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Problem 3.17, 3.18 (p.254) – Input to LTI [SS3:85]

3.17. Consider three continuous-time systems S_1, S_2, and S_3 whose responses to a complex exponential input e^{j5t} are specified as

$$S_1 : e^{j5t} \longrightarrow te^{j5t},$$
$$S_2 : e^{j5t} \longrightarrow e^{j5(t-1)},$$
$$S_3 : e^{j5t} \longrightarrow \cos(5t).$$

For each system, determine whether the given information is sufficient to conclude that the system is definitely *not* LTI.

3.18. Consider three discrete-time systems S_1, S_2, and S_3 whose respective responses to a complex exponential input $e^{j\pi n/2}$ are specified as

$$S_1 : e^{j\pi n/2} \longrightarrow e^{j\pi n/2}u[n],$$
$$S_2 : e^{j\pi n/2} \longrightarrow e^{j3\pi n/2},$$
$$S_3 : e^{j\pi n/2} \longrightarrow 2e^{j5\pi n/2}.$$

For each system, determine whether the given information is sufficient to conclude that the system is definitely *not* LTI.

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Problem 3.13 (p.253) – Output = Freq Resp & Input [SS3:86]

3.13. Consider a continuous-time LTI system whose frequency response is

$$H(j\omega) = \int_{-\infty}^{\infty} h(t)e^{-j\omega t}\,dt = \frac{\sin(4\omega)}{\omega}.$$

If the input to this system is a periodic signal

$$x(t) = \begin{cases} 1, & 0 \le t < 4 \\ -1, & 4 \le t < 8 \end{cases}$$

with period $T = 8$, determine the corresponding system output $y(t)$.

Problem 3.14 (p.253) – Output = Freq Resp & Input [SS3:86]

3.14. When the impulse train

$$x[n] = \sum_{k=-\infty}^{\infty} \delta[n-4k]$$

is the input to a particular LTI system with frequency response $H(e^{j\omega})$, the output of the system is found to be

$$y[n] = \cos\left(\frac{5\pi}{2}n + \frac{\pi}{4}\right).$$

Determine the values of $H(e^{jk\pi/2})$ for $k = 0, 1, 2,$ and 3.

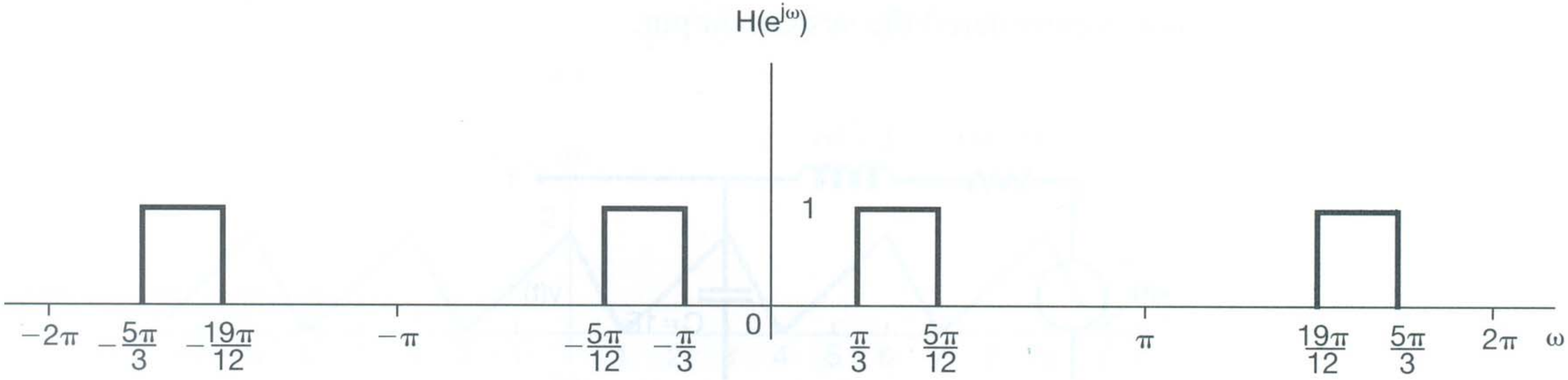
Problem 3.16 (p.253) – Output = Freq Resp & Input [SS3:86]

3.16. Determine the output of the filter shown in Figure P3.16 for the following periodic inputs:

(a) $x_1[n] = (-1)^n$

(b) $x_2[n] = 1 + \sin\left(\frac{3\pi}{8}n + \frac{\pi}{4}\right)$

(c) $x_3[n] = \sum_{k=-\infty}^{\infty}\left(\frac{1}{2}\right)^{n-4k} u[n-4k]$



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Problem 3.20 (p.254) – Differential Equation for RLC [SS3:99]

3.20. Consider a causal LTI system implemented as the *RLC* circuit shown in Figure P3.20. In this circuit, $x(t)$ is the input voltage. The voltage $y(t)$ across the capacitor is considered the system output.

(a) Find the differential equation relating $x(t)$ and $y(t)$.

(b) Determine the frequency response of this system by considering the output of the system to inputs of the form $x(t) = e^{j\omega t}$.

(c) Determine the output $y(t)$ if $x(t) = \sin(t)$.

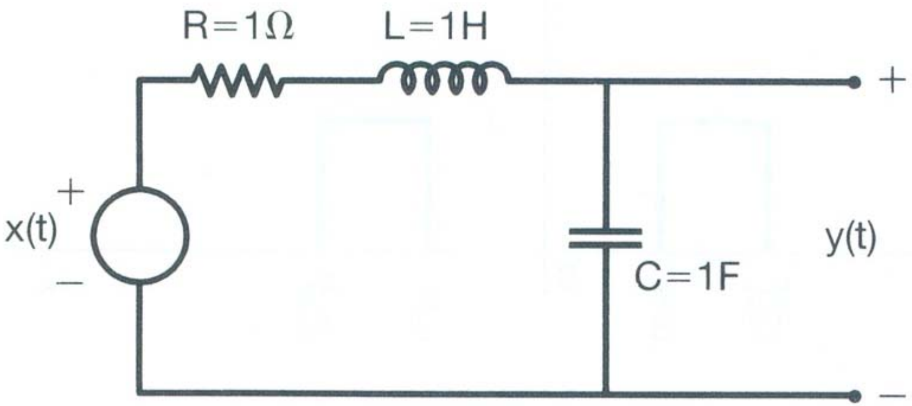

Figure P3.20