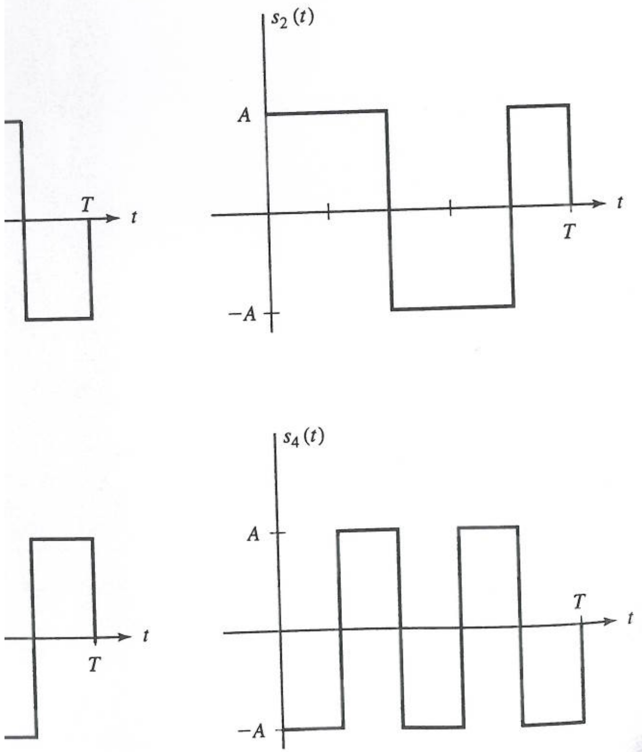
ords, we can construct M signal waveforms by mapping e $g_T(t)$ of duration T/N and a code bit $c_{mj} = 0$ into the

$$\mathbf{c}_1 = [1 \quad 1 \quad 1 \quad 1 \quad 0]$$
$$\mathbf{c}_2 = [1 \quad 1 \quad 0 \quad 0 \quad 1]$$
$$\mathbf{c}_3 = [1 \quad 0 \quad 1 \quad 0 \quad 1]$$
$$\mathbf{c}_4 = [0 \quad 1 \quad 0 \quad 1 \quad 0]$$

signal waveforms, as described above, using a rectangular pulse

above, a code bit 1 is mapped into the rectangular pulse $g_T(t)$ code bit 0 is mapped into the rectangular pulse $-g_T(t)$. Thus, veforms shown in Figure 7.28 that correspond to the four code



f $M = 4$ signal waveforms of dimension $N = 5$ constructed ords in Example 7.4.1.

Let us consider the geometric representation of a set of M signal waveforms generated from a set of M binary words of the form

$$\mathbf{c}_m = (c_{m1}, c_{m2}, \ldots, c_{mN}), \quad m = 1, 2, \ldots, M \tag{7.4.22}$$

where $c_{mj} = 0$ or 1 for all m and j. The M signal waveforms are of dimension N and are represented geometrically in vector form as

$$\mathbf{s}_m = (s_{m1}, s_{m2}, \ldots, s_{mN}), \quad m = 1, 2, \ldots, M \tag{7.4.23}$$

where $s_{mj} = \pm\sqrt{\mathcal{E}_s/N}$ for all m and j.

In general, there are 2^N possible signals that can be constructed from the 2^N possible binary code words. The M code words are a subset of the 2^N possible binary code words. We also observe that the 2^N possible signal points correspond to the vertices of an N-dimensional hypercube with its center at the origin. Figure 7.29 illustrates the signal points in $N = 2$ and $N = 3$ dimensions.

The M signals constructed in this manner have equal energy $\mathcal{E}_s$. The crosscorrelation coefficient between any pair of signals depends on how we select the M signals from the 2^N possible signals. This topic is treated in Chapter 9. It is apparent that any adjacent signal points have a crosscorrelation coefficient of (see Problem 7.2)

$$\gamma = \frac{N-2}{N} \tag{7.4.24}$$

and a corresponding Euclidean distance

$$d = 2\sqrt{\mathcal{E}_s/N} \tag{7.4.25}$$

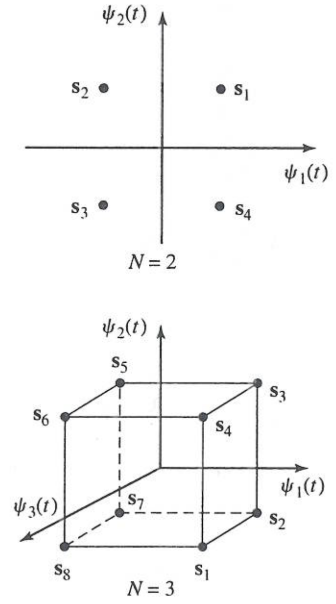


Figure 7.29 Signal-space diagrams for signals generated from binary codes.