Professor Fearing EECS120/Problem Set 1 v 1.01 Spring 2014

Due at 12 pm, Wed. Jan. 29 in HW box under stairs (1st floor Cory)

Note: $\Pi(t) = u(t+\frac{1}{2}) - u(t-\frac{1}{2})$, and $r(t) = tu(t)$ where $u(t)$ is the unit step.

1. (20 pts) What are signals and systems? For each example below, identify the input x, system $H\{\}$, and output y. Which of (x, H, y) are known *a priori*, which would need to be calculated or designed? *Example: NASDAQ market manipulation. Answer: Input: buy and sell orders. System: dealer network plus investor behavior plus order book. Output: share price. System known, output directly measured, design input to control price.*

a) a person running
b) a television broadcasting station
c) a television receiver
d) a communications satellite
e) ultrasonic imaging

2. (25 pts) For $f(t) = \Pi(\frac{t-1}{2})(1-2r(t))$, sketch:

a) $f(t)$
b) $f(\frac{t}{2})$
c) $f(\frac{1}{2}t+1)$,
d) $f(-\frac{1}{2}t+1)$
e) $f(3[-\frac{1}{2}t+1])$.

3. (10 pts) Show that the following functions have the two properties of the unit impulse, i.e. #1: $\delta(t-t_o) = 0$ for t not equal t_o and #2: $\int_{-\infty}^{\infty}\delta(t)dt = 1$

a) $\delta_1(t) = \lim_{a\to\infty} ae^{-at}u(t)$

b) $\delta_2(t) = \lim_{a\to 0} \frac{1}{a}(1-|\frac{t}{a}|)\Pi(\frac{t}{2a})$

4. (25 pts) For each of the following impulse responses, determine whether the system is BIBO stable. If the system is not BIBO stable, find a bounded input $x(t)$ which gives an unbounded output, and show that the output is unbounded for this input.

a. $h(t) = e^{-t}u(t)$
b. $h(t) = t^2e^{-t}u(t)$
c. $h(t) = u(t-1)$
d. $h(t) = \frac{1}{t}u(t-1)$
e. $h(t) = \sum_{n=-\infty}^{\infty}\Pi(t-2n)$

5. (20 pts)

An LTI system has impulse response $h(t) = \Pi(\frac{t-1}{2})$ and input $x(t) = \delta(t) + 3\delta(t-1) - 2\delta(t-2)$.

a. Using the principle of superposition for an LTI system, find output $y(t)$.
b. Find $y(t)$ using the convolution integral.