Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E.- SEMESTER–I • EXAMINATION – WINTER 2013

Subject Code: 2715203 **Date: 30-12-2013**

Subject Name: Digital Signal Processing

Time: 10.30 To 13.00 **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Find the Discrete Time Fourier Transform (DTFT) of a signal x(n) defined as **07**

$x(n)=1 \quad 0 \le n \le 6$

$\quad = 0 \quad otherwise$

Also plot the magnitude and phase spectra obtained from the DTFT function $X\left(e^{j\omega}\right)$

(b) State and prove Sampling Theorem **07**

Q.2 **(a)** Mention and Prove the following properties of of Discrete Fourier Transform (DFT) **07**

(i) Linearity (ii) Time Shifting

(iii) Frequency Shifting (iv) Time Scaling

(b) Draw the signal flow graph for an 8-point FFT. **07**

Compare the following arithmetic computational effort between 8-point FFT and 8-point DFT

(i) Complex Multiplication (ii) Real Multiplication

(iii) Complex Additions (iv) Real Additions

OR

(b) (i) Find $H(z)$ and determine its poles and zeros if **07**

$$y(n)+\frac{3}{4}y(n-1)+\frac{1}{8}y(n-2)=x(n)+x(n-1)$$

(ii) If $h_1(n)=\left(\frac{1}{2}\right)^n u(n)$ and $h_2(n)=\left(\frac{-1}{2}\right)^n u(n)$ are the impulse responses of two systems in cascade then determine the impulse response of the overall system with the following approaches

- $h(n)=h_1(n)\otimes h_2(n) \quad and \quad h(n)=Z^{-1}[H(z)]$

Q.3 **(a)** Consider a causal FIR system having the property $h(n)=h(N-1-n)$ where N is the length of the impulse response sequence. Obtain the expressions for magnitude and phase responses of the system with N as the order of the system. **07**

(b) Find $f(n)$, a causal sequence, if $F(z)$ is given by the following **07**

$$(i)\frac{1+z^{-1}}{1-z^{-1}+z^{-2}} \qquad (ii)\frac{1+2z^{-1}}{1-\frac{1}{2}z^{-1}} \qquad (iii)\frac{1}{\left(1-\frac{1}{2}z^{-1}\right)^2}$$

OR

Q.3 **(a)** The frequency response of a linear-phase response FIR system is given by **07**

$$H\left(e^{j\omega}\right)=e^{-j3\omega}\left(0.21145+0.386568.\cos\omega+0.28856.\cos 2\omega+0.21432.\cos 3\omega\right)$$

Determine its impulse response and its step response

(b) Find the impulse response for the following systems using Z-transform approach **07**

(i) $y(n)-\frac{3}{4}y(n-1)+\frac{1}{8}y(n-2)=x(n)$

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

Q.4 **(a)** Design an analog Butterworth filter to obtain H(s) with the following filter specifications **07**

- Passband frequency = 1,000Hz
- Stopband frequency = 12,000Hz
- Passband attenuation = 1dB
- Stopband attenuation = 60dB

(b) Let x(t) be a composite signal made up of four sinusoidal signals of frequencies 1kHz, 1.5kHz, 17kHz and 17.5kHz. **07**
Assuming the following sampling rates and plot the spectra of x(t = nTs) on ω (angle/sample) axis
(i) Fs = 16kHz (ii) Fs = 24kHz (iii) Fs = 48kHz

OR

Q.4 **(a)** Design an analog Chebyshev filter to obtain H(s) with the following filter specifications **07**

- Passband frequency = 500Hz
- Stopband frequency = 10,000Hz
- Passband attenuation = 1dB
- Stopband attenuation = 80dB

(b) Let $X(e^{j\omega})$ be the Fourier Transform of x(n). Show that $X(e^{j\omega})=X_e(e^{j\omega})+X_o(e^{j\omega})$ where $X_e(e^{j\omega})$ and $X_o(e^{j\omega})$ are the even and odd parts of $X(e^{j\omega})$ **07**

Q.5 **(a)** Obtain the cut-off frequencies of the following systems **07**

(i) $H(s)=\frac{1}{s+1}$

(ii) $H(s)=\frac{1}{s^2+\sqrt{2}s+1}$

Using impulse invariant transformation method, obtain H(z) and determine the d.c. gains of the above systems. Assume the sampling rate to be 1000Hz.

(b) Let $H(s)=\frac{10}{s+10}$ be the system function of an analog low pass system. Obtain H(z) out of H(s) using frequency transformation methods, if H(z) represents a digital highpass filter. **07**

OR

Q.5 **(a)** Let $H(s)=\frac{s+2}{s^2+4s+3}$ be the system function of an analog system. Using Bilinear Transformation method and assuming a sampling rate of fs = 1000Hz, obtain H(z) and determine its frequency response at ω = π/2. **07**

(b) Obtain the relations for the following analog system transformation methods **07**

(a) Low Pass to High Pass
(b) Low Pass to Band Pass
(c) Low Pass to Band Stop

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