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]

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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 $x(n)$. Also mention the underlying DFT property for this derivation. [6]

[P.T.O.]

$W_N^{-k/2}$

b) Sampling & Quantization:

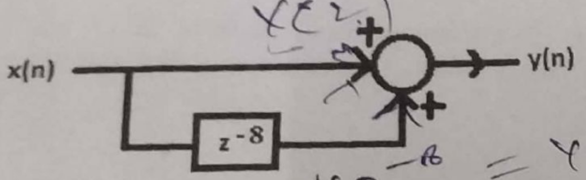
i) Derive SQNR expression for a sinusoidal periodic signal $x(t) = A\cos(2\pi ft)$. [3]

ii) Determine the resolution Δ, 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]



$(1+z^{-8})X(z) = Y(z)$

$\frac{Y(z)}{X(z)} = 1+z^{-8}$

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]

$w=0$ $H=1$

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