EE3210 Signals and Systems

Assignment 3

Instructions:

1. There are four problems in this assignment. Answer all questions.
2. The total marks for this assignment is 8 marks.
3. In answering the questions, you need to note that:
   - It is important for you to show us your intermediate steps and tell us what arguments you have made to obtain the results.
   - Both the intermediate steps and the arguments carry marks.
   - If you can show us the perfect intermediate steps and the in-between arguments but get the final results wrong for some reason, we will still award you marks for having understood the subject matter.
4. The submission deadline is 23:59 Saturday 15 March 2014.
5. Late submission penalty: 20% per day will be subtracted for late submission. Submissions that are overdue for more than four days will receive **ZERO** mark.
6. Submit your assignment on e-Portal/Blackboard.
   - The file must be in Acrobat `pdf` format.
   - The file must be named with the format `Assignment3-student ID.pdf`.
     - For example, if your student ID is 12345678, the file name must be: `Assignment3-12345678.pdf`.
7. For information on how to submit assignments on e-Portal/Blackboard, see

   `http://www6.cityu.edu.hk/elearn/animation/student/submit_assignment.htm`

Problem 1: (2 marks) Consider a discrete-time LTI system with unit impulse response $h[n] = \beta^n u[n]$. Use the convolution sum to find the response $y[n]$ of the system to the input $x[n] = \alpha^n u[n]$.

(a) Do this for $\alpha \neq \beta$.

(b) Do this for $\alpha = \beta$.

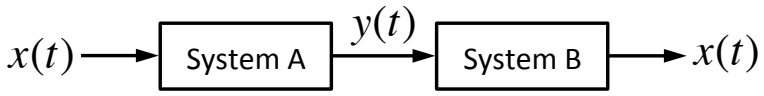
Problem 2: (2 marks) One of the important properties of convolution integral is the associative property, i.e.,

$$x(t) * [h_1(t) * h_2(t)] = [x(t) * h_1(t)] * h_2(t). \tag{1}$$

Prove the equality by showing that both sides of (1) equal

$$\int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} x(r) h_1(m) h_2(t - r - m)\, dr\, dm.$$

Problem 3: (2 marks) Consider the cascade of two systems shown in the figure below. The first system, A, is known to be an LTI system. The second system, B, is known to be the inverse of system A. Let $y_1(t)$ denote the response of system A to $x_1(t)$, and let $y_2(t)$ denote the response of system A to $x_2(t)$.

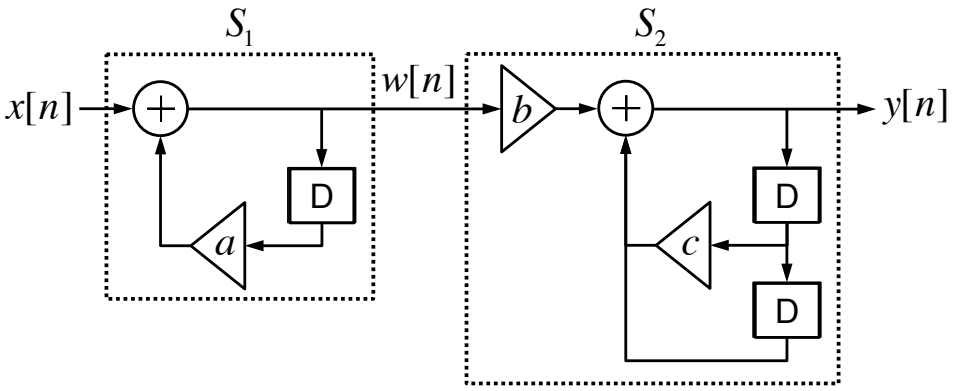


(a) What is the response of system B to the input $ay_1(t) + by_2(t)$, where a and b are constants?

(b) What is the response of system B to the input $y_1(t - t_0)$?

(c) Show that system B is an LTI system.

Problem 4: (2 marks) Consider a discrete-time LTI system that is obtained through a series interconnection of a system S_1 followed by a system S_2. The block diagram representation of the system is shown in the figure below.



Determine:

(a) The linear constant-coefficient difference equation that describes the relationship between the input $x[n]$ and the output $w[n]$ of system S_1.

(b) The linear constant-coefficient difference equation that describes the relationship between the input $w[n]$ and the output $y[n]$ of system S_2.

(c) The linear constant-coefficient difference equation that describes the relationship between the input $x[n]$ and the output $y[n]$ of the overall system.

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