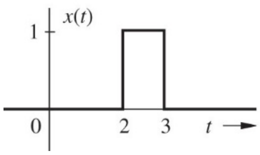
ENGR 3323: Signals and Systems

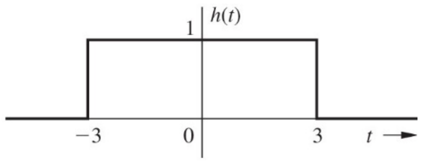
HW 4_Ch2

1) The unit impulse response of an LTIC system is $h(t) = e^{-2t} u(t)$. Find this system's (zero-state) response $y(t)$ if the input $x(t)$ is

a) $2u(t)$ b) $e^{-t} u(t)$ c) $\sin 3t\, u(t)$ d) the pulse $2\Pi\left(\frac{t-1}{2}\right)$ e) $\delta(t)$ f) $\delta(t-2)$

2) Figure below shows the input $x(t)$ and the impulse response $h(t)$ for an LTIC system. Let the output be $y(t)$.

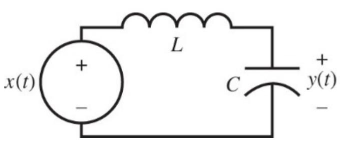




a. By inspection of $x(t)$ and $h(t)$, find $y(-1)$, $y(0)$, $y(1)$, $y(2)$, $y(3)$, $y(4)$, $y(5)$, and $y(6)$. Thus, by merely examining $x(t)$ and $h(t)$, you are required to see what the result of convolution yields at $t = -1, 0, 1, 2, 3, 4, 5$, and 6.

b. Find the system response to the input $x(t)$.

3) Consider the electric circuit shown below.



a. Determine the differential equation that relates the input $x(t)$ to output $y(t)$.

b. Find the characteristic equation for this circuit, and express the root(s) of the characteristic equation in terms of L and C.

c. Determine the zero-input response given an initial capacitor voltage of one volt and an initial inductor current of zero amps. That is, find $y_0(t)$ given $v_c(0) = 1$ V and $i_L(0) = 0$ A. [Hint: The coefficient(s) in $y_0(t)$ are independent of L and C.]

d. Plot $y_0(t)$ for $t \geq 0$. Does the zero-input response, which is caused solely by initial conditions, ever "die" out?

e. Determine the total response $y(t)$ to the input $x(t) = e^{-t}u(t)$. Assume an initial inductor current of $i_L(0^-) = 0$ A, an initialcapacitor voltage of $v_c(0^-) = 1$ V, $L = 1$ H, and $C = 1$ F.

4) Explain, with reasons, whether the LTIC systems described by the following equations are (i) stable or unstable in the BIBO sense; (ii) asymptotically stable, unstable, or marginally stable. Assume that the systems are controllable and observable.

a. $(D^2 + 8D + 12)y(t) = (D - 1)x(t)$

b. $D(D^2 + 3D + 2)y(t) = (D + 5)x(t)$

c. $D^2(D^2 + 2)y(t) = x(t)$

d. $(D + 1)(D^2 - 6D + 5)y(t) = (3D + 1)x(t)$

5) Determine a frequency ω that will cause the input $x(t) = \cos(\omega t)$ to produce a strong response when applied to the system descriptbed by $(D^2 + 2D + 13/4)\, y(t) = x(t)$. Carfully explain your choice.