Problem 8.27 Consider a random process defined by

$$X(t) = \sin(2\pi W t)$$

in which the frequency W is a random variable with the probability density function

$$f_W(w) = \begin{cases} \frac{1}{B} & 0 < w < B \\ 0 & \text{otherwise} \end{cases}$$

Show that X(t) is nonstationary.

Solution

At time t = 0, X(0)=0 and the distribution of X(0) is

$$F_{X(0)}(x) = \begin{cases} 0 & x < 0\\ 1 & x \ge 0 \end{cases}$$

At time t = 1, $X(1) = \sin(2\pi w)$, and the distribution of X(1) is clearly not a step function so

$$F_{X(1)}(x) \neq F_{X(0)}(x)$$

And the process X(t) is not first-order stationary, and hence nonstationary.

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