Note that some problems are from Oppenheim’s book and the answers were given at the end of the book. So if you just provide the answer without detailed steps, you will get zero point for that problem.

This homework focuses on how to utilize LCDE.

1. A causal and stable LTI system $S$ has the frequency response

$$H(j\omega) = \frac{j\omega + 4}{6 - \omega^2 + 5j\omega}$$

(a) Determine the differential equation relating the input $x(t)$ and the output $y(t)$ of $S$.

(b) Determine the impulse response $h(t)$ of $S$.

(c) What is the output of $S$ when the input is $x(t) = te^{-2t}u(t)$?

2. Consider an LTI system whose response to the input $x(t) = (e^{-t} + e^{-3t})u(t)$ is $y(t) = (2e^{-t} - 2e^{-4t})u(t)$

(a) Find the frequency response of the system

(b) Determine the system’s impulse response

(c) Find the LCDE that describes the system

3. The LCDE that describes a stable and causal LTI is

$$\frac{d^2y(t)}{dt^2} + \sqrt{2}\frac{dy(t)}{dt} + y(t) = 2\frac{d^2x(t)}{dt^2} - 2x(t)$$

Find the impulse response of the system.

4. A causal and stable LTI system $S$ has the following property

$$\left(\frac{4}{5}\right)^n u[n] \rightarrow n\left(\frac{4}{5}\right)^n u[n]$$

(a) Determine the frequency response $H(e^{j\omega})$ for the system $S$.

(b) Determine a difference equation relating any input $x[n]$ and the corresponding output $y[n]$. 

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