

Concept Question 2-6: Why must the sampling rate of a signal exceed double its maximum frequency, if it is to be reconstructed from its samples?

This is the sampling theorem, derived in Section 2-4. The essential part of the derivation is that the spectrum of the sampled signal consists of copies of the spectrum of the signal, repeating at the sampling rate. To keep these copies from overlapping, the sampling rate must exceed double the maximum frequency. Fig.2-6 illustrates this nicely.

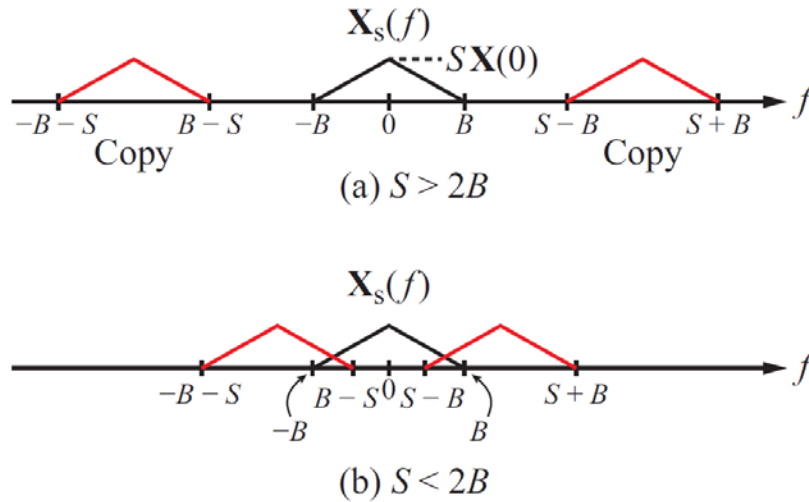


Figure 2-6 Sampling a signal $x(t)$ with maximum frequency B at a rate of S makes $\mathbf{X}(f)$ change amplitude to $S \mathbf{X}(f)$ and to repeat in f with period S . These copies (a) do not overlap if $S > 2B$, but (b) they do if $S < 2B$.