Blackman → $0{\cdot}42 - 0{\cdot}5\cos\left(\frac{2\pi n}{M-1}\right) + 0{\cdot}08\cos\left(\frac{4\pi n}{M-1}\right)$

$H(z) = b_0(1 - z_1 z^{-1})(1 - z_2 z^{-1})$

Hamming → $0{\cdot}54 - 0{\cdot}46\cos\left(\frac{2\pi n}{M-1}\right)$

$|H(w)|^2 = H(w)\,H^*(w)$



1 complex multiplication = 2 real multiplications per butterfly

Radix

Radix

no of butterfly inst → $\frac{N}{2}$

→ $\frac{N}{2}$

→ $2\left(\frac{N}{2}\right)$

DSP-2018

QuizSet-3A

Date: 22/11/2018

Time : 50 minutes

Marks: 20

→ $H(z) = 1 - z^{-2}$

---

**Question 1:** Do the following.

1) State True or False: Fourier transform of any sequence is same as it's Z transform evaluated on the unit circle. [1]
2) A transfer function with a double zero located at same frequency is linear phase system. [1]
3) Write down the window function for hamming window. [1]
4) State True or False: The phase of the LTI system should be constant to guarantee linear phase of the system. [1]
5) Any sequence $x(n)$ is related to it's odd and even sequence as $x(n) =$ ________. [1]
6) If $|H(w)^2| = H(w) \cdot H^*(w)$ and also $H(w) == H(z)|_{z=e^{jw}}$ than $|H(w)|^2 = H(z) \cdot H^*(z^{-1})$ is true. [1]

[P.T.O]

DSP- 2018
Lab exam #5

16UEC126

DSP-2018
QuizSet-2B
Date: 31/10/2018
Time : 60 minutes
Marks: 30

**Question 1:** Do the following.

1) Mention the number of complex multiplications needed for N point DFT using Radix-2 algorithms. [1]
2) Mention the number of real additions required by Radix-2 and Radix-4 butterfly respectively. [1]
3) Write down the expression for Forward DCT. [1]
4) State True or False: In radix-2 Decimation in time the input signal is applied in Bit reverse order and output is in natural order. [1]
5) For a circularly even symmetric sequence $x(n)$ having length $N = 4$, the sample $x\left(\frac{N-1}{2}\right)$ is equal to _____. [1]
6) In split radix, the even frequency components are calculated using ________ algorithm. [1]

[P.T.O]

The LNM-IIT, Jaipur, Rajasthan

DSP- 2018
Problem Set #1B
Roll No:

Time :50 Minutes

Weightage : 20 Marks[4 Marks each]

---

1) For a signal $x_a(n) = cos(\frac{\pi}{3}n)$
calculate the magnitude and phase spectrum. Comment on symmetries of both the spectrums.

2) Write down the Analysis and synthesis expression for Discrete time aperiodic signal.
The corresponding spectrum is ________ and ________.

3) Use DFT expression and write down the IDFT Matrix for N = 4 point.(No Zero padding)

4) For N = 128, calculate the no. of complex multiplications and additions required using
   - Using Direct method.
   - Using division $L = 64$, $M = 2$, where $N = L \cdot M$.
   - Can the multiplications reduces further compared to above step if we further divide the above $L = L_1 \cdot L_2$, where $L_1 = 32$, $L_2 = 2$ and keep same $M = 2$. Write down the no. of Complex multiplications required for this case.

5) Derive the symmetry property(Magnitude only) of fourier transform if discrete signal $x(n)$ is real.

The LNM-IIT, Jaipur, Rajasthan

DSP- 2018

Lab exam #5

Name:

Roll No: 16UEC126

Time: 75 minutes(60 + 15 (simulink))

---

1) Take random integer sequences
   x(n) of length N. (Make separate files for each part)

   a) Generate 2-point FFT using DIF-radix-2 for N = 2. [2]

   b) Generate 4-Point FFT using DIF-radix-2 for the above sequence with N = 4. [2]

   c) Generate 8-Point FFT using DIF-radix-2 for the sequence with N = 8. [4]

   d) Calculate the complexity in terms of complex multiplications using some count variable for step a and b. [2]

   e) Use simulink to simulate 4 point FFT of sequence [6,6,-6,-6]. [2]

1) A signal $x(t) = 2\sin(2\pi 6000t)$,
is sampled at $Fs_1 = 6e6$ to generate the ideal signal $x(n)$.

a) Generate a discrete time signal by sampling the above signal $x(t)$ with sampling rate $Fs_2 =$ 24000 Hz and display first 5 cycles. [2]

b) Generate a discrete time signal by sampling the above signal $x(t)$ with sampling rates $Fs_3 =$ 8000 and display first 3 cycles. Display spectrum using inbuilt fft for current and above step. [2]

c) Generate a discrete time signal by sampling the above signal $x(t)$ with sampling rates $Fs_3 =$ 12000, $Fs_4 = 600000$ Hz. Use linear interpolation to make all signals of equal length as ideal $x(n)$. [4]

d) Find and plot MSE for both the above cases. [2]

e) Use simulink to generate nearest neighbourhood interpolation to make the sampled signal at $Fs_2 = 24000$ of same length as $x(n)$. [2]

1) Convolution : (Make separate files for each code:).

a) Generate the circular convolution matrix and hence circular convolution output $y(n)$ for two random integer sequences
$x(n)$ and $h(n)$ with lengths 6 and 5 respectively. [2]

b) Generate DFT matrix of appropriate size using myDFT function. [2]

c) Prove circular convolution in time domain is Fourier transform pair with DFT multiplication of $x(n)$ and $h(n)$. [4]

d) Show linear convolution and circular convolution matches by appropriate method. [2]

e) Use simulink to circularly convolve two sequences taken from command window. [2]

# The LNM Institute of Information Technology, Jaipur

Mid-Term Examination, Spring Semester (2018-19)

Digital Signal Processing (ECE 326)

Time: 90 Min. M.M.: 35

*Instructions to students*

1. *This question paper is printed on both side of the paper and have 4 questions. All questions are compulsory. Marks are indicated in parentheses.*
2. *Use of electronic calculators only is permitted. No extra resources viz. graph papers, log-tables, trigonometric tables would be required.*
3. *Organize your work, in a reasonably neat and coherent way. Work scattered all over the page or across the answer script without a clear ordering will receive very less marks.*
4. *Mysterious or unsupported answers will not receive full marks. A correct answer, unsupported by calculations, explanation, or algebraic work will receive no marks; an incorrect answer supported by substantially correct calculations and explanations might still receive partial marks.*

1 a). A continuous-time signal $x(t)$ is composed of a linear combination of frequencies $F_1, F_2, F_3$ and $F_4$ (all are in Hz). The signal $x(t)$ is sampled at a 8 kHz rate and the sampled signals are passed through a lowpass filter with cutoff frequency of 3.5 kHz, generating a continuous-time signal $y(t)$ composed of three sinusoidal signals of frequencies 150 Hz, 400 Hz, 925 Hz respectively. The possible values of

$F_1 =$ ________ $F_2 =$: ________, $F_3 =$ ________, and $F_4 =$ ________. [4]

b). If a 3-bit ADC channel accepts analog input ranging from -2.5 to 2.5 volts, then [5]

(i). Find the number of quantization levels.

(ii). Calculate the step size of the quantizer.

(iii). Determine the quantization level when the analog voltage is -1.2 volts.

(iv). Write the binary code produced by the ADC.

2. Determine the total response $y[n], n \geq 0$ of the discrete-time system described by the second order difference equation $y[n] = 0.7y[n-1] - 0.1y[n-2] + 2x[n] - x[n-2]$, when the input sequence is $4^n u[n]$. (Hint: Using traditional method i.e. homogenious solution and particular solution) [4]

3 a). The system function of a causal discrete-time LTI system $H$ is given by $H(z) = \frac{\left(1-\frac{3}{2}z^{-1}\right)\left(1+\frac{1}{3}z^{-1}\right)\left(1+\frac{5}{3}z^{-1}\right)}{(1-z^{-1})^2\left(1-\frac{1}{4}z^{-1}\right)}$.

Give the pole-zero plot for $H(z)$ and specify the ROC. Is the system BIBO stble (YES/NO)? [4]

b). If the input to a causal discrete-time LTI system is $x[n] = (0.5)^n u[n] - (1/4)(0.5)^{n-1}u[n-1]$ with $u[n]$ is the unit setp sequence, then the output is [6]

$$y[n] = \left(\frac{1}{3}\right)^n u[n]$$

i). Determine the system function $H(z)$ of the system.

ii). Determine the impulse response $h[n]$ of the system.

iii). Find the step response $y[n]$ of the system. [6]

c). Given a discrete time system $H$ with system function

$$H(z) = \left(-\frac{2}{5}\right)\frac{\left(1-\frac{1}{2}z^{-1}\right)^2\left(1-\frac{1}{4}z^{-1}\right)}{\left(1+\frac{1}{3}z^{-1}\right)\left(1-\frac{2}{3}z^{-1}\right)\left(1+\frac{3}{5}z^{-1}\right)}$$

i). Find the difference equation that characterizes this system.

ii). Give the Direct form I and Direct form II realization of the system.

4. Given a discrete-time periodic signal $x[n] = \left\{\ldots, \boxed{1, 0, 1, 2, \underset{\uparrow}{3}, 2,} 1,0,1, \ldots\right\}$ [6]

a). Determine and sketch the magnitude and phase spectra of $x[n]$ upto five discrete-time Fourier series coefficients.

b). Calculate the power using from discrete-time Fourier series coefficients.

***

LNMIIT

**The LNM Institute of Information Technology**

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Digital Signal Processing (ECE326)
End Term Examination
Date: 3/12/2018

Time : 180 minutes [Marks: 50]

---

1) **State True or False**:

a) In radix-2 Decimation in frequency algorithm, the input signal is applied in bit reverse order and output is natural order. [1]

b) A discrete time aperiodic signal has continuous spectrum. [1]

c) A comb filter produces multiple notches in the magnitude spectrum at random discrete frequencies. [1]

d) The group delay of the LTI system $H(w) = e^{-j8w}$ guarantees linear phase of the system. [1]

e) A system having impulse response $h(n) = (\frac{9}{8})^n u(n)$ fullfills the condition of absolute summability and hense the stability of the system. [1]

2) **Mention the following.**

a) Mention the analysis and synthesis expression for continuous time periodic signal. [1]

b) Let a sequence is given by $x(n) = \{2, 5, -3, 6, 7, 8, 1, -9\}$, Determine $x((-3))_N$. [1]

c) State whether system given below is minimum phase, maximum phase or mixed phase. [1]

$$H(z) = (0.25)\left(\frac{z^{-1} + 2.5}{1 + 0.5z^{-1}}\right)\left(\frac{3.6z^{-1} + 4}{4 + z^{-1}}\right)$$

d) Mention the paley-wiener criteria and its use for LTI system. [1]

e) Write down the window function for hamming window. [1]

3) **Do the following.**

a) Mention where the poles and/or zeros lies for Digital resonator, Notch filter, Comb Filter. [2]

b) Mention the fourier transform pair for two sequences $x_1(n)$, $x_2(n)$ having multiplication in time domain. [2]

c) Calculate and write IDFT matrix for $N = 3$ point. [2]

d) Calculate No. of complex multiplications and complex additions required for N point DFT using Divide and conquer approach, where $L = 384$, $M = 4$. [2]

e) Calculate the number of samples required of a signal $x(t) = 2\cos(2\pi 6000t)$ for spectrum resolution of 0.3 KHz. [2]

4) **Do two of the following.**

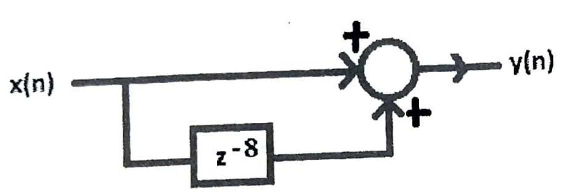
a) Derive the forward DCT expression for a discrete signal $x(n)$. [6]
Also mention the underlying DFT property for this derivation.

[P.T.O.]

b) Sampling & Quantization:
   i) Derive SQNR expression for a sinusoidal periodic signal $x(t) = A\cos(2\pi ft)$. [3]
   ii) Determine the resolution $\Delta$, quantization noise and SQNR value for signal $x(t) = 1.5\cos(2\pi(200)t)$ when 16 level quantizer is used to encode this signal. [3]

c) Calculate the complex multiplications required for N=16 using Radix-2 and Radix-4 algorithm.
   - If decimation is performed only once. [3]
   - If decimation is performed $log_r N$ times(Here r is radix). [3]

5) Let a system shown in the figure is exited with a composite signal $x(t) = \cos(2\pi(600)t) + \cos(2\pi(150)t)$ sampled at $F_s = 2400$ Hz. Calculate it's repsonse and conclude which frequency get's blocked by this system. [4]




6) **Do any one of the following:**

a) Filtering:
   - Write down expression for $H_r(w)$ for a linear phase FIR filter which fulfills the condition $h(n) = -h(M-1-n), 0 \le n \le M-1$, where M is even. [2]
   - Using above step and provided $|H_r(w = \frac{\pi}{3})| = 1$ and $|H_r(w = \pi)| = \frac{1}{\sqrt{2}}$ for $M = 4$, calculate impulse response $h(n)$ of the FIR filter. [3]
   - Let two signals, the first signal $x_1(n) = \sum_{k=-\infty}^{\infty} \delta(n-k)$ and another signal $x_2(t) = \cos(2\pi(3600)t)$ which is sampled at $F_s = 21.6$ KHz is given at the input of this filter. Mention which one will get blocked at the output. why?. [1]

b) Let a transfer function is given by

$$H(z) = \frac{b_0}{1 - 1.5cos\left(\frac{\pi}{8}\right)z^{-1} + 0.5625z^{-2}}$$

   - Mention the type of the system and its characteristic. [1]
   - Calculate value of $b_0$. [2]
   - Plot magnitude response at $(0, \pm\frac{\pi}{8}, \pm\pi)$. [3]

7) **Perform the following.**

a) Radix:
   i) Derive odd frequency components for Radix-4 DIF-FFT. [2]
   ii) Draw split-radix butterfly structure. [2]
   iii) Calculate DFT of sequence $x(n) = \{1, 1, -1, -1, 1, 1, -1, -1\}$ using above structure. [4]

WELL DONE