4.31. Figure P4.31-1 shows the overall system for filtering a continuous-time signal using a discrete-time filter. The frequency responses of the reconstruction filter $H_r(j\Omega)$ and the discrete-time filter $H(e^{j\omega})$ are shown in Figure P4.31-2.

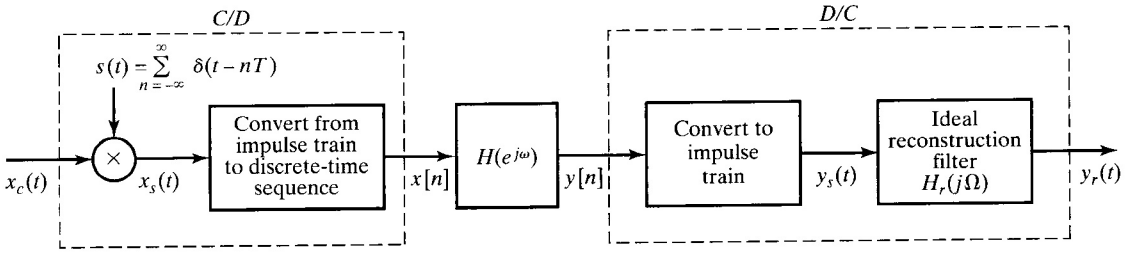

Figure P4.31-1

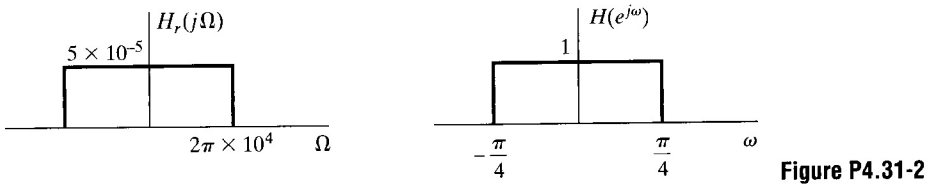

Figure P4.31-2

(a) For $X_c(j\Omega)$ as shown in Figure P4.31-3 and $1/T = 20$ kHz, sketch $X_s(j\Omega)$ and $X(e^{j\omega})$.

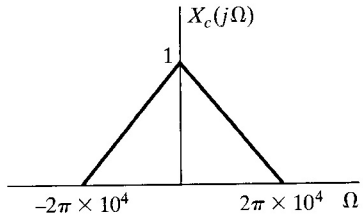

Figure P4.31-3

For a certain range of values of T, the overall system, with input $x_c(t)$ and output $y_c(t)$, is equivalent to a continuous-time lowpass filter with frequency response $H_{eff}(j\Omega)$ sketched in Figure P4.31-4.

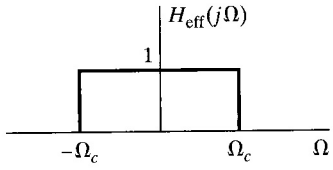

Figure P4.31-4

(b) Determine the range of values of T for which the information presented in (a) is true when $X_c(j\Omega)$ is bandlimited to $|\Omega| \leq 2\pi \times 10^4$ as shown in Figure P4.31-3.

(c) For the range of values determined in (b), sketch Ω_c as a function of $1/T$.

Note: This is one way of implementing a variable-cutoff continuous-time filter using fixed continuous-time and discrete-time filters and a variable sampling rate.