Homework #2, EECS 451, W04. Due Fri. Jan. 23, in class

Notes

- Problems prefaced by U, G, and B are for undergraduates, graduate students, and both sets of students respectively.
- Graduate students are expected to be able to solve problems of the "U" type. If you are unsure about any of those problems, you should try them (no need to write them up neatly though) and check against the solutions yourself.
- Undergraduates are encouraged to attempt the "G" problems and to look at their solutions. However, undergraduates will not need to do proofs on the exams.
- CUGS students who are taking this class for graduate credit are considered graduate students.
- Some problems are listed as zero points because they would be laborious to grade. It would be unwise to assume that points are always correlated with importance.

Review Problems (based on EECS 206)

These problems will not be graded. Solutions are posted on the web for you to check yourself.
Do not hand in your solutions to these problems.

R1. [B 0] Text 2.1. Concept(s): ***folding/shifting (convolution warmup).***

R2. [B 0] Text 2.2. Concept(s): ***elementary signal operations.***

R3. [B 0] Concept(s): ***signal notation.***
Express the following signal graphically, and with three different mathematical notations.

$$x[n] = \begin{cases} \left(\frac{1}{2}\right)^n, & n \text{ a nonnegative multiple of 4} \\ -\left(\frac{1}{2}\right)^n, & n \text{ a nonnegative multiple of 2, but not a nonnegative multiple of 4} \\ 0, & \text{otherwise.} \end{cases}$$

Here is a fifth useful representation: $x[n] = \left(\frac{1}{2}\right)^n \cos\left(\frac{\pi}{2}n\right) u[n]$. (Your three must be different from this.)

R4. [B 0] Concept(s): ***testing time invariance.***
Apply the procedure given in Text 2.6b to determine if the system in Text 2.6d is time invariant.
(Answer: it is time varying.)

R5. [B 0] Text 2.10. Concept(s): ***linearity for a time-invariant system.***

R6. [B 0] Text 2.15. Concept(s): ***geometric series.*** Memorize these formulas! We will use them repeatedly.

R7. [B 0] Text 2.16b-(9),(11). Concept(s): ***convolution.***
(You may use 2.16a to (partially) check your results.)
You may use MATLAB's `conv` command to check your work for finite-length signals, *e.g.*, for 2.16(b-1) you would type the following. `conv([1 2 4], [1 1 1 1 1])`

Skill Problems

1. [B 50] Text 2.7abdeijk. Concept(s): ***classifying system properties.***
Only your answer will be graded, not your work. Self check:
(a) is static, nonlinear, time-invariant, causal, stable
(d) is dynamic, linear, time-varying, noncausal, stable

2. [B 10] Text 2.11. Concept(s): ***time-invariance for a linear system.***
Hint. Consider combinations of inputs.

3. [B 10] Concept(s): ***convolution properties.***
If $y[n] = (x * h)[n]$, then show that $\sum_{n=-\infty}^{\infty} y[n] = \left(\sum_{n=-\infty}^{\infty} x[n]\right) \left(\sum_{n=-\infty}^{\infty} h[n]\right)$.

4. [B 20] Text 2.21ad. Concept(s): ***convolution.***
Assume $a \neq 0$ and $b \neq 0$. Hint: use (a) when solving (d).

5. [B 15] Text 2.21b. Concept(s): ***convolution.***
Use MATLAB's `stem` to plot the result. Make sure your horizontal axis is correct, *e.g.*, using 2.29a.
Turn in both your plots and your MATLAB m-file. You do not need to turn in your hand-computed solutions—just the MATLAB solutions will suffice for this problem.

6. [B 0] Text 2.29ab. Concept(s): ***convolution for finite-duration signals.***
For part (b), by "the limits" they mean the range of values of n for which the shorter signal $h[n]$ (after flipping and sliding to be $h[n-k]$) will partially overlap the signal $x[n]$ on the left side of the support of $x[n]$, etc.

7. [B 10] Text 2.33. Concept(s): ***interconnected LTI systems.***

Mastery Problems

8. [B 0] Concept(s): ***even and odd components, power.***
Show that the power of a power signal is the sum of the power of its even and odd components.

9. [G 10] Text 2.24. Concept(s): ***geometric series as the "elementary" signals.***

10. [G 10] Give an example of a simple system that satisfies the scaling property for any input signal, but is nevertheless nonlinear, *i.e.*, the additivity property fails.
(Thus, both the scaling *and* additivity properties must hold to conclude a system is linear.)
This problem is a "puzzle," a type of problem that will be assigned only rarely. No hints will be given.
Undergraduates: if you solve this, turn in your solution to me separately (for good karma).

11. [G 0] Text 2.8dg. Concept(s): ***cascade of two systems.***

12. [G 0] Text 2.9b. Concept(s): ***steady-state of stable systems.***