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.

c). Given a discrete time system H with system function [6]

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

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 $x[n] = \left\{\ldots, 1, 0, 1, 2, \underset{\uparrow}{3}, 2, 1, 0, 1, \ldots\right\}$ [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.

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