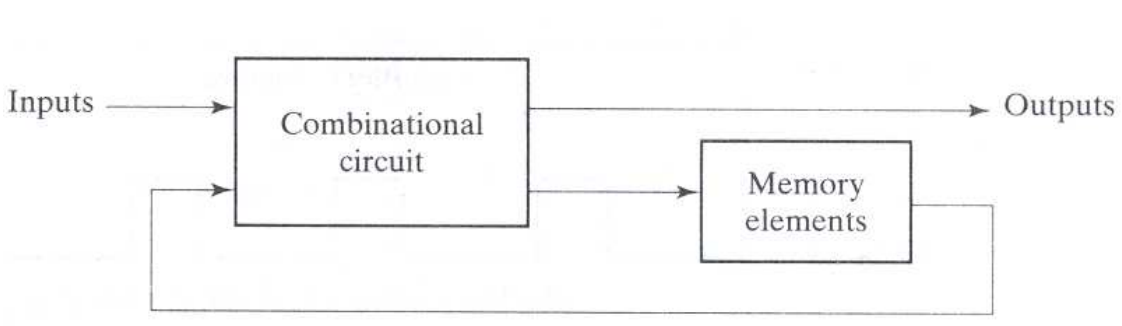
SEQUENTIAL CIRCUITS

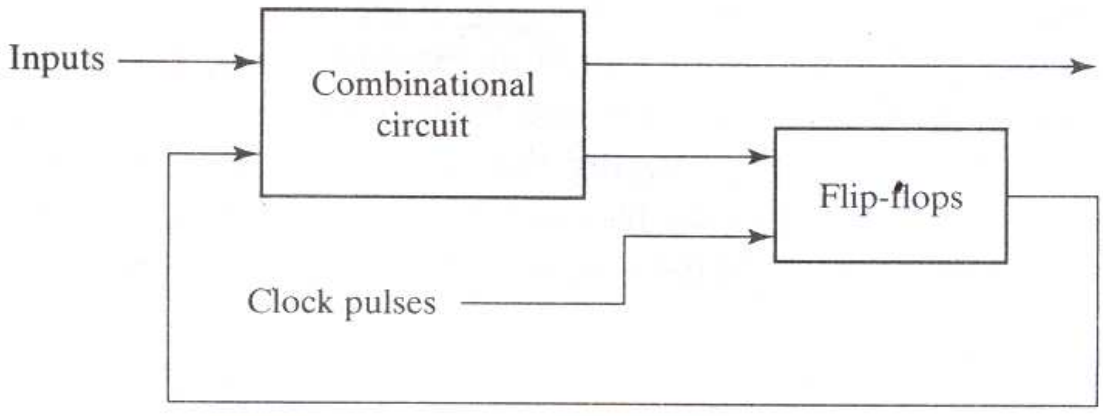
A block diagram of a sequential circuit is shown in Fig 1. It consists of a combinational circuit to which storage elements are connected to form a feedback path. The storage elements are devices capable of storing binary information. The binary information stored in these elements at any given time defines the state of the sequential circuit at that time. The sequential circuit receives binary information from external inputs. These inputs, together with the present state of the storage elements, determine the binary value of the outputs. They also determine the condition for changing the state in the storage elements. The block diagram demonstrate that the outputs in a sequential circuit are a function not only of the inputs, but also of the present state of the storage elements. The next state of the storage elements is also a function of external inputs and the present state. Thus, a sequential circuit is specified by a time sequence of inputs, outputs and internal states.



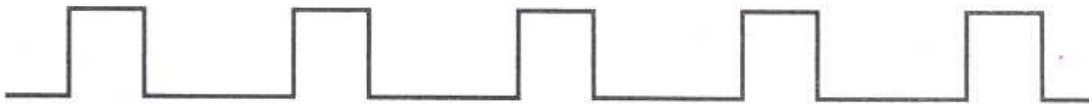
There are two main types of sequential circuits and their classification depends on the timing of their signals. A synchronous sequential circuit is a system whose behavior can be defined from the knowledge of its signals at discrete instants of time. The behavior of an asynchronous sequential circuit depends upon the input signals at any instant of time and the order in which the inputs change. The storage elements commonly used in asynchronous sequential circuits are time-delay devices. The storage capability of a time-delay device is due to the time it takes for the signal to propagate through the device. In practice, the internal propagation delay of logic gates is of sufficient duration to produce the needed delay so that actual delay units may not be necessary.

A synchronous sequential circuit employs signals that affect the storage elements only at discrete instants of time. Synchronization is achieved by a timing device called a clock generator that provides a periodic train of clock pulses. The clock pulses are distributed throughtout the system in such a way that storage elements are affected only with the arrival of each pulse. In practice, the clock pulses are applied with other signals that specify the required change in the storage elements. Synchronous sequential circuits that use clock pulses in the inputs of storage elements are called clocked sequential circuits. Clocked sequential circuits are the type most frequently encountered in practice. They seldom manifest instability problems and their timing is easily broken down into independent discrete steps, each of which can be considered separately.

The storage elements used in clocked sequential circuits are called flip-flops. A flip-flop is a binary storage device capable of storing one bit of information. A sequential circuit may use many flip-flops to store as many bits as necessary. The block diagram of a synchronous clocked sequential circuits is shown in Fig 2. The outputs can come either



(a) Block diagram



(b) Timing diagram of clock pulses

From the combinational circuit or from the flip-flops or both. The flip-flops receive their inputs from the combinational circuit and also from a block signal with pulses that occur at fixed intervals of time as shown in the timing diagram. The state of the flip-flops can change only during a clock pulse transition. When a clock pulse is not active, the feedback loop is broken because the flip-flop outputs cannot change even if the outputs of the combinational circuit driving their inputs change in value. Thus, the transition from one state to the next occurs only at predetermined time intervals dictated by the clock pulses.

1. COMBINATIONAL LOGIC CIRCUITS

- Output depends only on the present input
- Easier to design
- Speed of operation is high
- Memory unit is not required
- Ex : Parallel adder

2. SEQUENTIAL LOGIC CIRCUITS

- Output depends on the present input. Present input and past output also.
- Comparatively harder to designs
- Speed of operation is comparatively low
- Memory unit is required to store the past outputs.
- Ex : Serial adder.