l) $x(t) = \text{sinc}(2t/\pi)\cos t, -\infty < t < \infty$
:) $x(t) = \text{sinc}(2t/\pi)\cos 3t, -\infty < t < \infty$
) $x(t) = \text{sinc}(2t/\pi)\cos 6t, -\infty < t < \infty$
:) $x(t) = \text{sinc}^2(t/\pi)\cos 2t, -\infty < t < \infty$

ot $x(t)$ and the corresponding output $y(t)$ for each of the cases computed (a)–(g). Use a small ough time increment on the plot to capture the high-frequency content of the signal.

linear time-invariant continuous-time system has the frequency response function $H(\omega) =$ $(\omega + 4) + p_2(\omega - 4)$. Compute the output response for the following inputs:

) $x(t) = \delta(t)$
:) $x(t) = \cos t \sin \pi t, -\infty < t < \infty$
) $x(t) = \text{sinc}(4t/\pi), -\infty < t < \infty$
) $x(t) = \text{sinc}(4t/\pi)\cos 3t, -\infty < t < \infty$

ot $x(t)$ and the corresponding output $y(t)$ for each of the cases computed (a)–(d). Use a all-enough time increment on the plot to capture the high-frequency content of the signal.

periodic signal $x(t)$ with period $T = 2$ has the Fourier coefficients

$$c_k = \begin{cases} 0, & k = 0 \\ 0 & \text{if } k \text{ is even} \\ 1 & \text{if } k \text{ is odd} \end{cases}$$

ie signal $x(t)$ is applied to a linear time-invariant continuous-time system with the mag tude and phase curves shown in Figure P5.25. Determine the system output.

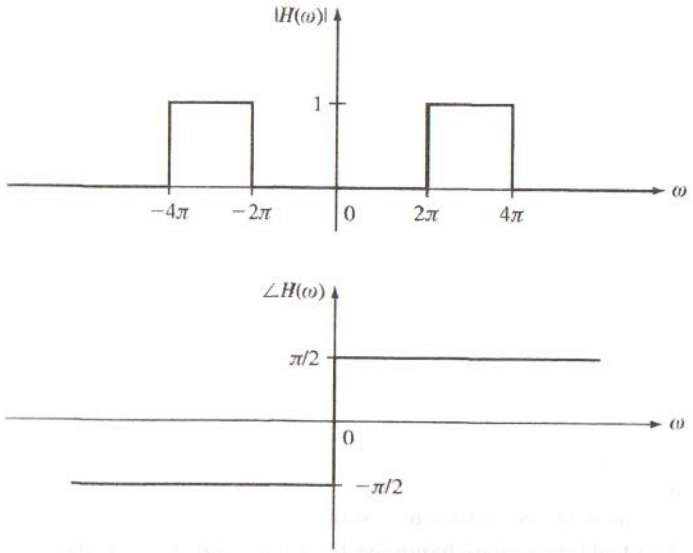


FIGURE P5.25

inear time-invariant continuous-time system has frequency function $H(\omega) = 5\cos 2\omega$, $\infty < \omega < \infty$.

Sketch the system's magnitude function $|H(\omega)|$ and phase function $\angle H(\omega)$.

Compute the system's impulse response $h(t)$.

Derive an expression for the output response $y(t)$ resulting from an arbitrary input $x(t)$

5.27. A *Hilbert transformer* is a linear time-invariant continuous-time system with impulse r sponse $h(t) = 1/t, -\infty < t < \infty$. Using the Fourier transform approach, determine t output response resulting from the input $x(t) = A\cos\omega_0 t, -\infty < t < \infty$, where ω_0 is arbitrary, strictly positive real number.

5.28. A linear time-invariant continuous-time system has frequency response function $H(\omega)$ $j\omega e^{-j\omega}$. The input $x(t) = \cos(\pi t/2)p_2(t)$ is applied to the system for $-\infty < t < \infty$.
(a) Determine the input spectrum $X(\omega)$ and the corresponding output spectrum $Y(\omega)$.
(b) Compute the output $y(t)$.

5.29. Consider the system in Figure P5.29, where $p(t)$ is an impulse train with period T an $H(\omega) = Tp_2(\omega)$. Compute $y(t)$ when

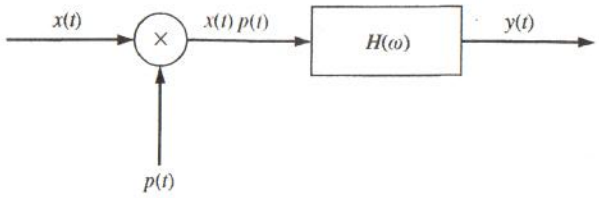


FIGURE P5.29

(a) $x(t) = \text{sinc}^2(t/2\pi)$ for $-\infty < t < \infty, T = \pi$
(b) $x(t) = \text{sinc}^2(t/2\pi)$ for $-\infty < t < \infty, T = 2\pi$
(c) For (a) and (b), compare the plots of $x(t)$ and the corresponding $y(t)$.
(d) Repeat part (a), using the interpolation formula to solve for $y(t)$, and plot your result with n ranging from $n = -5$ to $n = 5$.

5.30. Consider the signal whose Fourier transform is shown in Figure P5.30. Let $x_s(t) = x(t)p($ represent the sampled signal. Draw $|X_s(\omega)|$ for the following cases:

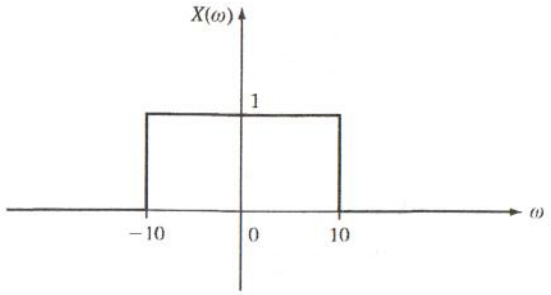


FIGURE P5.30

(a) $T = \pi/15$
(b) $T = 2\pi/15$

5.31. Repeat Problem 5.30 for the signal whose transform is shown in Figure P5.31.

5.32. Consider the signal with the amplitude spectrum shown in Figure P5.32. Let $x_s(t) = x(t)p($ represent the sampled signal. Draw $|X_s(\omega)|$ for the following cases:
(a) $T = \pi/4$ sec
(b) $T = \pi/2$ sec

5.39. An ideal linear-phase highpass digital filter has frequency function $H(\Omega)$, where for one period, $H(\Omega)$ is given by

$$H(\Omega) = \begin{cases} e^{-j3\Omega}, & \frac{\pi}{2} \le |\Omega| \le \pi \\ 0, & 0 \le |\Omega| < \frac{\pi}{2} \end{cases}$$

(a) Determine the unit-pulse response $h[n]$ of the filter.
(b) Compute the output response $y[n]$ of the filter when the input $x[n]$ is given by
(i) $x[n] = \cos(\pi n/4), n = 0, \pm1, \pm2, \ldots$
(ii) $x[n] = \cos(3\pi n/4), n = 0, \pm1, \pm2, \ldots$
(iii) $x[n] = \text{sinc}(n/2), n = 0, \pm1, \pm2, \ldots$
(iv) $x[n] = \text{sinc}(n/4), n = 0, \pm1, \pm2, \ldots$
(v) $x[n] = \text{sinc}(n/4)\cos(\pi n/8), n = 0, \pm1, \pm2, \ldots$
(vi) $x[n] = \text{sinc}(n/2)\cos(\pi n/8), n = 0, \pm1, \pm2, \ldots$
(c) For each signal defined in part (b), plot the input $x[n]$ and the corresponding output $y[n]$ to determine the effect of the filter.

5.40. A linear time-invariant discrete-time system has the frequency response function $H(\Omega)$ shown in Figure P5.40.

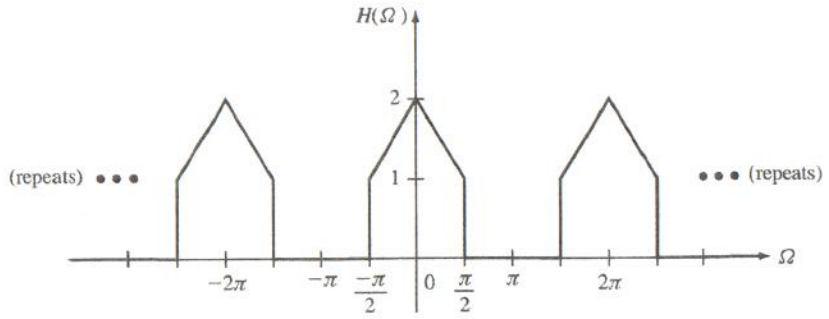
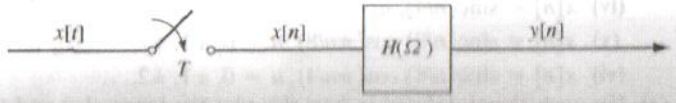


FIGURE P5.40

(a) Determine the unit-pulse response $h[n]$ of the system.
(b) Compute the output response $y[n]$ when the input $x[n]$ is equal to $\delta[n] - \delta[n-1]$.
(c) Compute the output response $y[n]$ when the input is $x[n] = 2 + \sin(\pi n/4) + 2\sin(\pi n/2)$.
(d) Compute the output response $y[n]$ when $x[n] = \text{sinc}(n/4), n = 0, \pm1, \pm2$.
(e) For the signals defined in parts (b) and (c), plot the input $x[n]$ and the corresponding output $y[n]$ to determine the effect of the filter.

5.41. As shown in Figure P5.41, a sampled version $x[n]$ of an analog signal $x(t)$ is applied to a linear time-invariant discrete-time system with frequency response function $H(\Omega)$



Choose the sampling interval T and determine the freq
so that

$$y[n] = \begin{cases} x[n], & \text{when } x(t) = A\cos\omega_0 t, \quad 100 \\ 0, & \text{when } x(t) = A\cos\omega_0 t, \quad 0 \le \end{cases}$$

Express $H(\Omega)$ in analytical form.

5.42. Consider the ideal lowpass digital filter with frequency resp

$$H(\Omega) = \begin{cases} e^{-j10\Omega}, & 0 \le |\Omega| \le \frac{\pi}{4} \\ 0, & \frac{\pi}{4} < |\Omega| < \end{cases}$$

(a) The input $x[n] = u[n] - u[n-10]$ is applied to the fi
(i) Using `fft` in MATLAB, compute the 32-point I sponse. *Note:* To calculate the DFT of the output, out the multiplication of the DFT of the input, X_k is the frequency response function of the filter. T
(ii) Using `ifft` in MATLAB, compute the output resp
(b) Repeat part (a) for the input $x[n] = u[n] - u[n-5]$.
(c) Compare the output response obtained in parts (a) a responses differ? Explain.
(d) Repeat part (a) for the input

$$x[n] = \begin{cases} r[n] - 0.5, & n = 0, 1, 2 \\ 0, & \text{all other } n \end{cases}$$

where $r[n]$ is a sequence of random numbers uniform How does the magnitude of the response compare wi Explain.

5.43. Repeat Problem 5.42 for the linear time-invariant discre response function

$$H(\Omega) = \frac{0.04}{e^{j2\Omega} - 1.6e^{j\Omega} + 0.64}$$

5.44. By definition of a WMA filter, the frequency response fu $\Omega = 0$.
(a) Design a 4-point WMA digital filter so that the freque following conditions: $H(\pi/2) = 0.2 - j0.2, H(\pi) = 0$ the input/output relationship of the filter.
(b) Plot the magnitude and phase functions of the filter de

5.45. Consider the discrete-time system given by the input/outp

$$y[n+1] + 0.9y[n] = 1.9x[n+1$$

(a) Show that the impulse response is given by $h[n] = 1.9$
(b) Compute the frequency response function, and sketch