Signals Analysis – Homework 04 (Systems and Convolution)

1) – For the **systems** described below, which the **input** is the signal $x[n]$ or $x(t)$ and the **output** is the signal $y[n]$ or $y(t)$, answer the following:

i) – What are the ***discrete*** ones and what are the ***continuous*** ones?;

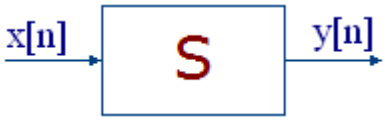
ii) – What are the ***linear*** ones and what are the ***non linear*** ones?;

iii) – What are the ***time variant*** ones and what are the ***time invariant*** ones?;

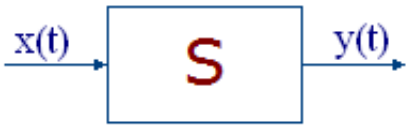
iv) – What are the ones ***with memory*** and what are the ones ***without memory***?;

v) – What are the ***causal*** ones and what are the ***non causal*** ones?;

vi) – What are the ***inversible*** ones and what are the ***non inversible*** ones?.



Discrete system



continuous system

System A → $y[n] = 2(x[n])^2 + 7\sqrt{x[n]} \cdot x[n] - 4x[n]$

System B → $\frac{d^2y}{dt^2} + (t-5)\frac{dy}{dt} + 3y = 4t\frac{dx}{dt} + 2x(t)$

System C → $y[n] - 2y[n-1] + 5y[n-2] = 0{,}5x[n] - 9x[n-1]$

System D → $\frac{\partial u}{\partial t} = 3\frac{\partial^2 u}{\partial x^2} + 6\frac{\partial^2 u}{\partial y^2} + 2\frac{\partial^2 u}{\partial z^2}$

System E → $\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + 3y(t+0{,}1) = \frac{dx}{dt} - 7x(t)$

System F → $y[n-1] - 4y[n] = -x[n] + 3x[n+1]$

System G → $y'' + 4y' - e^y = 2x' - 0{,}3x$

System H $\rightarrow$

$$\rightarrow \frac{d^2y}{dt^2} - \frac{dy}{dt} + 3y = \frac{dx}{dt} - 8x(t)$$

System I $\rightarrow \dfrac{d^2y}{dt^2} = y\dfrac{dx}{dt} + 2{,}5x(t)$

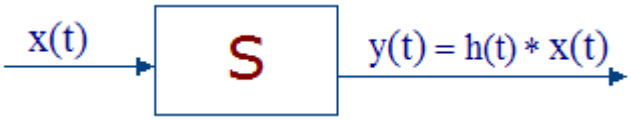
System J $\rightarrow y[n] = -3x[n] + 4$

System K $\rightarrow y'' - 2y'y = x' - 2x$

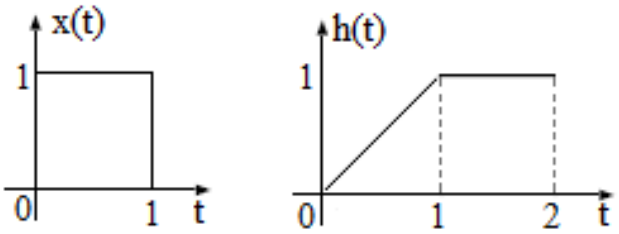
System L $\rightarrow y[n] = 2x[n-1] - 6x[n]$

System M $\rightarrow y[n] = -\sqrt[2]{|1{,}5x[n]|^3}$

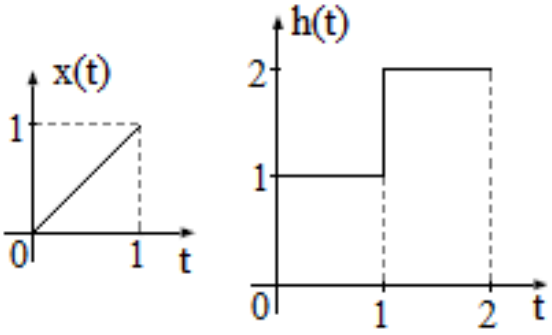
2) – Calculate the **output** signal $y(t)$ for the **continuous, linear and time invariant** (**LTI**) **systems** with **input** signal $x(t)$ and impulse response $h(t)$.



a)



b)



c) $x(t) = e^{-t} \cdot u_1(t)$ e $h(t) = u_1(t) - u_1(t-1)$

d) $x(t) = u_1(t)$ e $h(t) = t \cdot \left(u_1(t) - u_1(t-1)\right)$

e) $x(t) = e^{-|t|}$ e $h(t) = u_1(t+1) - u_1(t-1)$

f) $x(t) = e^{-t} \cdot u_1(t)$ e $h(t) = e^{t} \cdot \left(u_1(t) - u_1(t-4)\right)$

g) $x(t) = e^{\alpha t} \cdot u_1(t)$ e $h(t) = e^{\beta t} \cdot u_1(t)$, $\alpha \neq \beta$

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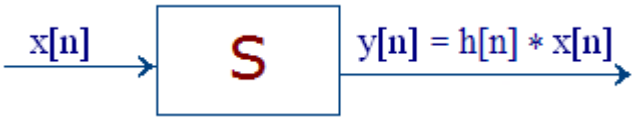
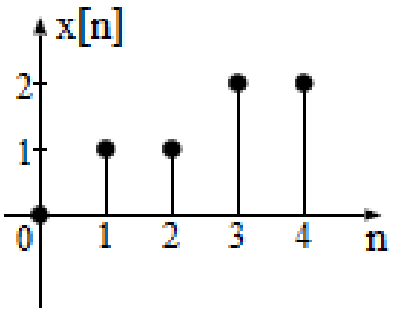
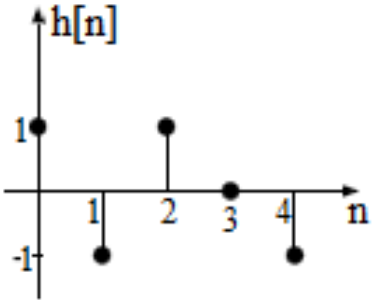
3) – Calculate the **output** signal $y[n]$ for the **discrete, linear and time invariant** (**LTI**) **systems,** with **input** signal $x[n]$ and impulse response $h[n]$.

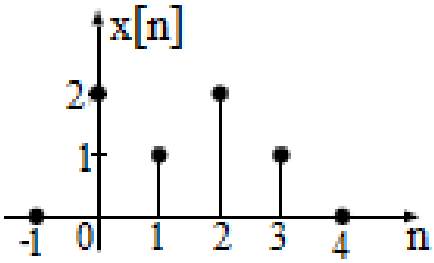


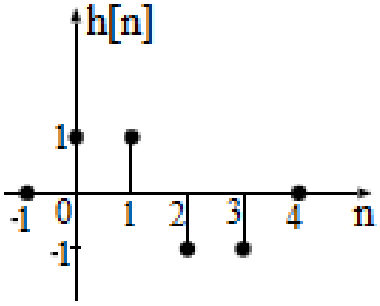
a)



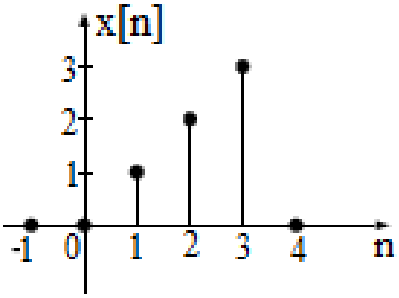


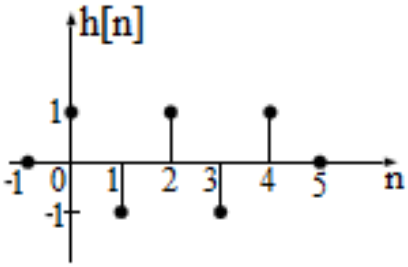
b)





c)





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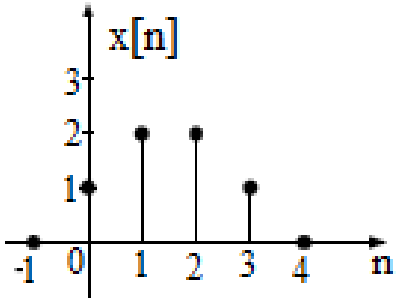
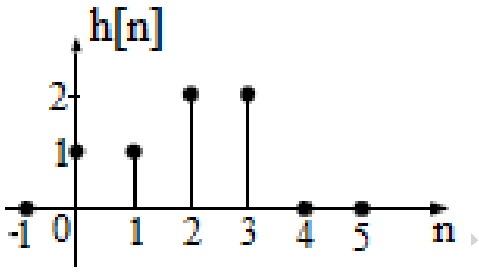
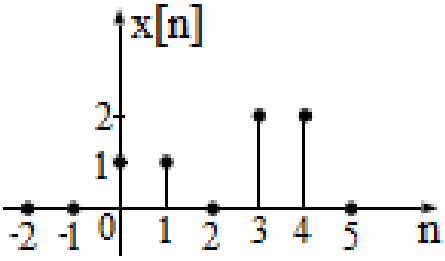
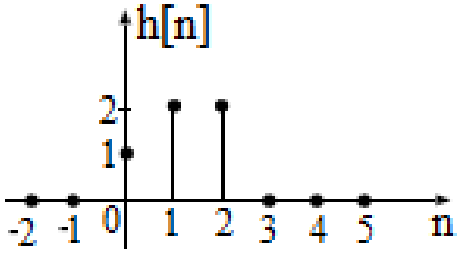
d)





e)





f) $x[n] = |n| \cdot (u_1[n+2] - u_1[n-3])$ e
$h[n] = u_o[n] - u_o[n-2] + u_o[n-4];$

g) $x[n] = 2 - 2u_2[n] + u_2[n-4]$ e
$h[n] = (-1)^n u_1[n].$

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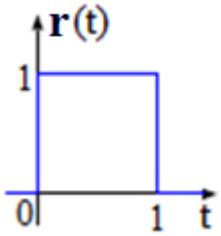
4) – Find the **output** signal $y(t)$ of the **linear and time invariant** (**LTI**) **systems** with **input** signal $r(t)$ given below that possess an unit impulse response $h(t)$ also given below, where $u_1(t)$ = unit step function.

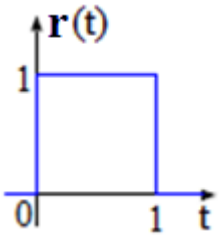
a)



$$h(t) = \left[u_1(t+1) - u_1(t-1)\right]$$

Find the **output** signal $y(t)$ of the system.

b)



$$h(t) = \left[-u_1(t) + u_1(t-1)\right]$$

6) – Calculate the impulse response $h(t)$ of the **linear and time invariant** (**LTI**) **systems** with **input** signal $r(t) = u_1(t)$ [unit step] and the **output** $y(t)$ is given by:

$$y(t) = 3 \cdot \text{sen}(2t)$$

7) – Calculate which was the $u(t)$ of this system which the impulse response is $h(t)$ and the **output** $y(t)$ of a system are given by:

a)

$$h(t) = e^{-2t} \qquad y(t) = e^{3t} \cdot \text{sen}(t)$$

b)

$$h(t) = e^{-2t} \qquad y(t) = 2e^{-2t} - 2e^{-3t}$$