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Thapar Institute of Engineering & Technology, Patiala, Punjab, India
Department of Electronics and Communication Engineering

B.E.-ECE & ENC (Second Year)
Semester-III; End Semester Examination
December 06th, 2018
Time:- 03 Hours; Max. Marks:- 100

Course Code: UEC404
Course Name: Signals and Systems
Thursday; 09:00 A.M. – 12:00 P.M.
Name of Instructors:- Dr. Kulbir Singh (Prof.)
Dr. Amit K. Kohli, Dr. S.K. Patel & Dr. B. Garg

Note: Strictly attempt all questions sequentially & Assume missing data, if any, suitably

Q.1 Find the z-transform and corresponding ROC for each of the following (10) signals:

i). $y(n) = \delta(n-1)$ ii). $y(n) = \delta(n+1)$ iii). $y(n) = a^n u(n) - a^n u(n-1)$

iv). $y_k(n) = \begin{cases} y[n/k], & \text{if } n \text{ is an integer multiple of } k \\ 0, & \text{if } n \text{ is not an integer multiple of } k \end{cases}$

Q.2 Consider an LTI system, for which, the input $x(n)$ and output $y(n)$ satisfy (10) the following linear constant-coefficient difference equation:

$$y(n) - (1/2)y(n-1) = x(n) + (1/3)x(n-1)$$

Find the system impulse response $h(n)$ and verify its stability based on its poles and zeros, i) if the ROC corresponding to $H[z]$ is $|z| > |1/2|$ and
ii) if the ROC corresponding to $H[z]$ is $|z| < |1/2|$

Q.3 Obtain the discrete-time Fourier-transform (DTFT) of the discrete-time (10) signal $x(n) = a^{|n|}$ with $|a| < 1$. Plot the magnitude spectrum $|X(e^{j\omega})|$ vs. ω and the phase spectrum $\angle X(e^{j\omega})$ vs. ω.

$$X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x(n) e^{-j\omega n}$$

Q.4 Consider the continuous-time signal $x(t)$, whose continuous-time (10) Fourier-transform (CTFT) is $X(j\omega) = \begin{cases} 1, & |\omega| < W \\ 0, & |\omega| > W \end{cases}$

$$X(j\omega) = \int_{-\infty}^{\infty} x(t) e^{-j\omega t} dt$$

Determine the signal $x(t)$ using the inverse-CTFT, and also plot it.

$$x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(j\omega) e^{j\omega t} dt$$

Q.5 Let the discrete-time composite periodic signal be

$$x(n) = 1 + \sin(2\pi n/N) + 3\cos(2\pi n/N) + \cos(4\pi n/N + \pi/2)$$

with period N. Calculate the Discrete-time Fourier-series (DTFS) spectral (10) coefficients a_k, and also plot the magnitude $|a_k|$ vs. k.

Q.6 The continuous-time periodic square-wave $x(t)$ is defined $\quad$ one (10)

period as $x(t) = \begin{cases} 1, & |t| < T_1 \\ 0, & T_1 < |t| < T/2 \end{cases}$

with the fundamental period T and the fundamental angular frequency $\omega_0 = 2\pi/T$. Plot this periodic square-wave $x(t)$; and calculate the Continuous-time Fourier-series (CTFS) spectral coefficients a_k.

Q.7(a) If the input signal to an LTI system is unit-step function $u(n)$ in the (05) discrete-time domain and the impulse response of concerned LTI system is also unit-step function $u(n)$, then obtain the output signal $y(n)$ using the linear convolution sum formula.

Q.7(b) Consider the z-transform $X(z) = 1/(1 - az^{-1})$ with $ROC \to |z| < |a|$ of an (05) unknown signal $x(n)$. Determine $x(n)$ using the power-series-expansion method based on long division. $\quad$ Xvidt I wh I-bz¹

$a^n u[n]$

Q.8 Compute the discrete-Fourier-transform (DFT) of the four-point sequence (10) $x(n) = [0\ 1\ 2\ 3]$, using the matrix W_4 of the linear transformation (i.e. by using the matrix method). $\quad 6/2j^{-2}, -2, -2j^{-2}\quad W_N = e^{-j\frac{2\pi}{N}}$

Q.9 Perform the circular convolution of the following two sequences: (10)

$x_1(n) = \begin{bmatrix} 2 & 1 & 2 & 1 \end{bmatrix}$ and $x_2(n) = \begin{bmatrix} 1 & 2 & 3 & 4 \end{bmatrix}$

Q.10(a) How the basic butterfly computation in the decimation-in-frequency fast- (04) Fourier-transform (FFT) algorithm is different from the basic butterfly computation in the decimation-in-time FFT algorithm? (Only comparison diagrams).

Q.10(b) Draw the signal flow graph for an $N = 8$ point decimation-in-frequency (06) FFT algorithm, using the butterfly computation scheme (clearly indicating its different stages).

Note. Use $\operatorname{sinc}(\theta) = \dfrac{\sin(\pi\theta)}{(\pi\theta)}$, wherever it is required.