Registration No: | | | | | | | | | | |

Total Number of Pages: 03 **M.TECH**

P2PDCC14

2nd Semester Regular Examination 2016-17

Advanced Digital Signal Processing

BRANCH: ELECTRICAL AND ELECTRONICS ENGG, INDUS. POWER CONTROL AND DRIVES (PT), POWER ELECTRONICS, POWER ELECTRONICS & DRIVES, POWER ELECTRONICS AND ELECTRICAL DRIVES

Time: 3 Hours

Max Marks: 100

Q.CODE: Z950

Answer Question No.1 which is compulsory and any FOUR from the rest.

The figures in the right hand margin indicate marks.

Q1 Answer the following questions: ***Short answer type*** **(2 x 10)**

a) Check the following system with the input sequence, $x(n)$ and the output sequence, $y(n)$ for linearity, time invariance and causality:

$$y(n) = x(-n)$$

b) Determine the magnitude and the phase response of a five point moving average system, described by the difference equation,

$$y(n) = \frac{1}{5}[x(n+2) + x(n+1) + x(n) + x(n-1) + x(n-2)].$$

c) What is finite word length effect in DSP?

d) What do you mean by parametric and non parametric methods of power spectrum estimation in DSP?

e) A linear time-invariant system with frequency response $H(\omega)$ is excited with the periodic input

$$x(n) = \sum_{k=-\infty}^{\infty} \delta(n - kN)$$

Suppose that the N-point DFT $Y(k)$ of the samples $y(n), 0 \le n \le N-1$ of the output sequence is computed. How is $Y(k)$ related to $H(\omega)$?

f) State and explain Gibbs phenomenon with suitable diagram. How its effect can be reduced?

g) While designing a digital FIR filter using window, how transition width, ω and stop-band attenuation, δ are affected by type of window function, used in the design and its length?

h) Obtain 1st order Butterworth low pass digital filter by applying bilinear transformation to the corresponding analog filter with cut-off frequency $\Omega_c = 500$ Hz and sampling frequency $\Omega_s = 2000$ kHz. What will be cut-off frequency of corresponding digital filter?

i) Compare characteristics and design aspects of infinite impulse response (IIR) digital filter and finite impulse response (FIR) digital filter.

j) Determine the autocorrelation sequence $\{\gamma_{xx}(m)\}, -\infty \le m \le +\infty$, for a sequence

$$x(n) = \begin{cases} 1 & -2 \le n \le 2 \\ 0 & otherwise \end{cases}$$

Q2 a) Obtain expression for discrete time Fourier transform (DTFT), $W(e^{jw})$ of a rectangular window : $w(n) = \begin{cases} 1 & 0 \le n \le N-1 \\ 0 & otherwise \end{cases}$ **(10)**

Draw magnitude and phase plot of $W(e^{jw})$ for N=5.

b) Consider an LTI system, initially at rest described by the difference equation: **(5+5)**

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

i. Determine the impulse response $h(n)$ of the system.

ii. What is the response of the system to the input signal

$$x(n) = \left[\left(\frac{1}{2}\right)^n + \left(-\frac{1}{2}\right)^n \right] u(n)$$

Q3 a) Convert the analog filter with system transfer function $H_a(s) = {(s+0.1)} \big/ {((s+0.1)^2 + 9)}$ into a digital filter by impulse invariance method **(10)**

b) Determine the unit sample response $\{h(n)\}$ of a linear phase FIR filter of length $M = 4$ for which the frequency response is specified as **(10)**

$$|H(\omega)| = \begin{cases} 1 & \omega = 0 \\ \frac{1}{2} & \omega = \frac{\pi}{2} \end{cases}$$

Q4 a) Given two sequences **(10)**

$x(n) = \cos(n\pi/2)$, and $h(n) = (-1)^n$, $n = 0, 1, 2, 3$.

Find $y(n) = x(n) * h(n)$, where $*$ denotes discrete convolution. Sketch the resulting sequence $y(n)$.

b) For the two sequences, mentioned in part (a), compute $y'(n) = IDFT\{X(k)H(k)\}$, where $X(k) = DFT\{x(n)\}$ and $H(k) = DFT\{h(n)\}$. **(10)**

Are the results obtained in part (a) and (b) identical? Explain your answer in more detail.

Q5 a) Study the limit cycle behaviour of the given system $y(n) = 0.85y(n-2) + 0.72y(n-1) + x(n)$. Also determine the dead band of the system **(10)**

b) Design a digital Butterworth filter satisfying the constraints **(10)**

$$\frac{1}{\sqrt{2}} \le \left|He^{jw}\right| \le 1. \quad 0 \le \omega \le \frac{2\pi}{3}$$

$$\left|He^{jw}\right| \le 0.2, \quad \frac{3\pi}{4} \le \omega \le \pi$$

with $T = 1$ sec, using bilinear transformation method.

Q6 a) The output of an A/D converter is applied to a digital filter described by the difference equation $y(n) = 0.999y(n-1) + x(n)$ where $x(n)$ and $y(n)$ are input sequence and output sequence respectively. What is the power produced by the quantization noise at the output of the filter when the input signal is quantized to have eight bits? **(10)**

b) The quantized signal $y(n)$ is to be filtered by a digital filter with unit sample response **(10)**

$$h(n) = \left[\left(\frac{1}{2}\right)^n + \left(-\frac{1}{2}\right)^n\right]u(n)$$

Assume that $y(n)$ is quantized to have eight bits. Determine the variance of the noise produced at the output of the filter due to the input quantization noise and determine the signal to noise ratio at the output.

Q7 a) Determine the power spectral density (PSD) for the random process generated by the difference equation **(10)**

$$x(n) = -0.81x(n-2) + w(n)$$

Where $w(n)$ is a white noise process with variance $\sigma_w^2 = 1$.

Determine the autocorrelation for the process.

b) Consider the ARMA process generated by the difference equation, $x(n) = 1.6x(n-1) - 0.63x(n-2) + w(n) + 0..9w(n-1)$; assuming white noise sequence $w(n)$ with variance $\sigma_w^2 = 1$as the input. **(5+5)**

i. Determine the system function of the whitening filter and its poles and zeroes.

ii. Determine the power density spectrum of $x(n)$.