

## EE 438 Digital Signal Processing with Applications

### Homework #1 due 9/1/95

1. Use Matlab to compute the following. Make sure that the axis of you plot are correctly labeled.

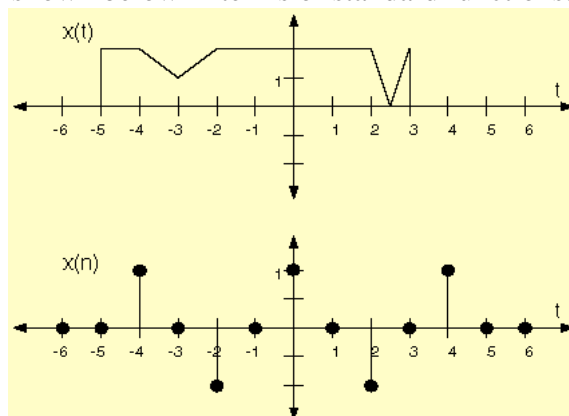
- i. Plot  $x(t)$  on  $[-T, T]$
- ii. Compute  $\max_{t \in [-T, T]} \{|x(t)|\}$
- a.  $x(t) = t^2$  for  $T = 10$
- b.  $x(t) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{1}{2}t^2\right)$  for  $T = 4$
- c.  $x(t) = \exp(\sin(t) + \cos(t))$  for  $T = 2\pi$

2. For each signal  $x(t)$  below, do the following:

- i. Sketch  $x(t)$
- ii. State whether it is right-sided, left-sided, or two-sided.
- iii. State whether it is causal, anti-causal, or neither.
- iv. Calculate the metrics  $E_x$ ,  $P_x$ ,  $x_{rms}$ ,  $M_x$ ,  $A_x$ , and  $x_{avg}$ .

- a.  $x(t) = \sum_{k=-\infty}^{\infty} \Lambda(2t - k)$
- b.  $x(t) = u(1 - 3t)e^{-(1-3t)}$
- c.  $x(t) = e^{-t^2/4}$
- d.  $x(t) = \frac{1}{|t + 1|}$

3. Express each signal shown below in terms of standard functions:



4. For each system below, determine whether or not it is:

- i. linear,
- ii. time-invariant,
- iii. causal,
- iv. stable,
- v. memoryless

For each of the above properties, if you think it holds, prove it. Otherwise, find a counter-example. In addition, find the response to an impulse.

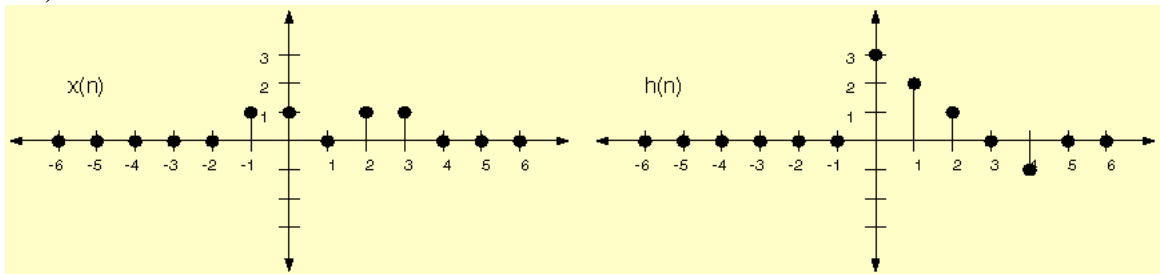
- a)  $y(t) = \int_0^t x(t) dt$
- b)  $y(n) = 2x(n) + 3$
- c)  $y(n) = x(n)2^n$

5. Find a general expression for the  $N$  roots  $z_i, i = 0, 1, \dots, N-1$  of the following polynomial, where  $z$  and  $w$  are complex-valued:  $z^N - w = 0$ . *Hint:* Express both  $z$  and  $w$  in polar coordinates, and note that angles need only match within a multiple of  $2\pi$  radians. Sketch the roots in the complex plane for the following values of  $N$  and  $w$ :

- a.  $N = 4, w = -2$ ,
- b.  $N = 5, w = j$ ,

6. A LTI system has input  $x(n)$  and impulse response  $h(n)$ . Compute the output  $y(n)$  for each of the following cases ( $a, b < 1$ ).

- a)  $x(n) = u(n) - u(n-4); h(n) = a^n u(n)$
- b)  $x(n) = a^n u(n); h(n) = b^n u(n) (a \neq b)$
- c)  $x(n) = a^n u(n); h(n) = a^n u(n)$
- d)



7. For each of the following D-T signals,
- i. Compute the DTFT  $X(\omega)$ . Simplify your answer as much as possible.
  - ii. Sketch  $|X(\omega)|$ .
- a.  $x[n] = e^{-2|n|}$ ,
  - b.  $x[n] = \begin{cases} (-1)^n, & 0 \leq n \leq 19, \\ 0, & \text{else,} \end{cases}$
  - c.  $x[n] = 4 \cos(\pi n / 12 + \pi / 3)$ .