My solution
M.R. Asharif
2012/6/6

(1)

Digital Signal Processing — **University of the Ryukyus**
Undergraduate Course — **Student's Name:** — **Faculty of Engineering**
Mid-Term Examination — **Sudent's No.** — **Dept. of Information Eng.**
2012.6.8 [write your answer in the blocks, each one 10-score] — **Prof. M.R. Asharif**

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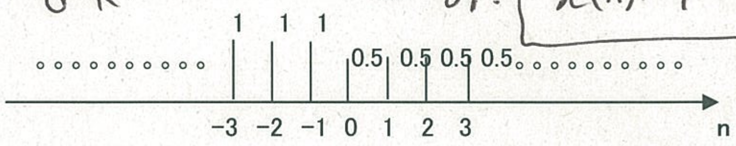
1. 図で信号、x(n)、を、u(n)関数を用いて表現せよ。

Another Solution: $x(n) = u(-n-1) + 0.5\,u(n)$
O.K.

or: $x(n) = 1 - 0.5\,u(n)$ ← another solution. O.K.

$x(n)= 0.5^{u(n)}$

$u(n) = \begin{cases} 1 : n \geq 0 \\ 0 : n < 0 \end{cases}$

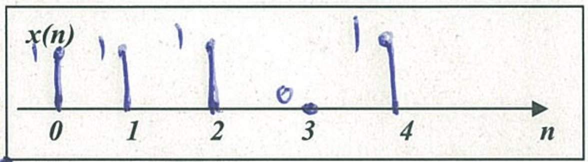


hint: $x(n)= (0.5)^{?}$

2. 次の信号をプロットせよ。ただし; *n= 0, 1, 2, 3, 4*

$$x(n) = u[\sin(\frac{2\pi n}{4})]$$

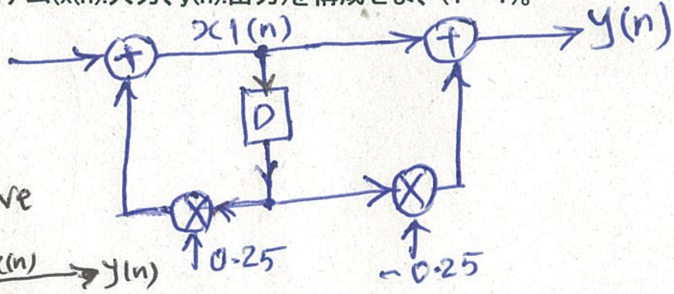
$x(0) = u[\sin(0)] = u(0) = 1$
$x(1) = u[\sin(\frac{\pi}{2})] = u(1) = 1$
$x(2) = u[\sin\pi]$
$x(2) = u(0) = 1$
$x(3) = u[\sin\frac{3\pi}{2}]$
$x(3) = u(-1) = 0$
$x(4) = u[\sin(2\pi)] = u(0) = 1$



3. 以下の二つ差分方程式を満足する離散時間システム(x(n):入力、y(n):出力)を構成せよ、(T＝1)。

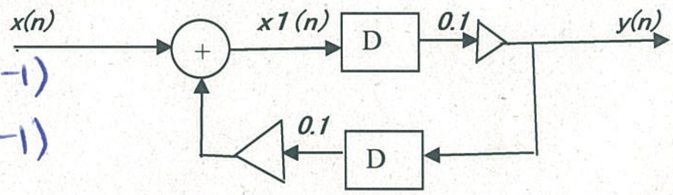
$$x1(n) = x(n) + 0.25\,x1(n-1)$$

$$y(n) = x1(n) - 0.25\,x1(n-1)$$



Another Solution: if we add the above two equations:
$y(n) = x(n)$ Then $x(n) \rightarrow y(n)$

4. 図に示す離散時間システム(IIR Digital Filter) の差分方程式を指出せよ、(T=1)。



$\begin{cases} x1(n) = x(n) + 0.1\,y(n-1) \\ y(n) = 0.1\,x1(n-1) \end{cases}$

$y(n) = 0.1\,x(n-1) + 0.01\,y(n-2)$

$y(n) = 0.1\,x(n-1) + 0.01\,y(n-2)$

5. 以下の入出力を示すシステムの線形性、時不変性、因果性、安定性を判定し、○か×で示せよ。

$y(n) = (n+1)\,x(n^2)$

Linearity,	Shift Invariance,	Causality,	Stability
○	×	×	×

Shift Invariance: Because of term (n+1)
Causality: Because of $x(n^2)$
Stability: Because when: $n \to \infty$, $y(n) \to \infty$ for finite $|x(n)| < M < \infty$
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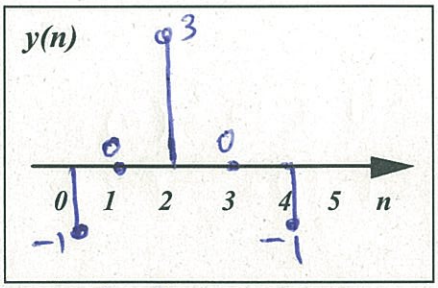
6・次のシステムでは $h(n)$ はインパルス応答、$x(n)$ は入力で、出力 $y(n)$ を計算せよ。

$h(n) = [1, 1, -1]$ （↑ n=0）　　$x(n) = [-1, 1, 1]$ （↑ n=0）



$y(n) = \sum_{k=0}^{2} h(k)x(n-k)$

$n=0: y(0) = h(0)x(0) = -1$

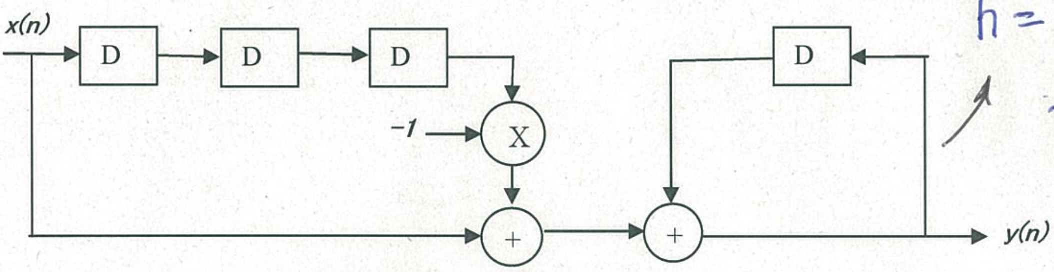
$n=1: y(1) = h(0)x(1) + h(1)x(0) = 1 - 1 = 0$

$n=2: y(2) = h(0)x(2) + h(1)x(1) + h(2)x(0) = 1 + 1 + 1 = 3$

$n=3: y(3) = h(0)x(3) + h(1)x(2) + h(2)x(1) = 1 - 1 = 0$

$n=4: y(4) = h(0)x(4) + h(1)x(3) + h(2)x(2) = -1$

7. 次の回路の差分方程式とインパルス応答を求めよ。　$y(-1)=0$，$x1(-1)=0$



$h = [1, 1, 1]$ （↑ n=0）

$y(n) = x(n) - x(n-3) + y(n-1)$

$h(n) = \delta(n) - \delta(n-3) + h(n-1)$

$n=0: h(0) = 1$

$n=1: h(1) = h(0) = 1$

$n=2: h(2) = h(1) = 1$

$n=3: h(3) = -\delta(0) + h(2) = -1 + 1 = 0$

$n=4: h(4) = h(3) = 0$

$n=5: h(5) = h(4) = 0$

— — —

y(n)=	$x(n) - x(n-3) + y(n-1)$
h(n)=	$\delta(n) + \delta(n-1) + \delta(n-2)$

also: $h(n) = u(n) - u(n-3)$ O.K.

8. つぎのインパルス応答を持つシステムは、安定かどうか判断せよ。(T=1)

$$h(n) = [\frac{1}{3^n}]u(n)$$

(安定)	不安定

$S = \sum_{n=0}^{\infty} |h(n)| = \sum_{n=0}^{\infty} \frac{1}{3^n} = 1 + \frac{1}{3} + \frac{1}{9} + \cdots$

$S = \frac{1}{1-\frac{1}{3}} = \frac{3}{2} = 1.5$

9. 次の離散時間システムのフーリエ変換 H(w)を求めよ。

$$h(nT) = 0.5\delta(nT + 2T) + 0.5\delta(nT - 2T)$$

1- T=0.1msの時、| H(w) | をプロットせよ。

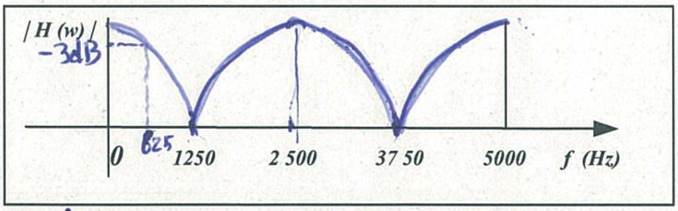
2- Arg[H(w)] をもとめよ。

3- f=625 Hz で | H(w) | (dB)を求めよ。

$H(e^{jw}) = \sum_{n=-2}^{2} h(nT) e^{-jwnT}$

$H(e^{jw}) = 0.5 e^{j2wT} + 0.5 e^{-j2wT} = \cos(2wT)$

$H(e^{jw}) = \cos(2 \times 2\pi f \times 0.1 \times 10^{-3}) = \cos\frac{4\pi f}{10000}$



| H (w) | = $\cos(2wT)$	$20\log_{10}\|H(w)\|_{f=625}$ = -3 dB
arg [H (w)] = 0, π	

$H|_{f=0} = 1$, $H|_{f=2500} = \cos\pi = -1$, $H|_{f=5000} = \cos 2\pi = 1$, $H|_{f=1250} = \cos\frac{\pi}{2} = 0$

$H|_{f=625} = \cos\frac{\pi}{4} = \frac{\sqrt{2}}{2} \rightarrow 20\log_{10}\frac{\sqrt{2}}{2} = -3$ dB