

Signals and Systems for Computer Engineering

Assignment #4

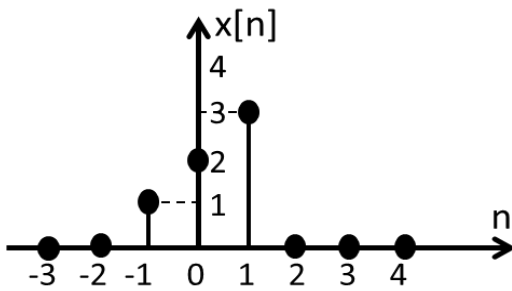
BLG354E - B.Berk Üstündağ

Assigned: May 30, 2021

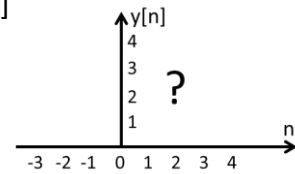
Due: June 07, 2021, 23:59 (submit through Ninova)

- 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 @ $T_s = 5\text{ms}$ time intervals and denote the sampled sequence as $x[n]$ where $n=0, 1, 2, \dots$ then 402nd sample value will be,

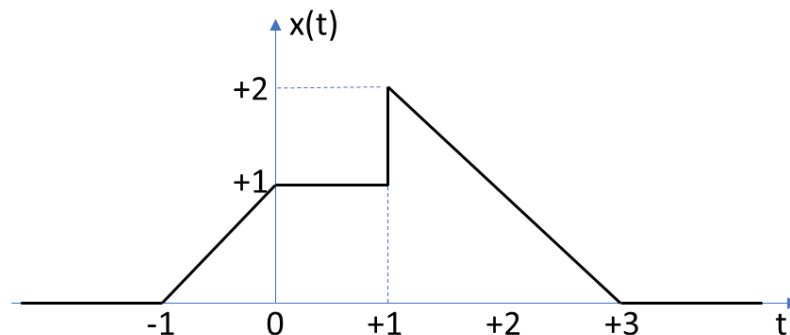
$$x[402] =$$

- 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 $X[k] = \text{DFT}\{x[n]\}$ can be given as,

$$X[k] = \{ \quad \quad \quad \}$$

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

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



$x(t)$ can mathematically be expressed as,

$$x(t) =$$

- 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.

$X[k]=\{ \quad \quad \quad \}$

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

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,

$y[0]= \quad , y[1]= \quad , y[2]= \quad , y[3]= \quad$

(initial condition can be considered as zero)

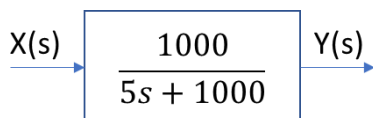
- 7- Write the pseudo code that performs $H(z)$ in question 6 if the input signal is periodically sampled at T_s

Timer Interrupt @ T_s :

$X = \text{Read (ADC)}$

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,

$f_c = \quad \quad \quad [\text{Hz}]$

(where $s=j\omega$)

and

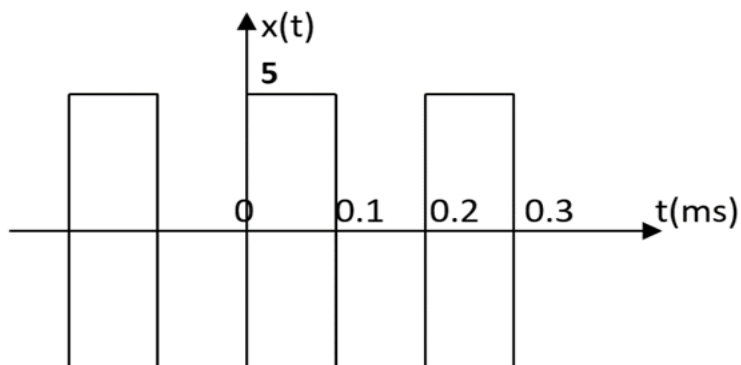
b) the bandwidth (-3dB Criteria) is,

BW= [Hz]

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

$y(t)=$

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 $x(t)$

$x(t)=$

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)

$<a<$

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

$T_0=$

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