Signals and Systems for Computer Engineering

Assignment #4

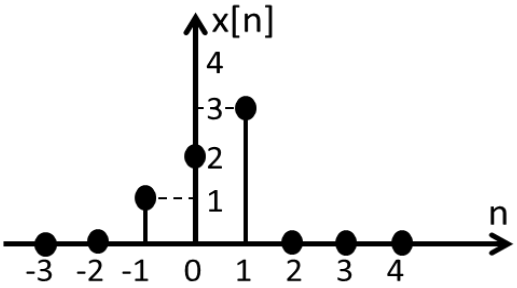
BLG354E - B.Berk Üstündağ

Assigned: May 30, 2021

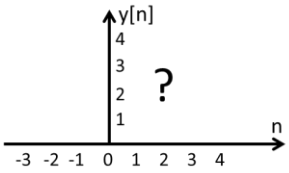
Due: June 07, 2021, **23:59** (submit through Ninova)

- Your submission must include your code and report.
- In the report, briefly explain your solution and include your plots (if applicable).
- Use only the Python programming language.
- Please **write your full name** (first name and last name) and **Student ID** at the top of your solution.
- Please show ALL work. Answers with no supporting explanations or work will not receive any partial credit. Your homework is not just a final report of your results; we want to see your steps. Upload all your steps to get to the solution.
- Assignments are individual.
- Do not copy & paste anything from anywhere. Use your own words.
- **No late submissions** will be accepted. Do not send your solutions by e-mail. We will only accept files that have been uploaded to the Ninova e-learning system before the deadline. Do not risk leaving your submission to the last few minutes.
- If you have any questions regarding the assignment, please e-mail **Enes Albay (albay@itu.edu.tr)**.

1- A discrete-time signal $x[n]$ is shown in the figure below. $y[n]$ is defined as $y[n] = x[n] * (0.5n^2 \cdot (u[n] - u[n-3]))$.



Find and sketch y[n]



2- A continuous time signal x(t) is given as $x(t)=10\cdot\sin(314t-\pi/4)$. If we periodically sample this signal @T_s=5ms time intervals and denote the sampled sequence as x[n] where n=0,1, 2, … then 402nd

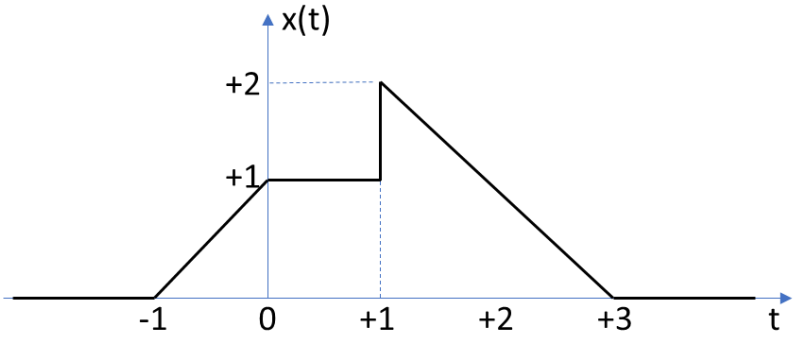
sample value will be, $x[402]= 8.93$

3- Find the 4-points DFT (Discrete Fourier Transform) of the sampled signal x[n] in question 2. If x[n]={x[0], x[1], x[2], x[3]} then its DFT X[k]=DFT{x[n]} can be given as,

$$X[k]=\{0,-14.15-14.15j,0,-14.15+14.15j\}$$

where, $\mathbf{W}_N = \begin{bmatrix} 1 & 1 & 1 & \cdots & 1 \\ 1 & W_N & W_N^2 & \cdots & W_N^{N-1} \\ 1 & W_N^2 & W_N^4 & \cdots & W_N^{2(N-1)} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & W_N^{N-1} & W_N^{2(N-1)} & \cdots & W_N^{(N-1)(N-1)} \end{bmatrix}$ and $W_N = e^{-j(2\pi/N)}$

4- Continuous time signal x(t) is shown in the figure below.



x(t) can mathematically be expressed as,

$$x(t)= (x+1)u(x+1)-xu(x)+(-x+2)u(x-1)+(x-3)u(x-3)$$

5- A discrete time signal sequence is given as x[n]={1,2,-1,0,1,2,-1,0}. Find 8-point DFT of this signal by using any of the methods.

$$X[k]=\{4,0,4-4j,0,-4,0,4+4j,0\}$$

6- Transfer function of a discrete time system H(z) is given as $(z) = \frac{Y(z)}{X(z)} = \frac{2z^{-1}}{(1-0.5z^{-1})^2}$ H

where z^{-1} denotes the unit delay. If a unit step signal x[n]=u[n] is applied to this system then the first 4 values of the output signal sequence y[n]={y[0], y[1], y[2], y[3]) would be,

y[0]= 0 , y[1]= 2 , y[2]= 4 , y[3]= 5.5

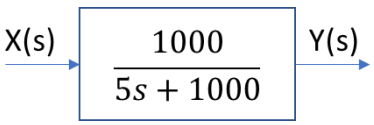
(initial condition can be considered as zero)

7- Write the pseudo code that performs H(z) in question 6 if the input signal is periodically sampled at T_s

Timer Interrupt @Ts:

X = Read (ADC)
A = X + B −0.25C
Y = 2B
Output(Y)
C = B
B = A
Return

8- If a transfer function of a 1st order low pass filter H(s) is given as



a) then the cut off frequency f_c of $H(j\omega)$ is,

f_c= 31.83 [Hz]

(where s=jω)

and

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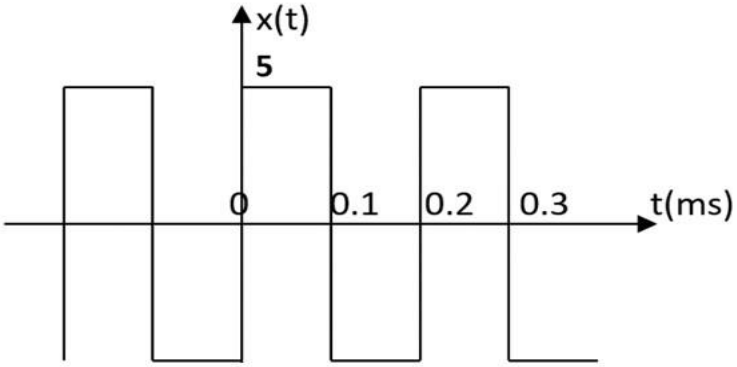
b) the bandwidth (-3dB Criteria) is,

BW= 31.75 [Hz]

9- If the continuous time signal x(t)=10sin(400πt) is applied to the low pass filter system described in question 8 then the output signal y(t) can be expressed as,

$$y(t)=\frac{20\pi e^{-200t}+10\sin(400\pi t)-20\pi\cos(400\pi t)}{1+4\pi^2}$$

10- A continuous time periodic signal x(t) is given in the figure shown below



Write the first two non -zero harmonic components in Fourier transform of x(t)

$$x(t)=\frac{20}{\pi}(\sin(10000\pi t)+\frac{1}{3}\sin(30000\pi t))$$

11- The input-output relationship of a discrete time system is given by the difference equation $y[n]=x[n-2]+2a\cdot y[n-1]-a^2\cdot y[n-2]$. Find the value interval of "a" that makes this system BIBO stable.

(where x and y denote input and the output respectively)

-1 <a< 1

12- Find the fundamental period of the signal $x(t)=\cos(\frac{14\pi}{3}t)+\sin(\frac{5\pi}{4}t)$

T_0= 24s

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a) Fill in the blanks first

b) Show the calculations for each question in a separate part after results.

c) Points per question is 100/12