University of Portland
School of Engineering

EE 262
Spring 2012
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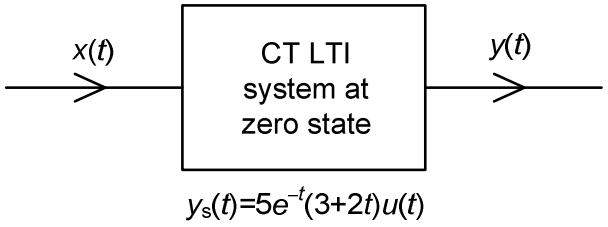
Homework # 5—Linear Time-Invariant (LTI) Systems
(Assigned: Monday, March 19, 2012)
(Due date: Monday, March 26, 2012, 1:35p.m.)

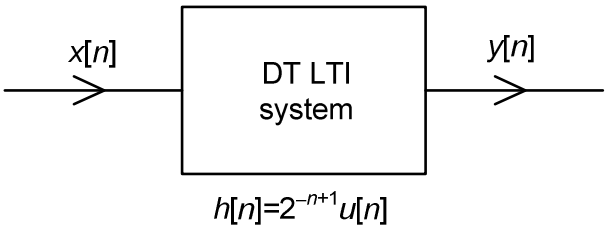
The following homework problems are prepared by A. Inan:

Problem # 1. Continuous-time (CT) LTI System. The unit-step response of a CT LTI system is given to be $y_s(t)=5e^{-t}(3+2t)u(t)$.

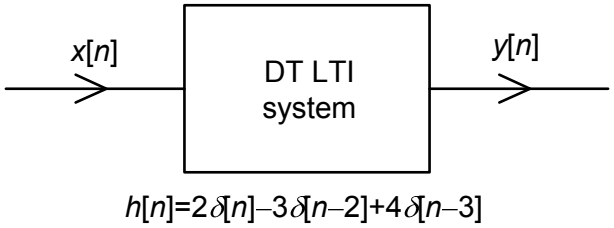


(a) Find the impulse response $h(t)$ of this LTI system.
(b) Find the zero-state response $y_{zs}(t)$ of this LTI system due to the input signal given by $x(t)=3u(t-1)-4\delta(t-2)$.

Problem # 2. Discrete-time (DT) LTI System. The impulse response of a DT LTI system is given by $h[n] = 2^{-n+1}u[n]$. Find the zero-state response of this LTI system due to an input signal given by $x[n]=3u[n-1]$.

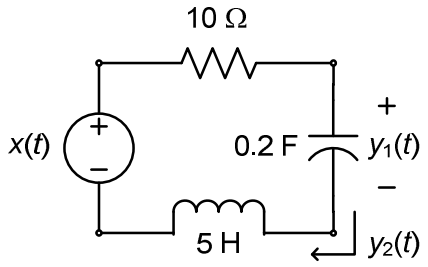


Problem # 3. DT LTI System. The impulse response of a DT LTI system is given by $h[n] = 2\delta[n]-3\delta[n-2]+4\delta[n-3]$.



(a) Find and sketch the unit-step response $y_s[n]$ of this LTI system.
(b) Find and sketch the zero-state response $y_{zs}[n]$ of this LTI system due to an input signal given by $x[n]=2u[n]-3u[n-1]$.

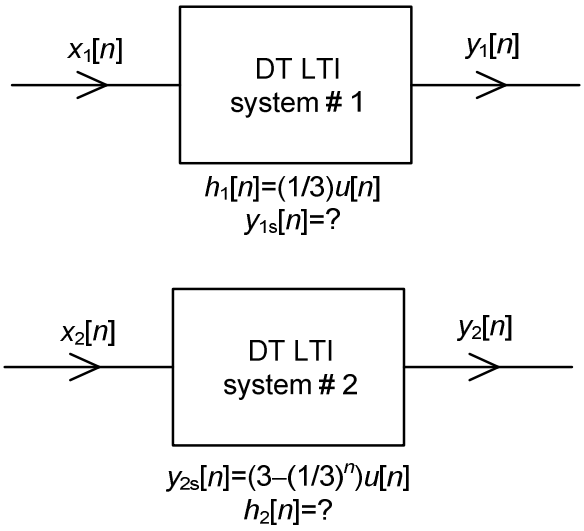
Problem # 4. Second-order electric circuit. For the second-order electric circuit shown:



(a) Find the unit-step responses $y_{1s}(t)$ and $y_{2s}(t)$.
(b) Using the results of part (a), find the impulse responses $h_1(t)$ and $h_2(t)$.
(c) Using part (b) results, find the transfer functions $H_1(s)$ and $H_2(s)$.
(d) Using the results of part (c), find the frequency responses $H_1(\omega)$ and $H_2(\omega)$ and express each in polar form as $|H(\omega)|e^{j\phi(\omega)}$.

Provide all the answers in their simplest form.

Problem # 5. DT LTI system. For each DT LTI system shown below, find the unknown response.



Problem # 6. Two CT LTI systems. Consider two CT LTI systems having impulse responses given by $h_1(t)=4e^{2-t}\,u(t)$ and $h_2(t)=3e^{-2t}u(t-1)$.

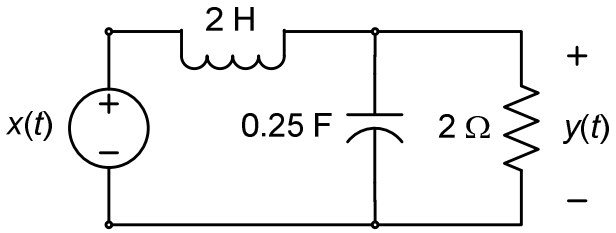
(a) Find the impulse response of the overall system if these two systems are cascaded together.

(b) Repeat part (a) if the two systems are connected in parallel and the output of the overall system is the sum of the two outputs.

Problem # 7. Two identical DT LTI systems. Consider a DT LTI system described by the difference equation $y[n]+0.5y[n-1]=3x[n]$.

(a) Find the impulse response $h[n]$ of this system.
(b) Find the unit-step response $y_s[n]$ of this system.
(c) Find the overall impulse response of two such systems connected in cascade form.
(d) Repeat part (c) if the two systems are connected in parallel.

Problem # 8. Second-order electric circuit. Consider the second-order electric circuit as shown.



(a) Find the differential equation relating the output signal $y(t)$ to the input signal $x(t)$.
(b) Find the roots of the characteristic equation of this circuit.
(c) Using part (b) results, find the unit-step response $y_s(t)$ of this circuit.
(d) Using $y_s(t)$ found in part (c), find the impulse response $h(t)$ of this circuit.
(e) Using $h(t)$, find the transfer function $H(s)$.