UNIT-II : DIGITAL ELECTRONICS

Registers

CHAPTER 3

A **register** is a small storage unit made up of **flip-flops**, which are basic memory elements. Each **flip-flop** can store **one bit** of information (either 0 or 1), and together they form a **register**.

For example, a **4-bit register** is made of 4 flip-flops and can store a 4-bit binary number (like 1010).

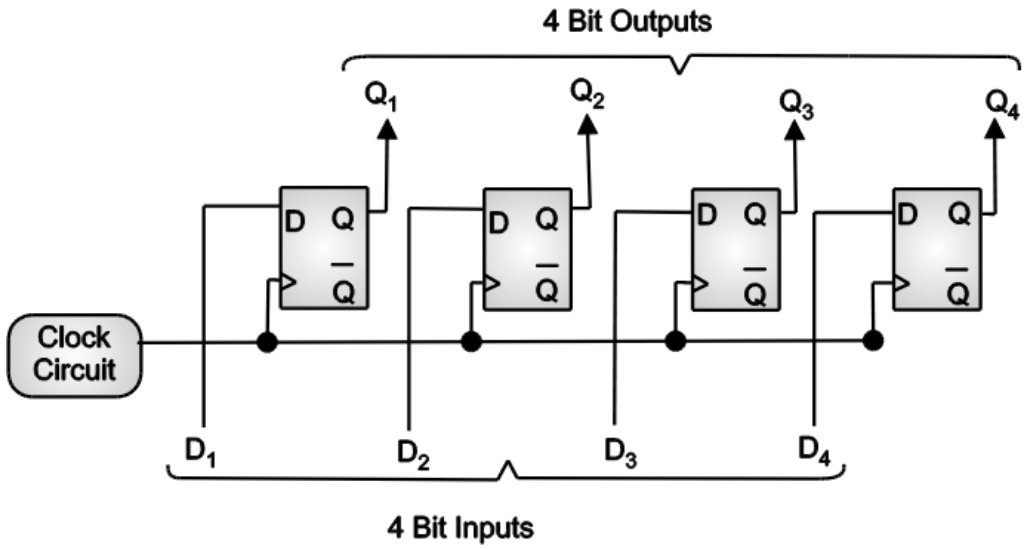


Figure 3.1

As you see in the above figure, the four-bit register consists of four flip-flops. Each flip-flop can store one-bit data. Here D Flip-flops are used. You can also see that the clock terminal of each flip-flop is connected together because we give the clock pulse to all flip-flops together.

Applications of Registers :

1. The main application of register is storing data in digital form.
2. They also can hold data and address.
3. The registers are also used to make digital memory chips like ROM Chips, Flash Memory etc.
4. Cache memory in CPU is also made by registers.

Classification of Registers :

Registers are classified on the basis of how the data bits are entered and taken out from a register.

There are four possible modes as follows :

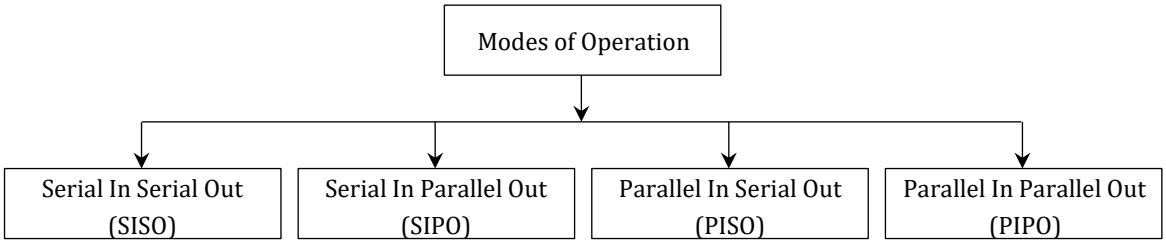
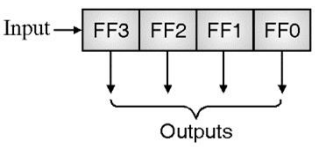
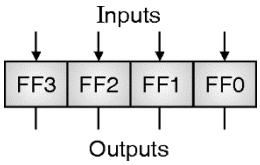
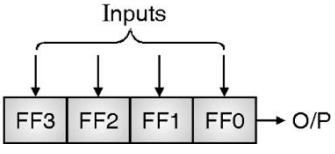


Figure 3.2

Brief Explanation of Various Modes of Shift Register :

Sr. No.	Mode	Illustrative Diagram	Comments
1.	Serial Input Serial Output (serial shift right)		Data bits shift from left to right by 1 position per clock cycle.
2.	Serial Input Serial Output (serial shift left)		Data bits shift from right to left by 1 position per clock.
3.	Serial Input Parallel Output		All output bits are made available simul-taneously after 4-clock pulses.
4.	Parallel Input Serial Output		All inputs are loaded simultaneously but output bit by bit.
5.	Parallel Input Parallel Output		All inputs are loaded simultaneously and are available at the output simultaneously.

3.1 SHIFT REGISTERS

A **shift register** is a type of register that can **shift data** in a specific direction (left or right), and also **load** or **output** data in serial or parallel forms. The registers that shift the bits to left are called “Shift left registers”, while the registers that shift the bits to right are called “Shift right registers”.

If the bits in a binary number are moved from one place to another 1 bit at a time, then this technique is referred to as serial shifting. Whereas if the shifting involves moving all the data bits simultaneously then it is referred to as parallel shifting. There are two ways to shift data into a register and similarly two ways to shift the data out of the register. This leads to the construction of four basic register types :

i) Serial In Serial Out shift register (SISO).

ii) Serial In Parallel Out shift register (SIPO).

iii) Parallel In Serial Out shift register (PISO).

iv) Parallel In Parallel Out shift register (PIPO).

3.1.1 SERIAL IN SERIAL OUT SHIFT REGISTER (SISO)

1. The shift register which allows serial input, i.e., one bit after the other through a single data line and produces a serial output is known as serial-in serial-out shift register. Since there is only one output, the data leaves the shift register one bit at a time in a serial pattern, thus the name serial-in serial-out, shift register.
2. The logic circuit given below shows a serial-in serial-out shift register. The circuit consists of four *D* flip-flops which are connected in a serial manner. All these flip-flops are synchronous with each other since the same clock signal is applied to each flip-flop.

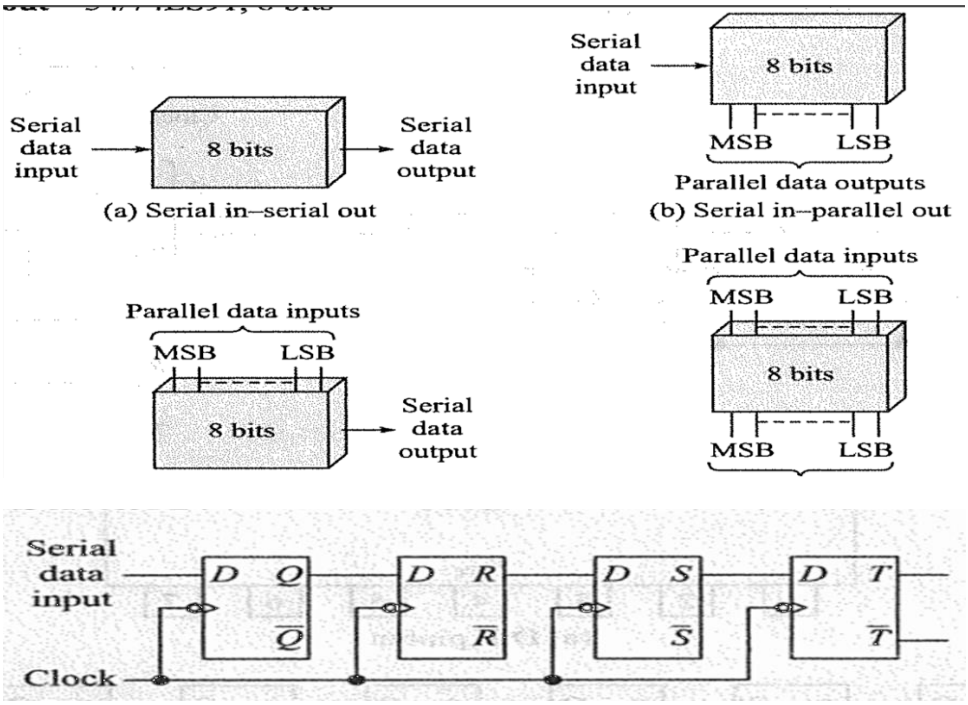


Figure 3.3

3. As output of one *D* flip-flop is connected to input of the next at every Clock trigger data stored in one flip-flop is transferred to the next. For this circuit, transfer takes place like this *Q R*, *R S*, *S T* and serial data input is transferred to *Q*.

3.1.2 SERIAL IN PARALLEL OUT SHIFT REGISTER (SIPO)

1. The shift register, which allows serial input (one bit after the other through a single data line) and produces a parallel output is known as Serial-In Parallel-Out shift register.
2. The logic circuit given below shows a serial-in parallel-out shift register. The circuit consists of four D flip-flops which are connected. The clear (*CLR*) signal is connected in addition to the clock signal to all the 4 flip-flops in order to RESET them. The output of the first flip-flop is connected to the input of the next flip-flop and so on. All these flip-flops are synchronous with each other since the same clock signal is applied to each flip-flop.

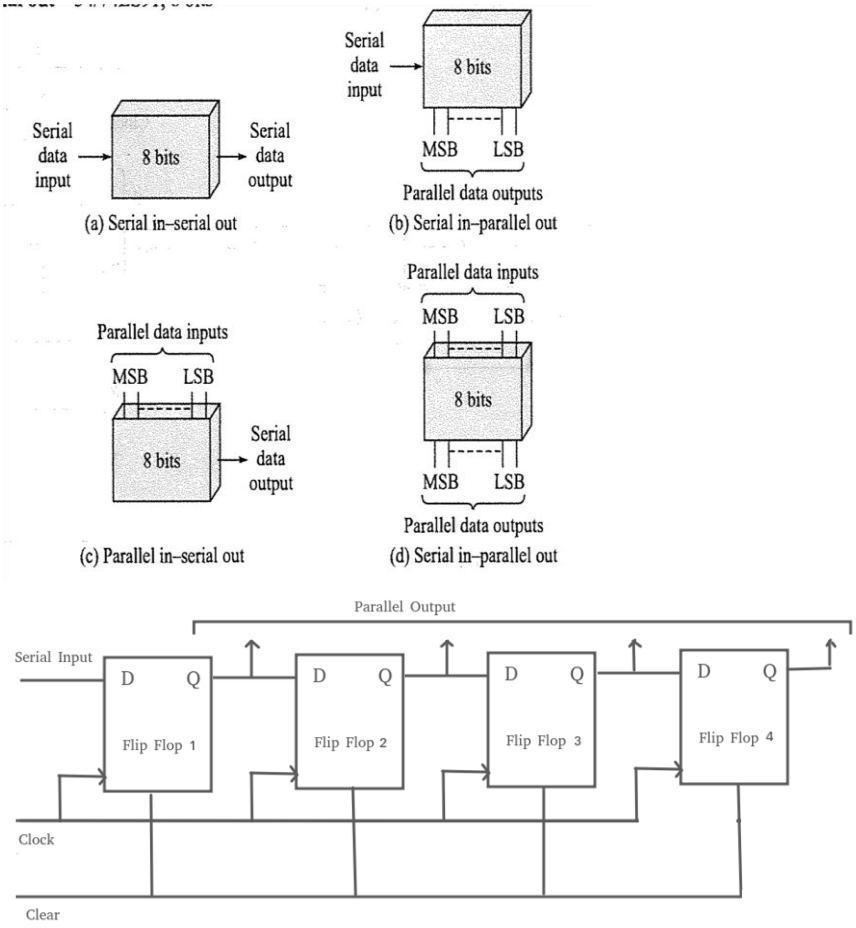


Figure 3.4

3. In order to shift the data out in parallel, it is simply necessary to have all the data bits available as outputs at the same time. This is easily accomplished by connecting the output of each flip-flop to an output pin.
4. It is similar to SISO with two exceptions : :
   i) the true side of each flip-flop is available as an output-thus all bits of any number stored in the register are available simultaneously as an output (this is a parallel data output); and
   ii) each flip-flop has an asynchronous clear input. Thus, a low level at the clear input will reset (clear) every flip-flop.

3.1.3 PARALLEL IN SERIAL OUT SHIFT REGISTER (PISO)

1. A Parallel-In Serial-Out shift register is used to convert parallel data to serial data.
2. The shift register, which allows parallel input, i.e., data is given separately to each flip-flop and in a simultaneous manner, and produces a serial output is known as Parallel-In Serial-Out shift register.
3. The logic circuit given below shows a parallel-in serial-out shift register. The circuit consists of four *D* flip-flops. The clock input is directly connected to all the flip-flops but the input bit is connected individually to each flip-flop. The output of the previous flip-flop and parallel data input are connected to the input of the *MUX* and the output of *MUX* is connected as the input to the next flip-flop. All these flip-flops are synchronous to each other since the same clock signal is applied to each flip-flop.

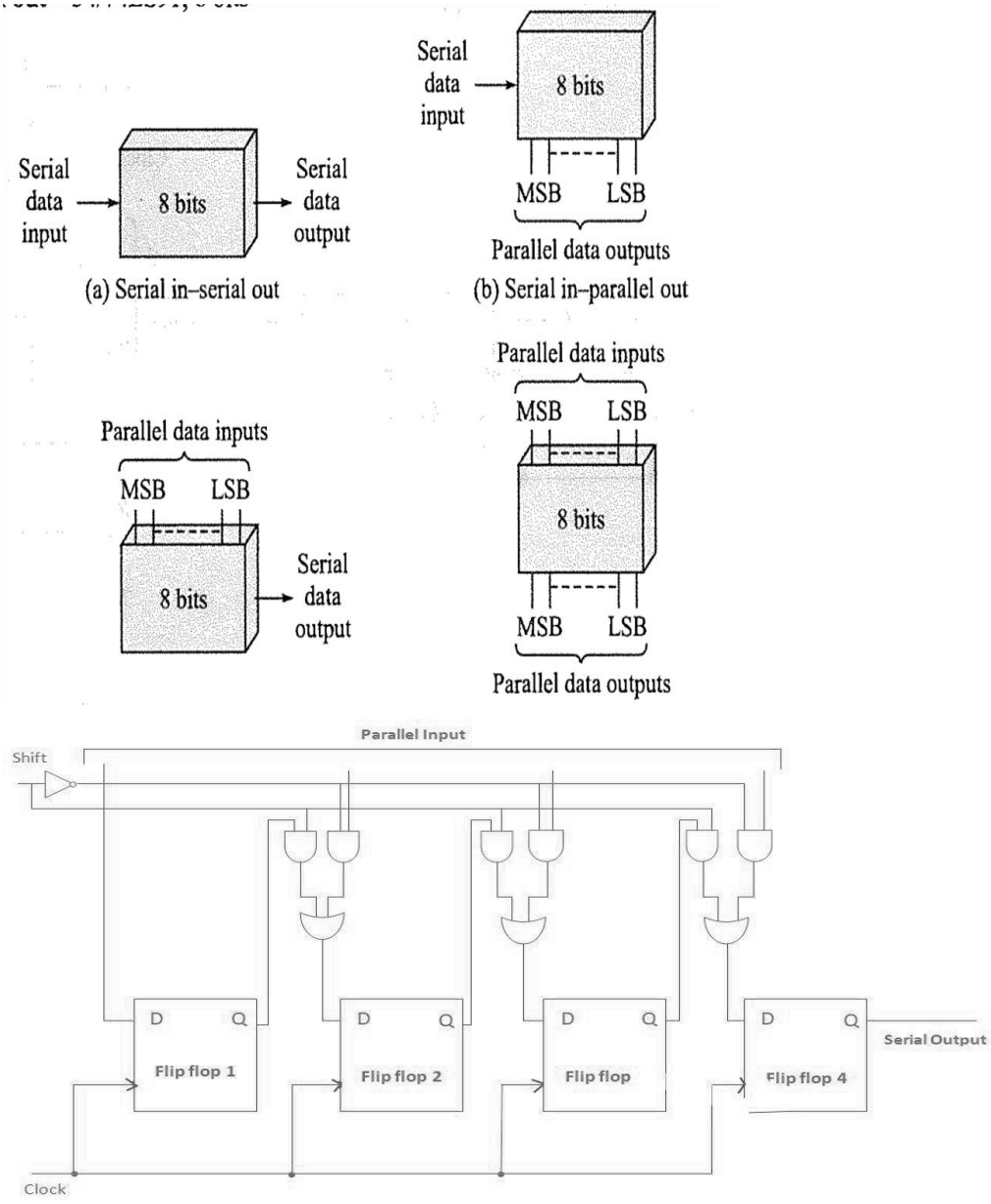


Figure 3.5

3.1.4 PARALLEL IN PARALLEL OUT SHIFT REGISTER (PIPO)

1. The shift register, which allows parallel input, i.e., data is given separately to each flip-flop and in a simultaneous manner, and also produces a parallel output is known as Parallel-In Parallel-Out shift register.
2. The logic circuit given below shows a parallel-in parallel-out shift register. The circuit consists of four *D* flip-flops which are connected to a common clock. In this type of register, there are no interconnections between the individual flip-flops since no serial shifting of the data is required. Data is given as input separately for each flip-flop and in the same way, output also is collected individually from each flip-flop.

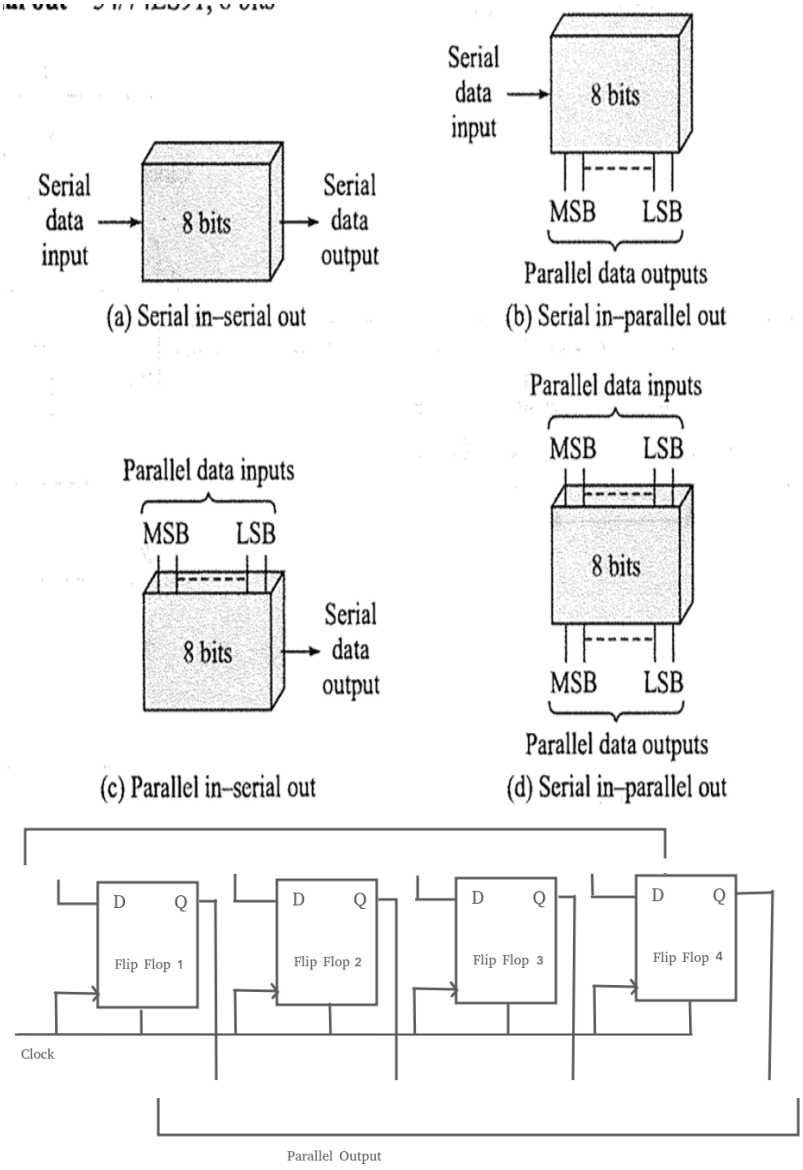


Figure 3.6

3. The input data bits are all shifted into the register in parallel. The stored data is immediately available, in parallel, at the outputs. This type of register is simply used to store data, and is sometimes called a data register, or data latch.

3.2 APPLICATIONS OF SHIFT REGISTERS

1. The shift registers are used for temporary data storage.
2. The shift registers are also used for data transfer and data manipulation.
3. The Serial-In Serial-Out and Parallel-In Parallel-Out shift registers are used to produce time delay to digital circuits.
4. The Serial-In Parallel-Out shift register is used to convert serial data into parallel data thus they are used in communication lines where demultiplexing of a data line into several parallel line is required.
5. A Parallel-In Serial-Out shift register us used to convert parallel data to serial data.

QUESTIONS

1. What is a Shift Register? What are the types of registers? Draw the block diagram of any one type of register.
2. What is a Shift Register? Give the full form of SISO and SIPO in Shift Registers.
3. What is a Shift Register? Draw the block diagram of SISO and PIPO Shift Registers.