

### Problem 5.25

- (a) In theory, any physical signal (exemplified by audio and video signals) has a spectrum that gradually decreases towards zero. From Fourier transform theory, we know that any signal cannot simultaneously have finite duration and finite bandwidth. Therefore, theoretically speaking, given a physical signal of finite duration, the band of frequencies occupied by that signal is infinitely large. Accordingly, when the signal is sampled in accordance with the Nyquist sampling theorem, there will always be some distortion produced by sampling the signal due to the aliasing phenomenon.
- (b) In practice, however, we usually limit the sampling rate to some finite value, depending on the application of interest. For example, for telephonic communication, it has been found experimentally that 3.1 kHz is considered to be adequate for describing the “effective” bandwidth of a voice signal, be that for a male or female. Thus, choosing a rate of 8 kHz is considered to be adequate for the uniform sampling of a voice signal in telephonic communication. In reality, there is some distortion produced by the sampling process, but for all practical purposes, the distortion is not significant enough to be perceived by a human listener. Indeed, it is for this reason that a sampling rate of 8 kHz is the universally accepted standard for the sampling of voice signals transmitted over a telephone line.

Similar remarks apply to the sampling of video signals; naturally, the sampling rate used for video signals is much higher than 8 kHz,