EECS 360 Short Quiz #1

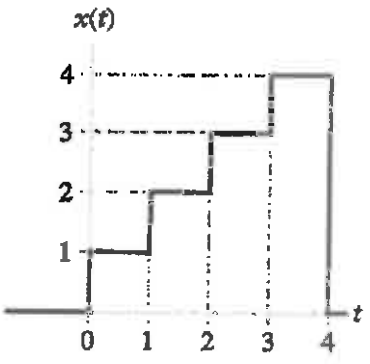
Signal and System Analysis

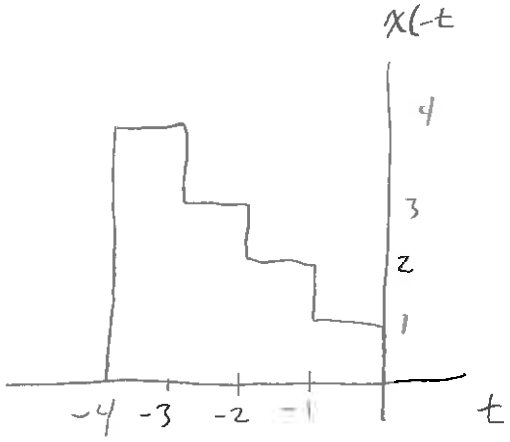
January 31, 2012

Name: KEY

Open book, open notes, no calculator. Be neat, write legibly. For full credit you must show all work and justify each answer. You may write on the both sides of the paper, and use additional sheets of paper if needed.

1. (40 %) Consider the signal $x(t)$ shown below:





(a) Sketch the even part of $x(t)$.

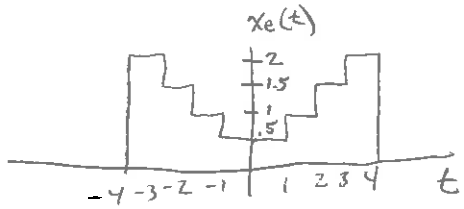
(b) Sketch the odd part of $x(t)$.

(c) Compute the energy of $x(t)$.

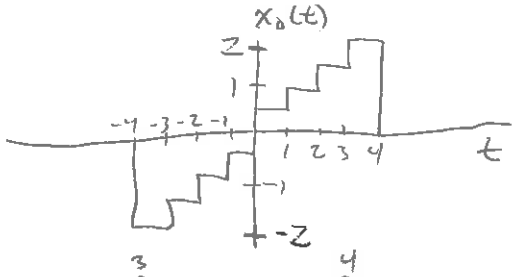
(d) Express $x(t)$ in terms of the rect(t) function.

(e) Express $x(t)$ in terms of the $u(t)$ function.

(a) $x_e(t) = \frac{1}{2}(x(t) + x(-t)) \Rightarrow$



(b) $x_o(t) = \frac{1}{2}(x(t) - x(-t)) \rightarrow$

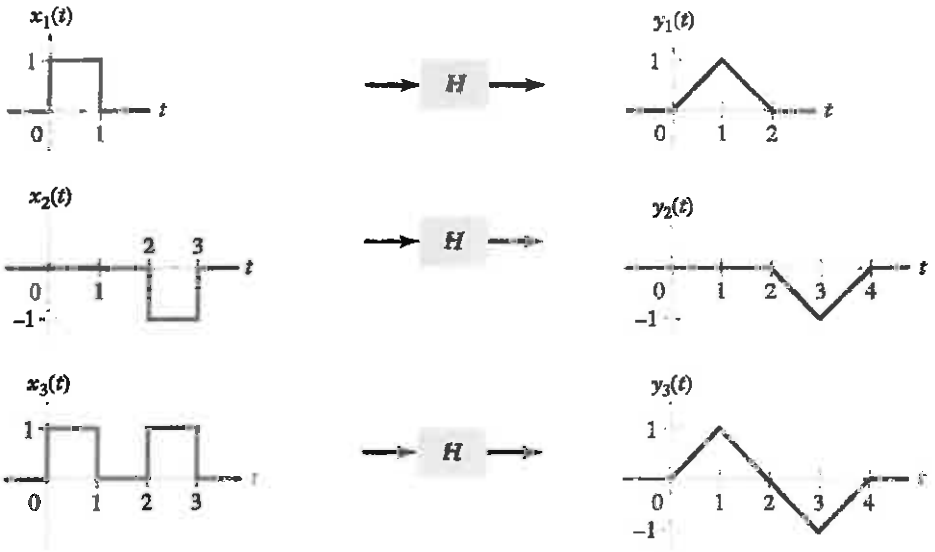


(c) $E_x = \int_{-\infty}^{\infty} |x(t)|^2 dt = \int_0^1 (1)^2 dt + \int_1^2 (2)^2 dt + \int_2^3 (3)^2 dt + \int_3^4 (4)^2 dt = 1^2 + 2^2 + 3^2 + 4^2 = 30$

(d) $x(t) = \text{rect}(t - \frac{1}{2}) + 2\,\text{rect}(t - 1\frac{1}{2}) + 3\,\text{rect}(t - 2\frac{1}{2}) + 4\,\text{rect}(t - 3\frac{1}{2})$

(e) $x(t) = u(t) + u(t-1) + u(t-2) + u(t-3) - 4u(t-4)$

2. (30 %) A system H is fed with three different input signals which result in three different output signals. These three input-output pairs are shown below.



Determine whether or not the system could be:

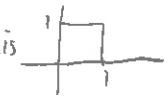
(a) Memoryless?

(b) Causal?

(c) Linear?

(d) Time invariant?

For all cases, justify your answers.

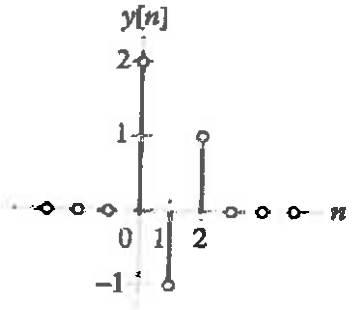
(a) because the system continues to respond to this  after the 1-second mark, ie. the response continues to the 2-second mark, then the system has some sort of memory => not memoryless

(b) $x_1(t)$ starts at $t=0$, $y_1(t)$ does not start before $t=0$
$x_2(t)$ " " $t=2$, $y_2(t)$ " " " " $t=2$
$x_3(t)$ " " $t=0$, $y_3(t)$ " " " " $t=0$
} it could be causal

(c) we can write $x_3(t)$ as $x_3(t) = x_1(t) - x_2(t)$, if it is linear, then we would have $y_3(t) = y_1(t) - y_2(t)$, but we don't => non linear

(d) we can write $x_2(t)$ as $x_2(t) = -x_1(t-2)$ => and we do have $y_2(t) = -y_1(t-2)$
In the case of $y_3(t)$, we are already messed up by the nonlinearity, so it is difficult to say if time invariance still holds => maybe time invariant maybe not

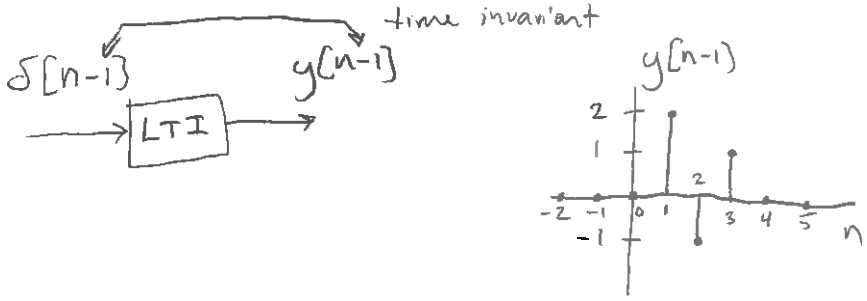
3. (30 %) A discrete-time system is both linear and time invariant. Suppose the system is fed with an input of $x[n] = \delta[n]$ and the resulting output $y[n]$ is shown below:



(a) Find the output due to an input $x[n] = \delta[n-1]$.

(b) Find the output due to an input $x[n] = 2\delta[n] - \delta[n-2]$.

(a)



(b)