University of Portland
School of Engineering

EE 262
Spring 2012
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Homework # 4—Convolution Integral and Sum
(Assigned: Monday, February 27, 2012)
(Due date: Wednesday, March 7, 2012, 1:35p.m.)

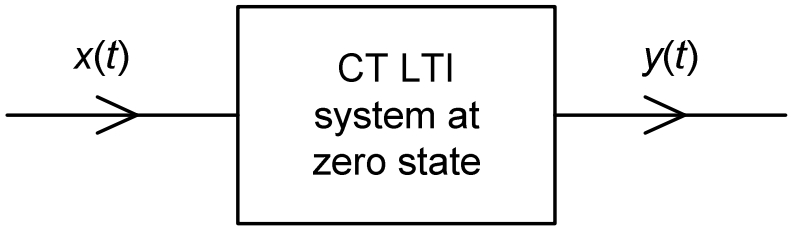
The following homework problems are prepared by A. Inan:

Problem # 1. Convolution integrals. Evaluate the following convolution integrals:

(a) $y(t) = e^{-at}u(t) * e^{-bt}u(t)$ where $a, b \geq 0$
(b) $y(t) = e^{-at}u(t) * u(t)$ where $a \geq 0$
(c) $y(t) = e^{-at}u(t) * \delta(t-b)$ where $a, b \geq 0$
(d) $y(t) = e^{-2t}u(t) * [3u(t-1)-2\delta(t-3)]$
(e) $y(t) = e^{-2t}u(t-1) * 3u(t-4)$

Provide $y(t)$ functions obtained in their simplest form.

Problem # 2. CT LTI System. The unit-step response of a continuous-time (CT) linear time-invariant (LTI) system shown is given by $y_s(t) = (3-2e^{-t})u(t)$. Find (a) the impulse response $h(t)$; (b) the unit-ramp response $y_r(t)$; and (c) the response $y(t)$ due to $x(t) = 2[u(t-1)-u(t-3)]$. Assume zero initial conditions.



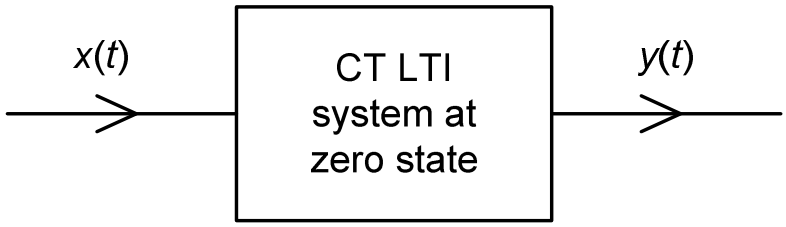
$y_s(t) = (3-2e^{-t})u(t)$

Problem # 3. Convolution integrals. Evaluate the following convolution integrals:

(a) $y(t) = u(t) * r(t)$
(b) $y(t) = u(t-a) * r(t-b)$
(c) $y(t) = [2r(t-1)+u(t-3)] * [u(t) -3\delta(t-2)]$

Provide $y(t)$ functions in their simplest form.

Problem # 4. CT LTI System. The impulse response of a CT LTI system shown is given by $h(t) = 2[u(t)–u(t–2)]$. If the input signal $x(t) = t[u(t–1)–u(t–3)]$ is applied to this system, find its response $y(t)$. Assume zero initial conditions.



$h(t) = 2[u(t)–u(t–2)]$

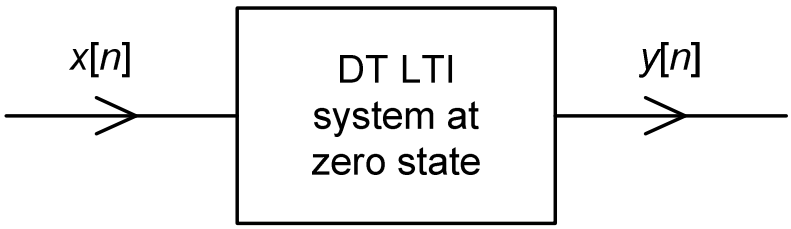
Problem # 5. Convolution integral. Evaluate and sketch the result of the convolution integral $y(t) = x(t) * h(t)$ where $x(t) = A[u(t–a)–u(t+a)]$, $h(t) = B[u(t+b)–u(t–b)]$, and $b \geq a \geq 0$. (Hint: First, sketch both functions to gain some insight as to what to expect as a result of the convolution integral.)

Problem # 6. Convolution sums. Evaluate the following convolution sums:

(a) $y[n] = x[n] * h[n] = (\delta[n–3]–2\delta[n–1]) * (3u[n+1]–2u[n–1]–u[n–3])$
(b) $y[n] = x[n] * h[n] = (2\delta[n+1]–3\delta[n–2]) * (2u[n]–5u[n–2]+3u[n–4])$

For each case, provide $y[n]$ function in its simplest form.

Problem # 7. DT LTI system. The impulse response of a discrete-time (DT) LTI system is given as $h[n] = \delta[n+1]–3\delta[n–2]$. Find the response $y[n]$ of this system due to an input signal $x[n] = n(u[n]–u[n–4])$. Assume zero initial conditions.



$h[n] = \delta[n+1]–3\delta[n–2]$