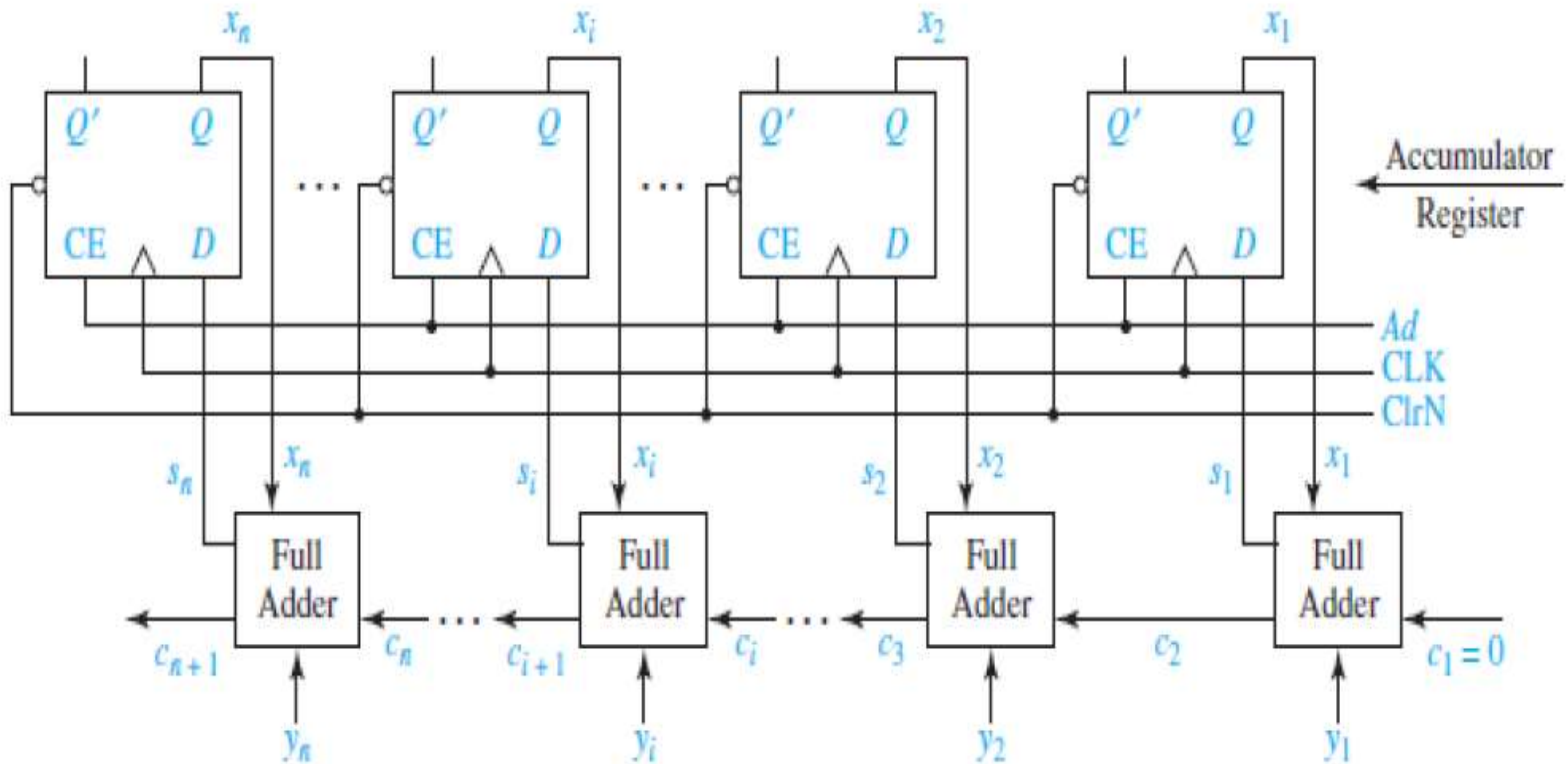
Data Transfer Using a Tri-State Bus



Parallel Adder with Accumulator:

In computer circuits, it is frequently desirable to store one number in a register of flip-flops (called an accumulator) and add a second number to it, leaving the result stored in the accumulator.

One way to build a parallel adder with an accumulator is to add a register to the adder as shown in the following Figure.



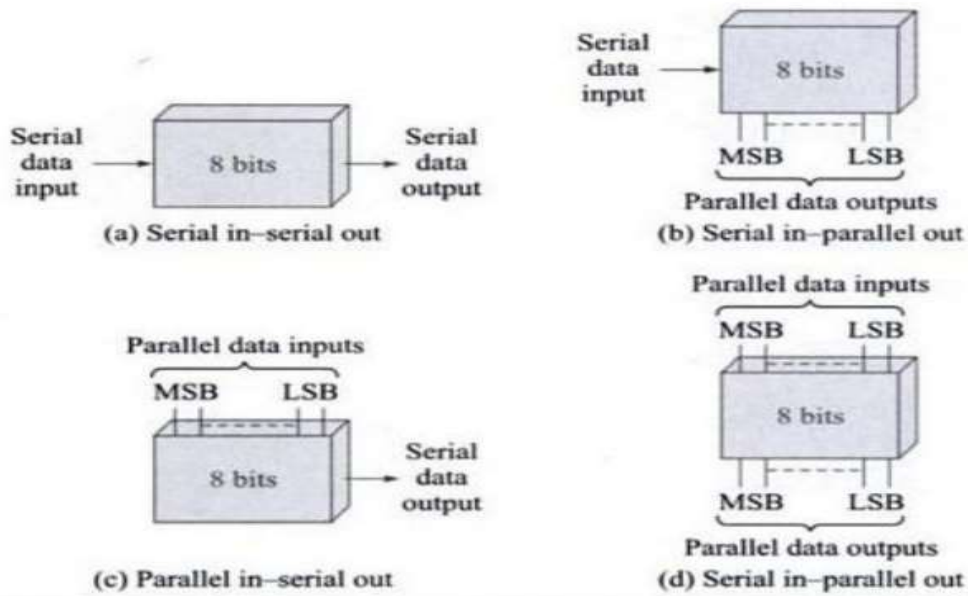
SHIFT REGISTERS:

A *shift register* is a register in which binary data can be stored, and this data can be shifted to the left or right when a shift signal is applied. Bits shifted out one end of the register may be lost, or if the shift register is of cyclic type, bits shifted out one end are shifted back in the other end.

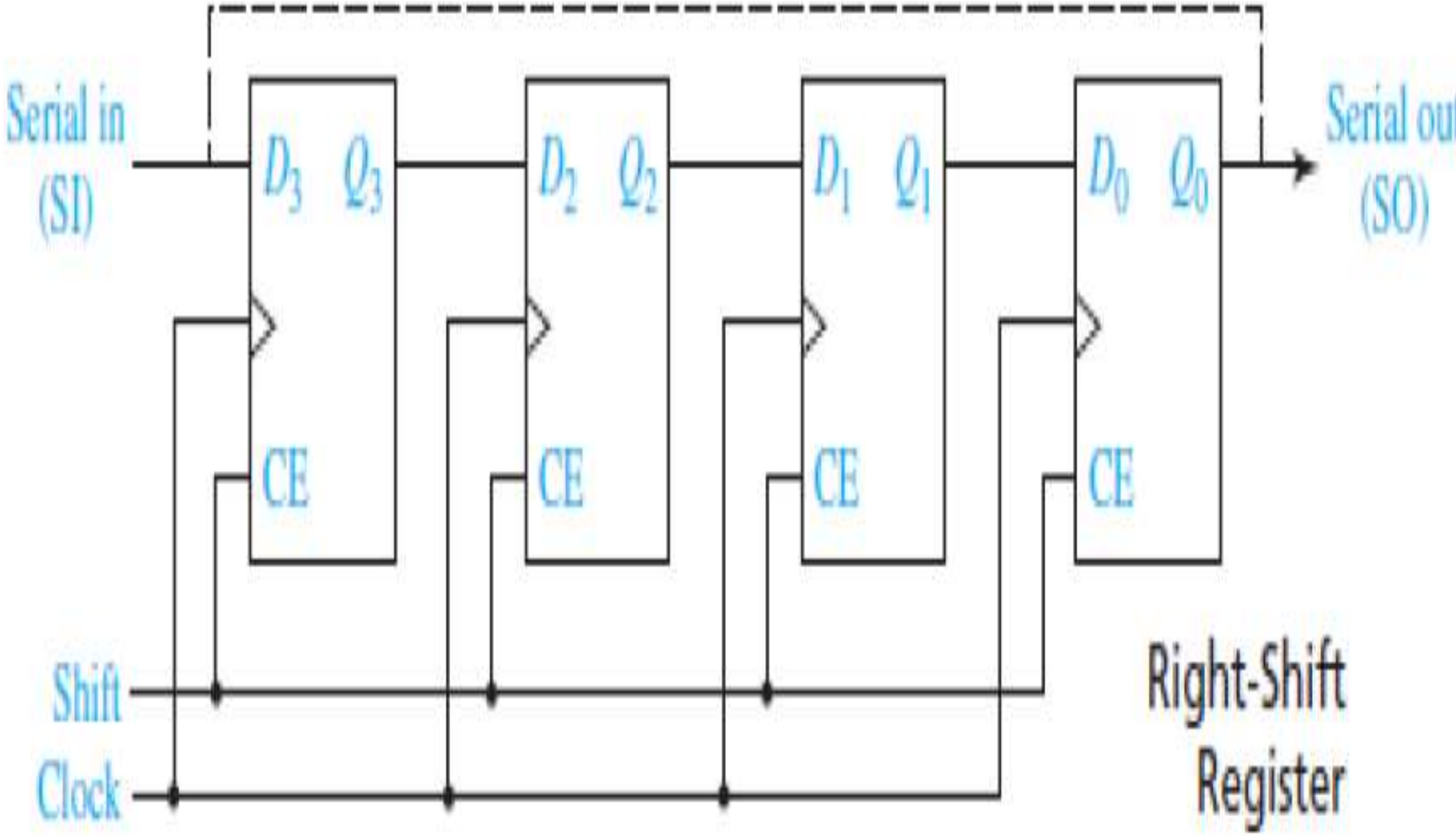
There are two ways to shift data into a register – serial or parallel; and there are two ways to shift the data out of the register – serial or parallel. This leads to the construction of four basic types of registers, as shown in the following Figure. All of these configurations are commercially available as TTL MSI/LSI circuits.

Examples:

- Serial in – serial out (SISO): 54/74LS91, 8-bits
- Serial in – parallel out (SIPO): 54/74164, 8-bits
- Parallel in – serial out (PISO): 54/74165, 8-bits
- Parallel in – parallel out (PIPO): 54/74194, 4-bits & 54/74168, 8-bits.

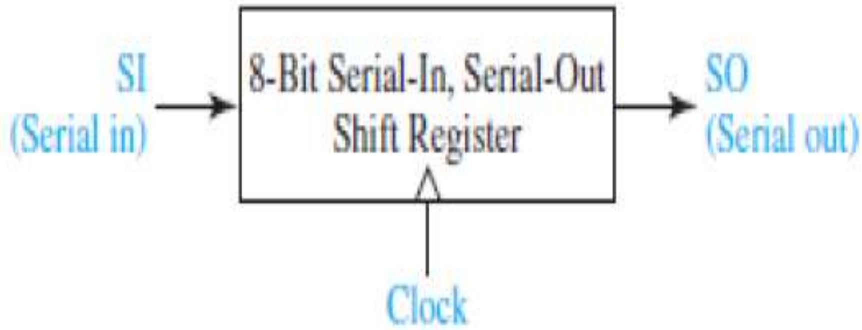


Types of Shift Registers

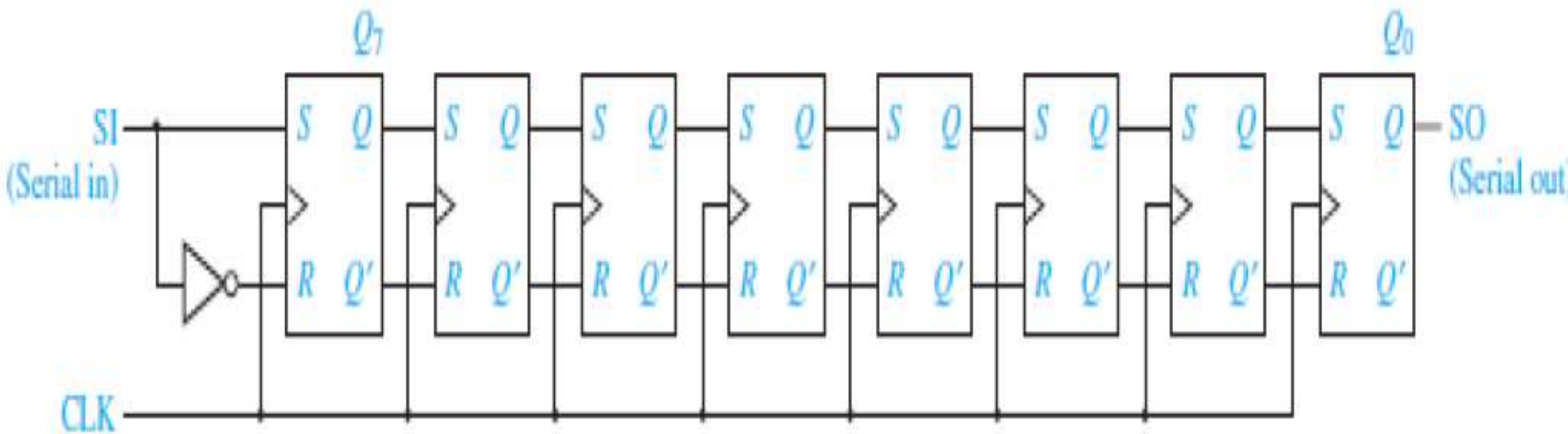


(a) Flip-flop connections

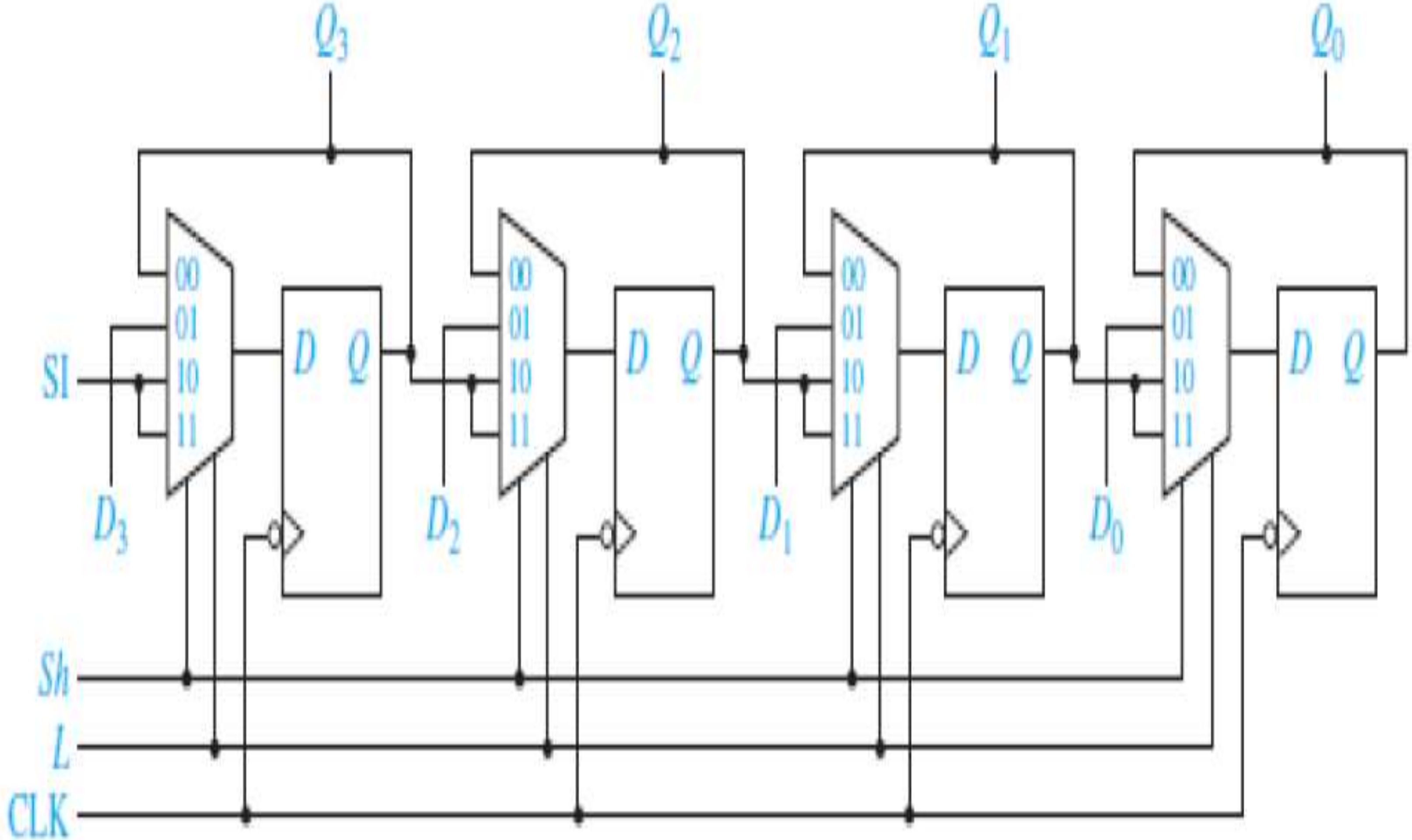
8-Bit Serial-in, Serial-out Shift Register



(a) Block diagram

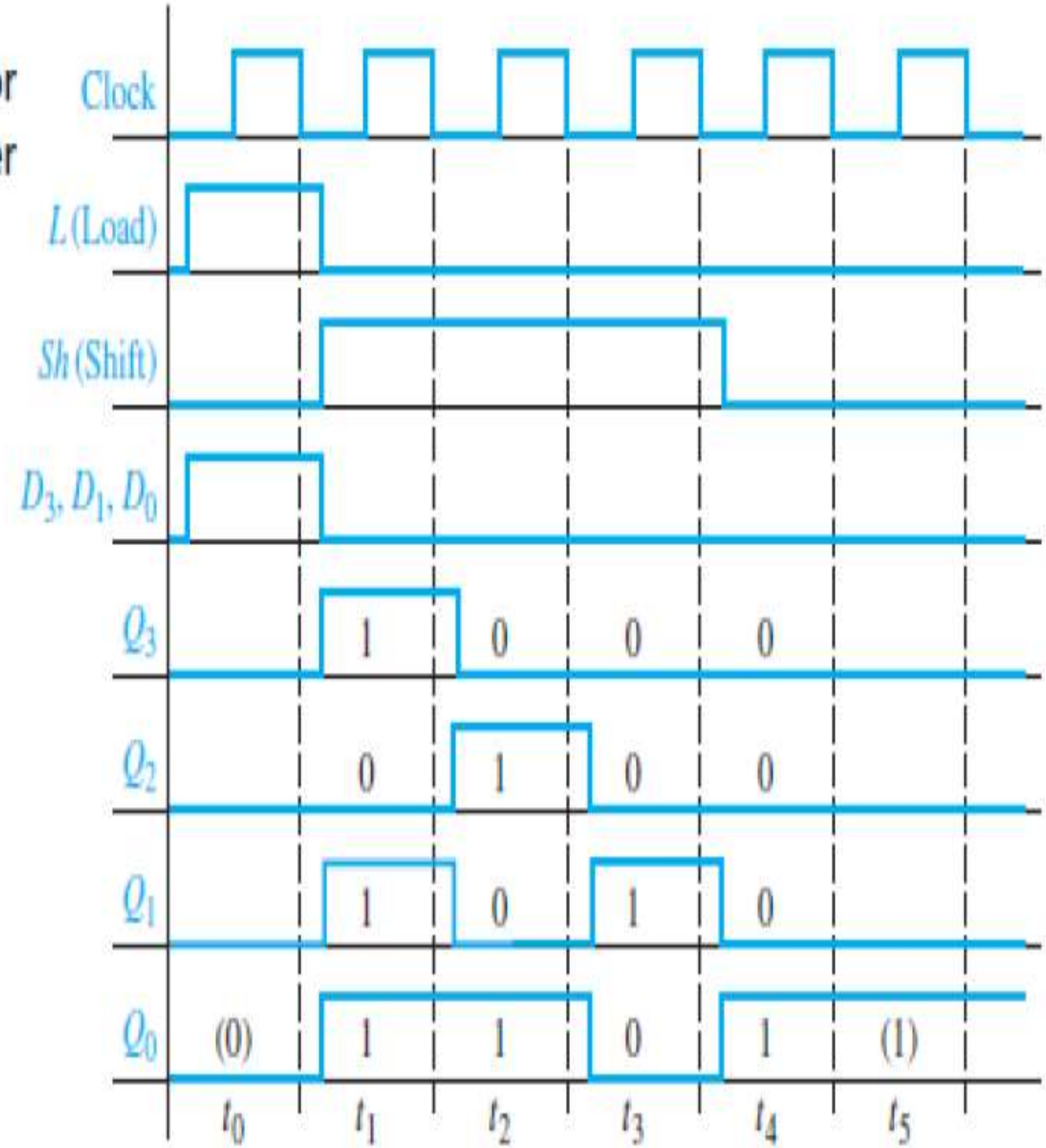


(b) Logic diagram

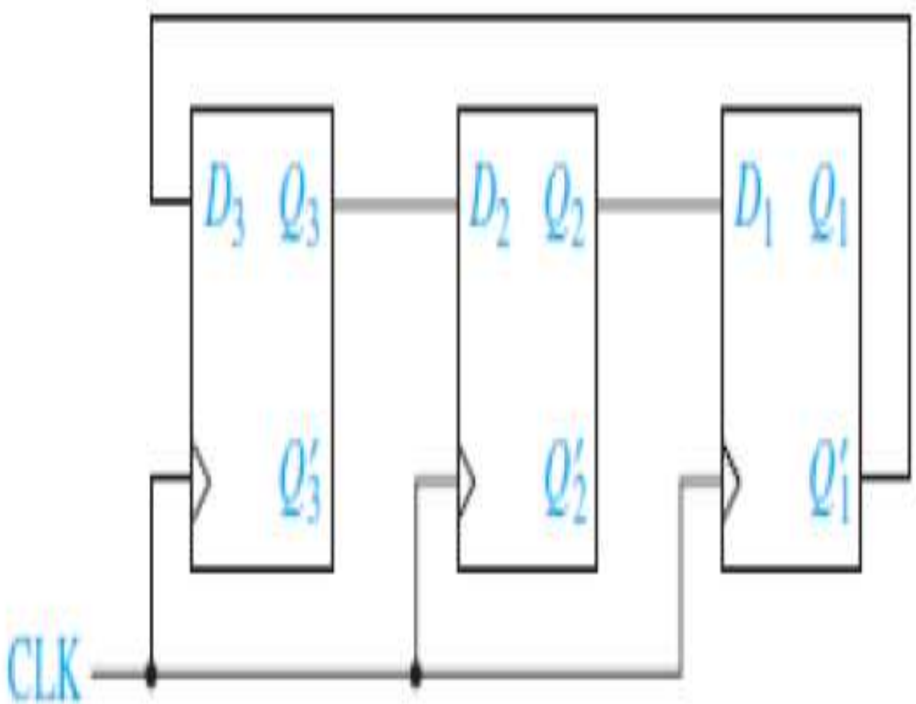


(b) Implementation using flip-flops and MUXes

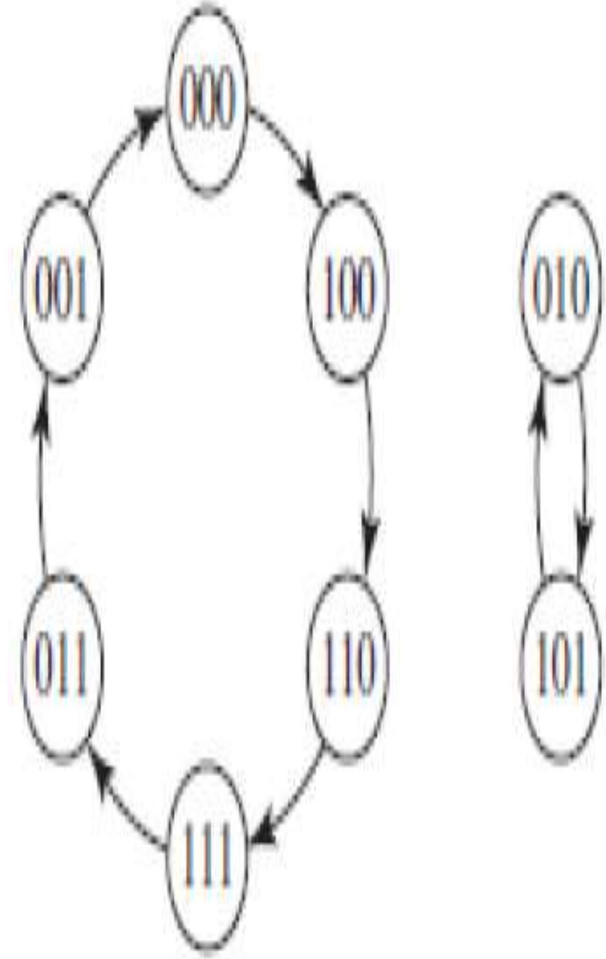
Timing Diagram for Shift Register



Shift Register with Inverted Feedback

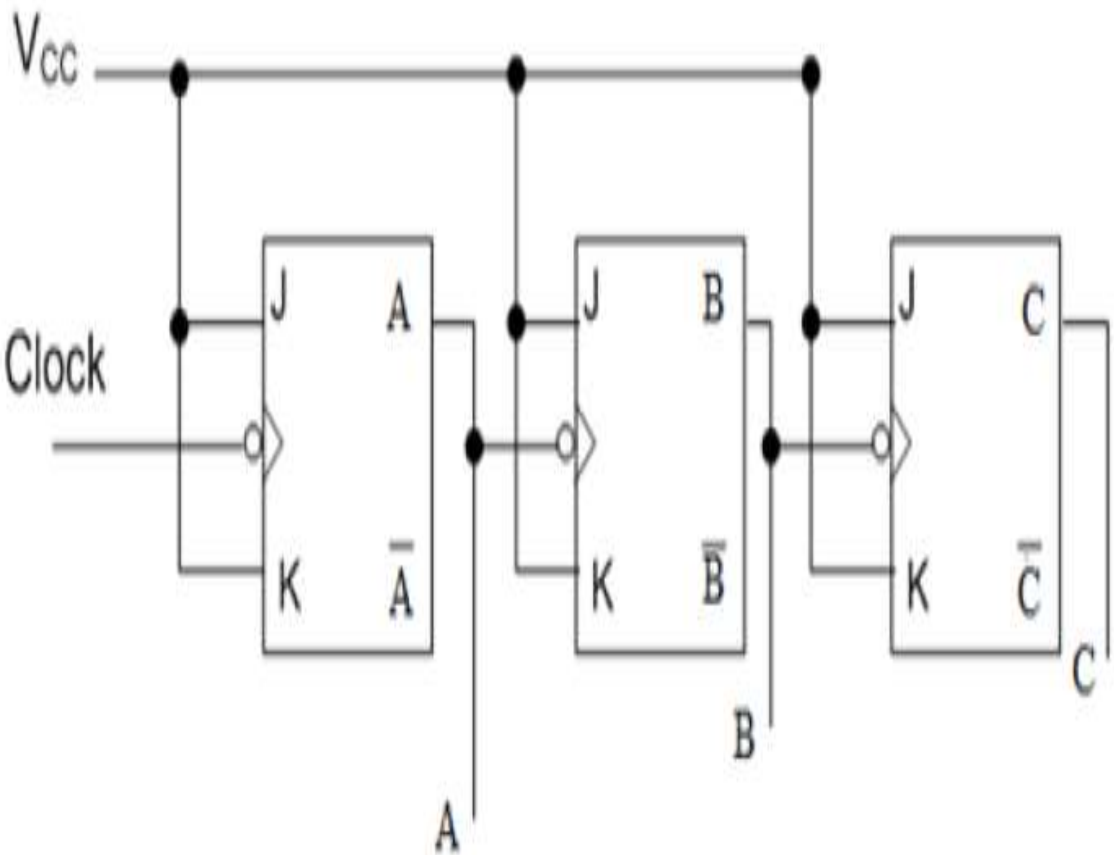


(a) Flip-flop connections



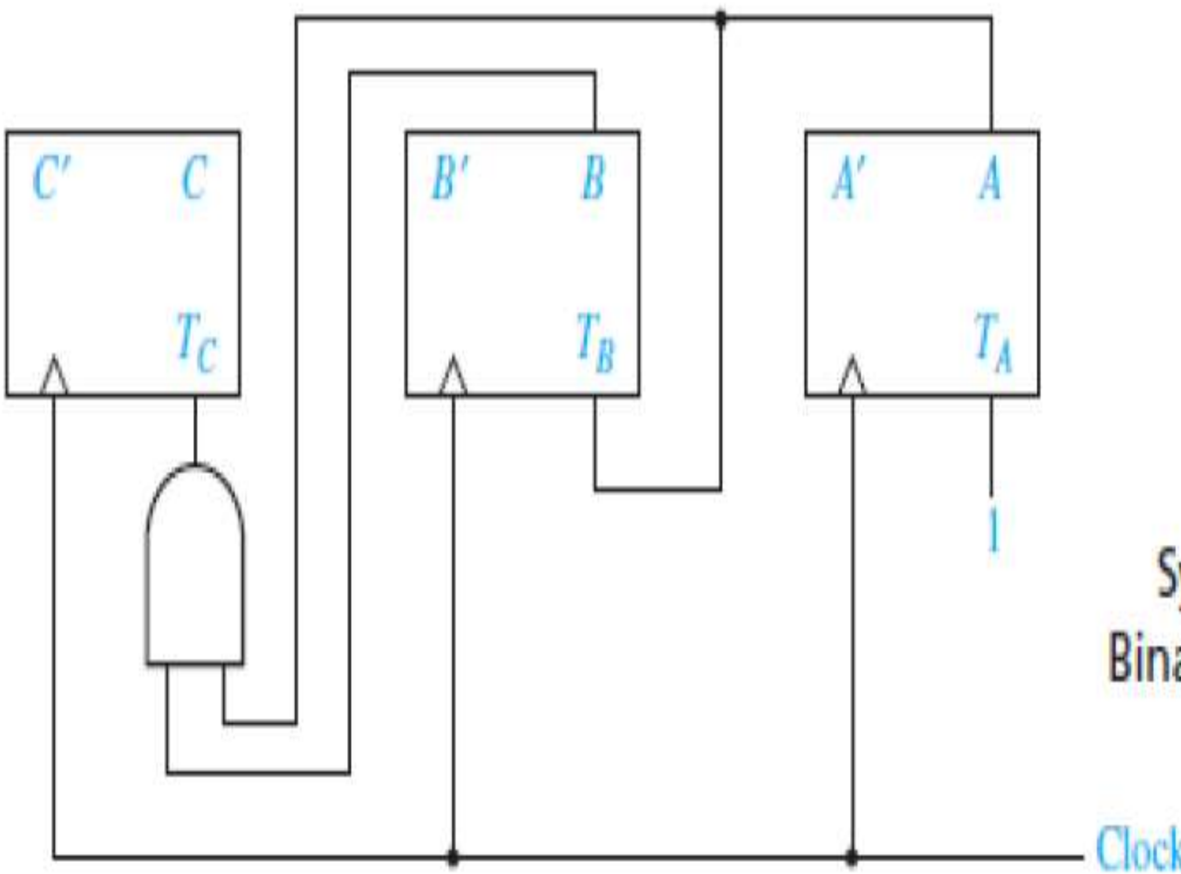
(b) State graph

Asynchronous Counters:



Negative Clock	C	B	A	State or Count
-	0	0	0	0
a	0	0	1	1
b	0	1	0	2
c	0	1	1	3

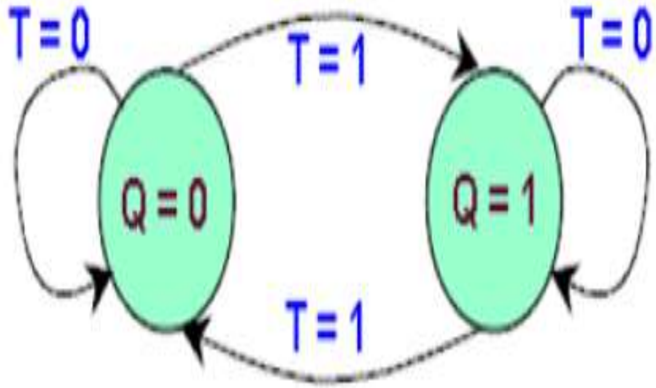
Synchronous Binary Counters Using T Flip-Flops: Consider the following Figure, a binary counter using three T flip-flops to count clock pulses.



Synchronous Binary Counter

T	Q	Q^+
0	0	0
0	1	1
1	0	1
1	1	0

Characteristic Table



State Diagram

$Q \rightarrow Q_{n+1}$		T
0	0	0
0	1	1
1	0	1
1	1	0

Excitation Table

Synchronous Binary Counters Using D Flip-Flops: Next, redesign the binary counter to use D flip-flops instead of T flip flops. The easiest way to do this is to convert each D flip-flop to a T flip-flop by adding an XOR (exclusive-OR) gate, as shown in the following Figure (The rightmost XOR gate can be replaced with an inverter because $A \oplus 1 = A'$).