Homework #1, EECS 206, Fall 2002. Due **Fri. Sep. 13**, by 4:30PM

Notes

- We will use the Wolverine access email service to send announcements to the class. Make sure that you have a proper email address associated with your uniquename for email to *uniquename*@umich.edu.
- You must write the Engineering Honor Pledge on your exams in this class for them to be graded. To review the honor pledge, visit `http://www.engin.umich.edu/org/ehc/`

Homework Policies

- Homework solutions must be placed in the 206 “lock box” outside of room 4234 EECS by the due date and time.
- Absolutely no late homework will be accepted. The “drop lowest score” policy on grade calculation is designed to cover unforseen circumstances like illness, flat tires, homework chewing dogs, etc.
- Solutions will be posted on the web shortly after the due date and time. To access the solutions you will need the password given in lecture.
- Homework will be returned in lab sections about a week after the due date.
- You must write your lab section number at the top of your solution, otherwise your score will not be entered.
- *Staple* your homework solution in the upper left corner, and put all problems *in the assigned order*.
- Write neatly. Annoyed graders will be understandably frugal with partial credit.
- Generally only a subset of the problems will be graded. The final answers to some of these problems are available. These problems are perhaps less likely to be graded. Problems that are not graded may be more likely to be used on exams. Be sure to check your answers against the solutions, even if the grader gives you full credit, since often there are both easy and hard ways to solve these problems!
- Points are indicated with square brackets. A problem marked [0] points will not be graded (though solutions will be provided), but may still be the basis for exam questions unless labeled “challenge.”
- Unless instructed otherwise, you may use Matlab to help solve any problem for which it is useful, even if not explicitly instructed to use Matlab by the problem. However, keep in mind that on the exams you will not have Matlab available, so if there is a “non-Matlab” approach then you will need to learn it too. Also, to ensure earning full credit (and to help get partial credit) you should convey to the grader how you solved the problem, (*e.g.*, by including the Matlab code that you used in your solution). Our recommendation would be to use Matlab to check your intuition and/or to get you started, and then try to solve the problems analytically.

Skills and Concepts

- signal characteristics
- signal value distribution and histograms
- periodicity
- signal operations: time shift and scaling
- matlab

Problems

0. [0]
   - Visit the EECS 206 web page and print the errata for the DSP First textbook and for the lecture notes.
   - Read Chapter 1 of text.
   - Read “Part 1” lecture notes.
   - **Write your lab section # on the top of your solutions!**

1. [30] For each of the following signals, determine the **maximum value** [1], the **mean value** [3], the **energy** [3], and the **RMS value** [3].

   (a) [10] $x(t) = \begin{cases} 7, & |t| \leq 1 \\ -7, & 1 < |t| \leq 2 \\ 0, & \text{otherwise}. \end{cases}$

   Hint: plot it!

   (b) [10] $x[n] = \begin{cases} (1/3)^n, & n \geq 0, \\ 0, & \text{otherwise} \end{cases}$

   (c) [10] $x(t) = \mathrm{e}^{-2|t|}$

   Hint: the energy is $E(x) = 1/2$.

2. [20] Determine the signal value distributions of each of the following signals.

   (a) [10] $x[n] = \sin\left(\frac{\pi}{2}n\right)$. (Use one period.)

   (b) [10] $x(t) = \begin{cases} 3, & |t| \leq 1 \\ -2, & 1 < |t| \leq 4. \end{cases}$ (Think about what happens as the number of signal samples increases, and express your singular value distribution using proportions.)

3. [10] Problem 8(a) in "Part 1" lecture notes. (Approximate mean from histogram.) Errata: the problem should say "discrete-time signal" rather than "continuous-time signal."

4. [15] Determine the fundamental period of each of the following signals.

   (a) [5] $x(t) = \sin(5\pi t)$

   (b) [5] $y[n] = \sin(5\pi n)$

   (c) [5] $z[n] = y[n] + x(2n)$

5. [20] Consider the following signal: $x(t) = \begin{cases} 3, & |t| \leq 4 \\ -3, & 4 \leq |t| \leq 8. \end{cases}$

   (a) [10] Sketch $y(t) = 3 + 2x(2t)$ carefully.

   (b) [10] Sketch $z(t) = x\left(\frac{1-t}{2}\right)$ carefully.

6. [20] Consider a signal $x(t)$ with support interval $[t_1, t_2]$, and define $y(t) = ax(t) + b$ over that same interval.

   (a) [10] Determine the relationship between the mean of $y(\cdot)$ and that of $x(\cdot)$.

   (b) [10] Determine the relationship between the mean-squared value of $y(\cdot)$ and the signal characteristics of $x(\cdot)$.

   (c) [0] Determine the relationship between the maximum of $y(\cdot)$ and the min and max of $x(\cdot)$.

   Answer:

$$\max(y) = \max_t y(t) = \begin{cases} a \max(x) + b, & a \geq 0 \\ a \min(x) + b, & a < 0. \end{cases}$$

7. [20] A first exercise with Matlab. Download the file `periodic.mat`, which is listed on the class website as a link just below the link to this homework set. This file is a Matlab workspace file that contains a vector called `signal1`, which is a segment of a nearly periodic discrete-time sequence. Perform the following.

   (a) [0] Start Matlab

   (b) [0] Load `periodic.mat`. To do this, type in `load periodic` at the Matlab prompt.

   You will need to understand MATLAB's "path" settings for this to work.

   (c) [5] Determine the length of the vector `signal1`.

   (d) [5] Determine its maximum and minimum values.

   (e) [10] Determine, approximately, the period of this approximately periodic discrete-time signal.