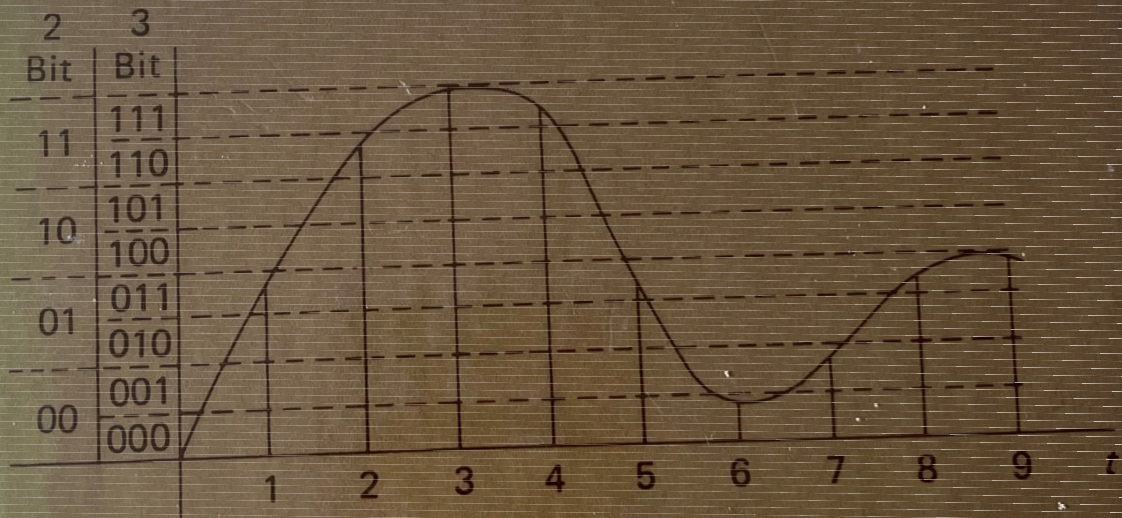
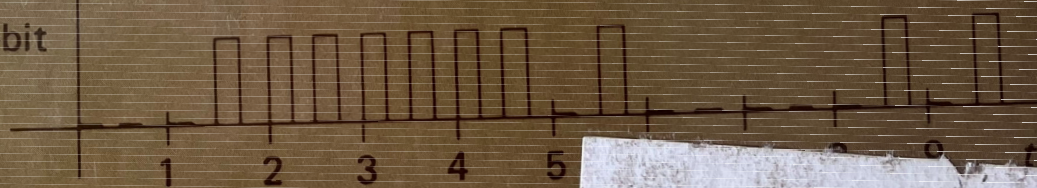


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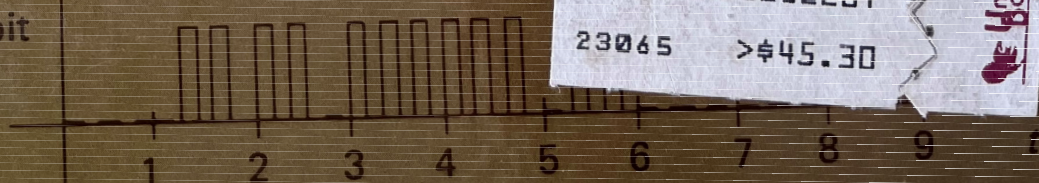
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SECOND EDITION

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TIME DIVISION MULTIPLEXING

We have continually stressed that signals could be separated from each other if they are non-overlapping in either time or frequency. Since the bandwidth of the pulse modulated waveform is extremely high (theoretically, it is infinity), frequency separation is not practical. Fortunately, the ideal pulse modulated waveform possesses portions of the time axis where the waveform is identically zero. Therefore, time separation is possible. When signals are added together such that they do not overlap in time, this is known as *time division multiplexing (TDM)*.

We can easily illustrate time division multiplexing (TDM) by returning to our original example of transmitting a signal by reading the list of sample values over a telephone.

Suppose that the reader is capable of reading two numbers every second, but the maximum frequency of $s(t)$ is only $\frac{1}{2}$ Hz. The sampling theorem tells us that at least one sample must be sent every second. If one sample per second is sent, the reader is idle for one half of every second. During this half second, a sample of another signal could be sent. Alternating between samples of the two signals is called *time division multiplexing*. The person at the receiver will realize that every other number is a sample of the second signal. The two signals can therefore be easily separated.

This operation can be described schematically with two switches, one at the transmitter and one at the receiver. The switches alternate between each of two positions making sure to take no longer than one sampling period to complete the entire circle. (See Fig. 6.13.)

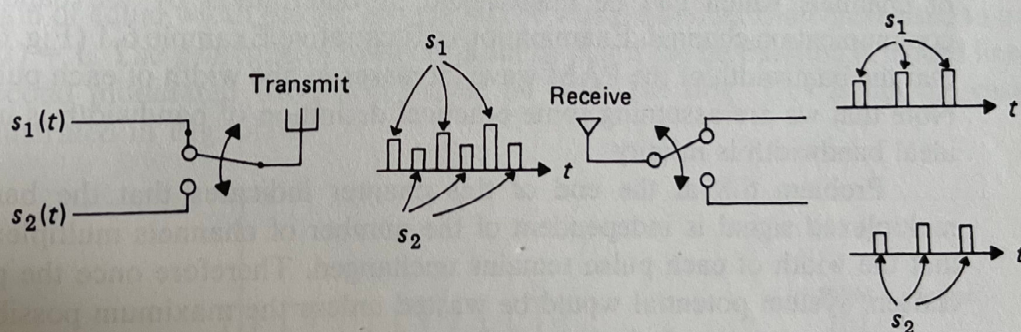


FIGURE 6.13 TDM of two signals.

If we now increase to 10 channels, we get a system as shown in Fig. 6.14.

The switch must make one complete rotation fast enough so that it arrives at channel # 1 in time for the second sample. The receiver switch must rotate in synchronism with that at the transmitter. In practice, this synchronization is not trivial to effect. If we knew exactly what was being sent as # 1, we could identify its samples at the receiver. Indeed, a common method of synchronization is to sacrifice one of the channels and send a known synchronizing signal in its place.

The only thing that limits how fast the switch can rotate, and therefore how many channels can be multiplexed, is the fraction of time required for each PAM