

Homework #1, BioE 2696 / ECE 2695 Control Theory in Neuroscience, Spring 2009

Problem 1. Consider a family of signals described by

$$u(t) = \begin{cases} 1/\sqrt{d}, & 0 \leq t \leq d \\ 0, & d < t < 1 \end{cases}$$

for $0 \leq t < 1$, and periodic with period 1 (i.e., the signal repeats every second). The parameter d , which satisfies $0 < d < 1$, is called the *duty cycle* of the periodic pulse signal. Sketch the signal for a few values of d . What are its peak, RMS (root-mean-square), and average-absolute values? As the duty-cycle d approaches 0, is the signal getting smaller or larger?

Problem 2. Find the DFT for each of the following signals:

(a) $x[n] = 6 \cos(2\pi n/32)$, $0 \leq n < 32$;

(b) $x[n] = e^{j2\pi n}$, $0 \leq n < 6$.

Problem 3. A sample and hold (S/H) system, with sample time h , is described by $y(t) = r(h \lfloor t/h \rfloor)$, where $r(t)$ is the input, $y(t)$ is the output, and $\lfloor x \rfloor$ denotes the largest integer that is less than or equal to x . Sketch an input and corresponding output signal for an S/H system, to illustrate that you understand what it does. Is an S/H system linear?

Problem 4. Compute the convolution $y(t) = x(t) * h(t)$ for the following pair of signals:

