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**CITY UNIVERSITY OF HONG KONG**

**Semester A 2015/2016**

**EE3210: Signals and Systems**

**Quiz 5**

1. Time allowed: 15 minutes
2. Total number of problems: 2
3. Total marks available: 11
4. This paper may not be retained by candidates

**Special Instructions**

5. This is a closed book exam
6. Attempt all questions from each problem
7. A list of possibly relevant equations is attached at the end of this paper

**Problem 1:** (5 marks)

Consider a continuous-time LTI system with unit impulse response

$$h(t) = e^{-t}.$$

Determine which of the following properties hold for this system:

- (a) Memoryless (1.5 mark)
- (b) Causal (1.5 marks)
- (c) Stable (2 marks)

Justify your answers.

**Problem 2:** (6 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 Figure 1 below.

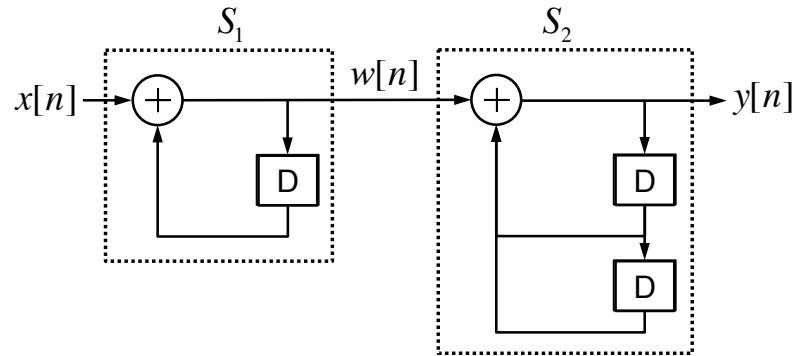


Figure 1

Determine the linear constant-coefficient difference equation that describes:

- (a) The relationship between the input  $x[n]$  and the output  $w[n]$  of system  $S_1$ . (2 marks)
- (b) The relationship between the input  $w[n]$  and the output  $y[n]$  of system  $S_2$ . (2 marks)
- (c) The relationship between the input  $x[n]$  and the output  $y[n]$  of the overall system. (2 marks)

## Appendix – A list of possibly relevant equations

- Convolution sum:  $x[n] * h[n] = \sum_{k=-\infty}^{+\infty} x[k]h[n-k]$ 
  - Commutative property:  $x[n] * h[n] = h[n] * x[n]$
  - Distributive property:  $x[n] * (h_1[n] + h_2[n]) = x[n] * h_1[n] + x[n] * h_2[n]$
  - Associative property:  $x[n] * (h_1[n] * h_2[n]) = (x[n] * h_1[n]) * h_2[n]$
- Convolution integral:  $x(t) * h(t) = \int_{-\infty}^{+\infty} x(\tau)h(t-\tau)d\tau$ 
  - Commutative property:  $x(t) * h(t) = h(t) * x(t)$
  - Distributive property:  $x(t) * [h_1(t) + h_2(t)] = x(t) * h_1(t) + x(t) * h_2(t)$
  - Associative property:  $x(t) * [h_1(t) * h_2(t)] = [x(t) * h_1(t)] * h_2(t)$
- Properties of continuous-time LTI systems:
  - Memoryless:  $h(t) = 0$  for  $t \neq 0$ .
  - Invertibility:  $h(t) * h_1(t) = \delta(t)$  where  $h_1(t)$  is the unit impulse response of the inverse system.
  - Causality:  $h(t) = 0$  for  $t < 0$ .
  - Stability:  $\int_{-\infty}^{+\infty} |h(t)| dt < \infty$
- Properties of discrete-time LTI systems:
  - Memoryless:  $h[n] = 0$  for  $n \neq 0$ .
  - Invertibility:  $h[n] * h_1[n] = \delta[n]$  where  $h_1[n]$  is the unit impulse response of the inverse system.
  - Causality:  $h[n] = 0$  for  $n < 0$ .
  - Stability:  $\sum_{n=-\infty}^{+\infty} |h[n]| < \infty$

— End of Paper —